



# CUDA DRIVER API

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## API Reference Manual



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# Chapter 1.

## DIFFERENCE BETWEEN THE DRIVER AND RUNTIME APIS

The driver and runtime APIs are very similar and can for the most part be used interchangeably. However, there are some key differences worth noting between the two.

### **Complexity vs. control**

The runtime API eases device code management by providing implicit initialization, context management, and module management. This leads to simpler code, but it also lacks the level of control that the driver API has.

In comparison, the driver API offers more fine-grained control, especially over contexts and module loading. Kernel launches are much more complex to implement, as the execution configuration and kernel parameters must be specified with explicit function calls. However, unlike the runtime, where all the kernels are automatically loaded during initialization and stay loaded for as long as the program runs, with the driver API it is possible to only keep the modules that are currently needed loaded, or even dynamically reload modules. The driver API is also language-independent as it only deals with cubin objects.

### **Context management**

Context management can be done through the driver API, but is not exposed in the runtime API. Instead, the runtime API decides itself which context to use for a thread: if a context has been made current to the calling thread through the driver API, the runtime will use that, but if there is no such context, it uses a "primary context." Primary contexts are created as needed, one per device per process, are reference-counted, and are then destroyed when there are no more references to them. Within one process, all users of the runtime API will share the primary context, unless a context has been made current to each thread. The context that the runtime uses, i.e, either the current

context or primary context, can be synchronized with `cudaDeviceSynchronize()`, and destroyed with `cudaDeviceReset()`.

Using the runtime API with primary contexts has its tradeoffs, however. It can cause trouble for users writing plug-ins for larger software packages, for example, because if all plug-ins run in the same process, they will all share a context but will likely have no way to communicate with each other. So, if one of them calls `cudaDeviceReset()` after finishing all its CUDA work, the other plug-ins will fail because the context they were using was destroyed without their knowledge. To avoid this issue, CUDA clients can use the driver API to create and set the current context, and then use the runtime API to work with it. However, contexts may consume significant resources, such as device memory, extra host threads, and performance costs of context switching on the device. This runtime-driver context sharing is important when using the driver API in conjunction with libraries built on the runtime API, such as cuBLAS or cuFFT.

## Chapter 2.

# 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.

### **Memcpy**

In the reference documentation, each memcpy function is categorized as synchronous or asynchronous, corresponding to the definitions below.

#### **Synchronous**

1. All transfers involving Unified Memory regions are fully synchronous with respect to the host.
2. 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.
3. For transfers from pinned host memory to device memory, the function is synchronous with respect to the host.
4. For transfers from device to either pageable or pinned host memory, the function returns only once the copy has completed.
5. For transfers from device memory to device memory, no host-side synchronization is performed.
6. 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 device memory to pageable host memory, the function will return only once the copy has completed.
2. For transfers from any host memory to any host memory, the function is fully synchronous with respect to the host.

3. 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.

### **Memset**

The synchronous memset functions are asynchronous with respect to the host except when the target is pinned host memory or a Unified Memory region, in which case they are fully synchronous. 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 3.

## STREAM SYNCHRONIZATION BEHAVIOR

### Default stream

The default stream, used when `0` is passed as a `cudaStream_t` or by APIs that operate on a stream implicitly, can be configured to have either [legacy](#) or [per-thread](#) synchronization behavior as described below.

The behavior can be controlled per compilation unit with the `--default-stream` nvcc option. Alternatively, per-thread behavior can be enabled by defining the `CUDA_API_PER_THREAD_DEFAULT_STREAM` macro before including any CUDA headers. Either way, the `CUDA_API_PER_THREAD_DEFAULT_STREAM` macro will be defined in compilation units using per-thread synchronization behavior.

### Legacy default stream

The legacy default stream is an implicit stream which synchronizes with all other streams in the same `CUcontext` except for non-blocking streams, described below. (For applications using the runtime APIs only, there will be one context per device.) When an action is taken in the legacy stream such as a kernel launch or `cudaStreamWaitEvent()`, the legacy stream first waits on all blocking streams, the action is queued in the legacy stream, and then all blocking streams wait on the legacy stream.

For example, the following code launches a kernel `k_1` in stream `s`, then `k_2` in the legacy stream, then `k_3` in stream `s`:

```
k_1<<<<1, 1, 0, s>>>>();  
k_2<<<<1, 1>>>>();  
k_3<<<<1, 1, 0, s>>>>();
```

The resulting behavior is that `k_2` will block on `k_1` and `k_3` will block on `k_2`.

Non-blocking streams which do not synchronize with the legacy stream can be created using the `cudaStreamNonBlocking` flag with the stream creation APIs.

The legacy default stream can be used explicitly with the `CUstream (cudaStream_t)` handle `CU_STREAM_LEGACY (cudaStreamLegacy)`.

### Per-thread default stream

The per-thread default stream is an implicit stream local to both the thread and the `CUcontext`, and which does not synchronize with other streams (just like explicitly created streams). The per-thread default stream is not a non-blocking stream and will synchronize with the legacy default stream if both are used in a program.

The per-thread default stream can be used explicitly with the `CUstream (cudaStream_t)` handle `CU_STREAM_PER_THREAD (cudaStreamPerThread)`.

## Chapter 4.

# GRAPH OBJECT THREAD SAFETY

Graph objects (**cudaGraph\_t**, **CUgraph**) are not internally synchronized and must not be accessed concurrently from multiple threads. API calls accessing the same graph object must be serialized externally.

Note that **this includes APIs which may appear to be read-only**, such as **cudaGraphClone()** (**cuGraphClone()**) and **cudaGraphInstantiate()** (**cuGraphInstantiate()**). No API or pair of APIs is guaranteed to be safe to call on the same graph object from two different threads without serialization.

# Chapter 5.

## MODULES

Here is a list of all modules:

- ▶ Data types used by CUDA driver
- ▶ Error Handling
- ▶ Initialization
- ▶ Version Management
- ▶ Device Management
- ▶ Device Management [DEPRECATED]
- ▶ Primary Context Management
- ▶ Context Management
- ▶ Context Management [DEPRECATED]
- ▶ Module Management
- ▶ Memory Management
- ▶ Virtual Memory Management
- ▶ Unified Addressing
- ▶ Stream Management
- ▶ Event Management
- ▶ External Resource Interoperability
- ▶ Stream memory operations
- ▶ Execution Control
- ▶ Execution Control [DEPRECATED]
- ▶ Graph Management
- ▶ Occupancy
- ▶ Texture Reference Management [DEPRECATED]
- ▶ Surface Reference Management [DEPRECATED]
- ▶ Texture Object Management
- ▶ Surface Object Management
- ▶ Peer Context Memory Access

- ▶ Graphics Interoperability
- ▶ Profiler Control [DEPRECATED]
- ▶ Profiler Control
- ▶ 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
- ▶ EGL Interoperability

## 5.1. Data types used by CUDA driver

struct CUaccessPolicyWindow

struct CUDA\_ARRAY3D\_DESCRIPTOR

struct CUDA\_ARRAY\_DESCRIPTOR

struct CUDA\_EXTERNAL\_MEMORY\_BUFFER\_DESC

struct CUDA\_EXTERNAL\_MEMORY\_HANDLE\_DESC

struct  
CUDA\_EXTERNAL\_MEMORY\_MIPMAPPED\_ARRAY\_DESC

struct CUDA\_EXTERNAL\_SEMAPHORE\_HANDLE\_DESC

struct CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_PARAMS

struct CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_PARAMS

struct CUDA\_HOST\_NODE\_PARAMS

struct CUDA\_KERNEL\_NODE\_PARAMS

struct CUDA\_LAUNCH\_PARAMS

struct CUDA\_MEMCPY2D

struct CUDA\_MEMCPY3D

struct CUDA\_MEMCPY3D\_PEER

struct CUDA\_MEMSET\_NODE\_PARAMS

struct CUDA\_POINTER\_ATTRIBUTE\_P2P\_TOKENS

struct CUDA\_RESOURCE\_DESC

struct CUDA\_RESOURCE\_VIEW\_DESC

struct CUDA\_TEXTURE\_DESC

struct CUdevprop

struct CUeglFrame

struct CUipcEventHandle

struct CUipcMemHandle

union CUKernelNodeAttrValue

struct CUmемAccessDesc

struct CUmемAllocationProp

struct CUmемLocation

union CUstreamAttrValue

union CUstreamBatchMemOpParams

enum CUaccessProperty

Specifies performance hint with [CUaccessPolicyWindow](#) for hitProp and missProp members

#### Values

**CU\_ACCESS\_PROPERTY\_NORMAL = 0**

Normal cache persistence.

**CU\_ACCESS\_PROPERTY\_STREAMING = 1**

Streaming access is less likely to persist from cache.

**CU\_ACCESS\_PROPERTY\_PERSISTING = 2**

Persisting access is more likely to persist in cache.

## enum CUaddress\_mode

Texture reference addressing modes

### Values

**CU\_TR\_ADDRESS\_MODE\_WRAP = 0**  
Wrapping address mode

**CU\_TR\_ADDRESS\_MODE\_CLAMP = 1**  
Clamp to edge address mode

**CU\_TR\_ADDRESS\_MODE\_MIRROR = 2**  
Mirror address mode

**CU\_TR\_ADDRESS\_MODE\_BORDER = 3**  
Border address mode

## enum CUarray\_cubemap\_face

Array indices for cube faces

### Values

**CU\_CUBEMAP\_FACE\_POSITIVE\_X = 0x00**  
Positive X face of cubemap

**CU\_CUBEMAP\_FACE\_NEGATIVE\_X = 0x01**  
Negative X face of cubemap

**CU\_CUBEMAP\_FACE\_POSITIVE\_Y = 0x02**  
Positive Y face of cubemap

**CU\_CUBEMAP\_FACE\_NEGATIVE\_Y = 0x03**  
Negative Y face of cubemap

**CU\_CUBEMAP\_FACE\_POSITIVE\_Z = 0x04**  
Positive Z face of cubemap

**CU\_CUBEMAP\_FACE\_NEGATIVE\_Z = 0x05**  
Negative Z face of cubemap

## enum CUarray\_format

Array formats

### Values

**CU\_AD\_FORMAT\_UNSIGNED\_INT8 = 0x01**  
Unsigned 8-bit integers

**CU\_AD\_FORMAT\_UNSIGNED\_INT16 = 0x02**  
Unsigned 16-bit integers

**CU\_AD\_FORMAT\_UNSIGNED\_INT32 = 0x03**



Unsigned 32-bit integers  
**CU\_AD\_FORMAT\_SIGNED\_INT8 = 0x08**  
 Signed 8-bit integers  
**CU\_AD\_FORMAT\_SIGNED\_INT16 = 0x09**  
 Signed 16-bit integers  
**CU\_AD\_FORMAT\_SIGNED\_INT32 = 0x0a**  
 Signed 32-bit integers  
**CU\_AD\_FORMAT\_HALF = 0x10**  
 16-bit floating point  
**CU\_AD\_FORMAT\_FLOAT = 0x20**  
 32-bit floating point

## enum CUcomputemode

Compute Modes

### Values

**CU\_COMPUTEMODE\_DEFAULT = 0**  
 Default compute mode (Multiple contexts allowed per device)  
**CU\_COMPUTEMODE\_PROHIBITED = 2**  
 Compute-prohibited mode (No contexts can be created on this device at this time)  
**CU\_COMPUTEMODE\_EXCLUSIVE\_PROCESS = 3**  
 Compute-exclusive-process mode (Only one context used by a single process can be present on this device at a time)

## enum CUctx\_flags

Context creation flags

### Values

**CU\_CTX\_SCHED\_AUTO = 0x00**  
 Automatic scheduling  
**CU\_CTX\_SCHED\_SPIN = 0x01**  
 Set spin as default scheduling  
**CU\_CTX\_SCHED\_YIELD = 0x02**  
 Set yield as default scheduling  
**CU\_CTX\_SCHED\_BLOCKING\_SYNC = 0x04**  
 Set blocking synchronization as default scheduling  
**CU\_CTX\_BLOCKING\_SYNC = 0x04**  
 Set blocking synchronization as default scheduling **Deprecated**  
 This flag was deprecated as of CUDA 4.0 and was replaced with **CU\_CTX\_SCHED\_BLOCKING\_SYNC**.  
**CU\_CTX\_SCHED\_MASK = 0x07**

**CU\_CTX\_MAP\_HOST = 0x08**

Support mapped pinned allocations

**CU\_CTX\_LMEM\_RESIZE\_TO\_MAX = 0x10**

Keep local memory allocation after launch

**CU\_CTX\_FLAGS\_MASK = 0x1f**

## enum CUdevice\_attribute

Device properties

### Values

**CU\_DEVICE\_ATTRIBUTE\_MAX\_THREADS\_PER\_BLOCK = 1**

Maximum number of threads per block

**CU\_DEVICE\_ATTRIBUTE\_MAX\_BLOCK\_DIM\_X = 2**

Maximum block dimension X

**CU\_DEVICE\_ATTRIBUTE\_MAX\_BLOCK\_DIM\_Y = 3**

Maximum block dimension Y

**CU\_DEVICE\_ATTRIBUTE\_MAX\_BLOCK\_DIM\_Z = 4**

Maximum block dimension Z

**CU\_DEVICE\_ATTRIBUTE\_MAX\_GRID\_DIM\_X = 5**

Maximum grid dimension X

**CU\_DEVICE\_ATTRIBUTE\_MAX\_GRID\_DIM\_Y = 6**

Maximum grid dimension Y

**CU\_DEVICE\_ATTRIBUTE\_MAX\_GRID\_DIM\_Z = 7**

Maximum grid dimension Z

**CU\_DEVICE\_ATTRIBUTE\_MAX\_SHARED\_MEMORY\_PER\_BLOCK = 8**

Maximum shared memory available per block in bytes

**CU\_DEVICE\_ATTRIBUTE\_SHARED\_MEMORY\_PER\_BLOCK = 8**

Deprecated, use

CU\_DEVICE\_ATTRIBUTE\_MAX\_SHARED\_MEMORY\_PER\_BLOCK

**CU\_DEVICE\_ATTRIBUTE\_TOTAL\_CONSTANT\_MEMORY = 9**

Memory available on device for \_\_constant\_\_ variables in a CUDA C kernel in bytes

**CU\_DEVICE\_ATTRIBUTE\_WARP\_SIZE = 10**

Warp size in threads

**CU\_DEVICE\_ATTRIBUTE\_MAX\_PITCH = 11**

Maximum pitch in bytes allowed by memory copies

**CU\_DEVICE\_ATTRIBUTE\_MAX\_REGISTERS\_PER\_BLOCK = 12**

Maximum number of 32-bit registers available per block

**CU\_DEVICE\_ATTRIBUTE\_REGISTERS\_PER\_BLOCK = 12**

Deprecated, use CU\_DEVICE\_ATTRIBUTE\_MAX\_REGISTERS\_PER\_BLOCK

**CU\_DEVICE\_ATTRIBUTE\_CLOCK\_RATE = 13**

Typical clock frequency in kilohertz

**CU\_DEVICE\_ATTRIBUTE\_TEXTURE\_ALIGNMENT = 14**

Alignment requirement for textures

**CU\_DEVICE\_ATTRIBUTE\_GPU\_OVERLAP = 15**

Device can possibly copy memory and execute a kernel concurrently. Deprecated. Use instead **CU\_DEVICE\_ATTRIBUTE\_ASYNC\_ENGINE\_COUNT**.

**CU\_DEVICE\_ATTRIBUTE\_MULTIPROCESSOR\_COUNT = 16**

Number of multiprocessors on device

**CU\_DEVICE\_ATTRIBUTE\_KERNEL\_EXEC\_TIMEOUT = 17**

Specifies whether there is a run time limit on kernels

**CU\_DEVICE\_ATTRIBUTE\_INTEGRATED = 18**

Device is integrated with host memory

**CU\_DEVICE\_ATTRIBUTE\_CAN\_MAP\_HOST\_MEMORY = 19**

Device can map host memory into CUDA address space

**CU\_DEVICE\_ATTRIBUTE\_COMPUTE\_MODE = 20**

Compute mode (See [CUcomputemode](#) for details)

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE1D\_WIDTH = 21**

Maximum 1D texture width

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_WIDTH = 22**

Maximum 2D texture width

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_HEIGHT = 23**

Maximum 2D texture height

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE3D\_WIDTH = 24**

Maximum 3D texture width

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE3D\_HEIGHT = 25**

Maximum 3D texture height

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE3D\_DEPTH = 26**

Maximum 3D texture depth

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_LAYERED\_WIDTH = 27**

Maximum 2D layered texture width

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_LAYERED\_HEIGHT = 28**

Maximum 2D layered texture height

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_LAYERED\_LAYERS = 29**

Maximum layers in a 2D layered texture

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_ARRAY\_WIDTH = 27**

Deprecated, use

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_LAYERED\_WIDTH**

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_ARRAY\_HEIGHT = 28**

Deprecated, use

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_LAYERED\_HEIGHT**

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_ARRAY\_NUMSLICES = 29**

Deprecated, use

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_LAYERED\_LAYERS**

**CU\_DEVICE\_ATTRIBUTE\_SURFACE\_ALIGNMENT = 30**

Alignment requirement for surfaces

**CU\_DEVICE\_ATTRIBUTE\_CONCURRENT\_KERNELS = 31**

Device can possibly execute multiple kernels concurrently

**CU\_DEVICE\_ATTRIBUTE\_ECC\_ENABLED = 32**

Device has ECC support enabled

**CU\_DEVICE\_ATTRIBUTE\_PCI\_BUS\_ID = 33**

PCI bus ID of the device

**CU\_DEVICE\_ATTRIBUTE\_PCI\_DEVICE\_ID = 34**

PCI device ID of the device

**CU\_DEVICE\_ATTRIBUTE\_TCC\_DRIVER = 35**

Device is using TCC driver model

**CU\_DEVICE\_ATTRIBUTE\_MEMORY\_CLOCK\_RATE = 36**

Peak memory clock frequency in kilohertz

**CU\_DEVICE\_ATTRIBUTE\_GLOBAL\_MEMORY\_BUS\_WIDTH = 37**

Global memory bus width in bits

**CU\_DEVICE\_ATTRIBUTE\_L2\_CACHE\_SIZE = 38**

Size of L2 cache in bytes

**CU\_DEVICE\_ATTRIBUTE\_MAX\_THREADS\_PER\_MULTIPROCESSOR = 39**

Maximum resident threads per multiprocessor

**CU\_DEVICE\_ATTRIBUTE\_ASYNC\_ENGINE\_COUNT = 40**

Number of asynchronous engines

**CU\_DEVICE\_ATTRIBUTE\_UNIFIED\_ADDRESSING = 41**

Device shares a unified address space with the host

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE1D\_LAYERED\_WIDTH = 42**

Maximum 1D layered texture width

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE1D\_LAYERED\_LAYERS = 43**

Maximum layers in a 1D layered texture

**CU\_DEVICE\_ATTRIBUTE\_CAN\_TEX2D\_GATHER = 44**

Deprecated, do not use.

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_GATHER\_WIDTH = 45**

Maximum 2D texture width if CUDA\_ARRAY3D\_TEXTURE\_GATHER is set

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_GATHER\_HEIGHT = 46**

Maximum 2D texture height if CUDA\_ARRAY3D\_TEXTURE\_GATHER is set

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE3D\_WIDTH\_ALTERNATE = 47**

Alternate maximum 3D texture width

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE3D\_HEIGHT\_ALTERNATE = 48**

Alternate maximum 3D texture height

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE3D\_DEPTH\_ALTERNATE = 49**

Alternate maximum 3D texture depth

**CU\_DEVICE\_ATTRIBUTE\_PCI\_DOMAIN\_ID = 50**

PCI domain ID of the device

**CU\_DEVICE\_ATTRIBUTE\_TEXTURE\_PITCH\_ALIGNMENT = 51**

Pitch alignment requirement for textures

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURECUBEMAP\_WIDTH = 52**

Maximum cubemap texture width/height

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURECUBEMAP\_LAYERED\_WIDTH = 53**

Maximum cubemap layered texture width/height

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURECUBEMAP\_LAYERED\_LAYERS = 54**

Maximum layers in a cubemap layered texture

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_SURFACE1D\_WIDTH = 55**

Maximum 1D surface width

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_SURFACE2D\_WIDTH = 56**

Maximum 2D surface width

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_SURFACE2D\_HEIGHT = 57**

Maximum 2D surface height

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_SURFACE3D\_WIDTH = 58**

Maximum 3D surface width

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_SURFACE3D\_HEIGHT = 59**

Maximum 3D surface height

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_SURFACE3D\_DEPTH = 60**

Maximum 3D surface depth

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_SURFACE1D\_LAYERED\_WIDTH = 61**

Maximum 1D layered surface width

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_SURFACE1D\_LAYERED\_LAYERS = 62**

Maximum layers in a 1D layered surface

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_SURFACE2D\_LAYERED\_WIDTH = 63**

Maximum 2D layered surface width

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_SURFACE2D\_LAYERED\_HEIGHT = 64**

Maximum 2D layered surface height

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_SURFACE2D\_LAYERED\_LAYERS = 65**

Maximum layers in a 2D layered surface

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_SURFACECUBEMAP\_WIDTH = 66**

Maximum cubemap surface width

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_SURFACECUBEMAP\_LAYERED\_WIDTH = 67**

Maximum cubemap layered surface width

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_SURFACECUBEMAP\_LAYERED\_LAYERS = 68**

Maximum layers in a cubemap layered surface

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE1D\_LINEAR\_WIDTH = 69**

Maximum 1D linear texture width

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_LINEAR\_WIDTH = 70**

Maximum 2D linear texture width

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_LINEAR\_HEIGHT = 71**

Maximum 2D linear texture height

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_LINEAR\_PITCH = 72**  
Maximum 2D linear texture pitch in bytes

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_MIPMAPPED\_WIDTH = 73**  
Maximum mipmapped 2D texture width

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE2D\_MIPMAPPED\_HEIGHT = 74**  
Maximum mipmapped 2D texture height

**CU\_DEVICE\_ATTRIBUTE\_COMPUTE\_CAPABILITY\_MAJOR = 75**  
Major compute capability version number

**CU\_DEVICE\_ATTRIBUTE\_COMPUTE\_CAPABILITY\_MINOR = 76**  
Minor compute capability version number

**CU\_DEVICE\_ATTRIBUTE\_MAXIMUM\_TEXTURE1D\_MIPMAPPED\_WIDTH = 77**  
Maximum mipmapped 1D texture width

**CU\_DEVICE\_ATTRIBUTE\_STREAM\_PRIORITIES\_SUPPORTED = 78**  
Device supports stream priorities

**CU\_DEVICE\_ATTRIBUTE\_GLOBAL\_L1\_CACHE\_SUPPORTED = 79**  
Device supports caching globals in L1

**CU\_DEVICE\_ATTRIBUTE\_LOCAL\_L1\_CACHE\_SUPPORTED = 80**  
Device supports caching locals in L1

**CU\_DEVICE\_ATTRIBUTE\_MAX\_SHARED\_MEMORY\_PER\_MULTIPROCESSOR = 81**  
Maximum shared memory available per multiprocessor in bytes

**CU\_DEVICE\_ATTRIBUTE\_MAX\_REGISTERS\_PER\_MULTIPROCESSOR = 82**  
Maximum number of 32-bit registers available per multiprocessor

**CU\_DEVICE\_ATTRIBUTE\_MANAGED\_MEMORY = 83**  
Device can allocate managed memory on this system

**CU\_DEVICE\_ATTRIBUTE\_MULTI\_GPU\_BOARD = 84**  
Device is on a multi-GPU board

**CU\_DEVICE\_ATTRIBUTE\_MULTI\_GPU\_BOARD\_GROUP\_ID = 85**  
Unique id for a group of devices on the same multi-GPU board

**CU\_DEVICE\_ATTRIBUTE\_HOST\_NATIVE\_ATOMIC\_SUPPORTED = 86**  
Link between the device and the host supports native atomic operations (this is a placeholder attribute, and is not supported on any current hardware)

**CU\_DEVICE\_ATTRIBUTE\_SINGLE\_TO\_DOUBLE\_PRECISION\_PERF\_RATIO = 87**  
Ratio of single precision performance (in floating-point operations per second) to double precision performance

**CU\_DEVICE\_ATTRIBUTE\_PAGEABLE\_MEMORY\_ACCESS = 88**  
Device supports coherently accessing pageable memory without calling `cudaHostRegister` on it

**CU\_DEVICE\_ATTRIBUTE\_CONCURRENT\_MANAGED\_ACCESS = 89**  
Device can coherently access managed memory concurrently with the CPU

**CU\_DEVICE\_ATTRIBUTE\_COMPUTE\_PREEMPTION\_SUPPORTED = 90**  
Device supports compute preemption.

**CU\_DEVICE\_ATTRIBUTE\_CAN\_USE\_HOST\_POINTER\_FOR\_REGISTERED\_MEM = 91**

Device can access host registered memory at the same virtual address as the CPU

**CU\_DEVICE\_ATTRIBUTE\_CAN\_USE\_STREAM\_MEM\_OPS = 92**

[cuStreamBatchMemOp](#) and related APIs are supported.

**CU\_DEVICE\_ATTRIBUTE\_CAN\_USE\_64\_BIT\_STREAM\_MEM\_OPS = 93**

64-bit operations are supported in [cuStreamBatchMemOp](#) and related APIs.

**CU\_DEVICE\_ATTRIBUTE\_CAN\_USE\_STREAM\_WAIT\_VALUE\_NOR = 94**

[CU\\_STREAM\\_WAIT\\_VALUE\\_NOR](#) is supported.

**CU\_DEVICE\_ATTRIBUTE\_COOPERATIVE\_LAUNCH = 95**

Device supports launching cooperative kernels via [cuLaunchCooperativeKernel](#)

**CU\_DEVICE\_ATTRIBUTE\_COOPERATIVE\_MULTI\_DEVICE\_LAUNCH = 96**

Device can participate in cooperative kernels launched via

[cuLaunchCooperativeKernelMultiDevice](#)

**CU\_DEVICE\_ATTRIBUTE\_MAX\_SHARED\_MEMORY\_PER\_BLOCK\_OPTIN = 97**

Maximum optin shared memory per block

**CU\_DEVICE\_ATTRIBUTE\_CAN\_FLUSH\_REMOTE\_WRITES = 98**

Both the [CU\\_STREAM\\_WAIT\\_VALUE\\_FLUSH](#) flag and the

[CU\\_STREAM\\_MEM\\_OP\\_FLUSH\\_REMOTE\\_WRITES](#) MemOp are supported on the device. See [Stream memory operations](#) for additional details.

**CU\_DEVICE\_ATTRIBUTE\_HOST\_REGISTER\_SUPPORTED = 99**

Device supports host memory registration via [cudaHostRegister](#).

**CU\_DEVICE\_ATTRIBUTE\_PAGEABLE\_MEMORY\_ACCESS\_USES\_HOST\_PAGE\_TABLES = 100**

Device accesses pageable memory via the host's page tables.

**CU\_DEVICE\_ATTRIBUTE\_DIRECT\_MANAGED\_MEM\_ACCESS\_FROM\_HOST = 101**

The host can directly access managed memory on the device without migration.

**CU\_DEVICE\_ATTRIBUTE\_VIRTUAL\_ADDRESS\_MANAGEMENT\_SUPPORTED = 102**

Device supports virtual address management APIs like [cuMemAddressReserve](#), [cuMemCreate](#), [cuMemMap](#) and related APIs

**CU\_DEVICE\_ATTRIBUTE\_HANDLE\_TYPE\_POSIX\_FILE\_DESCRIPTOR\_SUPPORTED = 103**

Device supports exporting memory to a posix file descriptor with

[cuMemExportToShareableHandle](#), if requested via [cuMemCreate](#)

**CU\_DEVICE\_ATTRIBUTE\_HANDLE\_TYPE\_WIN32\_HANDLE\_SUPPORTED = 104**

Device supports exporting memory to a Win32 NT handle with

[cuMemExportToShareableHandle](#), if requested via [cuMemCreate](#)

**CU\_DEVICE\_ATTRIBUTE\_HANDLE\_TYPE\_WIN32\_KMT\_HANDLE\_SUPPORTED = 105**

Device supports exporting memory to a Win32 KMT handle with

[cuMemExportToShareableHandle](#), if requested [cuMemCreate](#)



**CU\_DEVICE\_ATTRIBUTE\_MAX\_BLOCKS\_PER\_MULTIPROCESSOR = 106**

Maximum number of blocks per multiprocessor

**CU\_DEVICE\_ATTRIBUTE\_GENERIC\_COMPRESSION\_SUPPORTED = 107**

Device supports compression of memory

**CU\_DEVICE\_ATTRIBUTE\_MAX\_PERSISTING\_L2\_CACHE\_SIZE = 108**

Device's maximum L2 persisting lines capacity setting in bytes

**CU\_DEVICE\_ATTRIBUTE\_MAX\_ACCESS\_POLICY\_WINDOW\_SIZE = 109**

The maximum value of [CUaccessPolicyWindow::num\\_bytes](#).

**CU\_DEVICE\_ATTRIBUTE\_GPU\_DIRECT\_RDMA\_WITH\_CUDA\_VMM\_SUPPORTED = 110**

Device supports specifying the GPUDirect RDMA flag with [cuMemCreate](#)

**CU\_DEVICE\_ATTRIBUTE\_RESERVED\_SHARED\_MEMORY\_PER\_BLOCK = 111**

Shared memory reserved by CUDA driver per block in bytes

**CU\_DEVICE\_ATTRIBUTE\_MAX**

## enum CUdevice\_P2PAttribute

P2P Attributes

### Values

**CU\_DEVICE\_P2P\_ATTRIBUTE\_PERFORMANCE\_RANK = 0x01**

A relative value indicating the performance of the link between two devices

**CU\_DEVICE\_P2P\_ATTRIBUTE\_ACCESS\_SUPPORTED = 0x02**

P2P Access is enable

**CU\_DEVICE\_P2P\_ATTRIBUTE\_NATIVE\_ATOMIC\_SUPPORTED = 0x03**

Atomic operation over the link supported

**CU\_DEVICE\_P2P\_ATTRIBUTE\_ACCESS\_ACCESS\_SUPPORTED = 0x04**

[Deprecated](#) use

[CU\\_DEVICE\\_P2P\\_ATTRIBUTE\\_CUDA\\_ARRAY\\_ACCESS\\_SUPPORTED](#) instead

**CU\_DEVICE\_P2P\_ATTRIBUTE\_CUDA\_ARRAY\_ACCESS\_SUPPORTED = 0x04**

Accessing CUDA arrays over the link supported

## enum CUeglColorFormat

CUDA EGL Color Format - The different planar and multiplanar formats currently supported for CUDA\_EGL interops.

### Values

**CU\_EGL\_COLOR\_FORMAT\_YUV420\_PLANAR = 0x00**

Y, U, V in three surfaces, each in a separate surface, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU\_EGL\_COLOR\_FORMAT\_YUV420\_SEMIPLANAR = 0x01**



Y, UV in two surfaces (UV as one surface) with VU byte ordering, width, height ratio same as YUV420Planar.

**CU\_EGL\_COLOR\_FORMAT\_YUV422\_PLANAR = 0x02**

Y, U, V each in a separate surface, U/V width = 1/2 Y width, U/V height = Y height.

**CU\_EGL\_COLOR\_FORMAT\_YUV422\_SEMIPLANAR = 0x03**

Y, UV in two surfaces with VU byte ordering, width, height ratio same as YUV422Planar.

**CU\_EGL\_COLOR\_FORMAT\_RGB = 0x04**

R/G/B three channels in one surface with BGR byte ordering. Only pitch linear format supported.

**CU\_EGL\_COLOR\_FORMAT\_BGR = 0x05**

R/G/B three channels in one surface with RGB byte ordering. Only pitch linear format supported.

**CU\_EGL\_COLOR\_FORMAT\_ARGB = 0x06**

R/G/B/A four channels in one surface with BGRA byte ordering.

**CU\_EGL\_COLOR\_FORMAT\_RGBA = 0x07**

R/G/B/A four channels in one surface with ABGR byte ordering.

**CU\_EGL\_COLOR\_FORMAT\_L = 0x08**

single luminance channel in one surface.

**CU\_EGL\_COLOR\_FORMAT\_R = 0x09**

single color channel in one surface.

**CU\_EGL\_COLOR\_FORMAT\_YUV444\_PLANAR = 0x0A**

Y, U, V in three surfaces, each in a separate surface, U/V width = Y width, U/V height = Y height.

**CU\_EGL\_COLOR\_FORMAT\_YUV444\_SEMIPLANAR = 0x0B**

Y, UV in two surfaces (UV as one surface) with VU byte ordering, width, height ratio same as YUV444Planar.

**CU\_EGL\_COLOR\_FORMAT\_YUYV\_422 = 0x0C**

Y, U, V in one surface, interleaved as UYVY.

**CU\_EGL\_COLOR\_FORMAT\_UYVY\_422 = 0x0D**

Y, U, V in one surface, interleaved as YUYV.

**CU\_EGL\_COLOR\_FORMAT\_ABGR = 0x0E**

R/G/B/A four channels in one surface with RGBA byte ordering.

**CU\_EGL\_COLOR\_FORMAT\_BGRA = 0x0F**

R/G/B/A four channels in one surface with ARGB byte ordering.

**CU\_EGL\_COLOR\_FORMAT\_A = 0x10**

Alpha color format - one channel in one surface.

**CU\_EGL\_COLOR\_FORMAT\_RG = 0x11**

R/G color format - two channels in one surface with GR byte ordering

**CU\_EGL\_COLOR\_FORMAT\_AYUV = 0x12**

Y, U, V, A four channels in one surface, interleaved as VUYA.

**CU\_EGL\_COLOR\_FORMAT\_YVU444\_SEMIPLANAR = 0x13**

Y, VU in two surfaces (VU as one surface) with UV byte ordering, U/V width = Y width, U/V height = Y height.

**CU\_EGL\_COLOR\_FORMAT\_YVU422\_SEMIPLANAR = 0x14**

Y, VU in two surfaces (VU as one surface) with UV byte ordering, U/V width = 1/2 Y width, U/V height = Y height.

**CU\_EGL\_COLOR\_FORMAT\_YVU420\_SEMIPLANAR = 0x15**

Y, VU in two surfaces (VU as one surface) with UV byte ordering, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU\_EGL\_COLOR\_FORMAT\_Y10V10U10\_444\_SEMIPLANAR = 0x16**

Y10, V10U10 in two surfaces (VU as one surface) with UV byte ordering, U/V width = Y width, U/V height = Y height.

**CU\_EGL\_COLOR\_FORMAT\_Y10V10U10\_420\_SEMIPLANAR = 0x17**

Y10, V10U10 in two surfaces (VU as one surface) with UV byte ordering, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU\_EGL\_COLOR\_FORMAT\_Y12V12U12\_444\_SEMIPLANAR = 0x18**

Y12, V12U12 in two surfaces (VU as one surface) with UV byte ordering, U/V width = Y width, U/V height = Y height.

**CU\_EGL\_COLOR\_FORMAT\_Y12V12U12\_420\_SEMIPLANAR = 0x19**

Y12, V12U12 in two surfaces (VU as one surface) with UV byte ordering, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU\_EGL\_COLOR\_FORMAT\_VYUY\_ER = 0x1A**

Extended Range Y, U, V in one surface, interleaved as YVYU.

**CU\_EGL\_COLOR\_FORMAT\_UYVY\_ER = 0x1B**

Extended Range Y, U, V in one surface, interleaved as YUYV.

**CU\_EGL\_COLOR\_FORMAT\_YUYV\_ER = 0x1C**

Extended Range Y, U, V in one surface, interleaved as UYVY.

**CU\_EGL\_COLOR\_FORMAT\_YVYU\_ER = 0x1D**

Extended Range Y, U, V in one surface, interleaved as VYUY.

**CU\_EGL\_COLOR\_FORMAT\_YUV\_ER = 0x1E**

Extended Range Y, U, V three channels in one surface, interleaved as VUY. Only pitch linear format supported.

**CU\_EGL\_COLOR\_FORMAT\_YUVA\_ER = 0x1F**

Extended Range Y, U, V, A four channels in one surface, interleaved as AVUY.

**CU\_EGL\_COLOR\_FORMAT\_AYUV\_ER = 0x20**

Extended Range Y, U, V, A four channels in one surface, interleaved as VUYA.

**CU\_EGL\_COLOR\_FORMAT\_YUV444\_PLANAR\_ER = 0x21**

Extended Range Y, U, V in three surfaces, U/V width = Y width, U/V height = Y height.

**CU\_EGL\_COLOR\_FORMAT\_YUV422\_PLANAR\_ER = 0x22**

Extended Range Y, U, V in three surfaces, U/V width = 1/2 Y width, U/V height = Y height.

**CU\_EGL\_COLOR\_FORMAT\_YUV420\_PLANAR\_ER = 0x23**

Extended Range Y, U, V in three surfaces, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU\_EGL\_COLOR\_FORMAT\_YUV444\_SEMIPLANAR\_ER = 0x24**

Extended Range Y, UV in two surfaces (UV as one surface) with VU byte ordering, U/V width = Y width, U/V height = Y height.

**CU\_EGL\_COLOR\_FORMAT\_YUV422\_SEMIPLANAR\_ER = 0x25**

Extended Range Y, UV in two surfaces (UV as one surface) with VU byte ordering, U/V width = 1/2 Y width, U/V height = Y height.

**CU\_EGL\_COLOR\_FORMAT\_YUV420\_SEMIPLANAR\_ER = 0x26**

Extended Range Y, UV in two surfaces (UV as one surface) with VU byte ordering, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU\_EGL\_COLOR\_FORMAT\_YVU444\_PLANAR\_ER = 0x27**

Extended Range Y, V, U in three surfaces, U/V width = Y width, U/V height = Y height.

**CU\_EGL\_COLOR\_FORMAT\_YVU422\_PLANAR\_ER = 0x28**

Extended Range Y, V, U in three surfaces, U/V width = 1/2 Y width, U/V height = Y height.

**CU\_EGL\_COLOR\_FORMAT\_YVU420\_PLANAR\_ER = 0x29**

Extended Range Y, V, U in three surfaces, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU\_EGL\_COLOR\_FORMAT\_YVU444\_SEMIPLANAR\_ER = 0x2A**

Extended Range Y, VU in two surfaces (VU as one surface) with UV byte ordering, U/V width = Y width, U/V height = Y height.

**CU\_EGL\_COLOR\_FORMAT\_YVU422\_SEMIPLANAR\_ER = 0x2B**

Extended Range Y, VU in two surfaces (VU as one surface) with UV byte ordering, U/V width = 1/2 Y width, U/V height = Y height.

**CU\_EGL\_COLOR\_FORMAT\_YVU420\_SEMIPLANAR\_ER = 0x2C**

Extended Range Y, VU in two surfaces (VU as one surface) with UV byte ordering, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU\_EGL\_COLOR\_FORMAT\_BAYER\_RGGB = 0x2D**

Bayer format - one channel in one surface with interleaved RGGB ordering.

**CU\_EGL\_COLOR\_FORMAT\_BAYER\_BGGR = 0x2E**

Bayer format - one channel in one surface with interleaved BGGR ordering.

**CU\_EGL\_COLOR\_FORMAT\_BAYER\_GRBG = 0x2F**

Bayer format - one channel in one surface with interleaved GRBG ordering.

**CU\_EGL\_COLOR\_FORMAT\_BAYER\_GBRG = 0x30**

Bayer format - one channel in one surface with interleaved GBRG ordering.

**CU\_EGL\_COLOR\_FORMAT\_BAYER10\_RGGB = 0x31**

Bayer10 format - one channel in one surface with interleaved RGGB ordering. Out of 16 bits, 10 bits used 6 bits No-op.

**CU\_EGL\_COLOR\_FORMAT\_BAYER10\_BGGR = 0x32**

Bayer10 format - one channel in one surface with interleaved BGGR ordering. Out of 16 bits, 10 bits used 6 bits No-op.

**CU\_EGL\_COLOR\_FORMAT\_BAYER10\_GRBG = 0x33**

Bayer10 format - one channel in one surface with interleaved GRBG ordering. Out of 16 bits, 10 bits used 6 bits No-op.

**CU\_EGL\_COLOR\_FORMAT\_BAYER10\_GBRG = 0x34**

Bayer10 format - one channel in one surface with interleaved GBRG ordering. Out of 16 bits, 10 bits used 6 bits No-op.

**CU\_EGL\_COLOR\_FORMAT\_BAYER12\_RGGB = 0x35**

Bayer12 format - one channel in one surface with interleaved RGGB ordering. Out of 16 bits, 12 bits used 4 bits No-op.

**CU\_EGL\_COLOR\_FORMAT\_BAYER12\_BGGR = 0x36**

Bayer12 format - one channel in one surface with interleaved BGGR ordering. Out of 16 bits, 12 bits used 4 bits No-op.

**CU\_EGL\_COLOR\_FORMAT\_BAYER12\_GRBG = 0x37**

Bayer12 format - one channel in one surface with interleaved GRBG ordering. Out of 16 bits, 12 bits used 4 bits No-op.

**CU\_EGL\_COLOR\_FORMAT\_BAYER12\_GBRG = 0x38**

Bayer12 format - one channel in one surface with interleaved GBRG ordering. Out of 16 bits, 12 bits used 4 bits No-op.

**CU\_EGL\_COLOR\_FORMAT\_BAYER14\_RGGB = 0x39**

Bayer14 format - one channel in one surface with interleaved RGGB ordering. Out of 16 bits, 14 bits used 2 bits No-op.

**CU\_EGL\_COLOR\_FORMAT\_BAYER14\_BGGR = 0x3A**

Bayer14 format - one channel in one surface with interleaved BGGR ordering. Out of 16 bits, 14 bits used 2 bits No-op.

**CU\_EGL\_COLOR\_FORMAT\_BAYER14\_GRBG = 0x3B**

Bayer14 format - one channel in one surface with interleaved GRBG ordering. Out of 16 bits, 14 bits used 2 bits No-op.

**CU\_EGL\_COLOR\_FORMAT\_BAYER14\_GBRG = 0x3C**

Bayer14 format - one channel in one surface with interleaved GBRG ordering. Out of 16 bits, 14 bits used 2 bits No-op.

**CU\_EGL\_COLOR\_FORMAT\_BAYER20\_RGGB = 0x3D**

Bayer20 format - one channel in one surface with interleaved RGGB ordering. Out of 32 bits, 20 bits used 12 bits No-op.

**CU\_EGL\_COLOR\_FORMAT\_BAYER20\_BGGR = 0x3E**

Bayer20 format - one channel in one surface with interleaved BGGR ordering. Out of 32 bits, 20 bits used 12 bits No-op.

**CU\_EGL\_COLOR\_FORMAT\_BAYER20\_GRBG = 0x3F**

Bayer20 format - one channel in one surface with interleaved GRBG ordering. Out of 32 bits, 20 bits used 12 bits No-op.

**CU\_EGL\_COLOR\_FORMAT\_BAYER20\_GBRG = 0x40**

Bayer20 format - one channel in one surface with interleaved GBRG ordering. Out of 32 bits, 20 bits used 12 bits No-op.

**CU\_EGL\_COLOR\_FORMAT\_YVU444\_PLANAR = 0x41**

Y, V, U in three surfaces, each in a separate surface, U/V width = Y width, U/V height = Y height.

**CU\_EGL\_COLOR\_FORMAT\_YVU422\_PLANAR = 0x42**

Y, V, U in three surfaces, each in a separate surface, U/V width = 1/2 Y width, U/V height = Y height.

**CU\_EGL\_COLOR\_FORMAT\_YVU420\_PLANAR = 0x43**

Y, V, U in three surfaces, each in a separate surface, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU\_EGL\_COLOR\_FORMAT\_BAYER\_ISP\_RGGB = 0x44**

Nvidia proprietary Bayer ISP format - one channel in one surface with interleaved RGGB ordering and mapped to opaque integer datatype.

**CU\_EGL\_COLOR\_FORMAT\_BAYER\_ISP\_BGGR = 0x45**

Nvidia proprietary Bayer ISP format - one channel in one surface with interleaved BGGR ordering and mapped to opaque integer datatype.

**CU\_EGL\_COLOR\_FORMAT\_BAYER\_ISP\_GRBG = 0x46**

Nvidia proprietary Bayer ISP format - one channel in one surface with interleaved GRBG ordering and mapped to opaque integer datatype.

**CU\_EGL\_COLOR\_FORMAT\_BAYER\_ISP\_GBRG = 0x47**

Nvidia proprietary Bayer ISP format - one channel in one surface with interleaved GBRG ordering and mapped to opaque integer datatype.

**CU\_EGL\_COLOR\_FORMAT\_MAX**

## enum CUeglFrameType

CUDA EglFrame type - array or pointer

### Values

**CU\_EGL\_FRAME\_TYPE\_ARRAY = 0**

Frame type CUDA array

**CU\_EGL\_FRAME\_TYPE\_PITCH = 1**

Frame type pointer

## enum CUeglResourceLocationFlags

Resource location flags- system or vidmem

For CUDA context on iGPU, since video and system memory are equivalent - these flags will not have an effect on the execution.

For CUDA context on dGPU, applications can use the flag **CUeglResourceLocationFlags** to give a hint about the desired location.

**CU\_EGL\_RESOURCE\_LOCATION\_SYSTEMEM** - the frame data is made resident on the system memory to be accessed by CUDA.

**CU\_EGL\_RESOURCE\_LOCATION\_VIDMEM** - the frame data is made resident on the dedicated video memory to be accessed by CUDA.

There may be an additional latency due to new allocation and data migration, if the frame is produced on a different memory.

### Values

**CU\_EGL\_RESOURCE\_LOCATION\_SYSTEMEM** = 0x00

Resource location systemem

**CU\_EGL\_RESOURCE\_LOCATION\_VIDMEM** = 0x01

Resource location vidmem

## enum CUevent\_flags

Event creation flags

### Values

**CU\_EVENT\_DEFAULT** = 0x0

Default event flag

**CU\_EVENT\_BLOCKING\_SYNC** = 0x1

Event uses blocking synchronization

**CU\_EVENT\_DISABLE\_TIMING** = 0x2

Event will not record timing data

**CU\_EVENT\_INTERPROCESS** = 0x4

Event is suitable for interprocess use. **CU\_EVENT\_DISABLE\_TIMING** must be set

## enum CUexternalMemoryHandleType

External memory handle types

### Values

**CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_OPAQUE\_FD** = 1

Handle is an opaque file descriptor

**CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_OPAQUE\_WIN32** = 2

Handle is an opaque shared NT handle

**CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_OPAQUE\_WIN32\_KMT** = 3

Handle is an opaque, globally shared handle

**CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_D3D12\_HEAP** = 4

Handle is a D3D12 heap object

**CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_D3D12\_RESOURCE** = 5

Handle is a D3D12 committed resource

**CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_D3D11\_RESOURCE** = 6

Handle is a shared NT handle to a D3D11 resource

**CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_D3D11\_RESOURCE\_KMT = 7**

Handle is a globally shared handle to a D3D11 resource

**CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_NVSCIBUF = 8**

Handle is an NvSciBuf object

## enum CUexternalSemaphoreHandleType

External semaphore handle types

### Values

**CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_OPAQUE\_FD = 1**

Handle is an opaque file descriptor

**CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_OPAQUE\_WIN32 = 2**

Handle is an opaque shared NT handle

**CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_OPAQUE\_WIN32\_KMT = 3**

Handle is an opaque, globally shared handle

**CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_D3D12\_FENCE = 4**

Handle is a shared NT handle referencing a D3D12 fence object

**CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_D3D11\_FENCE = 5**

Handle is a shared NT handle referencing a D3D11 fence object

**CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_NVSCISYNC = 6**

Opaque handle to NvSciSync Object

**CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_D3D11\_KEYED\_MUTEX = 7**

Handle is a shared NT handle referencing a D3D11 keyed mutex object

**CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_D3D11\_KEYED\_MUTEX\_KMT = 8**

Handle is a globally shared handle referencing a D3D11 keyed mutex object

## enum CUfilter\_mode

Texture reference filtering modes

### Values

**CU\_TR\_FILTER\_MODE\_POINT = 0**

Point filter mode

**CU\_TR\_FILTER\_MODE\_LINEAR = 1**

Linear filter mode

## enum CUfunc\_cache

Function cache configurations

### Values

**CU\_FUNC\_CACHE\_PREFER\_NONE = 0x00**



no preference for shared memory or L1 (default)  
**CU\_FUNC\_CACHE\_PREFER\_SHARED = 0x01**  
 prefer larger shared memory and smaller L1 cache  
**CU\_FUNC\_CACHE\_PREFER\_L1 = 0x02**  
 prefer larger L1 cache and smaller shared memory  
**CU\_FUNC\_CACHE\_PREFER\_EQUAL = 0x03**  
 prefer equal sized L1 cache and shared memory

## enum CUfunction\_attribute

Function properties

### Values

**CU\_FUNC\_ATTRIBUTE\_MAX\_THREADS\_PER\_BLOCK = 0**

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.

**CU\_FUNC\_ATTRIBUTE\_SHARED\_SIZE\_BYTES = 1**

The size in bytes of statically-allocated shared memory required by this function. This does not include dynamically-allocated shared memory requested by the user at runtime.

**CU\_FUNC\_ATTRIBUTE\_CONST\_SIZE\_BYTES = 2**

The size in bytes of user-allocated constant memory required by this function.

**CU\_FUNC\_ATTRIBUTE\_LOCAL\_SIZE\_BYTES = 3**

The size in bytes of local memory used by each thread of this function.

**CU\_FUNC\_ATTRIBUTE\_NUM\_REGS = 4**

The number of registers used by each thread of this function.

**CU\_FUNC\_ATTRIBUTE\_PTX\_VERSION = 5**

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. Note that this may return the undefined value of 0 for cubins compiled prior to CUDA 3.0.

**CU\_FUNC\_ATTRIBUTE\_BINARY\_VERSION = 6**

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. Note that this will return a value of 10 for legacy cubins that do not have a properly-encoded binary architecture version.

**CU\_FUNC\_ATTRIBUTE\_CACHE\_MODE\_CA = 7**

The attribute to indicate whether the function has been compiled with user specified option "-Xptxas --dlcm=ca" set.

**CU\_FUNC\_ATTRIBUTE\_MAX\_DYNAMIC\_SHARED\_SIZE\_BYTES = 8**



The maximum size in bytes of dynamically-allocated shared memory that can be used by this function. If the user-specified dynamic shared memory size is larger than this value, the launch will fail. See [cuFuncSetAttribute](#)

#### **CU\_FUNC\_ATTRIBUTE\_PREFERRED\_SHARED\_MEMORY\_CARVEOUT = 9**

On devices where the L1 cache and shared memory use the same hardware resources, this sets the shared memory carveout preference, in percent of the total shared memory. Refer to [CU\\_DEVICE\\_ATTRIBUTE\\_MAX\\_SHARED\\_MEMORY\\_PER\\_MULTIPROCESSOR](#). This is only a hint, and the driver can choose a different ratio if required to execute the function. See [cuFuncSetAttribute](#)

#### **CU\_FUNC\_ATTRIBUTE\_MAX**

## **enum CUgraphicsMapResourceFlags**

Flags for mapping and unmapping interop resources

### **Values**

**CU\_GRAPHICS\_MAP\_RESOURCE\_FLAGS\_NONE = 0x00**

**CU\_GRAPHICS\_MAP\_RESOURCE\_FLAGS\_READ\_ONLY = 0x01**

**CU\_GRAPHICS\_MAP\_RESOURCE\_FLAGS\_WRITE\_DISCARD = 0x02**

## **enum CUgraphicsRegisterFlags**

Flags to register a graphics resource

### **Values**

**CU\_GRAPHICS\_REGISTER\_FLAGS\_NONE = 0x00**

**CU\_GRAPHICS\_REGISTER\_FLAGS\_READ\_ONLY = 0x01**

**CU\_GRAPHICS\_REGISTER\_FLAGS\_WRITE\_DISCARD = 0x02**

**CU\_GRAPHICS\_REGISTER\_FLAGS\_SURFACE\_LDST = 0x04**

**CU\_GRAPHICS\_REGISTER\_FLAGS\_TEXTURE\_GATHER = 0x08**

## **enum CUgraphNodeType**

Graph node types

### **Values**

**CU\_GRAPH\_NODE\_TYPE\_KERNEL = 0**

GPU kernel node

**CU\_GRAPH\_NODE\_TYPE\_MEMCPY = 1**

Memcpy node

**CU\_GRAPH\_NODE\_TYPE\_MEMSET = 2**

Memset node

**CU\_GRAPH\_NODE\_TYPE\_HOST = 3**

Host (executable) node

**CU\_GRAPH\_NODE\_TYPE\_GRAPH = 4**

Node which executes an embedded graph

**CU\_GRAPH\_NODE\_TYPE\_EMPTY = 5**

Empty (no-op) node

## enum CUipcMem\_flags

CUDA Ipc Mem Flags

### Values

**CU\_IPC\_MEM\_LAZY\_ENABLE\_PEER\_ACCESS = 0x1**

Automatically enable peer access between remote devices as needed

## enum CUjit\_cacheMode

Caching modes for dlcm

### Values

**CU\_JIT\_CACHE\_OPTION\_NONE = 0**

Compile with no -dlcm flag specified

**CU\_JIT\_CACHE\_OPTION\_CG**

Compile with L1 cache disabled

**CU\_JIT\_CACHE\_OPTION\_CA**

Compile with L1 cache enabled

## enum CUjit\_fallback

Cubin matching fallback strategies

### Values

**CU\_PREFER\_PTX = 0**

Prefer to compile ptx if exact binary match not found

**CU\_PREFER\_BINARY**

Prefer to fall back to compatible binary code if exact match not found

## enum CUjit\_option

Online compiler and linker options

### Values

**CU\_JIT\_MAX\_REGISTERS = 0**

Max number of registers that a thread may use. Option type: unsigned int Applies to: compiler only

### **CU\_JIT\_THREADS\_PER\_BLOCK**

IN: Specifies minimum number of threads per block to target compilation for OUT: Returns the number of threads the compiler actually targeted. This restricts the resource utilization for the compiler (e.g. max registers) such that a block with the given number of threads should be able to launch based on register limitations. Note, this option does not currently take into account any other resource limitations, such as shared memory utilization. Cannot be combined with [CU\\_JIT\\_TARGET](#). Option type: unsigned int Applies to: compiler only

### **CU\_JIT\_WALL\_TIME**

Overwrites the option value with the total wall clock time, in milliseconds, spent in the compiler and linker Option type: float Applies to: compiler and linker

### **CU\_JIT\_INFO\_LOG\_BUFFER**

Pointer to a buffer in which to print any log messages that are informational in nature (the buffer size is specified via option [CU\\_JIT\\_INFO\\_LOG\\_BUFFER\\_SIZE\\_BYTES](#)) Option type: char \* Applies to: compiler and linker

### **CU\_JIT\_INFO\_LOG\_BUFFER\_SIZE\_BYTES**

IN: Log buffer size in bytes. Log messages will be capped at this size (including null terminator) OUT: Amount of log buffer filled with messages Option type: unsigned int Applies to: compiler and linker

### **CU\_JIT\_ERROR\_LOG\_BUFFER**

Pointer to a buffer in which to print any log messages that reflect errors (the buffer size is specified via option [CU\\_JIT\\_ERROR\\_LOG\\_BUFFER\\_SIZE\\_BYTES](#)) Option type: char \* Applies to: compiler and linker

### **CU\_JIT\_ERROR\_LOG\_BUFFER\_SIZE\_BYTES**

IN: Log buffer size in bytes. Log messages will be capped at this size (including null terminator) OUT: Amount of log buffer filled with messages Option type: unsigned int Applies to: compiler and linker

### **CU\_JIT\_OPTIMIZATION\_LEVEL**

Level of optimizations to apply to generated code (0 - 4), with 4 being the default and highest level of optimizations. Option type: unsigned int Applies to: compiler only

### **CU\_JIT\_TARGET\_FROM\_CUCONTEXT**

No option value required. Determines the target based on the current attached context (default) Option type: No option value needed Applies to: compiler and linker

### **CU\_JIT\_TARGET**

Target is chosen based on supplied [CUjit\\_target](#). Cannot be combined with [CU\\_JIT\\_THREADS\\_PER\\_BLOCK](#). Option type: unsigned int for enumerated type [CUjit\\_target](#) Applies to: compiler and linker

### **CU\_JIT\_FALLBACK\_STRATEGY**

Specifies choice of fallback strategy if matching cubin is not found. Choice is based on supplied [CUjit\\_fallback](#). This option cannot be used with cuLink\* APIs as the linker

requires exact matches. Option type: unsigned int for enumerated type [CUjit\\_fallback](#)

Applies to: compiler only

#### **CU\_JIT\_GENERATE\_DEBUG\_INFO**

Specifies whether to create debug information in output (-g) (0: false, default) Option

type: int Applies to: compiler and linker

#### **CU\_JIT\_LOG\_VERBOSE**

Generate verbose log messages (0: false, default) Option type: int Applies to: compiler and linker

#### **CU\_JIT\_GENERATE\_LINE\_INFO**

Generate line number information (-lineinfo) (0: false, default) Option type: int

Applies to: compiler only

#### **CU\_JIT\_CACHE\_MODE**

Specifies whether to enable caching explicitly (-dlcm) Choice is based on supplied [CUjit\\_cacheMode\\_enum](#). Option type: unsigned int for enumerated type

[CUjit\\_cacheMode\\_enum](#) Applies to: compiler only

#### **CU\_JIT\_NEW\_SM3X\_OPT**

The below jit options are used for internal purposes only, in this version of CUDA

#### **CU\_JIT\_FAST\_COMPILE**

#### **CU\_JIT\_GLOBAL\_SYMBOL\_NAMES**

Array of device symbol names that will be relocated to the corresponding host addresses stored in [CU\\_JIT\\_GLOBAL\\_SYMBOL\\_ADDRESSES](#). Must contain [CU\\_JIT\\_GLOBAL\\_SYMBOL\\_COUNT](#) entries. When loading a device module, driver will relocate all encountered unresolved symbols to the host addresses. It is only allowed to register symbols that correspond to unresolved global variables. It is illegal to register the same device symbol at multiple addresses. Option type: const char \*\* Applies to: dynamic linker only

#### **CU\_JIT\_GLOBAL\_SYMBOL\_ADDRESSES**

Array of host addresses that will be used to relocate corresponding device symbols stored in [CU\\_JIT\\_GLOBAL\\_SYMBOL\\_NAMES](#). Must contain [CU\\_JIT\\_GLOBAL\\_SYMBOL\\_COUNT](#) entries. Option type: void \*\* Applies to: dynamic linker only

#### **CU\_JIT\_GLOBAL\_SYMBOL\_COUNT**

Number of entries in [CU\\_JIT\\_GLOBAL\\_SYMBOL\\_NAMES](#) and [CU\\_JIT\\_GLOBAL\\_SYMBOL\\_ADDRESSES](#) arrays. Option type: unsigned int Applies to: dynamic linker only

#### **CU\_JIT\_NUM\_OPTIONS**

## **enum CUjit\_target**

Online compilation targets

### **Values**

**CU\_TARGET\_COMPUTE\_20 = 20**

Compute device class 2.0  
**CU\_TARGET\_COMPUTE\_21 = 21**  
 Compute device class 2.1  
**CU\_TARGET\_COMPUTE\_30 = 30**  
 Compute device class 3.0  
**CU\_TARGET\_COMPUTE\_32 = 32**  
 Compute device class 3.2  
**CU\_TARGET\_COMPUTE\_35 = 35**  
 Compute device class 3.5  
**CU\_TARGET\_COMPUTE\_37 = 37**  
 Compute device class 3.7  
**CU\_TARGET\_COMPUTE\_50 = 50**  
 Compute device class 5.0  
**CU\_TARGET\_COMPUTE\_52 = 52**  
 Compute device class 5.2  
**CU\_TARGET\_COMPUTE\_53 = 53**  
 Compute device class 5.3  
**CU\_TARGET\_COMPUTE\_60 = 60**  
 Compute device class 6.0.  
**CU\_TARGET\_COMPUTE\_61 = 61**  
 Compute device class 6.1.  
**CU\_TARGET\_COMPUTE\_62 = 62**  
 Compute device class 6.2.  
**CU\_TARGET\_COMPUTE\_70 = 70**  
 Compute device class 7.0.  
**CU\_TARGET\_COMPUTE\_72 = 72**  
 Compute device class 7.2.  
**CU\_TARGET\_COMPUTE\_75 = 75**  
 Compute device class 7.5.  
**CU\_TARGET\_COMPUTE\_80 = 80**  
 Compute device class 8.0.

## enum CUjitInputType

Device code formats

### Values

**CU\_JIT\_INPUT\_CUBIN = 0**  
 Compiled device-class-specific device code Applicable options: none  
**CU\_JIT\_INPUT\_PTX**  
 PTX source code Applicable options: PTX compiler options  
**CU\_JIT\_INPUT\_FATBINARY**

Bundle of multiple cubins and/or PTX of some device code Applicable options: PTX compiler options, [CU\\_JIT\\_FALLBACK\\_STRATEGY](#)

### **CU\_JIT\_INPUT\_OBJECT**

Host object with embedded device code Applicable options: PTX compiler options, [CU\\_JIT\\_FALLBACK\\_STRATEGY](#)

### **CU\_JIT\_INPUT\_LIBRARY**

Archive of host objects with embedded device code Applicable options: PTX compiler options, [CU\\_JIT\\_FALLBACK\\_STRATEGY](#)

### **CU\_JIT\_NUM\_INPUT\_TYPES**

## **enum CUkernelNodeAttrID**

Graph kernel node Attributes

### **Values**

#### **CU\_KERNEL\_NODE\_ATTRIBUTE\_ACCESS\_POLICY\_WINDOW = 1**

Identifier for [CUkernelNodeAttrValue::accessPolicyWindow](#).

#### **CU\_KERNEL\_NODE\_ATTRIBUTE\_COOPERATIVE = 2**

Allows a kernel node to be cooperative (see [cuLaunchCooperativeKernel](#)).

## **enum CUlimit**

Limits

### **Values**

#### **CU\_LIMIT\_STACK\_SIZE = 0x00**

GPU thread stack size

#### **CU\_LIMIT\_PRINTF\_FIFO\_SIZE = 0x01**

GPU printf FIFO size

#### **CU\_LIMIT\_MALLOC\_HEAP\_SIZE = 0x02**

GPU malloc heap size

#### **CU\_LIMIT\_DEV\_RUNTIME\_SYNC\_DEPTH = 0x03**

GPU device runtime launch synchronize depth

#### **CU\_LIMIT\_DEV\_RUNTIME\_PENDING\_LAUNCH\_COUNT = 0x04**

GPU device runtime pending launch count

#### **CU\_LIMIT\_MAX\_L2\_FETCH\_GRANULARITY = 0x05**

A value between 0 and 128 that indicates the maximum fetch granularity of L2 (in Bytes). This is a hint

#### **CU\_LIMIT\_PERSISTING\_L2\_CACHE\_SIZE = 0x06**

A size in bytes for L2 persisting lines cache size

#### **CU\_LIMIT\_MAX**

## enum CUmem\_advise

Memory advise values

### Values

**CU\_MEM\_ADVICE\_SET\_READ\_MOSTLY = 1**

Data will mostly be read and only occasionally be written to

**CU\_MEM\_ADVICE\_UNSET\_READ\_MOSTLY = 2**

Undo the effect of **CU\_MEM\_ADVICE\_SET\_READ\_MOSTLY**

**CU\_MEM\_ADVICE\_SET\_PREFERRED\_LOCATION = 3**

Set the preferred location for the data as the specified device

**CU\_MEM\_ADVICE\_UNSET\_PREFERRED\_LOCATION = 4**

Clear the preferred location for the data

**CU\_MEM\_ADVICE\_SET\_ACCESSED\_BY = 5**

Data will be accessed by the specified device, so prevent page faults as much as possible

**CU\_MEM\_ADVICE\_UNSET\_ACCESSED\_BY = 6**

Let the Unified Memory subsystem decide on the page faulting policy for the specified device

## enum CUmemAccess\_flags

Specifies the memory protection flags for mapping.

### Values

**CU\_MEM\_ACCESS\_FLAGS\_PROT\_NONE = 0x0**

Default, make the address range not accessible

**CU\_MEM\_ACCESS\_FLAGS\_PROT\_READ = 0x1**

Make the address range read accessible

**CU\_MEM\_ACCESS\_FLAGS\_PROT\_READWRITE = 0x3**

Make the address range read-write accessible

**CU\_MEM\_ACCESS\_FLAGS\_PROT\_MAX = 0xFFFFFFFF**

## enum CUmemAllocationCompType

Specifies compression attribute for an allocation.

### Values

**CU\_MEM\_ALLOCATION\_COMP\_NONE = 0x0**

Allocating non-compressible memory

**CU\_MEM\_ALLOCATION\_COMP\_GENERIC = 0x1**

Allocating compressible memory

## enum CUmemAllocationGranularity\_flags

Flag for requesting different optimal and required granularities for an allocation.

### Values

**CU\_MEM\_ALLOC\_GRANULARITY\_MINIMUM = 0x0**

Minimum required granularity for allocation

**CU\_MEM\_ALLOC\_GRANULARITY\_RECOMMENDED = 0x1**

Recommended granularity for allocation for best performance

## enum CUmemAllocationHandleType

Flags for specifying particular handle types

### Values

**CU\_MEM\_HANDLE\_TYPE\_POSIX\_FILE\_DESCRIPTOR = 0x1**

Allows a file descriptor to be used for exporting. Permitted only on POSIX systems.  
(int)

**CU\_MEM\_HANDLE\_TYPE\_WIN32 = 0x2**

Allows a Win32 NT handle to be used for exporting. (HANDLE)

**CU\_MEM\_HANDLE\_TYPE\_WIN32\_KMT = 0x4**

Allows a Win32 KMT handle to be used for exporting. (D3DKMT\_HANDLE)

**CU\_MEM\_HANDLE\_TYPE\_MAX = 0xFFFFFFFF**

## enum CUmemAllocationType

Defines the allocation types available

### Values

**CU\_MEM\_ALLOCATION\_TYPE\_INVALID = 0x0**

**CU\_MEM\_ALLOCATION\_TYPE\_PINNED = 0x1**

This allocation type is 'pinned', i.e. cannot migrate from its current location while the application is actively using it

**CU\_MEM\_ALLOCATION\_TYPE\_MAX = 0xFFFFFFFF**

## enum CUmemAttach\_flags

CUDA Mem Attach Flags

### Values

**CU\_MEM\_ATTACH\_GLOBAL = 0x1**

Memory can be accessed by any stream on any device



**CU\_MEM\_ATTACH\_HOST = 0x2**

Memory cannot be accessed by any stream on any device

**CU\_MEM\_ATTACH\_SINGLE = 0x4**

Memory can only be accessed by a single stream on the associated device

## enum CUmemLocationType

Specifies the type of location

### Values

**CU\_MEM\_LOCATION\_TYPE\_INVALID = 0x0**

**CU\_MEM\_LOCATION\_TYPE\_DEVICE = 0x1**

Location is a device location, thus id is a device ordinal

**CU\_MEM\_LOCATION\_TYPE\_MAX = 0xFFFFFFFF**

## enum CUmemorytype

Memory types

### Values

**CU\_MEMORYTYPE\_HOST = 0x01**

Host memory

**CU\_MEMORYTYPE\_DEVICE = 0x02**

Device memory

**CU\_MEMORYTYPE\_ARRAY = 0x03**

Array memory

**CU\_MEMORYTYPE\_UNIFIED = 0x04**

Unified device or host memory

## enum CUoccupancy\_flags

Occupancy calculator flag

### Values

**CU\_OCCUPANCY\_DEFAULT = 0x0**

Default behavior

**CU\_OCCUPANCY\_DISABLE\_CACHING\_OVERRIDE = 0x1**

Assume global caching is enabled and cannot be automatically turned off

## enum CUpointer\_attribute

Pointer information

## Values

**CU\_POINTER\_ATTRIBUTE\_CONTEXT = 1**

The **CUcontext** on which a pointer was allocated or registered

**CU\_POINTER\_ATTRIBUTE\_MEMORY\_TYPE = 2**

The **CUmemorytype** describing the physical location of a pointer

**CU\_POINTER\_ATTRIBUTE\_DEVICE\_POINTER = 3**

The address at which a pointer's memory may be accessed on the device

**CU\_POINTER\_ATTRIBUTE\_HOST\_POINTER = 4**

The address at which a pointer's memory may be accessed on the host

**CU\_POINTER\_ATTRIBUTE\_P2P\_TOKENS = 5**

A pair of tokens for use with the nv-p2p.h Linux kernel interface

**CU\_POINTER\_ATTRIBUTE\_SYNC\_MEMOPS = 6**

Synchronize every synchronous memory operation initiated on this region

**CU\_POINTER\_ATTRIBUTE\_BUFFER\_ID = 7**

A process-wide unique ID for an allocated memory region

**CU\_POINTER\_ATTRIBUTE\_IS\_MANAGED = 8**

Indicates if the pointer points to managed memory

**CU\_POINTER\_ATTRIBUTE\_DEVICE\_ORDINAL = 9**

A device ordinal of a device on which a pointer was allocated or registered

**CU\_POINTER\_ATTRIBUTE\_IS\_LEGACY\_CUDA\_IPC\_CAPABLE = 10**

1 if this pointer maps to an allocation that is suitable for **cudaIpcGetMemHandle**, 0 otherwise

**CU\_POINTER\_ATTRIBUTE\_RANGE\_START\_ADDR = 11**

Starting address for this requested pointer

**CU\_POINTER\_ATTRIBUTE\_RANGE\_SIZE = 12**

Size of the address range for this requested pointer

**CU\_POINTER\_ATTRIBUTE\_MAPPED = 13**

1 if this pointer is in a valid address range that is mapped to a backing allocation, 0 otherwise

**CU\_POINTER\_ATTRIBUTE\_ALLOWED\_HANDLE\_TYPES = 14**

Bitmask of allowed **CUmemAllocationHandleType** for this allocation

**CU\_POINTER\_ATTRIBUTE\_IS\_GPU\_DIRECT\_RDMA\_CAPABLE = 15**

1 if the memory this pointer is referencing can be used with the GPUDirect RDMA API

## enum CUresourcetype

Resource types

## Values

**CU\_RESOURCE\_TYPE\_ARRAY = 0x00**

Array resource

**CU\_RESOURCE\_TYPE\_MIPMAPPED\_ARRAY = 0x01**

Mipmapped array resource

**CU\_RESOURCE\_TYPE\_LINEAR = 0x02**

Linear resource

**CU\_RESOURCE\_TYPE\_PITCH2D = 0x03**

Pitch 2D resource

## enum CUresourceViewFormat

Resource view format

### Values

**CU\_RES\_VIEW\_FORMAT\_NONE = 0x00**

No resource view format (use underlying resource format)

**CU\_RES\_VIEW\_FORMAT\_UINT\_1X8 = 0x01**

1 channel unsigned 8-bit integers

**CU\_RES\_VIEW\_FORMAT\_UINT\_2X8 = 0x02**

2 channel unsigned 8-bit integers

**CU\_RES\_VIEW\_FORMAT\_UINT\_4X8 = 0x03**

4 channel unsigned 8-bit integers

**CU\_RES\_VIEW\_FORMAT\_SINT\_1X8 = 0x04**

1 channel signed 8-bit integers

**CU\_RES\_VIEW\_FORMAT\_SINT\_2X8 = 0x05**

2 channel signed 8-bit integers

**CU\_RES\_VIEW\_FORMAT\_SINT\_4X8 = 0x06**

4 channel signed 8-bit integers

**CU\_RES\_VIEW\_FORMAT\_UINT\_1X16 = 0x07**

1 channel unsigned 16-bit integers

**CU\_RES\_VIEW\_FORMAT\_UINT\_2X16 = 0x08**

2 channel unsigned 16-bit integers

**CU\_RES\_VIEW\_FORMAT\_UINT\_4X16 = 0x09**

4 channel unsigned 16-bit integers

**CU\_RES\_VIEW\_FORMAT\_SINT\_1X16 = 0x0a**

1 channel signed 16-bit integers

**CU\_RES\_VIEW\_FORMAT\_SINT\_2X16 = 0x0b**

2 channel signed 16-bit integers

**CU\_RES\_VIEW\_FORMAT\_SINT\_4X16 = 0x0c**

4 channel signed 16-bit integers

**CU\_RES\_VIEW\_FORMAT\_UINT\_1X32 = 0x0d**

1 channel unsigned 32-bit integers

**CU\_RES\_VIEW\_FORMAT\_UINT\_2X32 = 0x0e**

2 channel unsigned 32-bit integers

**CU\_RES\_VIEW\_FORMAT\_UINT\_4X32 = 0x0f**

4 channel unsigned 32-bit integers

**CU\_RES\_VIEW\_FORMAT\_SINT\_1X32 = 0x10**  
 1 channel signed 32-bit integers  
**CU\_RES\_VIEW\_FORMAT\_SINT\_2X32 = 0x11**  
 2 channel signed 32-bit integers  
**CU\_RES\_VIEW\_FORMAT\_SINT\_4X32 = 0x12**  
 4 channel signed 32-bit integers  
**CU\_RES\_VIEW\_FORMAT\_FLOAT\_1X16 = 0x13**  
 1 channel 16-bit floating point  
**CU\_RES\_VIEW\_FORMAT\_FLOAT\_2X16 = 0x14**  
 2 channel 16-bit floating point  
**CU\_RES\_VIEW\_FORMAT\_FLOAT\_4X16 = 0x15**  
 4 channel 16-bit floating point  
**CU\_RES\_VIEW\_FORMAT\_FLOAT\_1X32 = 0x16**  
 1 channel 32-bit floating point  
**CU\_RES\_VIEW\_FORMAT\_FLOAT\_2X32 = 0x17**  
 2 channel 32-bit floating point  
**CU\_RES\_VIEW\_FORMAT\_FLOAT\_4X32 = 0x18**  
 4 channel 32-bit floating point  
**CU\_RES\_VIEW\_FORMAT\_UNSIGNED\_BC1 = 0x19**  
 Block compressed 1  
**CU\_RES\_VIEW\_FORMAT\_UNSIGNED\_BC2 = 0x1a**  
 Block compressed 2  
**CU\_RES\_VIEW\_FORMAT\_UNSIGNED\_BC3 = 0x1b**  
 Block compressed 3  
**CU\_RES\_VIEW\_FORMAT\_UNSIGNED\_BC4 = 0x1c**  
 Block compressed 4 unsigned  
**CU\_RES\_VIEW\_FORMAT\_SIGNED\_BC4 = 0x1d**  
 Block compressed 4 signed  
**CU\_RES\_VIEW\_FORMAT\_UNSIGNED\_BC5 = 0x1e**  
 Block compressed 5 unsigned  
**CU\_RES\_VIEW\_FORMAT\_SIGNED\_BC5 = 0x1f**  
 Block compressed 5 signed  
**CU\_RES\_VIEW\_FORMAT\_UNSIGNED\_BC6H = 0x20**  
 Block compressed 6 unsigned half-float  
**CU\_RES\_VIEW\_FORMAT\_SIGNED\_BC6H = 0x21**  
 Block compressed 6 signed half-float  
**CU\_RES\_VIEW\_FORMAT\_UNSIGNED\_BC7 = 0x22**  
 Block compressed 7

## enum CUresult

Error codes

## Values

### **CUDA\_SUCCESS = 0**

The API call returned with no errors. In the case of query calls, this also means that the operation being queried is complete (see [cuEventQuery\(\)](#) and [cuStreamQuery\(\)](#)).

### **CUDA\_ERROR\_INVALID\_VALUE = 1**

This indicates that one or more of the parameters passed to the API call is not within an acceptable range of values.

### **CUDA\_ERROR\_OUT\_OF\_MEMORY = 2**

The API call failed because it was unable to allocate enough memory to perform the requested operation.

### **CUDA\_ERROR\_NOT\_INITIALIZED = 3**

This indicates that the CUDA driver has not been initialized with [cuInit\(\)](#) or that initialization has failed.

### **CUDA\_ERROR\_DEINITIALIZED = 4**

This indicates that the CUDA driver is in the process of shutting down.

### **CUDA\_ERROR\_PROFILER\_DISABLED = 5**

This indicates profiler is not initialized for this run. This can happen when the application is running with external profiling tools like visual profiler.

### **CUDA\_ERROR\_PROFILER\_NOT\_INITIALIZED = 6**

**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 [cuProfilerStart](#) or [cuProfilerStop](#) without initialization.

### **CUDA\_ERROR\_PROFILER\_ALREADY\_STARTED = 7**

**Deprecated** This error return is deprecated as of CUDA 5.0. It is no longer an error to call [cuProfilerStart\(\)](#) when profiling is already enabled.

### **CUDA\_ERROR\_PROFILER\_ALREADY\_STOPPED = 8**

**Deprecated** This error return is deprecated as of CUDA 5.0. It is no longer an error to call [cuProfilerStop\(\)](#) when profiling is already disabled.

### **CUDA\_ERROR\_NO\_DEVICE = 100**

This indicates that no CUDA-capable devices were detected by the installed CUDA driver.

### **CUDA\_ERROR\_INVALID\_DEVICE = 101**

This indicates that the device ordinal supplied by the user does not correspond to a valid CUDA device.

### **CUDA\_ERROR\_INVALID\_IMAGE = 200**

This indicates that the device kernel image is invalid. This can also indicate an invalid CUDA module.

### **CUDA\_ERROR\_INVALID\_CONTEXT = 201**

This most frequently indicates that there is no context bound to the current thread. This can also be returned if the context passed to an API call is not a valid handle (such as a context that has had [cuCtxDestroy\(\)](#) invoked on it). This can also be returned if a user mixes different API versions (i.e. 3010 context with 3020 API calls). See [cuCtxGetApiVersion\(\)](#) for more details.

**CUDA\_ERROR\_CONTEXT\_ALREADY\_CURRENT = 202**

This indicates that the context being supplied as a parameter to the API call was already the active context. **Deprecated** This error return is deprecated as of CUDA 3.2. It is no longer an error to attempt to push the active context via `cuCtxPushCurrent()`.

**CUDA\_ERROR\_MAP\_FAILED = 205**

This indicates that a map or register operation has failed.

**CUDA\_ERROR\_UNMAP\_FAILED = 206**

This indicates that an unmap or unregister operation has failed.

**CUDA\_ERROR\_ARRAY\_IS\_MAPPED = 207**

This indicates that the specified array is currently mapped and thus cannot be destroyed.

**CUDA\_ERROR\_ALREADY\_MAPPED = 208**

This indicates that the resource is already mapped.

**CUDA\_ERROR\_NO\_BINARY\_FOR\_GPU = 209**

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.

**CUDA\_ERROR\_ALREADY\_ACQUIRED = 210**

This indicates that a resource has already been acquired.

**CUDA\_ERROR\_NOT\_MAPPED = 211**

This indicates that a resource is not mapped.

**CUDA\_ERROR\_NOT\_MAPPED\_AS\_ARRAY = 212**

This indicates that a mapped resource is not available for access as an array.

**CUDA\_ERROR\_NOT\_MAPPED\_AS\_POINTER = 213**

This indicates that a mapped resource is not available for access as a pointer.

**CUDA\_ERROR\_ECC\_UNCORRECTABLE = 214**

This indicates that an uncorrectable ECC error was detected during execution.

**CUDA\_ERROR\_UNSUPPORTED\_LIMIT = 215**

This indicates that the `CUlimit` passed to the API call is not supported by the active device.

**CUDA\_ERROR\_CONTEXT\_ALREADY\_IN\_USE = 216**

This indicates that the `CUcontext` passed to the API call can only be bound to a single CPU thread at a time but is already bound to a CPU thread.

**CUDA\_ERROR\_PEER\_ACCESS\_UNSUPPORTED = 217**

This indicates that peer access is not supported across the given devices.

**CUDA\_ERROR\_INVALID\_PTX = 218**

This indicates that a PTX JIT compilation failed.

**CUDA\_ERROR\_INVALID\_GRAPHICS\_CONTEXT = 219**

This indicates an error with OpenGL or DirectX context.

**CUDA\_ERROR\_NVLINK\_UNCORRECTABLE = 220**

This indicates that an uncorrectable NVLink error was detected during the execution.

**CUDA\_ERROR\_JIT\_COMPILER\_NOT\_FOUND = 221**

This indicates that the PTX JIT compiler library was not found.

**CUDA\_ERROR\_INVALID\_SOURCE = 300**

This indicates that the device kernel source is invalid.

**CUDA\_ERROR\_FILE\_NOT\_FOUND = 301**

This indicates that the file specified was not found.

**CUDA\_ERROR\_SHARED\_OBJECT\_SYMBOL\_NOT\_FOUND = 302**

This indicates that a link to a shared object failed to resolve.

**CUDA\_ERROR\_SHARED\_OBJECT\_INIT\_FAILED = 303**

This indicates that initialization of a shared object failed.

**CUDA\_ERROR\_OPERATING\_SYSTEM = 304**

This indicates that an OS call failed.

**CUDA\_ERROR\_INVALID\_HANDLE = 400**

This indicates that a resource handle passed to the API call was not valid. Resource handles are opaque types like [CUstream](#) and [CUevent](#).

**CUDA\_ERROR\_ILLEGAL\_STATE = 401**

This indicates that a resource required by the API call is not in a valid state to perform the requested operation.

**CUDA\_ERROR\_NOT\_FOUND = 500**

This indicates that a named symbol was not found. Examples of symbols are global/constant variable names, texture names, and surface names.

**CUDA\_ERROR\_NOT\_READY = 600**

This indicates that asynchronous operations issued previously have not completed yet. This result is not actually an error, but must be indicated differently than [CUDA\\_SUCCESS](#) (which indicates completion). Calls that may return this value include [cuEventQuery\(\)](#) and [cuStreamQuery\(\)](#).

**CUDA\_ERROR\_ILLEGAL\_ADDRESS = 700**

While executing a kernel, the device encountered a load or store instruction on an invalid memory address. This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

**CUDA\_ERROR\_LAUNCH\_OUT\_OF\_RESOURCES = 701**

This indicates that a launch did not occur because it did not have appropriate resources. 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. Passing arguments of the wrong size (i.e. a 64-bit pointer when a 32-bit int is expected) is equivalent to passing too many arguments and can also result in this error.

**CUDA\_ERROR\_LAUNCH\_TIMEOUT = 702**

This indicates that the device kernel took too long to execute. This can only occur if timeouts are enabled - see the device attribute

[CU\\_DEVICE\\_ATTRIBUTE\\_KERNEL\\_EXEC\\_TIMEOUT](#) for more information.

This leaves the process in an inconsistent state and any further CUDA work will



return the same error. To continue using CUDA, the process must be terminated and relaunched.

#### **CUDA\_ERROR\_LAUNCH\_INCOMPATIBLE\_TEXTURING = 703**

This error indicates a kernel launch that uses an incompatible texturing mode.

#### **CUDA\_ERROR\_PEER\_ACCESS\_ALREADY\_ENABLED = 704**

This error indicates that a call to `cuCtxEnablePeerAccess()` is trying to re-enable peer access to a context which has already had peer access to it enabled.

#### **CUDA\_ERROR\_PEER\_ACCESS\_NOT\_ENABLED = 705**

This error indicates that `cuCtxDisablePeerAccess()` is trying to disable peer access which has not been enabled yet via `cuCtxEnablePeerAccess()`.

#### **CUDA\_ERROR\_PRIMARY\_CONTEXT\_ACTIVE = 708**

This error indicates that the primary context for the specified device has already been initialized.

#### **CUDA\_ERROR\_CONTEXT\_IS\_DESTROYED = 709**

This error indicates that the context current to the calling thread has been destroyed using `cuCtxDestroy`, or is a primary context which has not yet been initialized.

#### **CUDA\_ERROR\_ASSERT = 710**

A device-side assert triggered during kernel execution. The context cannot be used anymore, and must be destroyed. All existing device memory allocations from this context are invalid and must be reconstructed if the program is to continue using CUDA.

#### **CUDA\_ERROR\_TOO\_MANY\_PEERS = 711**

This error indicates that the hardware resources required to enable peer access have been exhausted for one or more of the devices passed to `cuCtxEnablePeerAccess()`.

#### **CUDA\_ERROR\_HOST\_MEMORY\_ALREADY\_REGISTERED = 712**

This error indicates that the memory range passed to `cuMemHostRegister()` has already been registered.

#### **CUDA\_ERROR\_HOST\_MEMORY\_NOT\_REGISTERED = 713**

This error indicates that the pointer passed to `cuMemHostUnregister()` does not correspond to any currently registered memory region.

#### **CUDA\_ERROR\_HARDWARE\_STACK\_ERROR = 714**

While executing a kernel, the device encountered a stack error. This can be due to stack corruption or exceeding the stack size limit. This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

#### **CUDA\_ERROR\_ILLEGAL\_INSTRUCTION = 715**

While executing a kernel, the device encountered an illegal instruction. This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

#### **CUDA\_ERROR\_MISALIGNED\_ADDRESS = 716**

While executing a kernel, the device encountered a load or store instruction on a memory address which is not aligned. This leaves the process in an inconsistent state



and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

#### **CUDA\_ERROR\_INVALID\_ADDRESS\_SPACE = 717**

While executing a kernel, the device encountered an instruction which can only operate on memory locations in certain address spaces (global, shared, or local), but was supplied a memory address not belonging to an allowed address space. This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

#### **CUDA\_ERROR\_INVALID\_PC = 718**

While executing a kernel, the device program counter wrapped its address space. This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

#### **CUDA\_ERROR\_LAUNCH\_FAILED = 719**

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. Less common cases can be system specific - more information about these cases can be found in the system specific user guide. This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

#### **CUDA\_ERROR\_COOPERATIVE\_LAUNCH\_TOO\_LARGE = 720**

This error indicates that the number of blocks launched per grid for a kernel that was launched via either `cuLaunchCooperativeKernel` or `cuLaunchCooperativeKernelMultiDevice` exceeds the maximum number of blocks as allowed by `cuOccupancyMaxActiveBlocksPerMultiprocessor` or `cuOccupancyMaxActiveBlocksPerMultiprocessorWithFlags` times the number of multiprocessors as specified by the device attribute `CU_DEVICE_ATTRIBUTE_MULTIPROCESSOR_COUNT`.

#### **CUDA\_ERROR\_NOT\_PERMITTED = 800**

This error indicates that the attempted operation is not permitted.

#### **CUDA\_ERROR\_NOT\_SUPPORTED = 801**

This error indicates that the attempted operation is not supported on the current system or device.

#### **CUDA\_ERROR\_SYSTEM\_NOT\_READY = 802**

This error indicates that the system is not yet ready to start any CUDA work. To continue using CUDA, verify the system configuration is in a valid state and all required driver daemons are actively running. More information about this error can be found in the system specific user guide.

#### **CUDA\_ERROR\_SYSTEM\_DRIVER\_MISMATCH = 803**

This error indicates that there is a mismatch between the versions of the display driver and the CUDA driver. Refer to the compatibility documentation for supported versions.

**CUDA\_ERROR\_COMPAT\_NOT\_SUPPORTED\_ON\_DEVICE = 804**

This error indicates that the system was upgraded to run with forward compatibility but the visible hardware detected by CUDA does not support this configuration. Refer to the compatibility documentation for the supported hardware matrix or ensure that only supported hardware is visible during initialization via the `CUDA_VISIBLE_DEVICES` environment variable.

**CUDA\_ERROR\_STREAM\_CAPTURE\_UNSUPPORTED = 900**

This error indicates that the operation is not permitted when the stream is capturing.

**CUDA\_ERROR\_STREAM\_CAPTURE\_INVALIDATED = 901**

This error indicates that the current capture sequence on the stream has been invalidated due to a previous error.

**CUDA\_ERROR\_STREAM\_CAPTURE\_MERGE = 902**

This error indicates that the operation would have resulted in a merge of two independent capture sequences.

**CUDA\_ERROR\_STREAM\_CAPTURE\_UNMATCHED = 903**

This error indicates that the capture was not initiated in this stream.

**CUDA\_ERROR\_STREAM\_CAPTURE\_UNJOINED = 904**

This error indicates that the capture sequence contains a fork that was not joined to the primary stream.

**CUDA\_ERROR\_STREAM\_CAPTURE\_ISOLATION = 905**

This error indicates that a dependency would have been created which crosses the capture sequence boundary. Only implicit in-stream ordering dependencies are allowed to cross the boundary.

**CUDA\_ERROR\_STREAM\_CAPTURE\_IMPLICIT = 906**

This error indicates a disallowed implicit dependency on a current capture sequence from `cudaStreamLegacy`.

**CUDA\_ERROR\_CAPTURED\_EVENT = 907**

This error indicates that the operation is not permitted on an event which was last recorded in a capturing stream.

**CUDA\_ERROR\_STREAM\_CAPTURE\_WRONG\_THREAD = 908**

A stream capture sequence not initiated with the `CU_STREAM_CAPTURE_MODE_RELAXED` argument to `cuStreamBeginCapture` was passed to `cuStreamEndCapture` in a different thread.

**CUDA\_ERROR\_TIMEOUT = 909**

This error indicates that the timeout specified for the wait operation has lapsed.

**CUDA\_ERROR\_GRAPH\_EXEC\_UPDATE\_FAILURE = 910**

This error indicates that the graph update was not performed because it included changes which violated constraints specific to instantiated graph update.

**CUDA\_ERROR\_UNKNOWN = 999**

This indicates that an unknown internal error has occurred.

## enum CUshared\_carveout

Shared memory carveout configurations. These may be passed to `cuFuncSetAttribute`

**Values****CU\_SHARED\_MEM\_CARVEOUT\_DEFAULT = -1**

No preference for shared memory or L1 (default)

**CU\_SHARED\_MEM\_CARVEOUT\_MAX\_SHARED = 100**

Prefer maximum available shared memory, minimum L1 cache

**CU\_SHARED\_MEM\_CARVEOUT\_MAX\_L1 = 0**

Prefer maximum available L1 cache, minimum shared memory

## enum CUsharedconfig

Shared memory configurations

**Values****CU\_SHARED\_MEM\_CONFIG\_DEFAULT\_BANK\_SIZE = 0x00**

set default shared memory bank size

**CU\_SHARED\_MEM\_CONFIG\_FOUR\_BYTE\_BANK\_SIZE = 0x01**

set shared memory bank width to four bytes

**CU\_SHARED\_MEM\_CONFIG\_EIGHT\_BYTE\_BANK\_SIZE = 0x02**

set shared memory bank width to eight bytes

## enum CUstream\_flags

Stream creation flags

**Values****CU\_STREAM\_DEFAULT = 0x0**

Default stream flag

**CU\_STREAM\_NON\_BLOCKING = 0x1**

Stream does not synchronize with stream 0 (the NULL stream)

## enum CUstreamAttrID

Stream Attributes

**Values****CU\_STREAM\_ATTRIBUTE\_ACCESS\_POLICY\_WINDOW = 1**Identifier for [CUstreamAttrValue::accessPolicyWindow](#).**CU\_STREAM\_ATTRIBUTE\_SYNCHRONIZATION\_POLICY = 3**

CUSynchronizationPolicy for work queued up in this stream

## enum CUstreamBatchMemOpType

Operations for [cuStreamBatchMemOp](#)

## Values

**CU\_STREAM\_MEM\_OP\_WAIT\_VALUE\_32 = 1**

Represents a [cuStreamWaitValue32](#) operation

**CU\_STREAM\_MEM\_OP\_WRITE\_VALUE\_32 = 2**

Represents a [cuStreamWriteValue32](#) operation

**CU\_STREAM\_MEM\_OP\_WAIT\_VALUE\_64 = 4**

Represents a [cuStreamWaitValue64](#) operation

**CU\_STREAM\_MEM\_OP\_WRITE\_VALUE\_64 = 5**

Represents a [cuStreamWriteValue64](#) operation

**CU\_STREAM\_MEM\_OP\_FLUSH\_REMOTE\_WRITES = 3**

This has the same effect as [CU\\_STREAM\\_WAIT\\_VALUE\\_FLUSH](#), but as a standalone operation.

## enum CUstreamCaptureMode

Possible modes for stream capture thread interactions. For more details see [cuStreamBeginCapture](#) and [cuThreadExchangeStreamCaptureMode](#)

### Values

**CU\_STREAM\_CAPTURE\_MODE\_GLOBAL = 0**

**CU\_STREAM\_CAPTURE\_MODE\_THREAD\_LOCAL = 1**

**CU\_STREAM\_CAPTURE\_MODE\_RELAXED = 2**

## enum CUstreamCaptureStatus

Possible stream capture statuses returned by [cuStreamIsCapturing](#)

### Values

**CU\_STREAM\_CAPTURE\_STATUS\_NONE = 0**

Stream is not capturing

**CU\_STREAM\_CAPTURE\_STATUS\_ACTIVE = 1**

Stream is actively capturing

**CU\_STREAM\_CAPTURE\_STATUS\_INVALIDATED = 2**

Stream is part of a capture sequence that has been invalidated, but not terminated

## enum CUstreamWaitValue\_flags

Flags for [cuStreamWaitValue32](#) and [cuStreamWaitValue64](#)

### Values

**CU\_STREAM\_WAIT\_VALUE\_GEQ = 0x0**

Wait until (int32\_t)(\*addr - value) >= 0 (or int64\_t for 64 bit values). Note this is a cyclic comparison which ignores wraparound. (Default behavior.)

**CU\_STREAM\_WAIT\_VALUE\_EQ = 0x1**

Wait until `*addr == value`.

**CU\_STREAM\_WAIT\_VALUE\_AND = 0x2**

Wait until `(*addr & value) != 0`.

**CU\_STREAM\_WAIT\_VALUE\_NOR = 0x3**

Wait until `~(*addr | value) != 0`. Support for this operation can be queried with `cuDeviceGetAttribute()` and

`CU_DEVICE_ATTRIBUTE_CAN_USE_STREAM_WAIT_VALUE_NOR`.

**CU\_STREAM\_WAIT\_VALUE\_FLUSH = 1<<30**

Follow the wait operation with a flush of outstanding remote writes. This means that, if a remote write operation is guaranteed to have reached the device before the wait can be satisfied, that write is guaranteed to be visible to downstream device work. The device is permitted to reorder remote writes internally. For example, this flag would be required if two remote writes arrive in a defined order, the wait is satisfied by the second write, and downstream work needs to observe the first write. Support for this operation is restricted to selected platforms and can be queried with `CU_DEVICE_ATTRIBUTE_CAN_USE_WAIT_VALUE_FLUSH`.

## enum CUstreamWriteValue\_flags

Flags for `cuStreamWriteValue32`

### Values

**CU\_STREAM\_WRITE\_VALUE\_DEFAULT = 0x0**

Default behavior

**CU\_STREAM\_WRITE\_VALUE\_NO\_MEMORY\_BARRIER = 0x1**

Permits the write to be reordered with writes which were issued before it, as a performance optimization. Normally, `cuStreamWriteValue32` will provide a memory fence before the write, which has similar semantics to `__threadfence_system()` but is scoped to the stream rather than a CUDA thread.

## typedef struct CUarray\_st \*CUarray

CUDA array

## typedef struct CUctx\_st \*CUcontext

CUDA context

## typedef int CUdevice

CUDA device

**typedef unsigned int CUdeviceptr**

CUDA device pointer CUdeviceptr is defined as an unsigned integer type whose size matches the size of a pointer on the target platform.

**typedef struct CUeglStreamConnection\_st  
\*CUeglStreamConnection**

CUDA EGLStream Connection

**typedef struct CUevent\_st \*CUevent**

CUDA event

**typedef struct CUextMemory\_st \*CUexternalMemory**

CUDA external memory

**typedef struct CUextSemaphore\_st  
\*CUexternalSemaphore**

CUDA external semaphore

**typedef struct CUfunc\_st \*CUfunction**

CUDA function

**typedef struct CUgraph\_st \*CUgraph**

CUDA graph

**typedef struct CUgraphExec\_st \*CUgraphExec**

CUDA executable graph

**typedef struct CUgraphicsResource\_st  
\*CUgraphicsResource**

CUDA graphics interop resource

**typedef struct CUgraphNode\_st \*CUgraphNode**

CUDA graph node

```
typedef void (CUDA_CB *CUhostFn) (void* userData)
```

CUDA host function

```
typedef struct CUmipmappedArray_st  
*CUmipmappedArray
```

CUDA mipmapped array

```
typedef struct CUmod_st *CUmodule
```

CUDA module

```
typedef size_t (CUDA_CB *CUoccupancyB2DSize) (int  
blockSize)
```

Block size to per-block dynamic shared memory mapping for a certain kernel

```
typedef struct CUstream_st *CUstream
```

CUDA stream

```
typedef void (CUDA_CB *CUstreamCallback) (CUstream  
hStream, CUresult status, void* userData)
```

CUDA stream callback

```
typedef unsigned long long CUsurfObject
```

An opaque value that represents a CUDA surface object

```
typedef struct CUsurfref_st *CUsurfref
```

CUDA surface reference

```
typedef unsigned long long CUTexObject
```

An opaque value that represents a CUDA texture object

```
typedef struct CUTexref_st *CUTexref
```

CUDA texture reference

```
#define CU_DEVICE_CPU ((CUdevice)-1)
```

Device that represents the CPU

```
#define CU_DEVICE_INVALID ((CUdevice)-2)
```

Device that represents an invalid device

```
#define CU_IPC_HANDLE_SIZE 64
```

CUDA IPC handle size

```
#define CU_LAUNCH_PARAM_BUFFER_POINTER  
((void*)0x01)
```

Indicator that the next value in the `extra` parameter to `cuLaunchKernel` will be a pointer to a buffer containing all kernel parameters used for launching kernel `f`. This buffer needs to honor all alignment/padding requirements of the individual parameters. If `CU_LAUNCH_PARAM_BUFFER_SIZE` is not also specified in the `extra` array, then `CU_LAUNCH_PARAM_BUFFER_POINTER` will have no effect.

```
#define CU_LAUNCH_PARAM_BUFFER_SIZE ((void*)0x02)
```

Indicator that the next value in the `extra` parameter to `cuLaunchKernel` will be a pointer to a `size_t` which contains the size of the buffer specified with `CU_LAUNCH_PARAM_BUFFER_POINTER`. It is required that `CU_LAUNCH_PARAM_BUFFER_POINTER` also be specified in the `extra` array if the value associated with `CU_LAUNCH_PARAM_BUFFER_SIZE` is not zero.

```
#define CU_LAUNCH_PARAM_END ((void*)0x00)
```

End of array terminator for the `extra` parameter to `cuLaunchKernel`

```
#define CU_MEMHOSTALLOC_DEVICEMAP 0x02
```

If set, host memory is mapped into CUDA address space and `cuMemHostGetDevicePointer()` may be called on the host pointer. Flag for `cuMemHostAlloc()`

```
#define CU_MEMHOSTALLOC_PORTABLE 0x01
```

If set, host memory is portable between CUDA contexts. Flag for `cuMemHostAlloc()`



## **#define CU\_MEMHOSTALLOC\_WRITECOMBINED 0x04**

If set, host memory is allocated as write-combined - fast to write, faster to DMA, slow to read except via SSE4 streaming load instruction (MOVNTDQA). Flag for `cuMemHostAlloc()`

## **#define CU\_MEMHOSTREGISTER\_DEVICEMAP 0x02**

If set, host memory is mapped into CUDA address space and `cuMemHostGetDevicePointer()` may be called on the host pointer. Flag for `cuMemHostRegister()`

## **#define CU\_MEMHOSTREGISTER\_IOMEMORY 0x04**

If set, the passed memory pointer is treated as pointing to some memory-mapped I/O space, e.g. belonging to a third-party PCIe device. On Windows the flag is a no-op. On Linux that memory is marked as non cache-coherent for the GPU and is expected to be physically contiguous. It may return `CUDA_ERROR_NOT_PERMITTED` if run as an unprivileged user, `CUDA_ERROR_NOT_SUPPORTED` on older Linux kernel versions. On all other platforms, it is not supported and `CUDA_ERROR_NOT_SUPPORTED` is returned. Flag for `cuMemHostRegister()`

## **#define CU\_MEMHOSTREGISTER\_PORTABLE 0x01**

If set, host memory is portable between CUDA contexts. Flag for `cuMemHostRegister()`

## **#define CU\_PARAM\_TR\_DEFAULT -1**

For texture references loaded into the module, use default texunit from texture reference.

## **#define CU\_STREAM\_LEGACY ((CUstream)0x1)**

Legacy stream handle

Stream handle that can be passed as a `CUstream` to use an implicit stream with legacy synchronization behavior.

See details of the [synchronization behavior](#).

## **#define CU\_STREAM\_PER\_THREAD ((CUstream)0x2)**

Per-thread stream handle

Stream handle that can be passed as a `CUstream` to use an implicit stream with per-thread synchronization behavior.

See details of the [synchronization](#) behavior.

## **#define CU\_TRSA\_OVERRIDE\_FORMAT 0x01**

Override the texref format with a format inferred from the array. Flag for [cuTexRefSetArray\(\)](#)

## **#define CU\_TRSF\_DISABLE\_TRILINEAR\_OPTIMIZATION 0x20**

Disable any trilinear filtering optimizations. Flag for [cuTexRefSetFlags\(\)](#) and [cuTexObjectCreate\(\)](#)

## **#define CU\_TRSF\_NORMALIZED\_COORDINATES 0x02**

Use normalized texture coordinates in the range [0,1) instead of [0,dim). Flag for [cuTexRefSetFlags\(\)](#) and [cuTexObjectCreate\(\)](#)

## **#define CU\_TRSF\_READ\_AS\_INTEGER 0x01**

Read the texture as integers rather than promoting the values to floats in the range [0,1]. Flag for [cuTexRefSetFlags\(\)](#) and [cuTexObjectCreate\(\)](#)

## **#define CU\_TRSF\_SRGB 0x10**

Perform sRGB->linear conversion during texture read. Flag for [cuTexRefSetFlags\(\)](#) and [cuTexObjectCreate\(\)](#)

## **#define CUDA\_ARRAY3D\_2DARRAY 0x01**

Deprecated, use [CUDA\\_ARRAY3D\\_LAYERED](#)

## **#define CUDA\_ARRAY3D\_COLOR\_ATTACHMENT 0x20**

This flag indicates that the CUDA array may be bound as a color target in an external graphics API

## **#define CUDA\_ARRAY3D\_CUBEMAP 0x04**

If set, the CUDA array is a collection of six 2D arrays, representing faces of a cube. The width of such a CUDA array must be equal to its height, and Depth must be six. If [CUDA\\_ARRAY3D\\_LAYERED](#) flag is also set, then the CUDA array is a collection of cubemaps and Depth must be a multiple of six.

## **#define CUDA\_ARRAY3D\_DEPTH\_TEXTURE 0x10**

This flag if set indicates that the CUDA array is a DEPTH\_TEXTURE.

## **#define CUDA\_ARRAY3D\_LAYERED 0x01**

If set, the CUDA array is a collection of layers, where each layer is either a 1D or a 2D array and the Depth member of [CUDA\\_ARRAY3D\\_DESCRIPTOR](#) specifies the number of layers, not the depth of a 3D array.

## **#define CUDA\_ARRAY3D\_SURFACE\_LDST 0x02**

This flag must be set in order to bind a surface reference to the CUDA array

## **#define CUDA\_ARRAY3D\_TEXTURE\_GATHER 0x08**

This flag must be set in order to perform texture gather operations on a CUDA array.

## **#define**

## **CUDA\_COOPERATIVE\_LAUNCH\_MULTI\_DEVICE\_NO\_POST\_LAUNCH\_SYNC 0x02**

If set, any subsequent work pushed in a stream that participated in a call to [cuLaunchCooperativeKernelMultiDevice](#) will only wait for the kernel launched on the GPU corresponding to that stream to complete before it begins execution.

## **#define**

## **CUDA\_COOPERATIVE\_LAUNCH\_MULTI\_DEVICE\_NO\_PRE\_LAUNCH\_SYNC 0x01**

If set, each kernel launched as part of [cuLaunchCooperativeKernelMultiDevice](#) only waits for prior work in the stream corresponding to that GPU to complete before the kernel begins execution.

## **#define CUDA\_EXTERNAL\_MEMORY\_DEDICATED 0x1**

Indicates that the external memory object is a dedicated resource

**#define**

**CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_SKIP\_NVSCIBUF\_MEMSYNC**  
**0x01**

When the /p flags parameter of `CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS` contains this flag, it indicates that signaling an external semaphore object should skip performing appropriate memory synchronization operations over all the external memory objects that are imported as `CU_EXTERNAL_MEMORY_HANDLE_TYPE_NVSCIBUF`, which otherwise are performed by default to ensure data coherency with other importers of the same NvSciBuf memory objects.

**#define**

**CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_SKIP\_NVSCIBUF\_MEMSYNC**  
**0x02**

When the /p flags parameter of `CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS` contains this flag, it indicates that waiting on an external semaphore object should skip performing appropriate memory synchronization operations over all the external memory objects that are imported as `CU_EXTERNAL_MEMORY_HANDLE_TYPE_NVSCIBUF`, which otherwise are performed by default to ensure data coherency with other importers of the same NvSciBuf memory objects.

**#define CUDA\_NVSCISYNC\_ATTR\_SIGNAL 0x1**

When /p flags of `cuDeviceGetNvSciSyncAttributes` is set to this, it indicates that application needs signaler specific NvSciSyncAttr to be filled by `cuDeviceGetNvSciSyncAttributes`.

**#define CUDA\_NVSCISYNC\_ATTR\_WAIT 0x2**

When /p flags of `cuDeviceGetNvSciSyncAttributes` is set to this, it indicates that application needs waiter specific NvSciSyncAttr to be filled by `cuDeviceGetNvSciSyncAttributes`.

**#define CUDA\_VERSION 11000**

CUDA API version number

## #define MAX\_PLANES 3

Maximum number of planes per frame

## 5.2. Error Handling

This section describes the error handling functions of the low-level CUDA driver application programming interface.

### CUresult cuGetErrorName (CUresult error, const char \*\*pStr)

Gets the string representation of an error code enum name.

#### Parameters

##### error

- Error code to convert to string

##### pStr

- Address of the string pointer.

#### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE

#### Description

Sets \*pStr to the address of a NULL-terminated string representation of the name of the enum error code error. If the error code is not recognized, CUDA\_ERROR\_INVALID\_VALUE will be returned and \*pStr will be set to the NULL address.

#### See also:

CUresult, cudaGetErrorName

### CUresult cuGetErrorString (CUresult error, const char \*\*pStr)

Gets the string description of an error code.

#### Parameters

##### error

- Error code to convert to string

**pStr**

- Address of the string pointer.

**Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_VALUE`

**Description**

Sets \*pStr to the address of a NULL-terminated string description of the error code `error`. If the error code is not recognized, `CUDA_ERROR_INVALID_VALUE` will be returned and \*pStr will be set to the NULL address.

**See also:**

`CUresult`, `cudaGetErrorString`

## 5.3. Initialization

This section describes the initialization functions of the low-level CUDA driver application programming interface.

### CUresult culnit (unsigned int Flags)

Initialize the CUDA driver API.

**Parameters****Flags**

- Initialization flag for CUDA.

**Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_VALUE`,  
`CUDA_ERROR_INVALID_DEVICE`, `CUDA_ERROR_SYSTEM_DRIVER_MISMATCH`,  
`CUDA_ERROR_COMPAT_NOT_SUPPORTED_ON_DEVICE`

**Description**

Initializes the driver API and must be called before any other function from the driver API. Currently, the `Flags` parameter must be 0. If `culnit()` has not been called, any function from the driver API will return `CUDA_ERROR_NOT_INITIALIZED`.



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

## 5.4. Version Management

This section describes the version management functions of the low-level CUDA driver application programming interface.

### CUresult cuDriverGetVersion (int \*driverVersion)

Returns the latest CUDA version supported by driver.

#### Parameters

##### driverVersion

- Returns the CUDA driver version

#### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE

#### Description

Returns in \*driverVersion the version of CUDA supported by the driver. The version is returned as (1000 major + 10 minor). For example, CUDA 9.2 would be represented by 9020.

This function automatically returns CUDA\_ERROR\_INVALID\_VALUE if driverVersion is NULL.



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

#### See also:

[cudaDriverGetVersion](#), [cudaRuntimeGetVersion](#)

## 5.5. Device Management

This section describes the device management functions of the low-level CUDA driver application programming interface.

## CUresult cuDeviceGet (CUdevice \*device, int ordinal)

Returns a handle to a compute device.

### Parameters

#### device

- Returned device handle

#### ordinal

- Device number to get handle for

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_DEVICE

### Description

Returns in \*device a device handle given an ordinal in the range [0, **cuDeviceGetCount()-1**].



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

### See also:

cuDeviceGetAttribute, cuDeviceGetCount, cuDeviceGetName, cuDeviceGetUuid,  
cuDeviceGetLuid, cuDeviceTotalMem

## CUresult cuDeviceGetAttribute (int \*pi, CUdevice\_attribute attrib, CUdevice dev)

Returns information about the device.

### Parameters

#### pi

- Returned device attribute value

#### attrib

- Device attribute to query

#### dev

- Device handle



## Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_DEVICE

## Description

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

- ▶ `CU_DEVICE_ATTRIBUTE_MAX_THREADS_PER_BLOCK`: Maximum number of threads per block;
- ▶ `CU_DEVICE_ATTRIBUTE_MAX_BLOCK_DIM_X`: Maximum x-dimension of a block;
- ▶ `CU_DEVICE_ATTRIBUTE_MAX_BLOCK_DIM_Y`: Maximum y-dimension of a block;
- ▶ `CU_DEVICE_ATTRIBUTE_MAX_BLOCK_DIM_Z`: Maximum z-dimension of a block;
- ▶ `CU_DEVICE_ATTRIBUTE_MAX_GRID_DIM_X`: Maximum x-dimension of a grid;
- ▶ `CU_DEVICE_ATTRIBUTE_MAX_GRID_DIM_Y`: Maximum y-dimension of a grid;
- ▶ `CU_DEVICE_ATTRIBUTE_MAX_GRID_DIM_Z`: Maximum z-dimension of a grid;
- ▶ `CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_BLOCK`: Maximum amount of shared memory available to a thread block in bytes;
- ▶ `CU_DEVICE_ATTRIBUTE_TOTAL_CONSTANT_MEMORY`: Memory available on device for `__constant__` variables in a CUDA C kernel in bytes;
- ▶ `CU_DEVICE_ATTRIBUTE_WARP_SIZE`: Warp size in threads;
- ▶ `CU_DEVICE_ATTRIBUTE_MAX_PITCH`: Maximum pitch in bytes allowed by the memory copy functions that involve memory regions allocated through `cuMemAllocPitch()`;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_WIDTH`: Maximum 1D texture width;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_LINEAR_WIDTH`: Maximum width for a 1D texture bound to linear memory;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_MIPMAPPED_WIDTH`: Maximum mipmapped 1D texture width;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_WIDTH`: Maximum 2D texture width;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_HEIGHT`: Maximum 2D texture height;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_WIDTH`: Maximum width for a 2D texture bound to linear memory;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_HEIGHT`: Maximum height for a 2D texture bound to linear memory;

- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_PITCH`: Maximum pitch in bytes for a 2D texture bound to linear memory;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_MIPMAPPED_WIDTH`: Maximum mipmapped 2D texture width;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_MIPMAPPED_HEIGHT`: Maximum mipmapped 2D texture height;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE3D_WIDTH`: Maximum 3D texture width;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE3D_HEIGHT`: Maximum 3D texture height;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE3D_DEPTH`: Maximum 3D texture depth;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE3D_WIDTH_ALTERNATE`: Alternate maximum 3D texture width, 0 if no alternate maximum 3D texture size is supported;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE3D_HEIGHT_ALTERNATE`: Alternate maximum 3D texture height, 0 if no alternate maximum 3D texture size is supported;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE3D_DEPTH_ALTERNATE`: Alternate maximum 3D texture depth, 0 if no alternate maximum 3D texture size is supported;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURECUBEMAP_WIDTH`: Maximum cubemap texture width or height;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_LAYERED_WIDTH`: Maximum 1D layered texture width;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_LAYERED_LAYERS`: Maximum layers in a 1D layered texture;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LAYERED_WIDTH`: Maximum 2D layered texture width;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LAYERED_HEIGHT`: Maximum 2D layered texture height;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LAYERED_LAYERS`: Maximum layers in a 2D layered texture;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURECUBEMAP_LAYERED_WIDTH`: Maximum cubemap layered texture width or height;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURECUBEMAP_LAYERED_LAYERS`: Maximum layers in a cubemap layered texture;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE1D_WIDTH`: Maximum 1D surface width;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE2D_WIDTH`: Maximum 2D surface width;

- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE2D_HEIGHT`: Maximum 2D surface height;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE3D_WIDTH`: Maximum 3D surface width;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE3D_HEIGHT`: Maximum 3D surface height;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE3D_DEPTH`: Maximum 3D surface depth;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE1D_LAYERED_WIDTH`: Maximum 1D layered surface width;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE1D_LAYERED_LAYERS`: Maximum layers in a 1D layered surface;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE2D_LAYERED_WIDTH`: Maximum 2D layered surface width;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE2D_LAYERED_HEIGHT`: Maximum 2D layered surface height;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE2D_LAYERED_LAYERS`: Maximum layers in a 2D layered surface;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACECUBEMAP_WIDTH`: Maximum cubemap surface width;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACECUBEMAP_LAYERED_WIDTH`: Maximum cubemap layered surface width;
- ▶ `CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACECUBEMAP_LAYERED_LAYERS`: Maximum layers in a cubemap layered surface;
- ▶ `CU_DEVICE_ATTRIBUTE_MAX_REGISTERS_PER_BLOCK`: Maximum number of 32-bit registers available to a thread block;
- ▶ `CU_DEVICE_ATTRIBUTE_CLOCK_RATE`: The typical clock frequency in kilohertz;
- ▶ `CU_DEVICE_ATTRIBUTE_TEXTURE_ALIGNMENT`: Alignment requirement; texture base addresses aligned to `textureAlign` bytes do not need an offset applied to texture fetches;
- ▶ `CU_DEVICE_ATTRIBUTE_TEXTURE_PITCH_ALIGNMENT`: Pitch alignment requirement for 2D texture references bound to pitched memory;
- ▶ `CU_DEVICE_ATTRIBUTE_GPU_OVERLAP`: 1 if the device can concurrently copy memory between host and device while executing a kernel, or 0 if not;
- ▶ `CU_DEVICE_ATTRIBUTE_MULTIPROCESSOR_COUNT`: Number of multiprocessors on the device;
- ▶ `CU_DEVICE_ATTRIBUTE_KERNEL_EXEC_TIMEOUT`: 1 if there is a run time limit for kernels executed on the device, or 0 if not;
- ▶ `CU_DEVICE_ATTRIBUTE_INTEGRATED`: 1 if the device is integrated with the memory subsystem, or 0 if not;

- ▶ **CU\_DEVICE\_ATTRIBUTE\_CAN\_MAP\_HOST\_MEMORY**: 1 if the device can map host memory into the CUDA address space, or 0 if not;
- ▶ **CU\_DEVICE\_ATTRIBUTE\_COMPUTE\_MODE**: Compute mode that device is currently in. Available modes are as follows:
  - ▶ **CU\_COMPUTEMODE\_DEFAULT**: Default mode - Device is not restricted and can have multiple CUDA contexts present at a single time.
  - ▶ **CU\_COMPUTEMODE\_PROHIBITED**: Compute-prohibited mode - Device is prohibited from creating new CUDA contexts.
  - ▶ **CU\_COMPUTEMODE\_EXCLUSIVE\_PROCESS**: Compute-exclusive-process mode - Device can have only one context used by a single process at a time.
- ▶ **CU\_DEVICE\_ATTRIBUTE\_CONCURRENT\_KERNELS**: 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;
- ▶ **CU\_DEVICE\_ATTRIBUTE\_ECC\_ENABLED**: 1 if error correction is enabled on the device, 0 if error correction is disabled or not supported by the device;
- ▶ **CU\_DEVICE\_ATTRIBUTE\_PCI\_BUS\_ID**: PCI bus identifier of the device;
- ▶ **CU\_DEVICE\_ATTRIBUTE\_PCI\_DEVICE\_ID**: PCI device (also known as slot) identifier of the device;
- ▶ **CU\_DEVICE\_ATTRIBUTE\_PCI\_DOMAIN\_ID**: PCI domain identifier of the device
- ▶ **CU\_DEVICE\_ATTRIBUTE\_TCC\_DRIVER**: 1 if the device is using a TCC driver. TCC is only available on Tesla hardware running Windows Vista or later;
- ▶ **CU\_DEVICE\_ATTRIBUTE\_MEMORY\_CLOCK\_RATE**: Peak memory clock frequency in kilohertz;
- ▶ **CU\_DEVICE\_ATTRIBUTE\_GLOBAL\_MEMORY\_BUS\_WIDTH**: Global memory bus width in bits;
- ▶ **CU\_DEVICE\_ATTRIBUTE\_L2\_CACHE\_SIZE**: Size of L2 cache in bytes. 0 if the device doesn't have L2 cache;
- ▶ **CU\_DEVICE\_ATTRIBUTE\_MAX\_THREADS\_PER\_MULTIPROCESSOR**: Maximum resident threads per multiprocessor;
- ▶ **CU\_DEVICE\_ATTRIBUTE\_UNIFIED\_ADDRESSING**: 1 if the device shares a unified address space with the host, or 0 if not;
- ▶ **CU\_DEVICE\_ATTRIBUTE\_COMPUTE\_CAPABILITY\_MAJOR**: Major compute capability version number;
- ▶ **CU\_DEVICE\_ATTRIBUTE\_COMPUTE\_CAPABILITY\_MINOR**: Minor compute capability version number;
- ▶ **CU\_DEVICE\_ATTRIBUTE\_GLOBAL\_L1\_CACHE\_SUPPORTED**: 1 if device supports caching globals in L1 cache, 0 if caching globals in L1 cache is not supported by the device;

- ▶ **CU\_DEVICE\_ATTRIBUTE\_LOCAL\_L1\_CACHE\_SUPPORTED:** 1 if device supports caching locals in L1 cache, 0 if caching locals in L1 cache is not supported by the device;
- ▶ **CU\_DEVICE\_ATTRIBUTE\_MAX\_SHARED\_MEMORY\_PER\_MULTIPROCESSOR:** Maximum amount of shared memory available to a multiprocessor in bytes; this amount is shared by all thread blocks simultaneously resident on a multiprocessor;
- ▶ **CU\_DEVICE\_ATTRIBUTE\_MAX\_REGISTERS\_PER\_MULTIPROCESSOR:** Maximum number of 32-bit registers available to a multiprocessor; this number is shared by all thread blocks simultaneously resident on a multiprocessor;
- ▶ **CU\_DEVICE\_ATTRIBUTE\_MANAGED\_MEMORY:** 1 if device supports allocating managed memory on this system, 0 if allocating managed memory is not supported by the device on this system.
- ▶ **CU\_DEVICE\_ATTRIBUTE\_MULTI\_GPU\_BOARD:** 1 if device is on a multi-GPU board, 0 if not.
- ▶ **CU\_DEVICE\_ATTRIBUTE\_MULTI\_GPU\_BOARD\_GROUP\_ID:** Unique identifier for a group of devices associated with the same board. Devices on the same multi-GPU board will share the same identifier.
- ▶ **CU\_DEVICE\_ATTRIBUTE\_HOST\_NATIVE\_ATOMIC\_SUPPORTED:** 1 if Link between the device and the host supports native atomic operations.
- ▶ **CU\_DEVICE\_ATTRIBUTE\_SINGLE\_TO\_DOUBLE\_PRECISION\_PERF\_RATIO:** Ratio of single precision performance (in floating-point operations per second) to double precision performance.
- ▶ **CU\_DEVICE\_ATTRIBUTE\_PAGEABLE\_MEMORY\_ACCESS:** Device supports coherently accessing pageable memory without calling `cudaHostRegister` on it.
- ▶ **CU\_DEVICE\_ATTRIBUTE\_CONCURRENT\_MANAGED\_ACCESS:** Device can coherently access managed memory concurrently with the CPU.
- ▶ **CU\_DEVICE\_ATTRIBUTE\_COMPUTE\_PREEMPTION\_SUPPORTED:** Device supports Compute Preemption.
- ▶ **CU\_DEVICE\_ATTRIBUTE\_CAN\_USE\_HOST\_POINTER\_FOR\_REGISTERED\_MEM:** Device can access host registered memory at the same virtual address as the CPU.
- ▶ **CU\_DEVICE\_ATTRIBUTE\_MAX\_SHARED\_MEMORY\_PER\_BLOCK\_OPTIN:** The maximum per block shared memory size supported on this device. This is the maximum value that can be opted into when using the `cuFuncSetAttribute()` call. For more details see **CU\_FUNC\_ATTRIBUTE\_MAX\_DYNAMIC\_SHARED\_SIZE\_BYTES**
- ▶ **CU\_DEVICE\_ATTRIBUTE\_PAGEABLE\_MEMORY\_ACCESS\_USES\_HOST\_PAGE\_TABLES:** Device accesses pageable memory via the host's page tables.
- ▶ **CU\_DEVICE\_ATTRIBUTE\_DIRECT\_MANAGED\_MEM\_ACCESS\_FROM\_HOST:** The host can directly access managed memory on the device without migration.
- ▶ **CU\_DEVICE\_ATTRIBUTE\_VIRTUAL\_ADDRESS\_MANAGEMENT\_SUPPORTED:** Device supports virtual address management APIs like `cuMemAddressReserve`, `cuMemCreate`, `cuMemMap` and related APIs

- ▶ **CU\_DEVICE\_ATTRIBUTE\_HANDLE\_TYPE\_POSIX\_FILE\_DESCRIPTOR\_SUPPORTED:**  
Device supports exporting memory to a posix file descriptor with `cuMemExportToShareableHandle`, if requested via `cuMemCreate`
- ▶ **CU\_DEVICE\_ATTRIBUTE\_HANDLE\_TYPE\_WIN32\_HANDLE\_SUPPORTED:**  
Device supports exporting memory to a Win32 NT handle with `cuMemExportToShareableHandle`, if requested via `cuMemCreate`
- ▶ **CU\_DEVICE\_ATTRIBUTE\_HANDLE\_TYPE\_WIN32\_KMT\_HANDLE\_SUPPORTED:**  
Device supports exporting memory to a Win32 KMT handle with `cuMemExportToShareableHandle`, if requested via `cuMemCreate`
- ▶ **CU\_DEVICE\_ATTRIBUTE\_MAX\_PERSISTING\_L2\_CACHE\_SIZE:** maximum L2 cache size in byte for persisting lines
- ▶ **CU\_DEVICE\_ATTRIBUTE\_MAX\_BLOCKS\_PER\_MULTIPROCESSOR:** Maximum number of thread blocks that can reside on a multiprocessor.
- ▶ **CU\_DEVICE\_ATTRIBUTE\_GENERIC\_COMPRESSION\_SUPPORTED:** Device supports compressible memory allocation via `cuMemCreate`
- ▶ **CU\_DEVICE\_ATTRIBUTE\_RESERVED\_SHARED\_MEMORY\_PER\_BLOCK:** Amount of shared memory per block reserved by CUDA driver in bytes.



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

#### See also:

`cuDeviceGetCount`, `cuDeviceGetName`, `cuDeviceGetUuid`, `cuDeviceGet`, `cuDeviceTotalMem`, `cudaDeviceGetAttribute`, `cudaGetDeviceProperties`

## CUresult cuDeviceGetCount (int \*count)

Returns the number of compute-capable devices.

#### Parameters

##### count

- Returned number of compute-capable devices

#### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`

## Description

Returns in `*count` the number of devices with compute capability greater than or equal to 2.0 that are available for execution. If there is no such device, `cuDeviceGetCount()` returns 0.



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

## See also:

`cuDeviceGetAttribute`, `cuDeviceGetName`, `cuDeviceGetUuid`, `cuDeviceGetLuid`, `cuDeviceGet`, `cuDeviceTotalMem`, `cudaGetDeviceCount`

## CUresult cuDeviceGetLuid (char \*luid, unsigned int \*deviceNodeMask, CUdevice dev)

Return an LUID and device node mask for the device.

## Parameters

### luid

- Returned LUID

### deviceNodeMask

- Returned device node mask

### dev

- Device to get identifier string for

## Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_VALUE`,  
`CUDA_ERROR_INVALID_DEVICE`

## Description

Return identifying information (`luid` and `deviceNodeMask`) to allow matching device with graphics APIs.



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

## See also:



[cuDeviceGetAttribute](#), [cuDeviceGetCount](#), [cuDeviceGetName](#), [cuDeviceGet](#), [cuDeviceTotalMem](#), [cudaGetDeviceProperties](#)

## CUresult cuDeviceGetName (char \*name, int len, CUdevice dev)

Returns an identifier string for the device.

### Parameters

#### name

- Returned identifier string for the device

#### len

- Maximum length of string to store in name

#### dev

- Device to get identifier string for

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#), [CUDA\\_ERROR\\_INVALID\\_DEVICE](#)

### Description

Returns an ASCII string identifying the device `dev` in the NULL-terminated string pointed to by `name`. `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:

[cuDeviceGetAttribute](#), [cuDeviceGetUuid](#), [cuDeviceGetLuid](#), [cuDeviceGetCount](#),  
[cuDeviceGet](#), [cuDeviceTotalMem](#), [cudaGetDeviceProperties](#)



## CUresult cuDeviceGetNvSciSyncAttributes (void \*nvSciSyncAttrList, CUdevice dev, int flags)

Return NvSciSync attributes that this device can support.

### Parameters

#### **nvSciSyncAttrList**

- Return NvSciSync attributes supported.

#### **dev**

- Valid Cuda Device to get NvSciSync attributes for.

#### **flags**

- flags describing NvSciSync usage.

### Description

Returns in `nvSciSyncAttrList`, the properties of NvSciSync that this CUDA device, `dev` can support. The returned `nvSciSyncAttrList` can be used to create an NvSciSync object that matches this device's capabilities.

If `NvSciSyncAttrKey_RequiredPerm` field in `nvSciSyncAttrList` is already set this API will return `CUDA_ERROR_INVALID_VALUE`.

The applications should set `nvSciSyncAttrList` to a valid NvSciSyncAttrList failing which this API will return `CUDA_ERROR_INVALID_HANDLE`.

The `flags` controls how applications intends to use the NvSciSync created from the `nvSciSyncAttrList`. The valid flags are:

- ▶ `CUDA_NVSCISYNC_ATTR_SIGNAL`, specifies that the applications intends to signal an NvSciSync on this CUDA device.
- ▶ `CUDA_NVSCISYNC_ATTR_WAIT`, specifies that the applications intends to wait on an NvSciSync on this CUDA device.

At least one of these flags must be set, failing which the API returns `CUDA_ERROR_INVALID_VALUE`. Both the flags are orthogonal to one another: a developer may set both these flags that allows to set both wait and signal specific attributes in the same `nvSciSyncAttrList`.

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_VALUE`,  
`CUDA_ERROR_INVALID_HANDLE`, `CUDA_ERROR_INVALID_DEVICE`,  
`CUDA_ERROR_NOT_SUPPORTED`, `CUDA_ERROR_OUT_OF_MEMORY`

### See also:

`cuImportExternalSemaphore`, `cuDestroyExternalSemaphore`,  
`cuSignalExternalSemaphoresAsync`, `cuWaitExternalSemaphoresAsync`

## CUresult cuDeviceGetUuid (CUuuid \*uuid, CUdevice dev)

Return an UUID for the device.

### Parameters

#### uuid

- Returned UUID

#### dev

- Device to get identifier string for

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_INVALID\_DEVICE

### Description

Returns 16-octets identifying the device dev in the structure pointed by the uuid.



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

### See also:

cuDeviceGetAttribute, cuDeviceGetCount, cuDeviceGetName, cuDeviceGetLuid,  
cuDeviceGet, cuDeviceTotalMem, cudaGetDeviceProperties

## CUresult cuDeviceTotalMem (size\_t \*bytes, CUdevice dev)

Returns the total amount of memory on the device.

### Parameters

#### bytes

- Returned memory available on device in bytes

#### dev

- Device handle

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_DEVICE

**Description**

Returns in `*bytes` the total amount of memory available on the device `dev` in bytes.



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

**See also:**

`cuDeviceGetAttribute`, `cuDeviceGetCount`, `cuDeviceGetName`, `cuDeviceGetUuid`,  
`cuDeviceGet`, `cudaMemGetInfo`

## 5.6. Device Management [DEPRECATED]

This section describes the device management functions of the low-level CUDA driver application programming interface.

### CUresult cuDeviceComputeCapability (int \*major, int \*minor, CUdevice dev)

Returns the compute capability of the device.

**Parameters****major**

- Major revision number

**minor**

- Minor revision number

**dev**

- Device handle

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_DEVICE

## Description

### Deprecated

This function was deprecated as of CUDA 5.0 and its functionality superseded by `cuDeviceGetAttribute()`.

Returns in `*major` and `*minor` the major and minor revision numbers that define the compute capability of the device `dev`.



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

### See also:

`cuDeviceGetAttribute`, `cuDeviceGetCount`, `cuDeviceGetName`, `cuDeviceGetUuid`, `cuDeviceGet`, `cuDeviceTotalMem`

## CUresult cuDeviceGetProperties (CUdevprop \*prop, CUdevice dev)

Returns properties for a selected device.

### Parameters

#### **prop**

- Returned properties of device

#### **dev**

- Device to get properties for

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_DEVICE`

## Description

### Deprecated

This function was deprecated as of CUDA 5.0 and replaced by `cuDeviceGetAttribute()`.

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

```
typedef struct CUdevprop_st {
    int maxThreadsPerBlock;
    int maxThreadsDim[3];
    int maxGridSize[3];
    int sharedMemPerBlock;
    int totalConstantMemory;
    int SIMDWidth;
    int memPitch;
    int regsPerBlock;
    int clockRate;
    int textureAlign
} CUdevprop;
```

where:

- ▶ `maxThreadsPerBlock` is the maximum number of threads per block;
- ▶ `maxThreadsDim[3]` is the maximum sizes of each dimension of a block;
- ▶ `maxGridSize[3]` is the maximum sizes of each dimension of a grid;
- ▶ `sharedMemPerBlock` is the total amount of shared memory available per block in bytes;
- ▶ `totalConstantMemory` is the total amount of constant memory available on the device in bytes;
- ▶ `SIMDWidth` is the warp size;
- ▶ `memPitch` is the maximum pitch allowed by the memory copy functions that involve memory regions allocated through `cuMemAllocPitch()`;
- ▶ `regsPerBlock` is the total number of registers available per block;
- ▶ `clockRate` is the clock frequency in kilohertz;
- ▶ `textureAlign` is the alignment requirement; texture base addresses that are aligned to `textureAlign` bytes do not need an offset applied to texture fetches.



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

See also:

`cuDeviceGetAttribute`, `cuDeviceGetCount`, `cuDeviceGetName`, `cuDeviceGetUuid`, `cuDeviceGet`, `cuDeviceTotalMem`

## 5.7. Primary Context Management

This section describes the primary context management functions of the low-level CUDA driver application programming interface.

The primary context is unique per device and shared with the CUDA runtime API. These functions allow integration with other libraries using CUDA.

## CUresult cuDevicePrimaryCtxGetState (CUdevice dev, unsigned int \*flags, int \*active)

Get the state of the primary context.

### Parameters

#### dev

- Device to get primary context flags for

#### flags

- Pointer to store flags

#### active

- Pointer to store context state; 0 = inactive, 1 = active

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_DEVICE,  
CUDA\_ERROR\_INVALID\_VALUE,

### Description

Returns in `*flags` the flags for the primary context of `dev`, and in `*active` whether it is active. See [cuDevicePrimaryCtxSetFlags](#) for flag values.



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

### See also:

[cuDevicePrimaryCtxSetFlags](#), [cuCtxGetFlags](#), [cudaGetDeviceFlags](#)

## CUresult cuDevicePrimaryCtxRelease (CUdevice dev)

Release the primary context on the GPU.

### Parameters

#### dev

- Device which primary context is released

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_DEVICE

## Description

Releases the primary context interop on the device by decreasing the usage count by 1. If the usage drops to 0 the primary context of device `dev` will be destroyed regardless of how many threads it is current to.

Please note that unlike `cuCtxDestroy()` this method does not pop the context from stack in any circumstances.



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

## See also:

`cuDevicePrimaryCtxRetain`, `cuCtxDestroy`, `cuCtxGetApiVersion`, `cuCtxGetCacheConfig`, `cuCtxGetDevice`, `cuCtxGetFlags`, `cuCtxGetLimit`, `cuCtxPopCurrent`, `cuCtxPushCurrent`, `cuCtxSetCacheConfig`, `cuCtxSetLimit`, `cuCtxSynchronize`

## CUresult cuDevicePrimaryCtxReset (CUdevice dev)

Destroy all allocations and reset all state on the primary context.

## Parameters

### dev

- Device for which primary context is destroyed

## Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_DEVICE`,  
`CUDA_ERROR_PRIMARY_CONTEXT_ACTIVE`

## Description

Explicitly destroys and cleans up all resources associated with the current device in the current process.

Note that it is responsibility of the calling function to ensure that no other module in the process is using the device any more. For that reason it is recommended to use `cuDevicePrimaryCtxRelease()` in most cases. However it is safe for other modules to call `cuDevicePrimaryCtxRelease()` even after resetting the device.



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

**See also:**

[cuDevicePrimaryCtxRetain](#), [cuDevicePrimaryCtxRelease](#), [cuCtxGetApiVersion](#),  
[cuCtxGetCacheConfig](#), [cuCtxGetDevice](#), [cuCtxGetFlags](#), [cuCtxGetLimit](#),  
[cuCtxPopCurrent](#), [cuCtxPushCurrent](#), [cuCtxSetCacheConfig](#), [cuCtxSetLimit](#),  
[cuCtxSynchronize](#), [cudaDeviceReset](#)

## CUresult cuDevicePrimaryCtxRetain (CUcontext \*pctx, CUdevice dev)

Retain the primary context on the GPU.

**Parameters****pctx**

- Returned context handle of the new context

**dev**

- Device for which primary context is requested

**Returns**

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_DEVICE](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#),  
[CUDA\\_ERROR\\_OUT\\_OF\\_MEMORY](#), [CUDA\\_ERROR\\_UNKNOWN](#)

**Description**

Retains the primary context on the device, creating it if necessary, increasing its usage count. The caller must call [cuDevicePrimaryCtxRelease\(\)](#) when done using the context. Unlike [cuCtxCreate\(\)](#) the newly created context is not pushed onto the stack.

Context creation will fail with [CUDA\\_ERROR\\_UNKNOWN](#) if the compute mode of the device is [CU\\_COMPUTEMODE\\_PROHIBITED](#). The function [cuDeviceGetAttribute\(\)](#) can be used with [CU\\_DEVICE\\_ATTRIBUTE\\_COMPUTE\\_MODE](#) to determine the compute mode of the device. The nvidia-smi tool can be used to set the compute mode for devices. Documentation for nvidia-smi can be obtained by passing a -h option to it.

Please note that the primary context always supports pinned allocations. Other flags can be specified by [cuDevicePrimaryCtxSetFlags\(\)](#).



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

**See also:**



cuDevicePrimaryCtxRelease, cuDevicePrimaryCtxSetFlags, cuCtxCreate, cuCtxGetApiVersion, cuCtxGetCacheConfig, cuCtxGetDevice, cuCtxGetFlags, cuCtxGetLimit, cuCtxPopCurrent, cuCtxPushCurrent, cuCtxSetCacheConfig, cuCtxSetLimit, cuCtxSynchronize

## CUresult cuDevicePrimaryCtxSetFlags (CUdevice dev, unsigned int flags)

Set flags for the primary context.

### Parameters

**dev**

- Device for which the primary context flags are set

**flags**

- New flags for the device

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_DEVICE, CUDA\_ERROR\_INVALID\_VALUE,

### Description

Sets the flags for the primary context on the device overwriting perviously set ones.

The three LSBs of the `flags` parameter can be used to control how the OS thread, which owns the CUDA context at the time of an API call, interacts with the OS scheduler when waiting for results from the GPU. Only one of the scheduling flags can be set when creating a context.

- ▶ **CU\_CTX\_SCHED\_SPIN**: Instruct CUDA to actively spin when waiting for results from the GPU. This can decrease latency when waiting for the GPU, but may lower the performance of CPU threads if they are performing work in parallel with the CUDA thread.
- ▶ **CU\_CTX\_SCHED\_YIELD**: Instruct CUDA to yield its thread when waiting for results from the GPU. This can increase latency when waiting for the GPU, but can increase the performance of CPU threads performing work in parallel with the GPU.
- ▶ **CU\_CTX\_SCHED\_BLOCKING\_SYNC**: Instruct CUDA to block the CPU thread on a synchronization primitive when waiting for the GPU to finish work.
- ▶ **CU\_CTX\_BLOCKING\_SYNC**: Instruct CUDA to block the CPU thread on a synchronization primitive when waiting for the GPU to finish work.

**Deprecated:** This flag was deprecated as of CUDA 4.0 and was replaced with **CU\_CTX\_SCHED\_BLOCKING\_SYNC**.

- ▶ **CU\_CTX\_SCHED\_AUTO**: 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 GPU (**CU\_CTX\_SCHED\_YIELD**), otherwise CUDA will not yield while waiting for results and actively spin on the processor (**CU\_CTX\_SCHED\_SPIN**). Additionally, on Tegra devices, **CU\_CTX\_SCHED\_AUTO** uses a heuristic based on the power profile of the platform and may choose **CU\_CTX\_SCHED\_BLOCKING\_SYNC** for low-powered devices.
- ▶ **CU\_CTX\_LMEM\_RESIZE\_TO\_MAX**: 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.

**Deprecated:** This flag is deprecated and the behavior enabled by this flag is now the default and cannot be disabled.



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

See also:

[cuDevicePrimaryCtxRetain](#), [cuDevicePrimaryCtxGetState](#), [cuCtxCreate](#), [cuCtxGetFlags](#), [cudaSetDeviceFlags](#)

## 5.8. Context Management

This section describes the context management functions of the low-level CUDA driver application programming interface.

Please note that some functions are described in [Primary Context Management](#) section.

### CUresult cuCtxCreate (CUcontext \*pctx, unsigned int flags, CUdevice dev)

Create a CUDA context.

#### Parameters

##### **pctx**

- Returned context handle of the new context

##### **flags**

- Context creation flags

**dev**

- Device to create context on

## Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_DEVICE, CUDA\_ERROR\_INVALID\_VALUE,  
 CUDA\_ERROR\_OUT\_OF\_MEMORY, CUDA\_ERROR\_UNKNOWN

## Description



In most cases it is recommended to use [cuDevicePrimaryCtxRetain](#).

Creates a new CUDA context and associates it with the calling thread. The `flags` parameter is described below. The context is created with a usage count of 1 and the caller of [cuCtxCreate\(\)](#) must call [cuCtxDestroy\(\)](#) or when done using the context. If a context is already current to the thread, it is supplanted by the newly created context and may be restored by a subsequent call to [cuCtxPopCurrent\(\)](#).

The three LSBs of the `flags` parameter can be used to control how the OS thread, which owns the CUDA context at the time of an API call, interacts with the OS scheduler when waiting for results from the GPU. Only one of the scheduling flags can be set when creating a context.

- ▶ **CU\_CTX\_SCHED\_SPIN**: Instruct CUDA to actively spin when waiting for results from the GPU. This can decrease latency when waiting for the GPU, but may lower the performance of CPU threads if they are performing work in parallel with the CUDA thread.
- ▶ **CU\_CTX\_SCHED\_YIELD**: Instruct CUDA to yield its thread when waiting for results from the GPU. This can increase latency when waiting for the GPU, but can increase the performance of CPU threads performing work in parallel with the GPU.
- ▶ **CU\_CTX\_SCHED\_BLOCKING\_SYNC**: Instruct CUDA to block the CPU thread on a synchronization primitive when waiting for the GPU to finish work.
- ▶ **CU\_CTX\_BLOCKING\_SYNC**: Instruct CUDA to block the CPU thread on a synchronization primitive when waiting for the GPU to finish work.

**Deprecated:** This flag was deprecated as of CUDA 4.0 and was replaced with [CU\\_CTX\\_SCHED\\_BLOCKING\\_SYNC](#).

- ▶ **CU\_CTX\_SCHED\_AUTO**: 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 GPU ([CU\\_CTX\\_SCHED\\_YIELD](#)), otherwise

CUDA will not yield while waiting for results and actively spin on the processor (`CU_CTX_SCHED_SPIN`). Additionally, on Tegra devices, `CU_CTX_SCHED_AUTO` uses a heuristic based on the power profile of the platform and may choose `CU_CTX_SCHED_BLOCKING_SYNC` for low-powered devices.

- ▶ `CU_CTX_MAP_HOST`: Instruct CUDA to support mapped pinned allocations. This flag must be set in order to allocate pinned host memory that is accessible to the GPU.
- ▶ `CU_CTX_LMEM_RESIZE_TO_MAX`: 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.

**Deprecated:** This flag is deprecated and the behavior enabled by this flag is now the default and cannot be disabled. Instead, the per-thread stack size can be controlled with `cuCtxSetLimit()`.

Context creation will fail with `CUDA_ERROR_UNKNOWN` if the compute mode of the device is `CU_COMPUTEMODE_PROHIBITED`. The function `cuDeviceGetAttribute()` can be used with `CU_DEVICE_ATTRIBUTE_COMPUTE_MODE` to determine the compute mode of the device. The `nvidia-smi` tool can be used to set the compute mode for \* devices. Documentation for `nvidia-smi` can be obtained by passing a `-h` option to it.



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

See also:

`cuCtxDestroy`, `cuCtxGetApiVersion`, `cuCtxGetCacheConfig`, `cuCtxGetDevice`, `cuCtxGetFlags`, `cuCtxGetLimit`, `cuCtxPopCurrent`, `cuCtxPushCurrent`, `cuCtxSetCacheConfig`, `cuCtxSetLimit`, `cuCtxSynchronize`

## CUresult cuCtxDestroy (CUcontext ctx)

Destroy a CUDA context.

### Parameters

**ctx**

- Context to destroy

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description**

Destroys the CUDA context specified by `ctx`. The context `ctx` will be destroyed regardless of how many threads it is current to. It is the responsibility of the calling function to ensure that no API call issues using `ctx` while `cuCtxDestroy()` is executing.

If `ctx` is current to the calling thread then `ctx` will also be popped from the current thread's context stack (as though `cuCtxPopCurrent()` were called). If `ctx` is current to other threads, then `ctx` will remain current to those threads, and attempting to access `ctx` from those threads will result in the error `CUDA_ERROR_CONTEXT_IS_DESTROYED`.



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

**See also:**

`cuCtxCreate`, `cuCtxGetApiVersion`, `cuCtxGetCacheConfig`, `cuCtxGetDevice`,  
`cuCtxGetFlags`, `cuCtxGetLimit`, `cuCtxPopCurrent`, `cuCtxPushCurrent`,  
`cuCtxSetCacheConfig`, `cuCtxSetLimit`, `cuCtxSynchronize`

## CUresult cuCtxGetApiVersion (CUcontext ctx, unsigned int \*version)

Gets the context's API version.

**Parameters**

**ctx**

- Context to check

**version**

- Pointer to version

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_UNKNOWN

## Description

Returns a version number in `version` corresponding to the capabilities of the context (e.g. 3010 or 3020), which library developers can use to direct callers to a specific API version. If `ctx` is NULL, returns the API version used to create the currently bound context.

Note that new API versions are only introduced when context capabilities are changed that break binary compatibility, so the API version and driver version may be different. For example, it is valid for the API version to be 3020 while the driver version is 4020.



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

## See also:

[cuCtxCreate](#), [cuCtxDestroy](#), [cuCtxGetDevice](#), [cuCtxGetFlags](#), [cuCtxGetLimit](#), [cuCtxPopCurrent](#), [cuCtxPushCurrent](#), [cuCtxSetCacheConfig](#), [cuCtxSetLimit](#), [cuCtxSynchronize](#)

## CUresult cuCtxGetCacheConfig (CUfunc\_cache \*pconfig)

Returns the preferred cache configuration for the current context.

## Parameters

### pconfig

- Returned cache configuration

## Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#)

## Description

On devices where the L1 cache and shared memory use the same hardware resources, this function returns through `pconfig` the preferred cache configuration for the current context. This is only a preference. The driver 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 `pconfig` of [CU\\_FUNC\\_CACHE\\_PREFER\\_NONE](#) on devices where the size of the L1 cache and shared memory are fixed.

The supported cache configurations are:

- ▶ `CU_FUNC_CACHE_PREFER_NONE`: no preference for shared memory or L1 (default)
- ▶ `CU_FUNC_CACHE_PREFER_SHARED`: prefer larger shared memory and smaller L1 cache
- ▶ `CU_FUNC_CACHE_PREFER_L1`: prefer larger L1 cache and smaller shared memory
- ▶ `CU_FUNC_CACHE_PREFER_EQUAL`: prefer equal sized L1 cache and shared memory



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

#### See also:

`cuCtxCreate`, `cuCtxDestroy`, `cuCtxGetApiVersion`, `cuCtxGetDevice`, `cuCtxGetFlags`, `cuCtxGetLimit`, `cuCtxPopCurrent`, `cuCtxPushCurrent`, `cuCtxSetCacheConfig`, `cuCtxSetLimit`, `cuCtxSynchronize`, `cuFuncSetCacheConfig`, `cudaDeviceGetCacheConfig`

## CUresult cuCtxGetCurrent (CUcontext \*pctx)

Returns the CUDA context bound to the calling CPU thread.

#### Parameters

**pctx**

- Returned context handle

#### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`,

#### Description

Returns in `*pctx` the CUDA context bound to the calling CPU thread. If no context is bound to the calling CPU thread then `*pctx` is set to NULL and `CUDA_SUCCESS` is returned.



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

#### See also:

`cuCtxSetCurrent`, `cuCtxCreate`, `cuCtxDestroy`, `cudaGetDevice`

## CUresult cuCtxGetDevice (CUdevice \*device)

Returns the device ID for the current context.

### Parameters

#### device

- Returned device ID for the current context

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`,

### Description

Returns in \*device the ordinal of the current context's device.



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

### See also:

`cuCtxCreate`, `cuCtxDestroy`, `cuCtxGetApiVersion`, `cuCtxGetCacheConfig`,  
`cuCtxGetFlags`, `cuCtxGetLimit`, `cuCtxPopCurrent`, `cuCtxPushCurrent`,  
`cuCtxSetCacheConfig`, `cuCtxSetLimit`, `cuCtxSynchronize`, `cudaGetDevice`

## CUresult cuCtxGetFlags (unsigned int \*flags)

Returns the flags for the current context.

### Parameters

#### flags

- Pointer to store flags of current context

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`,



## Description

Returns in `*flags` the flags of the current context. See [cuCtxCreate](#) for flag values.



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

## See also:

[cuCtxCreate](#), [cuCtxGetApiVersion](#), [cuCtxGetCacheConfig](#), [cuCtxGetCurrent](#),  
[cuCtxGetDevice](#), [cuCtxGetLimit](#), [cuCtxGetSharedMemConfig](#),  
[cuCtxGetStreamPriorityRange](#), [cudaGetDeviceFlags](#)

## CUresult cuCtxGetLimit (size\_t \*pvalue, CUlimit limit)

Returns resource limits.

## Parameters

### pvalue

- Returned size of limit

### limit

- Limit to query

## Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#),  
[CUDA\\_ERROR\\_UNSUPPORTED\\_LIMIT](#)

## Description

Returns in `*pvalue` the current size of `limit`. The supported [CUlimit](#) values are:

- ▶ [CU\\_LIMIT\\_STACK\\_SIZE](#): stack size in bytes of each GPU thread.
- ▶ [CU\\_LIMIT\\_PRINTF\\_FIFO\\_SIZE](#): size in bytes of the FIFO used by the `printf()` device system call.
- ▶ [CU\\_LIMIT\\_MALLOC\\_HEAP\\_SIZE](#): size in bytes of the heap used by the `malloc()` and `free()` device system calls.
- ▶ [CU\\_LIMIT\\_DEV\\_RUNTIME\\_SYNC\\_DEPTH](#): maximum grid depth at which a thread can issue the device runtime call [cudaDeviceSynchronize\(\)](#) to wait on child grid launches to complete.
- ▶ [CU\\_LIMIT\\_DEV\\_RUNTIME\\_PENDING\\_LAUNCH\\_COUNT](#): maximum number of outstanding device runtime launches that can be made from this context.
- ▶ [CU\\_LIMIT\\_MAX\\_L2\\_FETCH\\_GRANULARITY](#): L2 cache fetch granularity.



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

#### See also:

[cuCtxCreate](#), [cuCtxDestroy](#), [cuCtxGetApiVersion](#), [cuCtxGetCacheConfig](#), [cuCtxGetDevice](#), [cuCtxGetFlags](#), [cuCtxPopCurrent](#), [cuCtxPushCurrent](#), [cuCtxSetCacheConfig](#), [cuCtxSetLimit](#), [cuCtxSynchronize](#), [cudaDeviceGetLimit](#)

## CUresult cuCtxGetSharedMemConfig (CUsharedconfig \*pConfig)

Returns the current shared memory configuration for the current context.

#### Parameters

##### pConfig

- returned shared memory configuration

#### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#)

#### Description

This function will return in `pConfig` the current size of shared memory banks in the current context. On devices with configurable shared memory banks, [cuCtxSetSharedMemConfig](#) can be used to change this setting, so that all subsequent kernel launches will by default use the new bank size. When [cuCtxGetSharedMemConfig](#) 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:

- ▶ [CU\\_SHARED\\_MEM\\_CONFIG\\_FOUR\\_BYTE\\_BANK\\_SIZE](#): shared memory bank width is four bytes.
- ▶ [CU\\_SHARED\\_MEM\\_CONFIG\\_EIGHT\\_BYTE\\_BANK\\_SIZE](#): shared memory bank width will eight bytes.



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

**See also:**

[cuCtxCreate](#), [cuCtxDestroy](#), [cuCtxGetApiVersion](#), [cuCtxGetCacheConfig](#),  
[cuCtxGetDevice](#), [cuCtxGetFlags](#), [cuCtxGetLimit](#), [cuCtxPopCurrent](#), [cuCtxPushCurrent](#),  
[cuCtxSetLimit](#), [cuCtxSynchronize](#), [cuCtxGetSharedMemConfig](#), [cuFuncSetCacheConfig](#),  
[cudaDeviceGetSharedMemConfig](#)

## CUresult cuCtxGetStreamPriorityRange (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**

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#),

**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 [cuStreamCreateWithPriority](#) 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 [cuDeviceGetAttribute](#)).



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

**See also:**

[cuStreamCreateWithPriority](#), [cuStreamGetPriority](#), [cuCtxGetDevice](#), [cuCtxGetFlags](#),  
[cuCtxSetLimit](#), [cuCtxSynchronize](#), [cudaDeviceGetStreamPriorityRange](#)

## CUresult cuCtxPopCurrent (CUcontext \*pctx)

Pops the current CUDA context from the current CPU thread.

### Parameters

**pctx**

- Returned new context handle

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#)

### Description

Pops the current CUDA context from the CPU thread and passes back the old context handle in \*pctx. That context may then be made current to a different CPU thread by calling [cuCtxPushCurrent\(\)](#).

If a context was current to the CPU thread before [cuCtxCreate\(\)](#) or [cuCtxPushCurrent\(\)](#) was called, this function makes that context current to the CPU thread again.



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

### See also:

[cuCtxCreate](#), [cuCtxDestroy](#), [cuCtxGetApiVersion](#), [cuCtxGetCacheConfig](#),  
[cuCtxGetDevice](#), [cuCtxGetFlags](#), [cuCtxGetLimit](#), [cuCtxPushCurrent](#),  
[cuCtxSetCacheConfig](#), [cuCtxSetLimit](#), [cuCtxSynchronize](#)

## CUresult cuCtxPushCurrent (CUcontext ctx)

Pushes a context on the current CPU thread.

### Parameters

**ctx**

- Context to push

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description**

Pushes the given context `ctx` onto the CPU thread's stack of current contexts. The specified context becomes the CPU thread's current context, so all CUDA functions that operate on the current context are affected.

The previous current context may be made current again by calling `cuCtxDestroy()` or `cuCtxPopCurrent()`.



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

**See also:**

`cuCtxCreate`, `cuCtxDestroy`, `cuCtxGetApiVersion`, `cuCtxGetCacheConfig`,  
`cuCtxGetDevice`, `cuCtxGetFlags`, `cuCtxGetLimit`, `cuCtxPopCurrent`,  
`cuCtxSetCacheConfig`, `cuCtxSetLimit`, `cuCtxSynchronize`

## CUresult cuCtxResetPersistingL2Cache (void)

Resets all persisting lines in cache to normal status.

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_NOT\_SUPPORTED

**Description**

`cuCtxResetPersistingL2Cache` Resets all persisting lines in cache to normal status. Takes effect on function return.



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

**See also:**

`CUaccessPolicyWindow`

## CUresult cuCtxSetCacheConfig (CUfunc\_cache config)

Sets the preferred cache configuration for the current context.

### Parameters

#### config

- Requested cache configuration

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

On devices where the L1 cache and shared memory use the same hardware resources, this sets through `config` the preferred cache configuration for the current context. This is only a preference. The driver 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 `cuFuncSetCacheConfig()` will be preferred over this context-wide setting. Setting the context-wide cache configuration to `CU_FUNC_CACHE_PREFER_NONE` 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:

- ▶ `CU_FUNC_CACHE_PREFER_NONE`: no preference for shared memory or L1 (default)
- ▶ `CU_FUNC_CACHE_PREFER_SHARED`: prefer larger shared memory and smaller L1 cache
- ▶ `CU_FUNC_CACHE_PREFER_L1`: prefer larger L1 cache and smaller shared memory
- ▶ `CU_FUNC_CACHE_PREFER_EQUAL`: prefer equal sized L1 cache and shared memory



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

**See also:**

[cuCtxCreate](#), [cuCtxDestroy](#), [cuCtxGetApiVersion](#), [cuCtxGetCacheConfig](#),  
[cuCtxGetDevice](#), [cuCtxGetFlags](#), [cuCtxGetLimit](#), [cuCtxPopCurrent](#), [cuCtxPushCurrent](#),  
[cuCtxSetLimit](#), [cuCtxSynchronize](#), [cuFuncSetCacheConfig](#), [cudaDeviceSetCacheConfig](#)

## CUresult cuCtxSetCurrent (CUcontext ctx)

Binds the specified CUDA context to the calling CPU thread.

**Parameters**

**ctx**

- Context to bind to the calling CPU thread

**Returns**

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#)

**Description**

Binds the specified CUDA context to the calling CPU thread. If `ctx` is NULL then the CUDA context previously bound to the calling CPU thread is unbound and [CUDA\\_SUCCESS](#) is returned.

If there exists a CUDA context stack on the calling CPU thread, this will replace the top of that stack with `ctx`. If `ctx` is NULL then this will be equivalent to popping the top of the calling CPU thread's CUDA context stack (or a no-op if the calling CPU thread's CUDA context stack is empty).



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

**See also:**

[cuCtxGetCurrent](#), [cuCtxCreate](#), [cuCtxDestroy](#), [cudaSetDevice](#)

## CUresult cuCtxSetLimit (CUlimit limit, size\_t value)

Set resource limits.

**Parameters**

**limit**

- Limit to set

**value**

- Size of limit

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_UNSUPPORTED\_LIMIT, CUDA\_ERROR\_OUT\_OF\_MEMORY,  
CUDA\_ERROR\_INVALID\_CONTEXT

**Description**

Setting `limit` to `value` is a request by the application to update the current limit maintained by the context. 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 `cuCtxGetLimit()` to find out exactly what the limit has been set to.

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

- ▶ `CU_LIMIT_STACK_SIZE` controls the stack size in bytes of each GPU thread. The driver automatically increases the per-thread stack size for each kernel launch as needed. This size isn't reset back to the original value after each launch. Setting this value will take effect immediately, and if necessary, the device will block until all preceding requested tasks are complete.
- ▶ `CU_LIMIT_PRINTF_FIFO_SIZE` controls the size in bytes of the FIFO used by the `printf()` device system call. Setting `CU_LIMIT_PRINTF_FIFO_SIZE` must be performed before launching any kernel that uses the `printf()` device system call, otherwise `CUDA_ERROR_INVALID_VALUE` will be returned.
- ▶ `CU_LIMIT_MALLOC_HEAP_SIZE` controls the size in bytes of the heap used by the `malloc()` and `free()` device system calls. Setting `CU_LIMIT_MALLOC_HEAP_SIZE` must be performed before launching any kernel that uses the `malloc()` or `free()` device system calls, otherwise `CUDA_ERROR_INVALID_VALUE` will be returned.
- ▶ `CU_LIMIT_DEV_RUNTIME_SYNC_DEPTH` 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 driver to reserve large amounts of device memory which can no longer be used for user allocations. If these reservations of device memory fail, `cuCtxSetLimit()` will return `CUDA_ERROR_OUT_OF_MEMORY`, 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 `CUDA_ERROR_UNSUPPORTED_LIMIT` being returned.

- ▶ `CU_LIMIT_DEV_RUNTIME_PENDING_LAUNCH_COUNT` controls the maximum number of outstanding device runtime launches that can be made from the current context. 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 driver to reserve larger amounts of device memory upfront which can no longer be used for allocations. If these reservations fail, `cuCtxSetLimit()` will return `CUDA_ERROR_OUT_OF_MEMORY`, 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 `CUDA_ERROR_UNSUPPORTED_LIMIT` being returned.
- ▶ `CU_LIMIT_MAX_L2_FETCH_GRANULARITY` controls the L2 cache fetch granularity. Values can range from 0B to 128B. This is purely a performance hint and it can be ignored or clamped depending on the platform.



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

#### See also:

`cuCtxCreate`, `cuCtxDestroy`, `cuCtxGetApiVersion`, `cuCtxGetCacheConfig`, `cuCtxGetDevice`, `cuCtxGetFlags`, `cuCtxGetLimit`, `cuCtxPopCurrent`, `cuCtxPushCurrent`, `cuCtxSetCacheConfig`, `cuCtxSynchronize`, `cudaDeviceSetLimit`

## CUresult cuCtxSetSharedMemConfig (CUsharedconfig config)

Sets the shared memory configuration for the current context.

### Parameters

#### config

- requested shared memory configuration

## Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

## Description

On devices with configurable shared memory banks, this function will set the context's shared memory bank size which is used for subsequent kernel launches.

Changed the shared memory configuration between launches may insert a device side synchronization point between those launches.

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:

- ▶ `CU_SHARED_MEM_CONFIG_DEFAULT_BANK_SIZE`: set bank width to the default initial setting (currently, four bytes).
- ▶ `CU_SHARED_MEM_CONFIG_FOUR_BYTE_BANK_SIZE`: set shared memory bank width to be natively four bytes.
- ▶ `CU_SHARED_MEM_CONFIG_EIGHT_BYTE_BANK_SIZE`: set shared memory bank width to be natively eight bytes.



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

## See also:

`cuCtxCreate`, `cuCtxDestroy`, `cuCtxGetApiVersion`, `cuCtxGetCacheConfig`,  
`cuCtxGetDevice`, `cuCtxGetFlags`, `cuCtxGetLimit`, `cuCtxPopCurrent`, `cuCtxPushCurrent`,  
`cuCtxSetLimit`, `cuCtxSynchronize`, `cuCtxGetSharedMemConfig`, `cuFuncSetCacheConfig`,  
`cudaDeviceSetSharedMemConfig`

## CUresult cuCtxSynchronize (void)

Block for a context's tasks to complete.

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT

### Description

Blocks until the device has completed all preceding requested tasks. `cuCtxSynchronize()` returns an error if one of the preceding tasks failed. If the context was created with the `CU_CTX_SCHED_BLOCKING_SYNC` flag, the CPU thread will block until the GPU context has finished its work.



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

### See also:

`cuCtxCreate`, `cuCtxDestroy`, `cuCtxGetApiVersion`, `cuCtxGetCacheConfig`,  
`cuCtxGetDevice`, `cuCtxGetFlags`, `cuCtxGetLimit`, `cuCtxPopCurrent`, `cuCtxPushCurrent`,  
`cuCtxSetCacheConfig`, `cuCtxSetLimit`, `cudaDeviceSynchronize`

## 5.9. Context Management [DEPRECATED]

This section describes the deprecated context management functions of the low-level CUDA driver application programming interface.

### CUresult cuCtxAttach (CUcontext \*pctx, unsigned int flags)

Increment a context's usage-count.

#### Parameters

##### pctx

- Returned context handle of the current context

##### flags

- Context attach flags (must be 0)

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description**

Deprecated

Note that this function is deprecated and should not be used.

Increments the usage count of the context and passes back a context handle in `*pctx` that must be passed to `cuCtxDetach()` when the application is done with the context. `cuCtxAttach()` fails if there is no context current to the thread.

Currently, the `flags` parameter must be 0.



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

**See also:**

`cuCtxCreate`, `cuCtxDestroy`, `cuCtxDetach`, `cuCtxGetApiVersion`, `cuCtxGetCacheConfig`,  
`cuCtxGetDevice`, `cuCtxGetFlags`, `cuCtxGetLimit`, `cuCtxPopCurrent`, `cuCtxPushCurrent`,  
`cuCtxSetCacheConfig`, `cuCtxSetLimit`, `cuCtxSynchronize`

## CUresult cuCtxDetach (CUcontext ctx)

Decrement a context's usage-count.

**Parameters**

`ctx`

- Context to destroy

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT

**Description**

Deprecated

Note that this function is deprecated and should not be used.

Decrements the usage count of the context `ctx`, and destroys the context if the usage count goes to 0. The context must be a handle that was passed back by `cuCtxCreate()` or `cuCtxAttach()`, and must be current to the calling thread.



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

#### See also:

`cuCtxCreate`, `cuCtxDestroy`, `cuCtxGetApiVersion`, `cuCtxGetCacheConfig`, `cuCtxGetDevice`, `cuCtxGetFlags`, `cuCtxGetLimit`, `cuCtxPopCurrent`, `cuCtxPushCurrent`, `cuCtxSetCacheConfig`, `cuCtxSetLimit`, `cuCtxSynchronize`

## 5.10. Module Management

This section describes the module management functions of the low-level CUDA driver application programming interface.

**CUresult cuLinkAddData (CUlinkState state, CUjitInputType type, void \*data, size\_t size, const char \*name, unsigned int numOptions, CUjit\_option \*options, void \*\*optionValues)**

Add an input to a pending linker invocation.

#### Parameters

##### **state**

A pending linker action.

##### **type**

The type of the input data.

##### **data**

The input data. PTX must be NULL-terminated.

##### **size**

The length of the input data.

##### **name**

An optional name for this input in log messages.

##### **numOptions**

Size of options.

##### **options**

Options to be applied only for this input (overrides options from `cuLinkCreate`).

**optionValues**

Array of option values, each cast to void \*.

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_HANDLE,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_IMAGE,  
 CUDA\_ERROR\_INVALID\_PTX, CUDA\_ERROR\_OUT\_OF\_MEMORY,  
 CUDA\_ERROR\_NO\_BINARY\_FOR\_GPU

**Description**

Ownership of data is retained by the caller. No reference is retained to any inputs after this call returns.

This method accepts only compiler options, which are used if the data must be compiled from PTX, and does not accept any of [CU\\_JIT\\_WALL\\_TIME](#), [CU\\_JIT\\_INFO\\_LOG\\_BUFFER](#), [CU\\_JIT\\_ERROR\\_LOG\\_BUFFER](#), [CU\\_JIT\\_TARGET\\_FROM\\_CUCONTEXT](#), or [CU\\_JIT\\_TARGET](#).

**See also:**

[cuLinkCreate](#), [cuLinkAddFile](#), [cuLinkComplete](#), [cuLinkDestroy](#)

**CUresult cuLinkAddFile (CUlinkState state,  
 CUjitInputType type, const char \*path, unsigned int  
 numOptions, CUjit\_option \*options, void \*\*optionValues)**

Add a file input to a pending linker invocation.

**Parameters****state**

A pending linker action

**type**

The type of the input data

**path**

Path to the input file

**numOptions**

Size of options

**options**

Options to be applied only for this input (overrides options from [cuLinkCreate](#))

**optionValues**

Array of option values, each cast to void \*

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_FILE\_NOT\_FOUND  
 CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_INVALID\_VALUE,  
 CUDA\_ERROR\_INVALID\_IMAGE, CUDA\_ERROR\_INVALID\_PTX,  
 CUDA\_ERROR\_OUT\_OF\_MEMORY, CUDA\_ERROR\_NO\_BINARY\_FOR\_GPU

**Description**

No reference is retained to any inputs after this call returns.

This method accepts only compiler options, which are used if the input must be compiled from PTX, and does not accept any of [CU\\_JIT\\_WALL\\_TIME](#), [CU\\_JIT\\_INFO\\_LOG\\_BUFFER](#), [CU\\_JIT\\_ERROR\\_LOG\\_BUFFER](#), [CU\\_JIT\\_TARGET\\_FROM\\_CUCONTEXT](#), or [CU\\_JIT\\_TARGET](#).

This method is equivalent to invoking [cuLinkAddData](#) on the contents of the file.

**See also:**

[cuLinkCreate](#), [cuLinkAddData](#), [cuLinkComplete](#), [cuLinkDestroy](#)

## CUresult cuLinkComplete (CUlinkState state, void \*\*cubinOut, size\_t \*sizeOut)

Complete a pending linker invocation.

**Parameters****state**

A pending linker invocation

**cubinOut**

On success, this will point to the output image

**sizeOut**

Optional parameter to receive the size of the generated image

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_HANDLE,  
 CUDA\_ERROR\_OUT\_OF\_MEMORY

**Description**

Completes the pending linker action and returns the cubin image for the linked device code, which can be used with [cuModuleLoadData](#). The cubin is owned by *state*, so it should be loaded before *state* is destroyed via [cuLinkDestroy](#). This call does not destroy *state*.

See also:

[cuLinkCreate](#), [cuLinkAddData](#), [cuLinkAddFile](#), [cuLinkDestroy](#), [cuModuleLoadData](#)

## CUresult cuLinkCreate (unsigned int numOptions, CUjit\_option \*options, void \*\*optionValues, CUlinkState \*stateOut)

Creates a pending JIT linker invocation.

### Parameters

#### numOptions

Size of options arrays

#### options

Array of linker and compiler options

#### optionValues

Array of option values, each cast to void \*

#### stateOut

On success, this will contain a CUlinkState to specify and complete this action

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_OUT\_OF\_MEMORY,  
CUDA\_ERROR\_JIT\_COMPILER\_NOT\_FOUND

### Description

If the call is successful, the caller owns the returned CUlinkState, which should eventually be destroyed with [cuLinkDestroy](#). The device code machine size (32 or 64 bit) will match the calling application.

Both linker and compiler options may be specified. Compiler options will be applied to inputs to this linker action which must be compiled from PTX. The options [CU\\_JIT\\_WALL\\_TIME](#), [CU\\_JIT\\_INFO\\_LOG\\_BUFFER\\_SIZE\\_BYTES](#), and [CU\\_JIT\\_ERROR\\_LOG\\_BUFFER\\_SIZE\\_BYTES](#) will accumulate data until the CUlinkState is destroyed.

optionValues must remain valid for the life of the CUlinkState if output options are used. No other references to inputs are maintained after this call returns.



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



**See also:**

[cuLinkAddData](#), [cuLinkAddFile](#), [cuLinkComplete](#), [cuLinkDestroy](#)

## CUresult cuLinkDestroy (CUlinkState state)

Destroys state for a JIT linker invocation.

**Parameters****state**

State object for the linker invocation

**Returns**

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_HANDLE](#)

**Description****See also:**

[cuLinkCreate](#)

## CUresult cuModuleGetFunction (CUfunction \*hfunc, CUmodule hmod, const char \*name)

Returns a function handle.

**Parameters****hfunc**

- Returned function handle

**hmod**

- Module to retrieve function from

**name**

- Name of function to retrieve

**Returns**

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#), [CUDA\\_ERROR\\_NOT\\_FOUND](#)

**Description**

Returns in \*hfunc the handle of the function of name name located in module hmod. If no function of that name exists, [cuModuleGetFunction\(\)](#) returns [CUDA\\_ERROR\\_NOT\\_FOUND](#).



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

#### See also:

[cuModuleGetGlobal](#), [cuModuleGetTexRef](#), [cuModuleLoad](#), [cuModuleLoadData](#), [cuModuleLoadDataEx](#), [cuModuleLoadFatBinary](#), [cuModuleUnload](#)

## CUresult cuModuleGetGlobal (CUdeviceptr \*dptr, size\_t \*bytes, CUmodule hmod, const char \*name)

Returns a global pointer from a module.

### Parameters

#### **dptr**

- Returned global device pointer

#### **bytes**

- Returned global size in bytes

#### **hmod**

- Module to retrieve global from

#### **name**

- Name of global to retrieve

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#), [CUDA\\_ERROR\\_NOT\\_FOUND](#)

### Description

Returns in \*dptr and \*bytes the base pointer and size of the global of name name located in module hmod. If no variable of that name exists, [cuModuleGetGlobal\(\)](#) returns [CUDA\\_ERROR\\_NOT\\_FOUND](#). Both parameters dptr and bytes are optional. If one of them is NULL, it is ignored.



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

#### See also:

`cuModuleGetFunction`, `cuModuleGetTexRef`, `cuModuleLoad`, `cuModuleLoadData`,  
`cuModuleLoadDataEx`, `cuModuleLoadFatBinary`, `cuModuleUnload`,  
`cudaGetSymbolAddress`, `cudaGetSymbolSize`

## CUresult cuModuleGetSurfRef (CUsurfref \*pSurfRef, CUmodule hmod, const char \*name)

Returns a handle to a surface reference.

### Parameters

#### **pSurfRef**

- Returned surface reference

#### **hmod**

- Module to retrieve surface reference from

#### **name**

- Name of surface reference to retrieve

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_NOT_FOUND`

### Description

Returns in \*pSurfRef the handle of the surface reference of name name in the module hmod. If no surface reference of that name exists, `cuModuleGetSurfRef()` returns `CUDA_ERROR_NOT_FOUND`.



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

### See also:

`cuModuleGetFunction`, `cuModuleGetGlobal`, `cuModuleGetTexRef`, `cuModuleLoad`,  
`cuModuleLoadData`, `cuModuleLoadDataEx`, `cuModuleLoadFatBinary`,  
`cuModuleUnload`, `cudaGetSurfaceReference`

## CUresult cuModuleGetTexRef (CUtexref \*pTexRef, CUmodule hmod, const char \*name)

Returns a handle to a texture reference.

### Parameters

#### **pTexRef**

- Returned texture reference

#### **hmod**

- Module to retrieve texture reference from

#### **name**

- Name of texture reference to retrieve

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_NOT\_FOUND

### Description

Returns in \*pTexRef the handle of the texture reference of name name in the module hmod. If no texture reference of that name exists, cuModuleGetTexRef() returns CUDA\_ERROR\_NOT\_FOUND. This texture reference handle should not be destroyed, since it will be destroyed when the module is unloaded.



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

### See also:

cuModuleGetFunction, cuModuleGetGlobal, cuModuleGetSurfRef, cuModuleLoad, cuModuleLoadData, cuModuleLoadDataEx, cuModuleLoadFatBinary, cuModuleUnload, cudaGetTextureReference

## CUresult cuModuleLoad (CUmodule \*module, const char \*fname)

Loads a compute module.

### Parameters

#### **module**

- Returned module

#### **fname**

- Filename of module to load

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_PTX,  
 CUDA\_ERROR\_NOT\_FOUND, CUDA\_ERROR\_OUT\_OF\_MEMORY,  
 CUDA\_ERROR\_FILE\_NOT\_FOUND, CUDA\_ERROR\_NO\_BINARY\_FOR\_GPU,  
 CUDA\_ERROR\_SHARED\_OBJECT\_SYMBOL\_NOT\_FOUND,  
 CUDA\_ERROR\_SHARED\_OBJECT\_INIT\_FAILED,  
 CUDA\_ERROR\_JIT\_COMPILER\_NOT\_FOUND

### Description

Takes a filename `fname` and loads the corresponding module `module` into the current context. The CUDA driver API does not attempt to lazily allocate the resources needed by a module; if the memory for functions and data (constant and global) needed by the module cannot be allocated, `cuModuleLoad()` fails. The file should be a cubin file as output by `nvcc`, or a PTX file either as output by `nvcc` or handwritten, or a fatbin file as output by `nvcc` from toolchain 4.0 or later.



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

### See also:

`cuModuleGetFunction`, `cuModuleGetGlobal`, `cuModuleGetTexRef`, `cuModuleLoadData`, `cuModuleLoadDataEx`, `cuModuleLoadFatBinary`, `cuModuleUnload`

## CUresult cuModuleLoadData (CUmodule \*module, const void \*image)

Load a module's data.

### Parameters

#### **module**

- Returned module

#### **image**

- Module data to load

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_PTX,  
 CUDA\_ERROR\_OUT\_OF\_MEMORY, CUDA\_ERROR\_NO\_BINARY\_FOR\_GPU,  
 CUDA\_ERROR\_SHARED\_OBJECT\_SYMBOL\_NOT\_FOUND,  
 CUDA\_ERROR\_SHARED\_OBJECT\_INIT\_FAILED,  
 CUDA\_ERROR\_JIT\_COMPILER\_NOT\_FOUND

### Description

Takes a pointer `image` and loads the corresponding module `module` into the current context. The pointer may be obtained by mapping a cubin or PTX or fatbin file, passing a cubin or PTX or fatbin file as a NULL-terminated text string, or incorporating a cubin or fatbin object into the executable resources and using operating system calls such as Windows `FindResource()` to obtain the pointer.



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

### See also:

`cuModuleGetFunction`, `cuModuleGetGlobal`, `cuModuleGetTexRef`, `cuModuleLoad`,  
`cuModuleLoadDataEx`, `cuModuleLoadFatBinary`, `cuModuleUnload`

**CUresult cuModuleLoadDataEx (CUmodule \*module,  
const void \*image, unsigned int numOptions,  
CUjit\_option \*options, void \*\*optionValues)**

Load a module's data with options.

### Parameters

#### **module**

- Returned module

#### **image**

- Module data to load

#### **numOptions**

- Number of options

#### **options**

- Options for JIT

#### **optionValues**

- Option values for JIT

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_PTX,  
CUDA\_ERROR\_OUT\_OF\_MEMORY, CUDA\_ERROR\_NO\_BINARY\_FOR\_GPU,  
CUDA\_ERROR\_SHARED\_OBJECT\_SYMBOL\_NOT\_FOUND,  
CUDA\_ERROR\_SHARED\_OBJECT\_INIT\_FAILED,  
CUDA\_ERROR\_JIT\_COMPILER\_NOT\_FOUND

### Description

Takes a pointer `image` and loads the corresponding module `module` into the current context. The pointer may be obtained by mapping a cubin or PTX or fatbin file, passing a cubin or PTX or fatbin file as a NULL-terminated text string, or incorporating a cubin or fatbin object into the executable resources and using operating system calls such as Windows `FindResource()` to obtain the pointer. Options are passed as an array via `options` and any corresponding parameters are passed in `optionValues`. The number of total options is supplied via `numOptions`. Any outputs will be returned via `optionValues`.



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

**See also:**

`cuModuleGetFunction`, `cuModuleGetGlobal`, `cuModuleGetTexRef`, `cuModuleLoad`,  
`cuModuleLoadData`, `cuModuleLoadFatBinary`, `cuModuleUnload`

## CUresult cuModuleLoadFatBinary (CUmodule \*module, const void \*fatCubin)

Load a module's data.

**Parameters****module**

- Returned module

**fatCubin**

- Fat binary to load

**Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_PTX`,  
`CUDA_ERROR_NOT_FOUND`, `CUDA_ERROR_OUT_OF_MEMORY`,  
`CUDA_ERROR_NO_BINARY_FOR_GPU`,  
`CUDA_ERROR_SHARED_OBJECT_SYMBOL_NOT_FOUND`,  
`CUDA_ERROR_SHARED_OBJECT_INIT_FAILED`,  
`CUDA_ERROR_JIT_COMPILER_NOT_FOUND`

**Description**

Takes a pointer `fatCubin` and loads the corresponding module `module` into the current context. The pointer represents a fat binary object, which is a collection of different cubin and/or PTX files, all representing the same device code, but compiled and optimized for different architectures.

Prior to CUDA 4.0, there was no documented API for constructing and using fat binary objects by programmers. Starting with CUDA 4.0, fat binary objects can be constructed by providing the `-fatbin` option to **nvcc**. More information can be found in the **nvcc** document.



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

**See also:**



[cuModuleGetFunction](#), [cuModuleGetGlobal](#), [cuModuleGetTexRef](#), [cuModuleLoad](#), [cuModuleLoadData](#), [cuModuleLoadDataEx](#), [cuModuleUnload](#)

## CUresult cuModuleUnload (CUmodule hmod)

Unloads a module.

### Parameters

#### **hmod**

- Module to unload

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

Unloads a module `hmod` from the current context.



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

### See also:

[cuModuleGetFunction](#), [cuModuleGetGlobal](#), [cuModuleGetTexRef](#), [cuModuleLoad](#), [cuModuleLoadData](#), [cuModuleLoadDataEx](#), [cuModuleLoadFatBinary](#)

## 5.11. Memory Management

This section describes the memory management functions of the low-level CUDA driver application programming interface.

## CUresult cuArray3DCreate (CUarray \*pHandle, const CUDA\_ARRAY3D\_DESCRIPTOR \*pAllocateArray)

Creates a 3D CUDA array.

### Parameters

#### **pHandle**

- Returned array

**pAllocateArray**

- 3D array descriptor

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_OUT\_OF\_MEMORY,  
 CUDA\_ERROR\_UNKNOWN

**Description**

Creates a CUDA array according to the [CUDA\\_ARRAY3D\\_DESCRIPTOR](#) structure `pAllocateArray` and returns a handle to the new CUDA array in `*pHandle`. The [CUDA\\_ARRAY3D\\_DESCRIPTOR](#) is defined as:

```
typedef struct {
    unsigned int Width;
    unsigned int Height;
    unsigned int Depth;
    CUarray_format Format;
    unsigned int NumChannels;
    unsigned int Flags;
} CUDA_ARRAY3D_DESCRIPTOR;
```

where:

- ▶ Width, Height, and Depth are the width, height, and depth of the CUDA array (in elements); the following types of CUDA arrays can be allocated:
  - ▶ A 1D array is allocated if Height and Depth extents are both zero.
  - ▶ A 2D array is allocated if only 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 Height is zero and the [CUDA\\_ARRAY3D\\_LAYERED](#) 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 [CUDA\\_ARRAY3D\\_LAYERED](#) 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 [CUDA\\_ARRAY3D\\_CUBEMAP](#) 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 [CUarray\\_cubemap\\_face](#).
  - ▶ A cubemap layered CUDA array is allocated if all three extents are non-zero, and both, [CUDA\\_ARRAY3D\\_CUBEMAP](#) and [CUDA\\_ARRAY3D\\_LAYERED](#) 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.

- Format specifies the format of the elements; `CUarray_format` is defined as:

```
typedef enum CUarray_format_enum {
    CU_AD_FORMAT_UNSIGNED_INT8 = 0x01,
    CU_AD_FORMAT_UNSIGNED_INT16 = 0x02,
    CU_AD_FORMAT_UNSIGNED_INT32 = 0x03,
    CU_AD_FORMAT_SIGNED_INT8 = 0x08,
    CU_AD_FORMAT_SIGNED_INT16 = 0x09,
    CU_AD_FORMAT_SIGNED_INT32 = 0x0a,
    CU_AD_FORMAT_HALF = 0x10,
    CU_AD_FORMAT_FLOAT = 0x20
} CUarray_format;
```

- NumChannels specifies the number of packed components per CUDA array element; it may be 1, 2, or 4;
- Flags may be set to
  - `CUDA_ARRAY3D_LAYERED` to enable creation of layered CUDA arrays. If this flag is set, Depth specifies the number of layers, not the depth of a 3D array.
  - `CUDA_ARRAY3D_SURFACE_LDST` to enable surface references to be bound to the CUDA array. If this flag is not set, `cuSurfRefSetArray` will fail when attempting to bind the CUDA array to a surface reference.
  - `CUDA_ARRAY3D_CUBEMAP` to enable creation of cubemaps. If this flag is set, Width must be equal to Height, and Depth must be six. If the `CUDA_ARRAY3D_LAYERED` flag is also set, then Depth must be a multiple of six.
  - `CUDA_ARRAY3D_TEXTURE_GATHER` to indicate that the CUDA array will be used for texture gather. Texture gather can only be performed on 2D CUDA arrays.

Width, Height and Depth must meet certain size requirements as listed in the following table. All values are specified in elements. Note that for brevity's sake, the full name of the device attribute is not specified. For ex., `TEXTURE1D_WIDTH` refers to the device attribute `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_WIDTH`.

Note that 2D CUDA arrays have different size requirements if the `CUDA_ARRAY3D_TEXTURE_GATHER` flag is set. Width and Height must not be greater than `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_GATHER_WIDTH` and `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_GATHER_HEIGHT` respectively, in that case.

CUDA array type	Valid extents that must always be met {(width range in elements), (height range), (depth range)}	Valid extents with <code>CUDA_ARRAY3D_SURFACE_LDST</code> set {(width range in elements), (height range), (depth range)}
1D	{ (1, <code>TEXTURE1D_WIDTH</code> ), 0, 0 }	{ (1, <code>SURFACE1D_WIDTH</code> ), 0, 0 }

2D	{ (1,TEXTURE2D_WIDTH), (1,TEXTURE2D_HEIGHT), 0 }	{ (1,SURFACE2D_WIDTH), (1,SURFACE2D_HEIGHT), 0 }
3D	{ (1,TEXTURE3D_WIDTH), (1,TEXTURE3D_HEIGHT), (1,TEXTURE3D_DEPTH) } OR { (1,TEXTURE3D_WIDTH_ALTERNATE (1,TEXTURE3D_HEIGHT_ALTERNATE (1,TEXTURE3D_DEPTH_ALTERNATE)	{ (1,SURFACE3D_WIDTH), (1,SURFACE3D_HEIGHT), (1,SURFACE3D_DEPTH) }
1D Layered	{ (1,TEXTURE1D_LAYERED_WIDTH), 0, (1,TEXTURE1D_LAYERED_LAYERS) }	{ (1,SURFACE1D_LAYERED_WIDTH), 0, (1,SURFACE1D_LAYERED_LAYERS) }
2D Layered	{ (1,TEXTURE2D_LAYERED_WIDTH), (1,TEXTURE2D_LAYERED_HEIGHT), (1,TEXTURE2D_LAYERED_LAYERS) }	{ (1,SURFACE2D_LAYERED_WIDTH), (1,SURFACE2D_LAYERED_HEIGHT), (1,SURFACE2D_LAYERED_LAYERS) }
Cubemap	{ (1,TEXTURECUBEMAP_WIDTH), (1,TEXTURECUBEMAP_WIDTH), 6 }	{ (1,SURFACECUBEMAP_WIDTH), (1,SURFACECUBEMAP_WIDTH), 6 }
Cubemap Layered	{ (1,TEXTURECUBEMAP_LAYERED_WIDTH), (1,TEXTURECUBEMAP_LAYERED_WIDTH), (1,TEXTURECUBEMAP_LAYERED_LAYERS) }	{ (1,SURFACECUBEMAP_LAYERED_WIDTH), (1,SURFACECUBEMAP_LAYERED_WIDTH), (1,SURFACECUBEMAP_LAYERED_LAYERS) }

Here are examples of CUDA array descriptions:

Description for a CUDA array of 2048 floats:

```

↑  CUDA_ARRAY3D_DESCRIPTOR desc;
    desc.Format = CU_AD_FORMAT_FLOAT;
    desc.NumChannels = 1;
    desc.Width = 2048;
    desc.Height = 0;
    desc.Depth = 0;

```

Description for a 64 x 64 CUDA array of floats:

```

↑  CUDA_ARRAY3D_DESCRIPTOR desc;
    desc.Format = CU_AD_FORMAT_FLOAT;
    desc.NumChannels = 1;
    desc.Width = 64;
    desc.Height = 64;
    desc.Depth = 0;

```

Description for a width x height x depth CUDA array of 64-bit, 4x16-bit float16's:

```

↑  CUDA_ARRAY3D_DESCRIPTOR desc;
    desc.FormatFlags = CU_AD_FORMAT_HALF;
    desc.NumChannels = 4;
    desc.Width = width;
    desc.Height = height;
    desc.Depth = depth;

```



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

#### See also:

`cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`, `cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`, `cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`, `cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoH`, `cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`, `cuMemcpyDtoDAsync`, `cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoA`, `cuMemcpyHtoAAsync`, `cuMemcpyHtoD`, `cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemFreeHost`, `cuMemGetAddressRange`, `cuMemGetInfo`, `cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`, `cuMemsetD2D16`, `cuMemsetD2D32`, `cuMemsetD8`, `cuMemsetD16`, `cuMemsetD32`, `cudaMalloc3DArray`

## CUresult cuArray3DGetDescriptor (CUDA\_ARRAY3D\_DESCRIPTOR \*pArrayDescriptor, CUarray hArray)

Get a 3D CUDA array descriptor.

#### Parameters

##### **pArrayDescriptor**

- Returned 3D array descriptor

##### **hArray**

- 3D array to get descriptor of

#### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_HANDLE`,  
`CUDA_ERROR_CONTEXT_IS_DESTROYED`

#### Description

Returns in `*pArrayDescriptor` a descriptor containing information on the format and dimensions of the CUDA array `hArray`. It is useful for subroutines that have been passed a CUDA array, but need to know the CUDA array parameters for validation or other purposes.

This function may be called on 1D and 2D arrays, in which case the `Height` and/or `Depth` members of the descriptor struct will be set to 0.



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

#### See also:

[cuArray3DCreate](#), [cuArrayCreate](#), [cuArrayDestroy](#), [cuArrayGetDescriptor](#), [cuMemAlloc](#), [cuMemAllocHost](#), [cuMemAllocPitch](#), [cuMemcpy2D](#), [cuMemcpy2DAsync](#), [cuMemcpy2DUnaligned](#), [cuMemcpy3D](#), [cuMemcpy3DAsync](#), [cuMemcpyAtoA](#), [cuMemcpyAtoD](#), [cuMemcpyAtoH](#), [cuMemcpyAtoHAsync](#), [cuMemcpyDtoA](#), [cuMemcpyDtoD](#), [cuMemcpyDtoDAsync](#), [cuMemcpyDtoH](#), [cuMemcpyDtoHAsync](#), [cuMemcpyHtoA](#), [cuMemcpyHtoAAsync](#), [cuMemcpyHtoD](#), [cuMemcpyHtoDAsync](#), [cuMemFree](#), [cuMemFreeHost](#), [cuMemGetAddressRange](#), [cuMemGetInfo](#), [cuMemHostAlloc](#), [cuMemHostGetDevicePointer](#), [cuMemsetD2D8](#), [cuMemsetD2D16](#), [cuMemsetD2D32](#), [cuMemsetD8](#), [cuMemsetD16](#), [cuMemsetD32](#), [cudaArrayGetInfo](#)

## CUresult cuArrayCreate (CUarray \*pHandle, const CUDA\_ARRAY\_DESCRIPTOR \*pAllocateArray)

Creates a 1D or 2D CUDA array.

#### Parameters

##### **pHandle**

- Returned array

##### **pAllocateArray**

- Array descriptor

#### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#), [CUDA\\_ERROR\\_OUT\\_OF\\_MEMORY](#),  
[CUDA\\_ERROR\\_UNKNOWN](#)

#### Description

Creates a CUDA array according to the [CUDA\\_ARRAY\\_DESCRIPTOR](#) structure `pAllocateArray` and returns a handle to the new CUDA array in `*pHandle`. The [CUDA\\_ARRAY\\_DESCRIPTOR](#) is defined as:

```
typedef struct {
    unsigned int Width;
    unsigned int Height;
    CUarray_format Format;
    unsigned int NumChannels;
} CUDA_ARRAY_DESCRIPTOR;
```

where:

- ▶ Width, and Height are the width, and height of the CUDA array (in elements); the CUDA array is one-dimensional if height is 0, two-dimensional otherwise;
- ▶ Format specifies the format of the elements; `CUarray_format` is defined as:

```
typedef enum CUarray_format_enum {
    CU_AD_FORMAT_UNSIGNED_INT8 = 0x01,
    CU_AD_FORMAT_UNSIGNED_INT16 = 0x02,
    CU_AD_FORMAT_UNSIGNED_INT32 = 0x03,
    CU_AD_FORMAT_SIGNED_INT8 = 0x08,
    CU_AD_FORMAT_SIGNED_INT16 = 0x09,
    CU_AD_FORMAT_SIGNED_INT32 = 0x0a,
    CU_AD_FORMAT_HALF = 0x10,
    CU_AD_FORMAT_FLOAT = 0x20
} CUarray_format;
```

- ▶ NumChannels specifies the number of packed components per CUDA array element; it may be 1, 2, or 4;

Here are examples of CUDA array descriptions:

Description for a CUDA array of 2048 floats:

```
CUDA_ARRAY_DESCRIPTOR desc;
desc.Format = CU_AD_FORMAT_FLOAT;
desc.NumChannels = 1;
desc.Width = 2048;
desc.Height = 1;
```

Description for a 64 x 64 CUDA array of floats:

```
CUDA_ARRAY_DESCRIPTOR desc;
desc.Format = CU_AD_FORMAT_FLOAT;
desc.NumChannels = 1;
desc.Width = 64;
desc.Height = 64;
```

Description for a width x height CUDA array of 64-bit, 4x16-bit float16's:

```
CUDA_ARRAY_DESCRIPTOR desc;
desc.FormatFlags = CU_AD_FORMAT_HALF;
desc.NumChannels = 4;
desc.Width = width;
desc.Height = height;
```

Description for a width x height CUDA array of 16-bit elements, each of which is two 8-bit unsigned chars:

```
CUDA_ARRAY_DESCRIPTOR arrayDesc;
desc.FormatFlags = CU_AD_FORMAT_UNSIGNED_INT8;
desc.NumChannels = 2;
desc.Width = width;
desc.Height = height;
```



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

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMallocArray

## CUresult cuArrayDestroy (CUarray hArray)

Destroys a CUDA array.

### Parameters

#### **hArray**

- Array to destroy

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_ARRAY\_IS\_MAPPED, CUDA\_ERROR\_CONTEXT\_IS\_DESTROYED

### Description

Destroys the CUDA array hArray.



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

### See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaFreeArray



## CUresult cuArrayGetDescriptor (CUDA\_ARRAY\_DESCRIPTOR \*pArrayDescriptor, CUarray hArray)

Get a 1D or 2D CUDA array descriptor.

### Parameters

#### **pArrayDescriptor**

- Returned array descriptor

#### **hArray**

- Array to get descriptor of

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE

### Description

Returns in \*pArrayDescriptor a descriptor containing information on the format and dimensions of the CUDA array hArray. It is useful for subroutines that have been passed a CUDA array, but need to know the CUDA array parameters for validation or other purposes.



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

### See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy,  
cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync,  
cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA,  
cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA,  
cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync,  
cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync,  
cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo,  
cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16,  
cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaArrayGetInfo

## CUresult cuDeviceGetByPCIBusId (CUdevice \*dev, const char \*pciBusId)

Returns a handle to a compute device.

### Parameters

#### dev

- Returned device handle

#### 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

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_INVALID\_DEVICE

### Description

Returns in \*device a device handle given a PCI bus ID string.



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

### See also:

cuDeviceGet, cuDeviceGetAttribute, cuDeviceGetPCIBusId, cudaDeviceGetByPCIBusId

## CUresult cuDeviceGetPCIBusId (char \*pciBusId, int len, CUdevice dev)

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

**dev**

- Device to get identifier string for

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_INVALID\_DEVICE

**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:**

`cuDeviceGet`, `cuDeviceGetAttribute`, `cuDeviceGetByPCIBusId`, `cudaDeviceGetPCIBusId`

## CUresult culpcCloseMemHandle (CUdeviceptr dptr)

Close memory mapped with `cuIpcOpenMemHandle`.

**Parameters****dptr**

- Device pointer returned by `cuIpcOpenMemHandle`

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_MAP\_FAILED, CUDA\_ERROR\_INVALID\_HANDLE,  
CUDA\_ERROR\_INVALID\_VALUE

**Description**

Unmaps memory returned by `cuIpcOpenMemHandle`. 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 and Windows operating systems. IPC functionality on Windows is restricted to GPUs in TCC mode

**See also:**

[cuMemAlloc](#), [cuMemFree](#), [cuIpcGetEventHandle](#), [cuIpcOpenEventHandle](#), [cuIpcGetMemHandle](#), [cuIpcOpenMemHandle](#), [cudaIpcCloseMemHandle](#)

## CUresult cuIpcGetEventHandle (CUipcEventHandle \*pHandle, CUevent event)

Gets an interprocess handle for a previously allocated event.

### Parameters

#### pHandle

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

#### event

- Event allocated with [CU\\_EVENT\\_INTERPROCESS](#) and [CU\\_EVENT\\_DISABLE\\_TIMING](#) flags.

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_HANDLE](#), [CUDA\\_ERROR\\_OUT\\_OF\\_MEMORY](#), [CUDA\\_ERROR\\_MAP\\_FAILED](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#)

### Description

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

After the event has been opened in the importing process, [cuEventRecord](#), [cuEventSynchronize](#), [cuStreamWaitEvent](#) and [cuEventQuery](#) may be used in either process. Performing operations on the imported event after the exported event has been freed with [cuEventDestroy](#) will result in undefined behavior.

IPC functionality is restricted to devices with support for unified addressing on Linux and Windows operating systems. IPC functionality on Windows is restricted to GPUs in TCC mode

**See also:**

[cuEventCreate](#), [cuEventDestroy](#), [cuEventSynchronize](#), [cuEventQuery](#),  
[cuStreamWaitEvent](#), [cuIpcOpenEventHandle](#), [cuIpcGetMemHandle](#),  
[cuIpcOpenMemHandle](#), [cuIpcCloseMemHandle](#), [cudaIpcGetEventHandle](#)

## CUresult culpcGetMemHandle (CUipcMemHandle \*pHandle, CUdeviceptr dptr)

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

**Parameters****pHandle**

- Pointer to user allocated [CUipcMemHandle](#) to return the handle in.

**dptr**

- Base pointer to previously allocated device memory

**Returns**

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_HANDLE](#),  
[CUDA\\_ERROR\\_INVALID\\_CONTEXT](#), [CUDA\\_ERROR\\_OUT\\_OF\\_MEMORY](#),  
[CUDA\\_ERROR\\_MAP\\_FAILED](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#)

**Description**

Takes a pointer to the base of an existing device memory allocation created with [cuMemAlloc](#) 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 [cuMemFree](#) and a subsequent call to [cuMemAlloc](#) returns memory with the same device address, [cuIpcGetMemHandle](#) will return a unique handle for the new memory.

IPC functionality is restricted to devices with support for unified addressing on Linux and Windows operating systems. IPC functionality on Windows is restricted to GPUs in TCC mode

**See also:**

[cuMemAlloc](#), [cuMemFree](#), [cuIpcGetEventHandle](#), [cuIpcOpenEventHandle](#),  
[cuIpcOpenMemHandle](#), [cuIpcCloseMemHandle](#), [cudaIpcGetMemHandle](#)

## CUresult culpcOpenEventHandle (CUevent \*phEvent, CUipcEventHandle handle)

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

### Parameters

#### phEvent

- Returns the imported event

#### handle

- Interprocess handle to open

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_MAP\_FAILED, CUDA\_ERROR\_PEER\_ACCESS\_UNSUPPORTED, CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_INVALID\_VALUE

### Description

Opens an interprocess event handle exported from another process with [cuIpcGetEventHandle](#). This function returns a [CUevent](#) that behaves like a locally created event with the [CU\\_EVENT\\_DISABLE\\_TIMING](#) flag specified. This event must be freed with [cuEventDestroy](#).

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

IPC functionality is restricted to devices with support for unified addressing on Linux and Windows operating systems. IPC functionality on Windows is restricted to GPUs in TCC mode

### See also:

[cuEventCreate](#), [cuEventDestroy](#), [cuEventSynchronize](#), [cuEventQuery](#), [cuStreamWaitEvent](#), [cuIpcGetEventHandle](#), [cuIpcGetMemHandle](#), [cuIpcOpenMemHandle](#), [cuIpcCloseMemHandle](#), [cudaIpcOpenEventHandle](#)

## CUresult culpcOpenMemHandle (CUdeviceptr \*pdptr, CUipcMemHandle handle, unsigned int Flags)

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

### Parameters

#### pdptr

- Returned device pointer

#### handle

- [CUipcMemHandle](#) to open

#### Flags

- Flags for this operation. Must be specified as [CU\\_IPC\\_MEM\\_LAZY\\_ENABLE\\_PEER\\_ACCESS](#)

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_MAP\\_FAILED](#), [CUDA\\_ERROR\\_INVALID\\_HANDLE](#),  
[CUDA\\_ERROR\\_TOO\\_MANY\\_PEERS](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#)

### Description

Maps memory exported from another process with [cuIpcGetMemHandle](#) into the current device address space. For contexts on different devices [cuIpcOpenMemHandle](#) can attempt to enable peer access between the devices as if the user called [cuCtxEnablePeerAccess](#). This behavior is controlled by the [CU\\_IPC\\_MEM\\_LAZY\\_ENABLE\\_PEER\\_ACCESS](#) flag. [cuDeviceCanAccessPeer](#) can determine if a mapping is possible.

[cuIpcOpenMemHandle](#) can open handles to devices that may not be visible in the process calling the API.

Contexts that may open [CUipcMemHandles](#) are restricted in the following way. [CUipcMemHandles](#) from each [CUdevice](#) in a given process may only be opened by one [CUcontext](#) per [CUdevice](#) per other process.

Memory returned from [cuIpcOpenMemHandle](#) must be freed with [cuIpcCloseMemHandle](#).

Calling [cuMemFree](#) on an exported memory region before calling [cuIpcCloseMemHandle](#) in the importing context will result in undefined behavior.

IPC functionality is restricted to devices with support for unified addressing on Linux and Windows operating systems. IPC functionality on Windows is restricted to GPUs in TCC mode



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

#### See also:

`cuMemAlloc`, `cuMemFree`, `cuIpcGetEventHandle`, `cuIpcOpenEventHandle`,  
`cuIpcGetMemHandle`, `cuIpcCloseMemHandle`, `cuCtxEnablePeerAccess`,  
`cuDeviceCanAccessPeer`, `cudaIpcOpenMemHandle`

## CUresult cuMemAlloc (CUdeviceptr \*dptr, size\_t bytesize)

Allocates device memory.

#### Parameters

##### **dptr**

- Returned device pointer

##### **bytesize**

- Requested allocation size in bytes

#### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_OUT_OF_MEMORY`

#### Description

Allocates `bytesize` bytes of linear memory on the device and returns in `*dptr` a pointer to the allocated memory. The allocated memory is suitably aligned for any kind of variable. The memory is not cleared. If `bytesize` is 0, `cuMemAlloc()` returns `CUDA_ERROR_INVALID_VALUE`.



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

#### See also:

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`,  
`cuArrayGetDescriptor`, `cuMemAllocHost`, `cuMemAllocPitch`, `cuMemcpy2D`,  
`cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`, `cuMemcpy3DAsync`,  
`cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoH`, `cuMemcpyAtoHAsync`,



[cuMemcpyDtoA](#), [cuMemcpyDtoD](#), [cuMemcpyDtoDAsync](#), [cuMemcpyDtoH](#), [cuMemcpyDtoHAsync](#), [cuMemcpyHtoA](#), [cuMemcpyHtoAAsync](#), [cuMemcpyHtoD](#), [cuMemcpyHtoDAsync](#), [cuMemFree](#), [cuMemFreeHost](#), [cuMemGetAddressRange](#), [cuMemGetInfo](#), [cuMemHostAlloc](#), [cuMemHostGetDevicePointer](#), [cuMemsetD2D8](#), [cuMemsetD2D16](#), [cuMemsetD2D32](#), [cuMemsetD8](#), [cuMemsetD16](#), [cuMemsetD32](#), [cudaMalloc](#)

## CUresult cuMemAllocHost (void \*\*pp, size\_t bytesize)

Allocates page-locked host memory.

### Parameters

#### pp

- Returned host pointer to page-locked memory

#### bytesize

- Requested allocation size in bytes

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#), [CUDA\\_ERROR\\_OUT\\_OF\\_MEMORY](#)

### Description

Allocates `bytesize` 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 [cuMemcpy\(\)](#). 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 [cuMemAllocHost\(\)](#) 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 all host memory allocated using [cuMemHostAlloc\(\)](#) will automatically be immediately accessible to all contexts on all devices which support unified addressing (as may be queried using [CU\\_DEVICE\\_ATTRIBUTE\\_UNIFIED\\_ADDRESSING](#)). The device pointer that may be used to access this host memory from those contexts is always equal to the returned host pointer `*pp`. See [Unified Addressing](#) for additional details.



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

**See also:**

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMallocHost

## CUresult cuMemAllocManaged (CUdeviceptr \*dptr, size\_t bytesize, unsigned int flags)

Allocates memory that will be automatically managed by the Unified Memory system.

**Parameters****dptr**

- Returned device pointer

**bytesize**

- Requested allocation size in bytes

**flags**

- Must be one of [CU\\_MEM\\_ATTACH\\_GLOBAL](#) or [CU\\_MEM\\_ATTACH\\_HOST](#)

**Returns**

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#), [CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#), [CUDA\\_ERROR\\_NOT\\_SUPPORTED](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#), [CUDA\\_ERROR\\_OUT\\_OF\\_MEMORY](#)

**Description**

Allocates `bytesize` bytes of managed memory on the device and returns in `*dptr` a pointer to the allocated memory. If the device doesn't support allocating managed memory, [CUDA\\_ERROR\\_NOT\\_SUPPORTED](#) is returned. Support for managed memory can be queried using the device attribute [CU\\_DEVICE\\_ATTRIBUTE\\_MANAGED\\_MEMORY](#). The allocated memory is suitably aligned for any kind of variable. The memory is not cleared. If `bytesize` is 0, [cuMemAllocManaged](#) returns [CUDA\\_ERROR\\_INVALID\\_VALUE](#). The pointer is valid on the CPU and on all GPUs in the system that support managed memory. All accesses to this pointer must obey the Unified Memory programming model.

`flags` specifies the default stream association for this allocation. `flags` must be one of `CU_MEM_ATTACH_GLOBAL` or `CU_MEM_ATTACH_HOST`. If `CU_MEM_ATTACH_GLOBAL` is specified, then this memory is accessible from any stream on any device. If `CU_MEM_ATTACH_HOST` is specified, then the allocation should not be accessed from devices that have a zero value for the device attribute `CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS`; an explicit call to `cuStreamAttachMemAsync` will be required to enable access on such devices.

If the association is later changed via `cuStreamAttachMemAsync` to a single stream, the default association as specified during `cuMemAllocManaged` is restored when that stream is destroyed. For `__managed__` variables, the default association is always `CU_MEM_ATTACH_GLOBAL`. Note that destroying a stream is an asynchronous operation, and as a result, the change to default association won't happen until all work in the stream has completed.

Memory allocated with `cuMemAllocManaged` should be released with `cuMemFree`.

Device memory oversubscription is possible for GPUs that have a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS`. Managed memory on such GPUs may be evicted from device memory to host memory at any time by the Unified Memory driver in order to make room for other allocations.

In a multi-GPU system where all GPUs have a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS`, managed memory may not be populated when this API returns and instead may be populated on access. In such systems, managed memory can migrate to any processor's memory at any time. The Unified Memory driver will employ heuristics to maintain data locality and prevent excessive page faults to the extent possible. The application can also guide the driver about memory usage patterns via `cuMemAdvise`. The application can also explicitly migrate memory to a desired processor's memory via `cuMemPrefetchAsync`.

In a multi-GPU system where all of the GPUs have a zero value for the device attribute `CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS` and all the GPUs have peer-to-peer support with each other, the physical storage for managed memory is created on the GPU which is active at the time `cuMemAllocManaged` is called. All other GPUs will reference the data at reduced bandwidth via peer mappings over the PCIe bus. The Unified Memory driver does not migrate memory among such GPUs.

In a multi-GPU system where not all GPUs have peer-to-peer support with each other and where the value of the device attribute `CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS` is zero for at least one of those GPUs, the location chosen for physical storage of managed memory is system-dependent.

- On Linux, the location chosen will be device memory as long as the current set of active contexts are on devices that either have peer-to-peer support with each other or have a non-zero value for the device attribute

**CUDA\_DEVICE\_ATTRIBUTE\_CONCURRENT\_MANAGED\_ACCESS**. If there is an active context on a GPU that does not have a non-zero value for that device attribute and it does not have peer-to-peer support with the other devices that have active contexts on them, then the location for physical storage will be 'zero-copy' or host memory. Note that this means that managed memory that is located in device memory is migrated to host memory if a new context is created on a GPU that doesn't have a non-zero value for the device attribute and does not support peer-to-peer with at least one of the other devices that has an active context. This in turn implies that context creation may fail if there is insufficient host memory to migrate all managed allocations.

- ▶ On Windows, the physical storage is always created in 'zero-copy' or host memory. All GPUs will reference the data at reduced bandwidth over the PCIe bus. In these circumstances, use of the environment variable `CUDA_VISIBLE_DEVICES` is recommended to restrict CUDA to only use those GPUs that have peer-to-peer support. Alternatively, users can also set `CUDA_MANAGED_FORCE_DEVICE_ALLOC` to a non-zero value to force the driver to always use device memory for physical storage. When this environment variable is set to a non-zero value, all contexts created in that process on devices that support managed memory have to be peer-to-peer compatible with each other. Context creation will fail if a context is created on a device that supports managed memory and is not peer-to-peer compatible with any of the other managed memory supporting devices on which contexts were previously created, even if those contexts have been destroyed. These environment variables are described in the CUDA programming guide under the "CUDA environment variables" section.
- ▶ On ARM, managed memory is not available on discrete gpu with Drive PX-2.



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

#### See also:

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`, `cuArrayGetDescriptor`, `cuMemAllocHost`, `cuMemAllocPitch`, `cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`, `cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoH`, `cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`, `cuMemcpyDtoDAsync`, `cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoA`, `cuMemcpyHtoAAsync`, `cuMemcpyHtoD`, `cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemFreeHost`, `cuMemGetAddressRange`, `cuMemGetInfo`, `cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`, `cuMemsetD2D16`, `cuMemsetD2D32`, `cuMemsetD8`, `cuMemsetD16`, `cuMemsetD32`, `cuDeviceGetAttribute`, `cuStreamAttachMemAsync`, `cudaMallocManaged`

## CUresult cuMemAllocPitch (CUdeviceptr \*dptr, size\_t \*pPitch, size\_t WidthInBytes, size\_t Height, unsigned int ElementSizeBytes)

Allocates pitched device memory.

### Parameters

#### dptr

- Returned device pointer

#### pPitch

- Returned pitch of allocation in bytes

#### WidthInBytes

- Requested allocation width in bytes

#### Height

- Requested allocation height in rows

#### ElementSizeBytes

- Size of largest reads/writes for range

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_OUT\_OF\_MEMORY

### Description

Allocates at least `WidthInBytes * Height` bytes of linear memory on the device and returns in `*dptr` 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. `ElementSizeBytes` specifies the size of the largest reads and writes that will be performed on the memory range. `ElementSizeBytes` may be 4, 8 or 16 (since coalesced memory transactions are not possible on other data sizes). If `ElementSizeBytes` is smaller than the actual read/write size of a kernel, the kernel will run correctly, but possibly at reduced speed. The pitch returned in `*pPitch` by `cuMemAllocPitch()` 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;
```

The pitch returned by `cuMemAllocPitch()` is guaranteed to work with `cuMemcpy2D()` under all circumstances. For allocations of 2D arrays, it is recommended that programmers consider performing pitch allocations using `cuMemAllocPitch()`. Due to 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).

The byte alignment of the pitch returned by `cuMemAllocPitch()` is guaranteed to match or exceed the alignment requirement for texture binding with `cuTexRefSetAddress2D()`.



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

#### See also:

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`, `cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`, `cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoH`, `cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`, `cuMemcpyDtoDAsync`, `cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoA`, `cuMemcpyHtoAAsync`, `cuMemcpyHtoD`, `cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemFreeHost`, `cuMemGetAddressRange`, `cuMemGetInfo`, `cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`, `cuMemsetD2D16`, `cuMemsetD2D32`, `cuMemsetD8`, `cuMemsetD16`, `cuMemsetD32`, `cudaMallocPitch`

## CUresult cuMemcpy (CUdeviceptr dst, CUdeviceptr src, size\_t ByteCount)

Copies memory.

### Parameters

#### **dst**

- Destination unified virtual address space pointer

#### **src**

- Source unified virtual address space pointer

#### **ByteCount**

- Size of memory copy in bytes

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`

## Description

Copies data between two pointers. `dst` and `src` are base pointers of the destination and source, respectively. `ByteCount` specifies the number of bytes to copy. Note that this function infers the type of the transfer (host to host, host to device, device to device, or device to host) from the pointer values. This function is only allowed in contexts which support unified addressing.



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits **synchronous** behavior for most use cases.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return `CUDA_ERROR_INVALID_VALUE`.

## See also:

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`, `cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`, `cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`, `cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoH`, `cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoA`, `cuMemcpyHtoAAsync`, `cuMemcpyHtoD`, `cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemFreeHost`, `cuMemGetAddressRange`, `cuMemGetInfo`, `cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`, `cuMemsetD2D16`, `cuMemsetD2D32`, `cuMemsetD8`, `cuMemsetD16`, `cuMemsetD32`, `cudaMemcpy`, `cudaMemcpyToSymbol`, `cudaMemcpyFromSymbol`

## CUresult cuMemcpy2D (const CUDA\_MEMCPY2D \*pCopy)

Copies memory for 2D arrays.

### Parameters

#### pCopy

- Parameters for the memory copy

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`, `CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`, `CUDA_ERROR_INVALID_VALUE`



## Description

Perform a 2D memory copy according to the parameters specified in `pCopy`. The `CUDA_MEMCPY2D` structure is defined as:

```
typedef struct CUDA_MEMCPY2D_st {
    unsigned int srcXInBytes, srcY;
    CUMemorytype srcMemoryType;
    const void *srcHost;
    CUdeviceptr srcDevice;
    CUarray srcArray;
    unsigned int srcPitch;

    unsigned int dstXInBytes, dstY;
    CUMemorytype dstMemoryType;
    void *dstHost;
    CUdeviceptr dstDevice;
    CUarray dstArray;
    unsigned int dstPitch;

    unsigned int WidthInBytes;
    unsigned int Height;
} CUDA_MEMCPY2D;
```

where:

- `srcMemoryType` and `dstMemoryType` specify the type of memory of the source and destination, respectively; `CUMemorytype_enum` is defined as:

```
typedef enum CUMemorytype_enum {
    CU_MEMORYTYPE_HOST = 0x01,
    CU_MEMORYTYPE_DEVICE = 0x02,
    CU_MEMORYTYPE_ARRAY = 0x03,
    CU_MEMORYTYPE_UNIFIED = 0x04
} CUMemorytype;
```

If `srcMemoryType` is `CU_MEMORYTYPE_UNIFIED`, `srcDevice` and `srcPitch` specify the (unified virtual address space) base address of the source data and the bytes per row to apply. `srcArray` is ignored. This value may be used only if unified addressing is supported in the calling context.

If `srcMemoryType` is `CU_MEMORYTYPE_HOST`, `srcHost` and `srcPitch` specify the (host) base address of the source data and the bytes per row to apply. `srcArray` is ignored.

If `srcMemoryType` is `CU_MEMORYTYPE_DEVICE`, `srcDevice` and `srcPitch` specify the (device) base address of the source data and the bytes per row to apply. `srcArray` is ignored.

If `srcMemoryType` is `CU_MEMORYTYPE_ARRAY`, `srcArray` specifies the handle of the source data. `srcHost`, `srcDevice` and `srcPitch` are ignored.

If `dstMemoryType` is `CU_MEMORYTYPE_HOST`, `dstHost` and `dstPitch` specify the (host) base address of the destination data and the bytes per row to apply. `dstArray` is ignored.



If `dstMemoryType` is `CU_MEMORYTYPE_UNIFIED`, `dstDevice` and `dstPitch` specify the (unified virtual address space) base address of the source data and the bytes per row to apply. `dstArray` is ignored. This value may be used only if unified addressing is supported in the calling context.

If `dstMemoryType` is `CU_MEMORYTYPE_DEVICE`, `dstDevice` and `dstPitch` specify the (device) base address of the destination data and the bytes per row to apply. `dstArray` is ignored.

If `dstMemoryType` is `CU_MEMORYTYPE_ARRAY`, `dstArray` specifies the handle of the destination data. `dstHost`, `dstDevice` and `dstPitch` are ignored.

- `srcXInBytes` and `srcY` specify the base address of the source data for the copy.

For host pointers, the starting address is

```
↑ void* Start = (void*)((char*)srcHost+srcY*srcPitch + srcXInBytes);
```

For device pointers, the starting address is

```
↑ CUdeviceptr Start = srcDevice+srcY*srcPitch+srcXInBytes;
```

For CUDA arrays, `srcXInBytes` must be evenly divisible by the array element size.

- `dstXInBytes` and `dstY` specify the base address of the destination data for the copy.

For host pointers, the base address is

```
↑ void* dstStart = (void*)((char*)dstHost+dstY*dstPitch + dstXInBytes);
```

For device pointers, the starting address is

```
↑ CUdeviceptr dstStart = dstDevice+dstY*dstPitch+dstXInBytes;
```

For CUDA arrays, `dstXInBytes` must be evenly divisible by the array element size.

- `WidthInBytes` and `Height` specify the width (in bytes) and height of the 2D copy being performed.
- If specified, `srcPitch` must be greater than or equal to `WidthInBytes + srcXInBytes`, and `dstPitch` must be greater than or equal to `WidthInBytes + dstXInBytes`.

`cuMemcpy2D()` returns an error if any pitch is greater than the maximum allowed (`CU_DEVICE_ATTRIBUTE_MAX_PITCH`). `cuMemAllocPitch()` passes back pitches that always work with `cuMemcpy2D()`. On intra-device memory copies (device to device, CUDA array to device, CUDA array to CUDA array), `cuMemcpy2D()` may fail for pitches not computed by `cuMemAllocPitch()`. `cuMemcpy2DUnaligned()` does not have this restriction, but may run significantly slower in the cases where `cuMemcpy2D()` would have returned an error code.



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

#### See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemcpy2D, cudaMemcpy2DToArray, cudaMemcpy2DFromArray

## CUresult cuMemcpy2DAsync (const CUDA\_MEMCPY2D \*pCopy, CUstream hStream)

Copies memory for 2D arrays.

### Parameters

#### pCopy

- Parameters for the memory copy

#### hStream

- Stream identifier

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE

## Description

Perform a 2D memory copy according to the parameters specified in `pCopy`. The `CUDA_MEMCPY2D` structure is defined as:

```
typedef struct CUDA_MEMCPY2D_st {
    unsigned int srcXInBytes, srcY;
    CUMemorytype srcMemoryType;
    const void *srcHost;
    CUdeviceptr srcDevice;
    CUarray srcArray;
    unsigned int srcPitch;
    unsigned int dstXInBytes, dstY;
    CUMemorytype dstMemoryType;
    void *dstHost;
    CUdeviceptr dstDevice;
    CUarray dstArray;
    unsigned int dstPitch;
    unsigned int WidthInBytes;
    unsigned int Height;
} CUDA_MEMCPY2D;
```

where:

- `srcMemoryType` and `dstMemoryType` specify the type of memory of the source and destination, respectively; `CUMemorytype_enum` is defined as:

```
typedef enum CUMemorytype_enum {
    CU_MEMORYTYPE_HOST = 0x01,
    CU_MEMORYTYPE_DEVICE = 0x02,
    CU_MEMORYTYPE_ARRAY = 0x03,
    CU_MEMORYTYPE_UNIFIED = 0x04
} CUMemorytype;
```

If `srcMemoryType` is `CU_MEMORYTYPE_HOST`, `srcHost` and `srcPitch` specify the (host) base address of the source data and the bytes per row to apply. `srcArray` is ignored.

If `srcMemoryType` is `CU_MEMORYTYPE_UNIFIED`, `srcDevice` and `srcPitch` specify the (unified virtual address space) base address of the source data and the bytes per row to apply. `srcArray` is ignored. This value may be used only if unified addressing is supported in the calling context.

If `srcMemoryType` is `CU_MEMORYTYPE_DEVICE`, `srcDevice` and `srcPitch` specify the (device) base address of the source data and the bytes per row to apply. `srcArray` is ignored.

If `srcMemoryType` is `CU_MEMORYTYPE_ARRAY`, `srcArray` specifies the handle of the source data. `srcHost`, `srcDevice` and `srcPitch` are ignored.

If `dstMemoryType` is `CU_MEMORYTYPE_UNIFIED`, `dstDevice` and `dstPitch` specify the (unified virtual address space) base address of the source data and the bytes per row to apply. `dstArray` is ignored. This value may be used only if unified addressing is supported in the calling context.

If `dstMemoryType` is `CU_MEMORYTYPE_HOST`, `dstHost` and `dstPitch` specify the (host) base address of the destination data and the bytes per row to apply. `dstArray` is ignored.

If `dstMemoryType` is `CU_MEMORYTYPE_DEVICE`, `dstDevice` and `dstPitch` specify the (device) base address of the destination data and the bytes per row to apply. `dstArray` is ignored.

If `dstMemoryType` is `CU_MEMORYTYPE_ARRAY`, `dstArray` specifies the handle of the destination data. `dstHost`, `dstDevice` and `dstPitch` are ignored.

- ▶ `srcXInBytes` and `srcY` specify the base address of the source data for the copy.

For host pointers, the starting address is

```
↑ void* Start = (void*)((char*)srcHost+srcY*srcPitch + srcXInBytes);
```

For device pointers, the starting address is

```
↑ CUdeviceptr Start = srcDevice+srcY*srcPitch+srcXInBytes;
```

For CUDA arrays, `srcXInBytes` must be evenly divisible by the array element size.

- ▶ `dstXInBytes` and `dstY` specify the base address of the destination data for the copy.

For host pointers, the base address is

```
↑ void* dstStart = (void*)((char*)dstHost+dstY*dstPitch + dstXInBytes);
```

For device pointers, the starting address is

```
↑ CUdeviceptr dstStart = dstDevice+dstY*dstPitch+dstXInBytes;
```

For CUDA arrays, `dstXInBytes` must be evenly divisible by the array element size.

- ▶ `WidthInBytes` and `Height` specify the width (in bytes) and height of the 2D copy being performed.
- ▶ If specified, `srcPitch` must be greater than or equal to `WidthInBytes + srcXInBytes`, and `dstPitch` must be greater than or equal to `WidthInBytes + dstXInBytes`.
- ▶ If specified, `srcPitch` must be greater than or equal to `WidthInBytes + srcXInBytes`, and `dstPitch` must be greater than or equal to `WidthInBytes + dstXInBytes`.
- ▶ If specified, `srcHeight` must be greater than or equal to `Height + srcY`, and `dstHeight` must be greater than or equal to `Height + dstY`.

`cuMemcpy2DAsync()` returns an error if any pitch is greater than the maximum allowed (`CU_DEVICE_ATTRIBUTE_MAX_PITCH`). `cuMemAllocPitch()` passes back pitches that always work with `cuMemcpy2D()`. On intra-device memory copies (device to device, CUDA array to device, CUDA array to CUDA array), `cuMemcpy2DAsync()` may fail for pitches not computed by `cuMemAllocPitch()`.



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

#### See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemcpy2DAsync, cudaMemcpy2DToArrayAsync, cudaMemcpy2DFromArrayAsync

## CUresult cuMemcpy2DUnaligned (const CUDA\_MEMCPY2D \*pCopy)

Copies memory for 2D arrays.

#### Parameters

##### pCopy

- Parameters for the memory copy

#### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_VALUE

## Description

Perform a 2D memory copy according to the parameters specified in `pCopy`. The `CUDA_MEMCPY2D` structure is defined as:

```
typedef struct CUDA_MEMCPY2D_st {
    unsigned int srcXInBytes, srcY;
    CUMemorytype srcMemoryType;
    const void *srcHost;
    CUdeviceptr srcDevice;
    CUarray srcArray;
    unsigned int srcPitch;
    unsigned int dstXInBytes, dstY;
    CUMemorytype dstMemoryType;
    void *dstHost;
    CUdeviceptr dstDevice;
    CUarray dstArray;
    unsigned int dstPitch;
    unsigned int WidthInBytes;
    unsigned int Height;
} CUDA_MEMCPY2D;
```

where:

- `srcMemoryType` and `dstMemoryType` specify the type of memory of the source and destination, respectively; `CUMemorytype_enum` is defined as:

```
typedef enum CUMemorytype_enum {
    CU_MEMORYTYPE_HOST = 0x01,
    CU_MEMORYTYPE_DEVICE = 0x02,
    CU_MEMORYTYPE_ARRAY = 0x03,
    CU_MEMORYTYPE_UNIFIED = 0x04
} CUMemorytype;
```

If `srcMemoryType` is `CU_MEMORYTYPE_UNIFIED`, `srcDevice` and `srcPitch` specify the (unified virtual address space) base address of the source data and the bytes per row to apply. `srcArray` is ignored. This value may be used only if unified addressing is supported in the calling context.

If `srcMemoryType` is `CU_MEMORYTYPE_HOST`, `srcHost` and `srcPitch` specify the (host) base address of the source data and the bytes per row to apply. `srcArray` is ignored.

If `srcMemoryType` is `CU_MEMORYTYPE_DEVICE`, `srcDevice` and `srcPitch` specify the (device) base address of the source data and the bytes per row to apply. `srcArray` is ignored.

If `srcMemoryType` is `CU_MEMORYTYPE_ARRAY`, `srcArray` specifies the handle of the source data. `srcHost`, `srcDevice` and `srcPitch` are ignored.

If `dstMemoryType` is `CU_MEMORYTYPE_UNIFIED`, `dstDevice` and `dstPitch` specify the (unified virtual address space) base address of the source data and the bytes per row to apply. `dstArray` is ignored. This value may be used only if unified addressing is supported in the calling context.

If `dstMemoryType` is `CU_MEMORYTYPE_HOST`, `dstHost` and `dstPitch` specify the (host) base address of the destination data and the bytes per row to apply. `dstArray` is ignored.

If `dstMemoryType` is `CU_MEMORYTYPE_DEVICE`, `dstDevice` and `dstPitch` specify the (device) base address of the destination data and the bytes per row to apply. `dstArray` is ignored.

If `dstMemoryType` is `CU_MEMORYTYPE_ARRAY`, `dstArray` specifies the handle of the destination data. `dstHost`, `dstDevice` and `dstPitch` are ignored.

- `srcXInBytes` and `srcY` specify the base address of the source data for the copy.

For host pointers, the starting address is

```
↑ void* Start = (void*)((char*)srcHost+srcY*srcPitch + srcXInBytes);
```

For device pointers, the starting address is

```
↑ CUDeviceptr Start = srcDevice+srcY*srcPitch+srcXInBytes;
```

For CUDA arrays, `srcXInBytes` must be evenly divisible by the array element size.

- `dstXInBytes` and `dstY` specify the base address of the destination data for the copy.

For host pointers, the base address is

```
↑ void* dstStart = (void*)((char*)dstHost+dstY*dstPitch + dstXInBytes);
```

For device pointers, the starting address is

```
↑ CUDeviceptr dstStart = dstDevice+dstY*dstPitch+dstXInBytes;
```

For CUDA arrays, `dstXInBytes` must be evenly divisible by the array element size.

- `WidthInBytes` and `Height` specify the width (in bytes) and height of the 2D copy being performed.
- If specified, `srcPitch` must be greater than or equal to `WidthInBytes + srcXInBytes`, and `dstPitch` must be greater than or equal to `WidthInBytes + dstXInBytes`.

`cuMemcpy2D()` returns an error if any pitch is greater than the maximum allowed (`CU_DEVICE_ATTRIBUTE_MAX_PITCH`). `cuMemAllocPitch()` passes back pitches that always work with `cuMemcpy2D()`. On intra-device memory copies (device to device, CUDA array to device, CUDA array to CUDA array), `cuMemcpy2D()` may fail for pitches not computed by `cuMemAllocPitch()`. `cuMemcpy2DUnaligned()` does not have this restriction, but may run significantly slower in the cases where `cuMemcpy2D()` would have returned an error code.



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

- This function exhibits **synchronous** behavior for most use cases.

#### See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemcpy2D, cudaMemcpy2DToArray, cudaMemcpy2DFromArray

## CUresult cuMemcpy3D (const CUDA\_MEMCPY3D \*pCopy)

Copies memory for 3D arrays.

#### Parameters

##### pCopy

- Parameters for the memory copy

#### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE



## Description

Perform a 3D memory copy according to the parameters specified in `pCopy`. The `CUDA_MEMCPY3D` structure is defined as:

```
typedef struct CUDA_MEMCPY3D_st {
    unsigned int srcXInBytes, srcY, srcZ;
    unsigned int srcLOD;
    CUMemorytype srcMemoryType;
    const void *srcHost;
    CUdeviceptr srcDevice;
    CUarray srcArray;
    unsigned int srcPitch; // ignored when src is array
    unsigned int srcHeight; // ignored when src is array; may
    be 0 if Depth==1

    unsigned int dstXInBytes, dstY, dstZ;
    unsigned int dstLOD;
    CUMemorytype dstMemoryType;
    void *dstHost;
    CUdeviceptr dstDevice;
    CUarray dstArray;
    unsigned int dstPitch; // ignored when dst is array
    unsigned int dstHeight; // ignored when dst is array; may
    be 0 if Depth==1

    unsigned int WidthInBytes;
    unsigned int Height;
    unsigned int Depth;
} CUDA_MEMCPY3D;
```

where:

- `srcMemoryType` and `dstMemoryType` specify the type of memory of the source and destination, respectively; `CUMemorytype_enum` is defined as:

```
typedef enum CUMemorytype_enum {
    CU_MEMORYTYPE_HOST = 0x01,
    CU_MEMORYTYPE_DEVICE = 0x02,
    CU_MEMORYTYPE_ARRAY = 0x03,
    CU_MEMORYTYPE_UNIFIED = 0x04
} CUMemorytype;
```

If `srcMemoryType` is `CU_MEMORYTYPE_UNIFIED`, `srcDevice` and `srcPitch` specify the (unified virtual address space) base address of the source data and the bytes per row to apply. `srcArray` is ignored. This value may be used only if unified addressing is supported in the calling context.

If `srcMemoryType` is `CU_MEMORYTYPE_HOST`, `srcHost`, `srcPitch` and `srcHeight` specify the (host) base address of the source data, the bytes per row, and the height of each 2D slice of the 3D array. `srcArray` is ignored.

If `srcMemoryType` is `CU_MEMORYTYPE_DEVICE`, `srcDevice`, `srcPitch` and `srcHeight` specify the (device) base address of the source data, the bytes per row, and the height of each 2D slice of the 3D array. `srcArray` is ignored.

If `srcMemoryType` is `CU_MEMORYTYPE_ARRAY`, `srcArray` specifies the handle of the source data. `srcHost`, `srcDevice`, `srcPitch` and `srcHeight` are ignored.

If `dstMemoryType` is `CU_MEMORYTYPE_UNIFIED`, `dstDevice` and `dstPitch` specify the (unified virtual address space) base address of the source data and the bytes per row to apply. `dstArray` is ignored. This value may be used only if unified addressing is supported in the calling context.

If `dstMemoryType` is `CU_MEMORYTYPE_HOST`, `dstHost` and `dstPitch` specify the (host) base address of the destination data, the bytes per row, and the height of each 2D slice of the 3D array. `dstArray` is ignored.

If `dstMemoryType` is `CU_MEMORYTYPE_DEVICE`, `dstDevice` and `dstPitch` specify the (device) base address of the destination data, the bytes per row, and the height of each 2D slice of the 3D array. `dstArray` is ignored.

If `dstMemoryType` is `CU_MEMORYTYPE_ARRAY`, `dstArray` specifies the handle of the destination data. `dstHost`, `dstDevice`, `dstPitch` and `dstHeight` are ignored.

- ▶ `srcXInBytes`, `srcY` and `srcZ` specify the base address of the source data for the copy.

For host pointers, the starting address is

```
↑ void* Start = (void*)((char*)srcHost+(srcZ*srcHeight+srcY)*srcPitch +
srcXInBytes);
```

For device pointers, the starting address is

```
↑ CUdeviceptr Start = srcDevice+(srcZ*srcHeight+srcY)*srcPitch+srcXInBytes;
```

For CUDA arrays, `srcXInBytes` must be evenly divisible by the array element size.

- ▶ `dstXInBytes`, `dstY` and `dstZ` specify the base address of the destination data for the copy.

For host pointers, the base address is

```
↑ void* dstStart = (void*)((char*)dstHost+(dstZ*dstHeight+dstY)*dstPitch +
dstXInBytes);
```

For device pointers, the starting address is

```
↑ CUdeviceptr dstStart = dstDevice+(dstZ*dstHeight+dstY)*dstPitch+dstXInBytes;
```

For CUDA arrays, `dstXInBytes` must be evenly divisible by the array element size.

- ▶ `WidthInBytes`, `Height` and `Depth` specify the width (in bytes), height and depth of the 3D copy being performed.
- ▶ If specified, `srcPitch` must be greater than or equal to `WidthInBytes + srcXInBytes`, and `dstPitch` must be greater than or equal to `WidthInBytes + dstXInBytes`.
- ▶ If specified, `srcHeight` must be greater than or equal to `Height + srcY`, and `dstHeight` must be greater than or equal to `Height + dstY`.

`cuMemcpy3D()` returns an error if any pitch is greater than the maximum allowed (`CU_DEVICE_ATTRIBUTE_MAX_PITCH`).

The `srcLOD` and `dstLOD` members of the `CUDA_MEMCPY3D` structure must be set to 0.



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

#### See also:

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`, `cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`, `cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoH`, `cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`, `cuMemcpyDtoDAsync`, `cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoA`, `cuMemcpyHtoAAsync`, `cuMemcpyHtoD`, `cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemFreeHost`, `cuMemGetAddressRange`, `cuMemGetInfo`, `cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`, `cuMemsetD2D16`, `cuMemsetD2D32`, `cuMemsetD8`, `cuMemsetD16`, `cuMemsetD32`, `cudaMemcpy3D`

## CUresult cuMemcpy3DAsync (const CUDA\_MEMCPY3D \*pCopy, CUstream hStream)

Copies memory for 3D arrays.

### Parameters

#### **pCopy**

- Parameters for the memory copy

#### **hStream**

- Stream identifier

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`, `CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`, `CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_HANDLE`

## Description

Perform a 3D memory copy according to the parameters specified in `pCopy`. The `CUDA_MEMCPY3D` structure is defined as:

```
typedef struct CUDA_MEMCPY3D_st {
    unsigned int srcXInBytes, srcY, srcZ;
    unsigned int srcLOD;
    CUMemorytype srcMemoryType;
    const void *srcHost;
    CUdeviceptr srcDevice;
    CUarray srcArray;
    unsigned int srcPitch; // ignored when src is array
    unsigned int srcHeight; // ignored when src is array; may
    be 0 if Depth==1

    unsigned int dstXInBytes, dstY, dstZ;
    unsigned int dstLOD;
    CUMemorytype dstMemoryType;
    void *dstHost;
    CUdeviceptr dstDevice;
    CUarray dstArray;
    unsigned int dstPitch; // ignored when dst is array
    unsigned int dstHeight; // ignored when dst is array; may
    be 0 if Depth==1

    unsigned int WidthInBytes;
    unsigned int Height;
    unsigned int Depth;
} CUDA_MEMCPY3D;
```

where:

- `srcMemoryType` and `dstMemoryType` specify the type of memory of the source and destination, respectively; `CUMemorytype_enum` is defined as:

```
typedef enum CUMemorytype_enum {
    CU_MEMORYTYPE_HOST = 0x01,
    CU_MEMORYTYPE_DEVICE = 0x02,
    CU_MEMORYTYPE_ARRAY = 0x03,
    CU_MEMORYTYPE_UNIFIED = 0x04
} CUMemorytype;
```

If `srcMemoryType` is `CU_MEMORYTYPE_UNIFIED`, `srcDevice` and `srcPitch` specify the (unified virtual address space) base address of the source data and the bytes per row to apply. `srcArray` is ignored. This value may be used only if unified addressing is supported in the calling context.

If `srcMemoryType` is `CU_MEMORYTYPE_HOST`, `srcHost`, `srcPitch` and `srcHeight` specify the (host) base address of the source data, the bytes per row, and the height of each 2D slice of the 3D array. `srcArray` is ignored.

If `srcMemoryType` is `CU_MEMORYTYPE_DEVICE`, `srcDevice`, `srcPitch` and `srcHeight` specify the (device) base address of the source data, the bytes per row, and the height of each 2D slice of the 3D array. `srcArray` is ignored.

If `srcMemoryType` is `CU_MEMORYTYPE_ARRAY`, `srcArray` specifies the handle of the source data. `srcHost`, `srcDevice`, `srcPitch` and `srcHeight` are ignored.

If `dstMemoryType` is `CU_MEMORYTYPE_UNIFIED`, `dstDevice` and `dstPitch` specify the (unified virtual address space) base address of the source data and the bytes per row to apply. `dstArray` is ignored. This value may be used only if unified addressing is supported in the calling context.

If `dstMemoryType` is `CU_MEMORYTYPE_HOST`, `dstHost` and `dstPitch` specify the (host) base address of the destination data, the bytes per row, and the height of each 2D slice of the 3D array. `dstArray` is ignored.

If `dstMemoryType` is `CU_MEMORYTYPE_DEVICE`, `dstDevice` and `dstPitch` specify the (device) base address of the destination data, the bytes per row, and the height of each 2D slice of the 3D array. `dstArray` is ignored.

If `dstMemoryType` is `CU_MEMORYTYPE_ARRAY`, `dstArray` specifies the handle of the destination data. `dstHost`, `dstDevice`, `dstPitch` and `dstHeight` are ignored.

- ▶ `srcXInBytes`, `srcY` and `srcZ` specify the base address of the source data for the copy.

For host pointers, the starting address is

```
↑ void* Start = (void*)((char*)srcHost+(srcZ*srcHeight+srcY)*srcPitch +
srcXInBytes);
```

For device pointers, the starting address is

```
↑ CUDeviceptr Start = srcDevice+(srcZ*srcHeight+srcY)*srcPitch+srcXInBytes;
```

For CUDA arrays, `srcXInBytes` must be evenly divisible by the array element size.

- ▶ `dstXInBytes`, `dstY` and `dstZ` specify the base address of the destination data for the copy.

For host pointers, the base address is

```
↑ void* dstStart = (void*)((char*)dstHost+(dstZ*dstHeight+dstY)*dstPitch +
dstXInBytes);
```

For device pointers, the starting address is

```
↑ CUDeviceptr dstStart = dstDevice+(dstZ*dstHeight+dstY)*dstPitch+dstXInBytes;
```

For CUDA arrays, `dstXInBytes` must be evenly divisible by the array element size.

- ▶ `WidthInBytes`, `Height` and `Depth` specify the width (in bytes), height and depth of the 3D copy being performed.
- ▶ If specified, `srcPitch` must be greater than or equal to `WidthInBytes + srcXInBytes`, and `dstPitch` must be greater than or equal to `WidthInBytes + dstXInBytes`.
- ▶ If specified, `srcHeight` must be greater than or equal to `Height + srcY`, and `dstHeight` must be greater than or equal to `Height + dstY`.

`cuMemcpy3DAsync()` returns an error if any pitch is greater than the maximum allowed (`CU_DEVICE_ATTRIBUTE_MAX_PITCH`).

The `srcLOD` and `dstLOD` members of the `CUDA_MEMCPY3D` structure must be set to 0.



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

### See also:

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`, `cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`, `cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`, `cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoH`, `cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`, `cuMemcpyDtoDAsync`, `cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoA`, `cuMemcpyHtoAAsync`, `cuMemcpyHtoD`, `cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemFreeHost`, `cuMemGetAddressRange`, `cuMemGetInfo`, `cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`, `cuMemsetD2D8Async`, `cuMemsetD2D16`, `cuMemsetD2D16Async`, `cuMemsetD2D32`, `cuMemsetD2D32Async`, `cuMemsetD8`, `cuMemsetD8Async`, `cuMemsetD16`, `cuMemsetD16Async`, `cuMemsetD32`, `cuMemsetD32Async`, `cudaMemcpy3DAsync`

## CUresult cuMemcpy3DPeer (const CUDA\_MEMCPY3D\_PEER \*pCopy)

Copies memory between contexts.

### Parameters

#### pCopy

- Parameters for the memory copy

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`

## Description

Perform a 3D memory copy according to the parameters specified in `pCopy`. See the definition of the `CUDA_MEMCPY3D_PEER` structure for documentation of its parameters.



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

## See also:

`cuMemcpyDtoD`, `cuMemcpyPeer`, `cuMemcpyDtoDAsync`, `cuMemcpyPeerAsync`, `cuMemcpy3DPeerAsync`, `cudaMemcpy3DPeer`

## CUresult cuMemcpy3DPeerAsync (const CUDA\_MEMCPY3D\_PEER \*pCopy, CUstream hStream)

Copies memory between contexts asynchronously.

## Parameters

### `pCopy`

- Parameters for the memory copy

### `hStream`

- Stream identifier

## Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`

## Description

Perform a 3D memory copy according to the parameters specified in `pCopy`. See the definition of the `CUDA_MEMCPY3D_PEER` 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.
- This function uses standard **default stream** semantics.

**See also:**

`cuMemcpyDtoD`, `cuMemcpyPeer`, `cuMemcpyDtoDAsync`, `cuMemcpyPeerAsync`,  
`cuMemcpy3DPeerAsync`, `cudaMemcpy3DPeerAsync`

## CUresult cuMemcpyAsync (CUdeviceptr dst, CUdeviceptr src, size\_t ByteCount, CUstream hStream)

Copies memory asynchronously.

**Parameters****dst**

- Destination unified virtual address space pointer

**src**

- Source unified virtual address space pointer

**ByteCount**

- Size of memory copy in bytes

**hStream**

- Stream identifier

**Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_HANDLE`

**Description**

Copies data between two pointers. `dst` and `src` are base pointers of the destination and source, respectively. `ByteCount` specifies the number of bytes to copy. Note that this function infers the type of the transfer (host to host, host to device, device to device, or device to host) from the pointer values. This function is only allowed in contexts which support unified addressing.



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits **asynchronous** behavior for most use cases.
- This function uses standard **default stream** semantics.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return `CUDA_ERROR_INVALID_VALUE`.



**See also:**

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemcpyAsync, cudaMemcpyToSymbolAsync, cudaMemcpyFromSymbolAsync

## CUresult cuMemcpyAtoA (CUarray dstArray, size\_t dstOffset, CUarray srcArray, size\_t srcOffset, size\_t ByteCount)

Copies memory from Array to Array.

**Parameters****dstArray**

- Destination array

**dstOffset**

- Offset in bytes of destination array

**srcArray**

- Source array

**srcOffset**

- Offset in bytes of source array

**ByteCount**

- Size of memory copy in bytes

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

**Description**

Copies from one 1D CUDA array to another. `dstArray` and `srcArray` specify the handles of the destination and source CUDA arrays for the copy, respectively. `dstOffset` and `srcOffset` specify the destination and source offsets in bytes into the

CUDA arrays. `ByteCount` is the number of bytes to be copied. The size of the elements in the CUDA arrays need not be the same format, but the elements must be the same size; and count must be evenly divisible by that size.



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

#### See also:

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`, `cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`, `cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`, `cuMemcpy3DAsync`, `cuMemcpyAtoD`, `cuMemcpyAtoH`, `cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`, `cuMemcpyDtoDAsync`, `cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoA`, `cuMemcpyHtoAAsync`, `cuMemcpyHtoD`, `cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemFreeHost`, `cuMemGetAddressRange`, `cuMemGetInfo`, `cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`, `cuMemsetD2D16`, `cuMemsetD2D32`, `cuMemsetD8`, `cuMemsetD16`, `cuMemsetD32`, `cudaMemcpyArrayToArray`

## CUresult cuMemcpyAtoD (CUdeviceptr dstDevice, CUarray srcArray, size\_t srcOffset, size\_t ByteCount)

Copies memory from Array to Device.

### Parameters

#### **dstDevice**

- Destination device pointer

#### **srcArray**

- Source array

#### **srcOffset**

- Offset in bytes of source array

#### **ByteCount**

- Size of memory copy in bytes

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`, `CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`, `CUDA_ERROR_INVALID_VALUE`

## Description

Copies from one 1D CUDA array to device memory. `dstDevice` specifies the base pointer of the destination and must be naturally aligned with the CUDA array elements. `srcArray` and `srcOffset` specify the CUDA array handle and the offset in bytes into the array where the copy is to begin. `ByteCount` specifies the number of bytes to copy and must be evenly divisible by the array element size.



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

## See also:

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`, `cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`, `cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`, `cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoH`, `cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`, `cuMemcpyDtoDAsync`, `cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoA`, `cuMemcpyHtoAAsync`, `cuMemcpyHtoD`, `cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemFreeHost`, `cuMemGetAddressRange`, `cuMemGetInfo`, `cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`, `cuMemsetD2D16`, `cuMemsetD2D32`, `cuMemsetD8`, `cuMemsetD16`, `cuMemsetD32`, `cudaMemcpyFromArray`

## CUresult cuMemcpyAtoH (void \*dstHost, CUarray srcArray, size\_t srcOffset, size\_t ByteCount)

Copies memory from Array to Host.

### Parameters

#### **dstHost**

- Destination device pointer

#### **srcArray**

- Source array

#### **srcOffset**

- Offset in bytes of source array

#### **ByteCount**

- Size of memory copy in bytes

## Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

## Description

Copies from one 1D CUDA array to host memory. `dstHost` specifies the base pointer of the destination. `srcArray` and `srcOffset` specify the CUDA array handle and starting offset in bytes of the source data. `ByteCount` specifies the number of bytes to copy.



- ▶ Note that this function may also return error codes from previous, asynchronous launches.
- ▶ This function exhibits **synchronous** behavior for most use cases.
- ▶ Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA\_ERROR\_INVALID\_VALUE.

## See also:

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`,  
`cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`,  
`cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`,  
`cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoHAsync`,  
`cuMemcpyDtoA`, `cuMemcpyDtoD`, `cuMemcpyDtoDAsync`, `cuMemcpyDtoH`,  
`cuMemcpyDtoHAsync`, `cuMemcpyHtoA`, `cuMemcpyHtoAAsync`, `cuMemcpyHtoD`,  
`cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemFreeHost`, `cuMemGetAddressRange`,  
`cuMemGetInfo`, `cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`,  
`cuMemsetD2D16`, `cuMemsetD2D32`, `cuMemsetD8`, `cuMemsetD16`, `cuMemsetD32`,  
`cudaMemcpyFromArray`

## CUresult cuMemcpyAtoHAsync (void \*dstHost, CUarray srcArray, size\_t srcOffset, size\_t ByteCount, CUstream hStream)

Copies memory from Array to Host.

## Parameters

### dstHost

- Destination pointer

**srcArray**

- Source array

**srcOffset**

- Offset in bytes of source array

**ByteCount**

- Size of memory copy in bytes

**hStream**

- Stream identifier

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE

**Description**

Copies from one 1D CUDA array to host memory. `dstHost` specifies the base pointer of the destination. `srcArray` and `srcOffset` specify the CUDA array handle and starting offset in bytes of the source data. `ByteCount` specifies the number of bytes to copy.



- ▶ Note that this function may also return error codes from previous, asynchronous launches.
- ▶ This function exhibits **asynchronous** behavior for most use cases.
- ▶ This function uses standard **default stream** semantics.
- ▶ Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA\_ERROR\_INVALID\_VALUE.

**See also:**

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`,  
`cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`,  
`cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`,  
`cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoH`,  
`cuMemcpyDtoA`, `cuMemcpyDtoD`, `cuMemcpyDtoDAsync`, `cuMemcpyDtoH`,  
`cuMemcpyDtoHAsync`, `cuMemcpyHtoA`, `cuMemcpyHtoAAsync`, `cuMemcpyHtoD`,  
`cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemFreeHost`, `cuMemGetAddressRange`,  
`cuMemGetInfo`, `cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`,  
`cuMemsetD2D8Async`, `cuMemsetD2D16`, `cuMemsetD2D16Async`,  
`cuMemsetD2D32`, `cuMemsetD2D32Async`, `cuMemsetD8`, `cuMemsetD8Async`,

[cuMemsetD16](#), [cuMemsetD16Async](#), [cuMemsetD32](#), [cuMemsetD32Async](#),  
[cudaMemcpyFromArrayAsync](#)

## CUresult cuMemcpyDtoA (CUarray dstArray, size\_t dstOffset, CUdeviceptr srcDevice, size\_t ByteCount)

Copies memory from Device to Array.

### Parameters

#### **dstArray**

- Destination array

#### **dstOffset**

- Offset in bytes of destination array

#### **srcDevice**

- Source device pointer

#### **ByteCount**

- Size of memory copy in bytes

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#)

### Description

Copies from device memory to a 1D CUDA array. `dstArray` and `dstOffset` specify the CUDA array handle and starting index of the destination data. `srcDevice` specifies the base pointer of the source. `ByteCount` specifies the number of bytes to 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:

[cuArray3DCreate](#), [cuArray3DGetDescriptor](#), [cuArrayCreate](#), [cuArrayDestroy](#),  
[cuArrayGetDescriptor](#), [cuMemAlloc](#), [cuMemAllocHost](#), [cuMemAllocPitch](#),  
[cuMemcpy2D](#), [cuMemcpy2DAsync](#), [cuMemcpy2DUnaligned](#), [cuMemcpy3D](#),  
[cuMemcpy3DAsync](#), [cuMemcpyAtoA](#), [cuMemcpyAtoD](#), [cuMemcpyAtoH](#),  
[cuMemcpyAtoHAsync](#), [cuMemcpyDtoD](#), [cuMemcpyDtoDAsync](#), [cuMemcpyDtoH](#),  
[cuMemcpyDtoHAsync](#), [cuMemcpyHtoA](#), [cuMemcpyHtoAAsync](#), [cuMemcpyHtoD](#),  
[cuMemcpyHtoDAsync](#), [cuMemFree](#), [cuMemFreeHost](#), [cuMemGetAddressRange](#),

`cuMemGetInfo`, `cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`,  
`cuMemsetD2D16`, `cuMemsetD2D32`, `cuMemsetD8`, `cuMemsetD16`, `cuMemsetD32`,  
`cudaMemcpyToArray`

## CUresult cudaMemcpyDtoD (CUdeviceptr dstDevice, CUdeviceptr srcDevice, size\_t ByteCount)

Copies memory from Device to Device.

### Parameters

#### **dstDevice**

- Destination device pointer

#### **srcDevice**

- Source device pointer

#### **ByteCount**

- Size of memory copy in bytes

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`

### Description

Copies from device memory to device memory. `dstDevice` and `srcDevice` are the base pointers of the destination and source, respectively. `ByteCount` specifies the number of bytes to 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:

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`,  
`cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`,  
`cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`,  
`cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoH`,  
`cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoH`, `cuMemcpyDtoHAsync`,  
`cuMemcpyHtoA`, `cuMemcpyHtoAAsync`, `cuMemcpyHtoD`, `cuMemcpyHtoDAsync`,  
`cuMemFree`, `cuMemFreeHost`, `cuMemGetAddressRange`, `cuMemGetInfo`,  
`cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`, `cuMemsetD2D16`,

[cuMemsetD2D32](#), [cuMemsetD8](#), [cuMemsetD16](#), [cuMemsetD32](#), [cudaMemcpy](#), [cudaMemcpyToSymbol](#), [cudaMemcpyFromSymbol](#)

## CUresult cudaMemcpyDtoDAsync (CUdeviceptr dstDevice, CUdeviceptr srcDevice, size\_t ByteCount, CUstream hStream)

Copies memory from Device to Device.

### Parameters

#### dstDevice

- Destination device pointer

#### srcDevice

- Source device pointer

#### ByteCount

- Size of memory copy in bytes

#### hStream

- Stream identifier

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#), [CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#), [CUDA\\_ERROR\\_INVALID\\_HANDLE](#)

### Description

Copies from device memory to device memory. `dstDevice` and `srcDevice` are the base pointers of the destination and source, respectively. `ByteCount` specifies the number of bytes to copy.



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

### See also:

[cuArray3DCreate](#), [cuArray3DGetDescriptor](#), [cuArrayCreate](#), [cuArrayDestroy](#), [cuArrayGetDescriptor](#), [cuMemAlloc](#), [cuMemAllocHost](#), [cuMemAllocPitch](#), [cuMemcpy2D](#), [cuMemcpy2DAsync](#), [cuMemcpy2DUnaligned](#), [cuMemcpy3D](#), [cuMemcpy3DAsync](#), [cuMemcpyAtoA](#), [cuMemcpyAtoD](#), [cuMemcpyAtoH](#), [cuMemcpyAtoHAsync](#), [cuMemcpyDtoA](#), [cuMemcpyDtoD](#), [cuMemcpyDtoH](#),



cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemcpyAsync, cudaMemcpyToSymbolAsync, cudaMemcpyFromSymbolAsync

## CUresult cuMemcpyDtoH (void \*dstHost, CUdeviceptr srcDevice, size\_t ByteCount)

Copies memory from Device to Host.

### Parameters

#### dstHost

- Destination host pointer

#### srcDevice

- Source device pointer

#### ByteCount

- Size of memory copy in bytes

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_VALUE

### Description

Copies from device to host memory. `dstHost` and `srcDevice` specify the base pointers of the destination and source, respectively. `ByteCount` specifies the number of bytes to copy.



- ▶ Note that this function may also return error codes from previous, asynchronous launches.
- ▶ This function exhibits **synchronous** behavior for most use cases.
- ▶ Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA\_ERROR\_INVALID\_VALUE.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemcpy, cudaMemcpyFromSymbol

## CUresult cuMemcpyDtoHAsync (void \*dstHost, CUdeviceptr srcDevice, size\_t ByteCount, CUstream hStream)

Copies memory from Device to Host.

### Parameters

#### dstHost

- Destination host pointer

#### srcDevice

- Source device pointer

#### ByteCount

- Size of memory copy in bytes

#### hStream

- Stream identifier

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE

### Description

Copies from device to host memory. `dstHost` and `srcDevice` specify the base pointers of the destination and source, respectively. `ByteCount` specifies the number of bytes to copy.



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

- ▶ This function uses standard [default stream](#) semantics.
- ▶ Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return `CUDA_ERROR_INVALID_VALUE`.

**See also:**

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`, `cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`, `cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`, `cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoH`, `cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`, `cuMemcpyDtoDAsync`, `cuMemcpyDtoH`, `cuMemcpyHtoA`, `cuMemcpyHtoAAsync`, `cuMemcpyHtoD`, `cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemFreeHost`, `cuMemGetAddressRange`, `cuMemGetInfo`, `cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`, `cuMemsetD2D8Async`, `cuMemsetD2D16`, `cuMemsetD2D16Async`, `cuMemsetD2D32`, `cuMemsetD2D32Async`, `cuMemsetD8`, `cuMemsetD8Async`, `cuMemsetD16`, `cuMemsetD16Async`, `cuMemsetD32`, `cuMemsetD32Async`, `cudaMemcpyAsync`, `cudaMemcpyFromSymbolAsync`

## CUresult cuMemcpyHtoA (CUarray dstArray, size\_t dstOffset, const void \*srcHost, size\_t ByteCount)

Copies memory from Host to Array.

**Parameters****dstArray**

- Destination array

**dstOffset**

- Offset in bytes of destination array

**srcHost**

- Source host pointer

**ByteCount**

- Size of memory copy in bytes

**Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`

## Description

Copies from host memory to a 1D CUDA array. `dstArray` and `dstOffset` specify the CUDA array handle and starting offset in bytes of the destination data. `pSrc` specifies the base address of the source. `ByteCount` specifies the number of bytes to copy.



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits **synchronous** behavior for most use cases.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return `CUDA_ERROR_INVALID_VALUE`.

## See also:

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`, `cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`, `cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`, `cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoH`, `cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`, `cuMemcpyDtoDAsync`, `cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoAAsync`, `cuMemcpyHtoD`, `cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemFreeHost`, `cuMemGetAddressRange`, `cuMemGetInfo`, `cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`, `cuMemsetD2D16`, `cuMemsetD2D32`, `cuMemsetD8`, `cuMemsetD16`, `cuMemsetD32`, `cudaMemcpyToArray`

## CUresult cuMemcpyHtoAAsync (CUarray dstArray, size\_t dstOffset, const void \*srcHost, size\_t ByteCount, CUstream hStream)

Copies memory from Host to Array.

### Parameters

#### **dstArray**

- Destination array

#### **dstOffset**

- Offset in bytes of destination array

#### **srcHost**

- Source host pointer

#### **ByteCount**

- Size of memory copy in bytes

**hStream**

- Stream identifier

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE

**Description**

Copies from host memory to a 1D CUDA array. `dstArray` and `dstOffset` specify the CUDA array handle and starting offset in bytes of the destination data. `srcHost` specifies the base address of the source. `ByteCount` specifies the number of bytes to copy.



- ▶ Note that this function may also return error codes from previous, asynchronous launches.
- ▶ This function exhibits **asynchronous** behavior for most use cases.
- ▶ This function uses standard **default stream** semantics.
- ▶ Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA\_ERROR\_INVALID\_VALUE.

**See also:**

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`,  
`cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`,  
`cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`,  
`cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoH`,  
`cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`, `cuMemcpyDtoDAsync`,  
`cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoA`, `cuMemcpyHtoD`,  
`cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemFreeHost`, `cuMemGetAddressRange`,  
`cuMemGetInfo`, `cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`,  
`cuMemsetD2D8Async`, `cuMemsetD2D16`, `cuMemsetD2D16Async`, `cuMemsetD2D32`,  
`cuMemsetD2D32Async`, `cuMemsetD8`, `cuMemsetD8Async`, `cuMemsetD16`,  
`cuMemsetD16Async`, `cuMemsetD32`, `cuMemsetD32Async`, `cudaMemcpyToArrayAsync`

## CUresult cuMemcpyHtoD (CUdeviceptr dstDevice, const void \*srcHost, size\_t ByteCount)

Copies memory from Host to Device.

### Parameters

#### dstDevice

- Destination device pointer

#### srcHost

- Source host pointer

#### ByteCount

- Size of memory copy in bytes

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

Copies from host memory to device memory. `dstDevice` and `srcHost` are the base addresses of the destination and source, respectively. `ByteCount` specifies the number of bytes to copy.



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits **synchronous** behavior for most use cases.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA\_ERROR\_INVALID\_VALUE.

### See also:

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`,  
`cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`,  
`cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`,  
`cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoH`,  
`cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`, `cuMemcpyDtoDAsync`,  
`cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoA`, `cuMemcpyHtoAAsync`,  
`cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemFreeHost`, `cuMemGetAddressRange`,  
`cuMemGetInfo`, `cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`,

`cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemcpy, cudaMemcpyToSymbol`

## **CUresult cuMemcpyHtoDAsync (CUdeviceptr dstDevice, const void \*srcHost, size\_t ByteCount, CUstream hStream)**

Copies memory from Host to Device.

### **Parameters**

#### **dstDevice**

- Destination device pointer

#### **srcHost**

- Source host pointer

#### **ByteCount**

- Size of memory copy in bytes

#### **hStream**

- Stream identifier

### **Returns**

`CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE`

### **Description**

Copies from host memory to device memory. `dstDevice` and `srcHost` are the base addresses of the destination and source, respectively. `ByteCount` specifies the number of bytes to copy.



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits [asynchronous](#) behavior for most use cases.
- This function uses standard [default stream](#) semantics.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return `CUDA_ERROR_INVALID_VALUE`.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemcpyAsync, cudaMemcpyToSymbolAsync

## CUresult cuMemcpyPeer (CUdeviceptr dstDevice, CUcontext dstContext, CUdeviceptr srcDevice, CUcontext srcContext, size\_t ByteCount)

Copies device memory between two contexts.

### Parameters

#### dstDevice

- Destination device pointer

#### dstContext

- Destination context

#### srcDevice

- Source device pointer

#### srcContext

- Source context

#### ByteCount

- Size of memory copy in bytes

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_VALUE

### Description

Copies from device memory in one context to device memory in another context. `dstDevice` is the base device pointer of the destination memory and `dstContext` is the destination context. `srcDevice` is the base device pointer of the source memory and `srcContext` is the source pointer. `ByteCount` specifies the number of bytes to 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:

`cuMemcpyDtoD`, `cuMemcpy3DPeer`, `cuMemcpyDtoDAsync`, `cuMemcpyPeerAsync`, `cuMemcpy3DPeerAsync`, `cudaMemcpyPeer`

## CUresult cuMemcpyPeerAsync (CUdeviceptr dstDevice, CUcontext dstContext, CUdeviceptr srcDevice, CUcontext srcContext, size\_t ByteCount, CUstream hStream)

Copies device memory between two contexts asynchronously.

### Parameters

#### **dstDevice**

- Destination device pointer

#### **dstContext**

- Destination context

#### **srcDevice**

- Source device pointer

#### **srcContext**

- Source context

#### **ByteCount**

- Size of memory copy in bytes

#### **hStream**

- Stream identifier

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`, `CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`, `CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_HANDLE`

### Description

Copies from device memory in one context to device memory in another context. `dstDevice` is the base device pointer of the destination memory and `dstContext` is the destination context. `srcDevice` is the base device pointer of the source memory and `srcContext` is the source pointer. `ByteCount` specifies the number of bytes to copy.



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

#### See also:

[cuMemcpyDtoD](#), [cuMemcpyPeer](#), [cuMemcpy3DPeer](#), [cuMemcpyDtoDAsync](#), [cuMemcpy3DPeerAsync](#), [cudaMemcpyPeerAsync](#)

## CUresult cuMemFree (CUdeviceptr dptr)

Frees device memory.

### Parameters

#### dptr

- Pointer to memory to free

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#)

### Description

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



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

#### See also:

[cuArray3DCreate](#), [cuArray3DGetDescriptor](#), [cuArrayCreate](#), [cuArrayDestroy](#),  
[cuArrayGetDescriptor](#), [cuMemAlloc](#), [cuMemAllocHost](#), [cuMemAllocPitch](#),  
[cuMemcpy2D](#), [cuMemcpy2DAsync](#), [cuMemcpy2DUnaligned](#), [cuMemcpy3D](#),  
[cuMemcpy3DAsync](#), [cuMemcpyAtoA](#), [cuMemcpyAtoD](#), [cuMemcpyAtoH](#),  
[cuMemcpyAtoHAsync](#), [cuMemcpyDtoA](#), [cuMemcpyDtoD](#), [cuMemcpyDtoDAsync](#),  
[cuMemcpyDtoH](#), [cuMemcpyDtoHAsync](#), [cuMemcpyHtoA](#), [cuMemcpyHtoAAsync](#),  
[cuMemcpyHtoD](#), [cuMemcpyHtoDAsync](#), [cuMemFreeHost](#), [cuMemGetAddressRange](#),  
[cuMemGetInfo](#), [cuMemHostAlloc](#), [cuMemHostGetDevicePointer](#), [cuMemsetD2D8](#),

`cuMemsetD2D16`, `cuMemsetD2D32`, `cuMemsetD8`, `cuMemsetD16`, `cuMemsetD32`,  
`cudaFree`

## CUresult cuMemFreeHost (void \*p)

Frees page-locked host memory.

### Parameters

**p**

- Pointer to memory to free

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`

### Description

Frees the memory space pointed to by `p`, which must have been returned by a previous call to `cuMemAllocHost()`.



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

### See also:

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`,  
`cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`,  
`cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`,  
`cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoH`,  
`cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`, `cuMemcpyDtoDAsync`,  
`cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoA`, `cuMemcpyHtoAAsync`,  
`cuMemcpyHtoD`, `cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemGetAddressRange`,  
`cuMemGetInfo`, `cuMemHostAlloc`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`,  
`cuMemsetD2D16`, `cuMemsetD2D32`, `cuMemsetD8`, `cuMemsetD16`, `cuMemsetD32`,  
`cudaFreeHost`

## CUresult cuMemGetAddressRange (CUdeviceptr \*pbase, size\_t \*psize, CUdeviceptr dptr)

Get information on memory allocations.

### Parameters

#### **pbase**

- Returned base address

#### **psize**

- Returned size of device memory allocation

#### **dptr**

- Device pointer to query

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_NOT\_FOUND, CUDA\_ERROR\_INVALID\_VALUE

### Description

Returns the base address in \*pbase and size in \*psize of the allocation by [cuMemAlloc\(\)](#) or [cuMemAllocPitch\(\)](#) that contains the input pointer `dptr`. Both parameters `pbase` and `psize` are optional. If one of them is NULL, it is ignored.



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

### See also:

[cuArray3DCreate](#), [cuArray3DGetDescriptor](#), [cuArrayCreate](#), [cuArrayDestroy](#),  
[cuArrayGetDescriptor](#), [cuMemAlloc](#), [cuMemAllocHost](#), [cuMemAllocPitch](#),  
[cuMemcpy2D](#), [cuMemcpy2DAsync](#), [cuMemcpy2DUnaligned](#), [cuMemcpy3D](#),  
[cuMemcpy3DAsync](#), [cuMemcpyAtoA](#), [cuMemcpyAtoD](#), [cuMemcpyAtoH](#),  
[cuMemcpyAtoHAsync](#), [cuMemcpyDtoA](#), [cuMemcpyDtoD](#), [cuMemcpyDtoDAsync](#),  
[cuMemcpyDtoH](#), [cuMemcpyDtoHAsync](#), [cuMemcpyHtoA](#), [cuMemcpyHtoAAsync](#),  
[cuMemcpyHtoD](#), [cuMemcpyHtoDAsync](#), [cuMemFree](#), [cuMemFreeHost](#), [cuMemGetInfo](#),  
[cuMemHostAlloc](#), [cuMemHostGetDevicePointer](#), [cuMemsetD2D8](#), [cuMemsetD2D16](#),  
[cuMemsetD2D32](#), [cuMemsetD8](#), [cuMemsetD16](#), [cuMemsetD32](#)

## CUresult cuMemGetInfo (size\_t \*free, size\_t \*total)

Gets free and total memory.

### Parameters

#### free

- Returned free memory in bytes

#### total

- Returned total memory in bytes

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

Returns in \*free and \*total respectively, the free and total amount of memory available for allocation by the CUDA context, in bytes.



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

### See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy,  
cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch,  
cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D,  
cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH,  
cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync,  
cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync,  
cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost,  
cuMemGetAddressRange, cuMemHostAlloc, cuMemHostGetDevicePointer,  
cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16,  
cuMemsetD32, cudaMemGetInfo

## CUresult cuMemHostAlloc (void \*\*pp, size\_t bytesize, unsigned int Flags)

Allocates page-locked host memory.

### Parameters

#### pp

- Returned host pointer to page-locked memory

#### bytesize

- Requested allocation size in bytes

#### Flags

- Flags for allocation request

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_OUT\_OF\_MEMORY

### Description

Allocates `bytesize` 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 `cuMemcpyHtoD()`. 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.

- ▶ **CU\_MEMHOSTALLOC\_PORTABLE**: The memory returned by this call will be considered as pinned memory by all CUDA contexts, not just the one that performed the allocation.
- ▶ **CU\_MEMHOSTALLOC\_DEVICEMAP**: Maps the allocation into the CUDA address space. The device pointer to the memory may be obtained by calling `cuMemHostGetDevicePointer()`.
- ▶ **CU\_MEMHOSTALLOC\_WRITECOMBINED**: 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 GPU 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.

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

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

The memory allocated by this function must be freed with `cuMemFreeHost()`.

Note all host memory allocated using `cuMemHostAlloc()` will automatically be immediately accessible to all contexts on all devices which support unified addressing (as may be queried using `CU_DEVICE_ATTRIBUTE_UNIFIED_ADDRESSING`). Unless the flag `CU_MEMHOSTALLOC_WRITECOMBINED` is specified, the device pointer that may be used to access this host memory from those contexts is always equal to the returned host pointer `*pp`. If the flag `CU_MEMHOSTALLOC_WRITECOMBINED` is specified, then the function `cuMemHostGetDevicePointer()` must be used to query the device pointer, even if the context supports unified addressing. See [Unified Addressing](#) for additional details.



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

#### See also:

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`, `cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`, `cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`, `cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoH`, `cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`, `cuMemcpyDtoDAsync`, `cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoA`, `cuMemcpyHtoAAsync`, `cuMemcpyHtoD`, `cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemFreeHost`, `cuMemGetAddressRange`, `cuMemGetInfo`, `cuMemHostGetDevicePointer`, `cuMemsetD2D8`, `cuMemsetD2D16`, `cuMemsetD2D32`, `cuMemsetD8`, `cuMemsetD16`, `cuMemsetD32`, `cudaHostAlloc`

## CUresult cuMemHostGetDevicePointer (CUdeviceptr \*pdptr, void \*p, unsigned int Flags)

Passes back device pointer of mapped pinned memory.

### Parameters

#### pdptr

- Returned device pointer

#### p

- Host pointer

#### Flags

- Options (must be 0)

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

Passes back the device pointer `pdptr` corresponding to the mapped, pinned host buffer `p` allocated by `cuMemHostAlloc`.

`cuMemHostGetDevicePointer()` will fail if the `CU_MEMHOSTALLOC_DEVICEMAP` flag was not specified at the time the memory was allocated, or if the function is called on a GPU that does not support mapped pinned memory.

For devices that have a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_CAN_USE_HOST_POINTER_FOR_REGISTERED_MEM`, the memory can also be accessed from the device using the host pointer `p`. The device pointer returned by `cuMemHostGetDevicePointer()` may or may not match the original host pointer `p` and depends on the devices visible to the application. If all devices visible to the application have a non-zero value for the device attribute, the device pointer returned by `cuMemHostGetDevicePointer()` will match the original pointer `p`. If any device visible to the application has a zero value for the device attribute, the device pointer returned by `cuMemHostGetDevicePointer()` will not match the original host pointer `p`, but it will be suitable for use on all devices provided Unified Virtual Addressing is enabled. In such systems, it is valid to access the memory using either pointer on devices that have a non-zero value for the device attribute. Note however that such devices should access the memory using only one of the two pointers and not both.

`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:

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`,  
`cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`,  
`cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`, `cuMemcpy3D`,  
`cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`, `cuMemcpyAtoH`,  
`cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`, `cuMemcpyDtoDAsync`,  
`cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoA`, `cuMemcpyHtoAAsync`,  
`cuMemcpyHtoD`, `cuMemcpyHtoDAsync`, `cuMemFree`, `cuMemFreeHost`,  
`cuMemGetAddressRange`, `cuMemGetInfo`, `cuMemHostAlloc`, `cuMemsetD2D8`,  
`cuMemsetD2D16`, `cuMemsetD2D32`, `cuMemsetD8`, `cuMemsetD16`, `cuMemsetD32`,  
`cudaHostGetDevicePointer`

## CUresult cuMemHostGetFlags (unsigned int \*pFlags, void \*p)

Passes back flags that were used for a pinned allocation.

#### Parameters

##### pFlags

- Returned flags word

##### p

- Host pointer

#### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`

#### Description

Passes back the flags `pFlags` that were specified when allocating the pinned host buffer `p` allocated by `cuMemHostAlloc`.

`cuMemHostGetFlags()` will fail if the pointer does not reside in an allocation performed by `cuMemAllocHost()` or `cuMemHostAlloc()`.



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

See also:

[cuMemAllocHost](#), [cuMemHostAlloc](#), [cudaHostGetFlags](#)

## CUresult cuMemHostRegister (void \*p, size\_t bytesize, unsigned int Flags)

Registers an existing host memory range for use by CUDA.

### Parameters

**p**

- Host pointer to memory to page-lock

**bytesize**

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

**Flags**

- Flags for allocation request

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_OUT\_OF\_MEMORY,  
CUDA\_ERROR\_HOST\_MEMORY\_ALREADY\_REGISTERED,  
CUDA\_ERROR\_NOT\_PERMITTED, CUDA\_ERROR\_NOT\_SUPPORTED

### Description

Page-locks the memory range specified by `p` and `bytesize` and maps it for the device(s) as specified by `Flags`. This memory range also is added to the same tracking mechanism as [cuMemHostAlloc](#) to automatically accelerate calls to functions such as [cuMemcpyHtoD\(\)](#). 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.

This function has limited support on Mac OS X. OS 10.7 or higher is required.

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

- ▶ `CU_MEMHOSTREGISTER_PORTABLE`: The memory returned by this call will be considered as pinned memory by all CUDA contexts, not just the one that performed the allocation.
- ▶ `CU_MEMHOSTREGISTER_DEVICEMAP`: Maps the allocation into the CUDA address space. The device pointer to the memory may be obtained by calling `cuMemHostGetDevicePointer()`.
- ▶ `CU_MEMHOSTREGISTER_IOMEMORY`: The pointer is treated as pointing to some I/O memory space, e.g. the PCI Express resource of a 3rd party device.

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 `CU_CTX_MAP_HOST` flag in order for the `CU_MEMHOSTREGISTER_DEVICEMAP` flag to have any effect.

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

For devices that have a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_CAN_USE_HOST_POINTER_FOR_REGISTERED_MEM`, the memory can also be accessed from the device using the host pointer `p`. The device pointer returned by `cuMemHostGetDevicePointer()` may or may not match the original host pointer `ptr` and depends on the devices visible to the application. If all devices visible to the application have a non-zero value for the device attribute, the device pointer returned by `cuMemHostGetDevicePointer()` will match the original pointer `ptr`. If any device visible to the application has a zero value for the device attribute, the device pointer returned by `cuMemHostGetDevicePointer()` will not match the original host pointer `ptr`, but it will be suitable for use on all devices provided Unified Virtual Addressing is enabled. In such systems, it is valid to access the memory using either pointer on devices that have a non-zero value for the device attribute. Note however that such devices should access the memory using only one of the two pointers and not both.

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



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

See also:

`cuMemHostUnregister`, `cuMemHostGetFlags`, `cuMemHostGetDevicePointer`, `cudaHostRegister`

## CUresult cuMemHostUnregister (void \*p)

Unregisters a memory range that was registered with cuMemHostRegister.

### Parameters

**p**

- Host pointer to memory to unregister

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_OUT\_OF\_MEMORY,  
CUDA\_ERROR\_HOST\_MEMORY\_NOT\_REGISTERED,

### Description

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

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



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

### See also:

cuMemHostRegister, cudaHostUnregister

## CUresult cuMemsetD16 (CUdeviceptr dstDevice, unsigned short us, size\_t N)

Initializes device memory.

### Parameters

**dstDevice**

- Destination device pointer

**us**

- Value to set

**N**

- Number of elements

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description**

Sets the memory range of N 16-bit values to the specified value *us*. The *dstDevice* pointer must be two byte aligned.



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

**See also:**

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy,  
 cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch,  
 cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned,  
 cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD,  
 cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD,  
 cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA,  
 cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree,  
 cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc,  
 cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async,  
 cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async,  
 cuMemsetD8, cuMemsetD8Async, cuMemsetD16Async, cuMemsetD32,  
 cuMemsetD32Async, cudaMemset

## CUresult cuMemsetD16Async (CUdeviceptr dstDevice, unsigned short us, size\_t N, CUstream hStream)

Sets device memory.

**Parameters****dstDevice**

- Destination device pointer

**us**

- Value to set

**N**

- Number of elements

**hStream**

- Stream identifier

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

**Description**

Sets the memory range of  $N$  16-bit values to the specified value `us`. The `dstDevice` pointer must be two byte aligned.



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

**See also:**

[cuArray3DCreate](#), [cuArray3DGetDescriptor](#), [cuArrayCreate](#), [cuArrayDestroy](#),  
[cuArrayGetDescriptor](#), [cuMemAlloc](#), [cuMemAllocHost](#), [cuMemAllocPitch](#),  
[cuMemcpy2D](#), [cuMemcpy2DAsync](#), [cuMemcpy2DUnaligned](#),  
[cuMemcpy3D](#), [cuMemcpy3DAsync](#), [cuMemcpyAtoA](#), [cuMemcpyAtoD](#),  
[cuMemcpyAtoH](#), [cuMemcpyAtoHAsync](#), [cuMemcpyDtoA](#), [cuMemcpyDtoD](#),  
[cuMemcpyDtoDAsync](#), [cuMemcpyDtoH](#), [cuMemcpyDtoHAsync](#), [cuMemcpyHtoA](#),  
[cuMemcpyHtoAAsync](#), [cuMemcpyHtoD](#), [cuMemcpyHtoDAsync](#), [cuMemFree](#),  
[cuMemFreeHost](#), [cuMemGetAddressRange](#), [cuMemGetInfo](#), [cuMemHostAlloc](#),  
[cuMemHostGetDevicePointer](#), [cuMemsetD2D8](#), [cuMemsetD2D8Async](#),  
[cuMemsetD2D16](#), [cuMemsetD2D16Async](#), [cuMemsetD2D32](#), [cuMemsetD2D32Async](#),  
[cuMemsetD8](#), [cuMemsetD8Async](#), [cuMemsetD16](#), [cuMemsetD32](#), [cuMemsetD32Async](#),  
[cudaMemsetAsync](#)

## CUresult cuMemsetD2D16 (CUdeviceptr dstDevice, size\_t dstPitch, unsigned short us, size\_t Width, size\_t Height)

Initializes device memory.

**Parameters****dstDevice**

- Destination device pointer

**dstPitch**

- Pitch of destination device pointer

**us**

- Value to set

**Width**

- Width of row

**Height**

- Number of rows

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description**

Sets the 2D memory range of `Width` 16-bit values to the specified value `us`. `Height` specifies the number of rows to set, and `dstPitch` specifies the number of bytes between each row. The `dstDevice` pointer and `dstPitch` offset must be two byte aligned. This function performs fastest when the pitch is one that has been passed back by `cuMemAllocPitch()`.



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

**See also:**

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`,  
`cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`,  
`cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`,  
`cuMemcpy3D`, `cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`,  
`cuMemcpyAtoH`, `cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`,  
`cuMemcpyDtoDAsync`, `cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoA`,  
`cuMemcpyHtoAAsync`, `cuMemcpyHtoD`, `cuMemcpyHtoDAsync`, `cuMemFree`,  
`cuMemFreeHost`, `cuMemGetAddressRange`, `cuMemGetInfo`, `cuMemHostAlloc`,  
`cuMemHostGetDevicePointer`, `cuMemsetD2D8`, `cuMemsetD2D8Async`,  
`cuMemsetD2D16Async`, `cuMemsetD2D32`, `cuMemsetD2D32Async`, `cuMemsetD8`,  
`cuMemsetD8Async`, `cuMemsetD16`, `cuMemsetD16Async`, `cuMemsetD32`,  
`cuMemsetD32Async`, `cudaMemset2D`

## CUresult cuMemsetD2D16Async (CUdeviceptr dstDevice, size\_t dstPitch, unsigned short us, size\_t Width, size\_t Height, CUstream hStream)

Sets device memory.

### Parameters

#### dstDevice

- Destination device pointer

#### dstPitch

- Pitch of destination device pointer

#### us

- Value to set

#### Width

- Width of row

#### Height

- Number of rows

#### hStream

- Stream identifier

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

Sets the 2D memory range of Width 16-bit values to the specified value us. Height specifies the number of rows to set, and dstPitch specifies the number of bytes between each row. The dstDevice pointer and dstPitch offset must be two byte aligned. This function performs fastest when the pitch is one that has been passed back by cuMemAllocPitch().



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

See also:



[cuArray3DCreate](#), [cuArray3DGetDescriptor](#), [cuArrayCreate](#), [cuArrayDestroy](#),  
[cuArrayGetDescriptor](#), [cuMemAlloc](#), [cuMemAllocHost](#), [cuMemAllocPitch](#),  
[cuMemcpy2D](#), [cuMemcpy2DAsync](#), [cuMemcpy2DUnaligned](#),  
[cuMemcpy3D](#), [cuMemcpy3DAsync](#), [cuMemcpyAtoA](#), [cuMemcpyAtoD](#),  
[cuMemcpyAtoH](#), [cuMemcpyAtoHAsync](#), [cuMemcpyDtoA](#), [cuMemcpyDtoD](#),  
[cuMemcpyDtoDAsync](#), [cuMemcpyDtoH](#), [cuMemcpyDtoHAsync](#), [cuMemcpyHtoA](#),  
[cuMemcpyHtoAAsync](#), [cuMemcpyHtoD](#), [cuMemcpyHtoDAsync](#), [cuMemFree](#),  
[cuMemFreeHost](#), [cuMemGetAddressRange](#), [cuMemGetInfo](#), [cuMemHostAlloc](#),  
[cuMemHostGetDevicePointer](#), [cuMemsetD2D8](#), [cuMemsetD2D8Async](#),  
[cuMemsetD2D16](#), [cuMemsetD2D32](#), [cuMemsetD2D32Async](#), [cuMemsetD8](#),  
[cuMemsetD8Async](#), [cuMemsetD16](#), [cuMemsetD16Async](#), [cuMemsetD32](#),  
[cuMemsetD32Async](#), [cudaMemset2DAsync](#)

## CUresult cuMemsetD2D32 (CUdeviceptr dstDevice, size\_t dstPitch, unsigned int ui, size\_t Width, size\_t Height)

Initializes device memory.

### Parameters

#### dstDevice

- Destination device pointer

#### dstPitch

- Pitch of destination device pointer

#### ui

- Value to set

#### Width

- Width of row

#### Height

- Number of rows

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#)

### Description

Sets the 2D memory range of `Width` 32-bit values to the specified value `ui`. `Height` specifies the number of rows to set, and `dstPitch` specifies the number of bytes between each row. The `dstDevice` pointer and `dstPitch` offset must be four byte aligned. This function performs fastest when the pitch is one that has been passed back by [cuMemAllocPitch\(\)](#).



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

#### See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemset2D

## CUresult cuMemsetD2D32Async (CUdeviceptr dstDevice, size\_t dstPitch, unsigned int ui, size\_t Width, size\_t Height, CUstream hStream)

Sets device memory.

### Parameters

#### dstDevice

- Destination device pointer

#### dstPitch

- Pitch of destination device pointer

#### ui

- Value to set

#### Width

- Width of row

#### Height

- Number of rows

#### hStream

- Stream identifier

## Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

## Description

Sets the 2D memory range of `Width` 32-bit values to the specified value `ui`. `Height` specifies the number of rows to set, and `dstPitch` specifies the number of bytes between each row. The `dstDevice` pointer and `dstPitch` offset must be four byte aligned. This function performs fastest when the pitch is one that has been passed back by `cuMemAllocPitch()`.



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

## See also:

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`,  
`cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`,  
`cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`,  
`cuMemcpy3D`, `cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`,  
`cuMemcpyAtoH`, `cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`,  
`cuMemcpyDtoDAsync`, `cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoA`,  
`cuMemcpyHtoAAsync`, `cuMemcpyHtoD`, `cuMemcpyHtoDAsync`, `cuMemFree`,  
`cuMemFreeHost`, `cuMemGetAddressRange`, `cuMemGetInfo`, `cuMemHostAlloc`,  
`cuMemHostGetDevicePointer`, `cuMemsetD2D8`, `cuMemsetD2D8Async`,  
`cuMemsetD2D16`, `cuMemsetD2D16Async`, `cuMemsetD2D32`, `cuMemsetD8`,  
`cuMemsetD8Async`, `cuMemsetD16`, `cuMemsetD16Async`, `cuMemsetD32`,  
`cuMemsetD32Async`, `cudaMemset2DAsync`

## CUresult cuMemsetD2D8 (CUdeviceptr dstDevice, size\_t dstPitch, unsigned char uc, size\_t Width, size\_t Height)

Initializes device memory.

## Parameters

### **dstDevice**

- Destination device pointer

**dstPitch**

- Pitch of destination device pointer

**uc**

- Value to set

**Width**

- Width of row

**Height**

- Number of rows

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description**

Sets the 2D memory range of `Width` 8-bit values to the specified value `uc`. `Height` specifies the number of rows to set, and `dstPitch` specifies the number of bytes between each row. This function performs fastest when the pitch is one that has been passed back by `cuMemAllocPitch()`.



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

**See also:**

`cuArray3DCreate`, `cuArray3DGetDescriptor`, `cuArrayCreate`, `cuArrayDestroy`,  
`cuArrayGetDescriptor`, `cuMemAlloc`, `cuMemAllocHost`, `cuMemAllocPitch`,  
`cuMemcpy2D`, `cuMemcpy2DAsync`, `cuMemcpy2DUnaligned`,  
`cuMemcpy3D`, `cuMemcpy3DAsync`, `cuMemcpyAtoA`, `cuMemcpyAtoD`,  
`cuMemcpyAtoH`, `cuMemcpyAtoHAsync`, `cuMemcpyDtoA`, `cuMemcpyDtoD`,  
`cuMemcpyDtoDAsync`, `cuMemcpyDtoH`, `cuMemcpyDtoHAsync`, `cuMemcpyHtoA`,  
`cuMemcpyHtoAAsync`, `cuMemcpyHtoD`, `cuMemcpyHtoDAsync`, `cuMemFree`,  
`cuMemFreeHost`, `cuMemGetAddressRange`, `cuMemGetInfo`, `cuMemHostAlloc`,  
`cuMemHostGetDevicePointer`, `cuMemsetD2D8Async`, `cuMemsetD2D16`,  
`cuMemsetD2D16Async`, `cuMemsetD2D32`, `cuMemsetD2D32Async`, `cuMemsetD8`,  
`cuMemsetD8Async`, `cuMemsetD16`, `cuMemsetD16Async`, `cuMemsetD32`,  
`cuMemsetD32Async`, `cudaMemset2D`

## CUresult cuMemsetD2D8Async (CUdeviceptr dstDevice, size\_t dstPitch, unsigned char uc, size\_t Width, size\_t Height, CUstream hStream)

Sets device memory.

### Parameters

#### dstDevice

- Destination device pointer

#### dstPitch

- Pitch of destination device pointer

#### uc

- Value to set

#### Width

- Width of row

#### Height

- Number of rows

#### hStream

- Stream identifier

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

Sets the 2D memory range of Width 8-bit values to the specified value uc. Height specifies the number of rows to set, and dstPitch specifies the number of bytes between each row. This function performs fastest when the pitch is one that has been passed back by [cuMemAllocPitch\(\)](#).



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

### See also:

[cuArray3DCreate](#), [cuArray3DGetDescriptor](#), [cuArrayCreate](#), [cuArrayDestroy](#),  
[cuArrayGetDescriptor](#), [cuMemAlloc](#), [cuMemAllocHost](#), [cuMemAllocPitch](#),

cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned,  
 cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD,  
 cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD,  
 cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA,  
 cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree,  
 cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc,  
 cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16,  
 cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8,  
 cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32,  
 cuMemsetD32Async, cudaMemset2DAsync

## CUresult cuMemsetD32 (CUdeviceptr dstDevice, unsigned int ui, size\_t N)

Initializes device memory.

### Parameters

#### dstDevice

- Destination device pointer

#### ui

- Value to set

#### N

- Number of elements

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

### Description

Sets the memory range of N 32-bit values to the specified value ui. The dstDevice pointer must be four byte aligned.



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

### See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy,  
 cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch,

cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned,  
 cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD,  
 cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD,  
 cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA,  
 cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree,  
 cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc,  
 cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async,  
 cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async,  
 cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async,  
 cuMemsetD32Async, cudaMemset

## CUresult cuMemsetD32Async (CUdeviceptr dstDevice, unsigned int ui, size\_t N, CUstream hStream)

Sets device memory.

### Parameters

#### dstDevice

- Destination device pointer

#### ui

- Value to set

#### N

- Number of elements

#### hStream

- Stream identifier

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

### Description

Sets the memory range of N 32-bit values to the specified value ui. The dstDevice pointer must be four byte aligned.



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

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cudaMemsetAsync

## CUresult cuMemsetD8 (CUdeviceptr dstDevice, unsigned char uc, size\_t N)

Initializes device memory.

### Parameters

#### dstDevice

- Destination device pointer

#### uc

- Value to set

#### N

- Number of elements

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_VALUE

### Description

Sets the memory range of N 8-bit values to the specified value uc.



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

See also:



cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemset

## CUresult cuMemsetD8Async (CUdeviceptr dstDevice, unsigned char uc, size\_t N, CUstream hStream)

Sets device memory.

### Parameters

#### dstDevice

- Destination device pointer

#### uc

- Value to set

#### N

- Number of elements

#### hStream

- Stream identifier

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_VALUE

### Description

Sets the memory range of N 8-bit values to the specified value uc.



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

**See also:**

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemsetAsync

**CUresult cuMipmappedArrayCreate (CUmipmappedArray \*pHandle, const CUDA\_ARRAY3D\_DESCRIPTOR \*pMipmappedArrayDesc, unsigned int numMipmapLevels)**

Creates a CUDA mipmapped array.

**Parameters****pHandle**

- Returned mipmapped array

**pMipmappedArrayDesc**

- mipmapped array descriptor

**numMipmapLevels**

- Number of mipmap levels

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_OUT\_OF\_MEMORY, CUDA\_ERROR\_UNKNOWN

**Description**

Creates a CUDA mipmapped array according to the [CUDA\\_ARRAY3D\\_DESCRIPTOR](#) structure pMipmappedArrayDesc and returns a handle to the new CUDA mipmapped array in \*pHandle. numMipmapLevels specifies the number of mipmap levels to be allocated. This value is clamped to the range [1, 1 + floor(log2(max(width, height, depth)))].

The `CUDA_ARRAY3D_DESCRIPTOR` is defined as:

```
typedef struct {
    unsigned int Width;
    unsigned int Height;
    unsigned int Depth;
    CUarray_format Format;
    unsigned int NumChannels;
    unsigned int Flags;
} CUDA_ARRAY3D_DESCRIPTOR;
```

where:

- ▶ Width, Height, and Depth are the width, height, and depth of the CUDA array (in elements); the following types of CUDA arrays can be allocated:
  - ▶ A 1D mipmapped array is allocated if Height and Depth extents are both zero.
  - ▶ A 2D mipmapped array is allocated if only 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 Height is zero and the `CUDA_ARRAY3D_LAYERED` flag is set. Each layer is a 1D 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 `CUDA_ARRAY3D_LAYERED` flag is set. Each layer is a 2D 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 `CUDA_ARRAY3D_CUBEMAP` 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 `CUarray_cubemap_face`.
  - ▶ A cubemap layered CUDA mipmapped array is allocated if all three extents are non-zero, and both, `CUDA_ARRAY3D_CUBEMAP` and `CUDA_ARRAY3D_LAYERED` 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.
- ▶ Format specifies the format of the elements; `CUarray_format` is defined as:

```
typedef enum CUarray_format_enum {
    CU_AD_FORMAT_UNSIGNED_INT8 = 0x01,
    CU_AD_FORMAT_UNSIGNED_INT16 = 0x02,
    CU_AD_FORMAT_UNSIGNED_INT32 = 0x03,
    CU_AD_FORMAT_SIGNED_INT8 = 0x08,
    CU_AD_FORMAT_SIGNED_INT16 = 0x09,
    CU_AD_FORMAT_SIGNED_INT32 = 0x0a,
    CU_AD_FORMAT_HALF = 0x10,
    CU_AD_FORMAT_FLOAT = 0x20
} CUarray_format;
```

- ▶ NumChannels specifies the number of packed components per CUDA array element; it may be 1, 2, or 4;

- Flags may be set to
  - `CUDA_ARRAY3D_LAYERED` to enable creation of layered CUDA mipmapped arrays. If this flag is set, `Depth` specifies the number of layers, not the depth of a 3D array.
  - `CUDA_ARRAY3D_SURFACE_LDST` to enable surface references to be bound to individual mipmap levels of the CUDA mipmapped array. If this flag is not set, `cuSurfRefSetArray` will fail when attempting to bind a mipmap level of the CUDA mipmapped array to a surface reference.
  - `CUDA_ARRAY3D_CUBEMAP` to enable creation of mipmapped cubemaps. If this flag is set, `Width` must be equal to `Height`, and `Depth` must be six. If the `CUDA_ARRAY3D_LAYERED` flag is also set, then `Depth` must be a multiple of six.
  - `CUDA_ARRAY3D_TEXTURE_GATHER` to indicate that the CUDA mipmapped array will be used for texture gather. Texture gather can only be performed on 2D CUDA mipmapped arrays.

`Width`, `Height` and `Depth` must meet certain size requirements as listed in the following table. All values are specified in elements. Note that for brevity's sake, the full name of the device attribute is not specified. For ex., `TEXTURE1D_MIPMAPPED_WIDTH` refers to the device attribute `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_MIPMAPPED_WIDTH`.

CUDA array type	Valid extents that must always be met {(width range in elements), (height range), (depth range)}	Valid extents with <code>CUDA_ARRAY3D_SURFACE_LDST</code> set {(width range in elements), (height range), (depth range)}
1D	{ (1, <code>TEXTURE1D_MIPMAPPED_WIDTH</code> ), 0, 0 }	{ (1, <code>SURFACE1D_WIDTH</code> ), 0, 0 }
2D	{ (1, <code>TEXTURE2D_MIPMAPPED_WIDTH</code> ), (1, <code>TEXTURE2D_MIPMAPPED_HEIGHT</code> ), 0 }	{ (1, <code>SURFACE2D_WIDTH</code> ), (1, <code>SURFACE2D_HEIGHT</code> ), 0 }
3D	{ (1, <code>TEXTURE3D_WIDTH</code> ), (1, <code>TEXTURE3D_HEIGHT</code> ), (1, <code>TEXTURE3D_DEPTH</code> ) } OR { (1, <code>TEXTURE3D_WIDTH_ALTERNATE</code> ), (1, <code>TEXTURE3D_HEIGHT_ALTERNATE</code> ), (1, <code>TEXTURE3D_DEPTH_ALTERNATE</code> ) }	{ (1, <code>SURFACE3D_WIDTH</code> ), (1, <code>SURFACE3D_HEIGHT</code> ), (1, <code>SURFACE3D_DEPTH</code> ) }
1D Layered	{ (1, <code>TEXTURE1D_LAYERED_WIDTH</code> ), 0, (1, <code>TEXTURE1D_LAYERED_LAYERS</code> ) }	{ (1, <code>SURFACE1D_LAYERED_WIDTH</code> ), 0, (1, <code>SURFACE1D_LAYERED_LAYERS</code> ) }

2D Layered	{ (1,TEXTURE2D_LAYERED_WIDTH), { (1,SURFACE2D_LAYERED_WIDTH), (1,TEXTURE2D_LAYERED_HEIGHT), (1,SURFACE2D_LAYERED_HEIGHT), (1,TEXTURE2D_LAYERED_LAYERS) } (1,SURFACE2D_LAYERED_LAYERS) }
Cubemap	{ (1,TEXTURECUBEMAP_WIDTH), { (1,SURFACECUBEMAP_WIDTH), (1,TEXTURECUBEMAP_WIDTH), 6 } (1,SURFACECUBEMAP_WIDTH), 6 }
Cubemap Layered	{ (1,TEXTURECUBEMAP_LAYERED_WIDTH), { (1,SURFACECUBEMAP_LAYERED_WIDTH), (1,TEXTURECUBEMAP_LAYERED_WIDTH), (1,SURFACECUBEMAP_LAYERED_WIDTH), (1,TEXTURECUBEMAP_LAYERED_LAYERS) } (1,SURFACECUBEMAP_LAYERED_LAYERS) }



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

#### See also:

[cuMipmappedArrayDestroy](#), [cuMipmappedArrayGetLevel](#), [cuArrayCreate](#),  
[cudaMallocMipmappedArray](#)

## CUresult cuMipmappedArrayDestroy (CUmipmappedArray hMipmappedArray)

Destroys a CUDA mipmapped array.

#### Parameters

##### **hMipmappedArray**

- Mipmapped array to destroy

#### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_ARRAY\_IS\_MAPPED,  
CUDA\_ERROR\_CONTEXT\_IS\_DESTROYED

#### Description

Destroys the CUDA mipmapped array hMipmappedArray.



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

**See also:**

[cuMipmappedArrayCreate](#), [cuMipmappedArrayGetLevel](#), [cuArrayCreate](#), [cudaFreeMipmappedArray](#)

## CUresult cuMipmappedArrayGetLevel (CUarray \*pLevelArray, CUmipmappedArray hMipmappedArray, unsigned int level)

Gets a mipmap level of a CUDA mipmapped array.

**Parameters****pLevelArray**

- Returned mipmap level CUDA array

**hMipmappedArray**

- CUDA mipmapped array

**level**

- Mipmap level

**Returns**

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#), [CUDA\\_ERROR\\_INVALID\\_HANDLE](#)

**Description**

Returns in \*pLevelArray a CUDA array that represents a single mipmap level of the CUDA mipmapped array hMipmappedArray.

If level is greater than the maximum number of levels in this mipmapped array, [CUDA\\_ERROR\\_INVALID\\_VALUE](#) is returned.



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

**See also:**

[cuMipmappedArrayCreate](#), [cuMipmappedArrayDestroy](#), [cuArrayCreate](#), [cudaGetMipmappedArrayLevel](#)

## 5.12. Virtual Memory Management

This section describes the virtual memory management functions of the low-level CUDA driver application programming interface.

### CUresult cuMemAddressFree (CUdeviceptr ptr, size\_t size)

Free an address range reservation.

#### Parameters

##### ptr

- Starting address of the virtual address range to free

##### size

- Size of the virtual address region to free

#### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_PERMITTED, CUDA\_ERROR\_NOT\_SUPPORTED

#### Description

Frees a virtual address range reserved by cuMemAddressReserve. The size must match what was given to memAddressReserve and the ptr given must match what was returned from memAddressReserve.

#### See also:

[cuMemAddressReserve](#)

### CUresult cuMemAddressReserve (CUdeviceptr \*ptr, size\_t size, size\_t alignment, CUdeviceptr addr, unsigned long long flags)

Allocate an address range reservation.

#### Parameters

##### ptr

- Resulting pointer to start of virtual address range allocated

**size**

- Size of the reserved virtual address range requested

**alignment**

- Alignment of the reserved virtual address range requested

**addr**

- Fixed starting address range requested

**flags**

- Currently unused, must be zero

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE,  
 CUDA\_ERROR\_OUT\_OF\_MEMORY, CUDA\_ERROR\_NOT\_INITIALIZED,  
 CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_PERMITTED,  
 CUDA\_ERROR\_NOT\_SUPPORTED

**Description**

Reserves a virtual address range based on the given parameters, giving the starting address of the range in `ptr`. This API requires a system that supports UVA. The size and address parameters must be a multiple of the host page size and the alignment must be a power of two or zero for default alignment.

**See also:**

[cuMemAddressFree](#)

**CUresult cuMemCreate**

(CUmemGenericAllocationHandle \*handle, size\_t size,  
 const CUmemAllocationProp \*prop, unsigned long long  
 flags)

Create a shareable memory handle representing a memory allocation of a given size described by the given properties.

**Parameters****handle**

- Value of handle returned. All operations on this allocation are to be performed using this handle.

**size**

- Size of the allocation requested

**prop**

- Properties of the allocation to create.



**flags**

- flags for future use, must be zero now.

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE,  
 CUDA\_ERROR\_OUT\_OF\_MEMORY, CUDA\_ERROR\_INVALID\_DEVICE,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_PERMITTED, CUDA\_ERROR\_NOT\_SUPPORTED

**Description**

This creates a memory allocation on the target device specified through the `prop` structure. The created allocation will not have any device or host mappings. The generic memory `handle` for the allocation can be mapped to the address space of calling process via `cuMemMap`. This handle cannot be transmitted directly to other processes (see `cuMemExportToShareableHandle`). On Windows, the caller must also pass an `LPSECURITYATTRIBUTE` in `prop` to be associated with this handle which limits or allows access to this handle for a recipient process (see `CUmemAllocationProp::win32HandleMetaData` for more). The size of this allocation must be a multiple of the value given via `cuMemGetAllocationGranularity` with the `CU_MEM_ALLOC_GRANULARITY_MINIMUM` flag.



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

**See also:**

`cuMemRelease`, `cuMemExportToShareableHandle`, `cuMemImportFromShareableHandle`

**CUresult cuMemExportToShareableHandle (void  
 \*shareableHandle, CUmemGenericAllocationHandle  
 handle, CUmemAllocationHandleType handleType,  
 unsigned long long flags)**

Exports an allocation to a requested shareable handle type.

**Parameters****shareableHandle**

- Pointer to the location in which to store the requested handle type

**handle**

- CUDA handle for the memory allocation

**handleType**

- Type of shareable handle requested (defines type and size of the `shareableHandle` output parameter)

**flags**

- Reserved, must be zero

**Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_VALUE`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_PERMITTED`, `CUDA_ERROR_NOT_SUPPORTED`

**Description**

Given a CUDA memory handle, create a shareable memory allocation handle that can be used to share the memory with other processes. The recipient process can convert the shareable handle back into a CUDA memory handle using `cuMemImportFromShareableHandle` and map it with `cuMemMap`. The implementation of what this handle is and how it can be transferred is defined by the requested handle type in `handleType`.

Once all shareable handles are closed and the allocation is released, the allocated memory referenced will be released back to the OS and uses of the CUDA handle afterward will lead to undefined behavior.

This API can also be used in conjunction with other APIs (e.g. Vulkan, OpenGL) that support importing memory from the shareable type.

**See also:**

`cuMemImportFromShareableHandle`

## **CUresult cuMemGetAccess (unsigned long long \*flags, const CUmemLocation \*location, CUdeviceptr ptr)**

Get the access flags set for the given `location` and `ptr`.

**Parameters****flags**

- Flags set for this location

**location**

- Location in which to check the flags for

**ptr**

- Address in which to check the access flags for

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE,  
 CUDA\_ERROR\_INVALID\_DEVICE, CUDA\_ERROR\_NOT\_INITIALIZED,  
 CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_PERMITTED,  
 CUDA\_ERROR\_NOT\_SUPPORTED

**Description****See also:**

[cuMemSetAccess](#)

## CUresult cuMemGetAllocationGranularity (size\_t \*granularity, const CUmemAllocationProp \*prop, CUmemAllocationGranularity\_flags option)

Calculates either the minimal or recommended granularity.

**Parameters****granularity**

Returned granularity.

**prop**

Property for which to determine the granularity for

**option**

Determines which granularity to return

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_PERMITTED, CUDA\_ERROR\_NOT\_SUPPORTED

**Description**

Calculates either the minimal or recommended granularity for a given allocation specification and returns it in granularity. This granularity can be used as a multiple for alignment, size, or address mapping.

**See also:**

[cuMemCreate](#), [cuMemMap](#)

## CUresult cuMemGetAllocationPropertiesFromHandle (CUmemAllocationProp \*prop, CUmemGenericAllocationHandle handle)

Retrieve the contents of the property structure defining properties for this handle.

### Parameters

#### prop

- Pointer to a properties structure which will hold the information about this handle

#### handle

- Handle which to perform the query on

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_PERMITTED, CUDA\_ERROR\_NOT\_SUPPORTED

### Description

#### See also:

cuMemCreate, cuMemImportFromShareableHandle

## CUresult cuMemImportFromShareableHandle (CUmemGenericAllocationHandle \*handle, void \*osHandle, CUmemAllocationHandleType shHandleType)

Imports an allocation from a requested shareable handle type.

### Parameters

#### handle

- CUDA Memory handle for the memory allocation.

#### osHandle

- Shareable Handle representing the memory allocation that is to be imported.

#### shHandleType

- handle type of the exported handle CUmemAllocationHandleType.

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_PERMITTED, CUDA\_ERROR\_NOT\_SUPPORTED

## Description

If the current process cannot support the memory described by this shareable handle, this API will error as `CUDA_ERROR_NOT_SUPPORTED`.



Importing shareable handles exported from some graphics APIs(Vulkan, OpenGL, etc) created on devices under an SLI group may not be supported, and thus this API will return `CUDA_ERROR_NOT_SUPPORTED`. There is no guarantee that the contents of `handle` will be the same CUDA memory handle for the same given OS shareable handle, or the same underlying allocation.

## See also:

[cuMemExportToShareableHandle](#), [cuMemMap](#), [cuMemRelease](#)

## CUresult cuMemMap (CUdeviceptr ptr, size\_t size, size\_t offset, CUmемGenericAllocationHandle handle, unsigned long long flags)

Maps an allocation handle to a reserved virtual address range.

## Parameters

### ptr

- Address where memory will be mapped.

### size

- Size of the memory mapping.

### offset

handle from which to start mapping Note: currently must be zero.

- Offset into the memory represented by

### handle

- Handle to a shareable memory

### flags

- flags for future use, must be zero now.

## Returns

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_VALUE`,  
`CUDA_ERROR_INVALID_DEVICE`, `CUDA_ERROR_OUT_OF_MEMORY`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_PERMITTED`, `CUDA_ERROR_NOT_SUPPORTED`

- ▶ `handle` from which to start mapping
- ▶ Note: currently must be zero.

## Description

Maps bytes of memory represented by `handle` starting from byte `offset` to `size` to address range `[addr, addr + size]`. This range must be an address reservation previously reserved with `cuMemAddressReserve`, and `offset + size` must be less than the size of the memory allocation. Both `ptr`, `size`, and `offset` must be a multiple of the value given via `cuMemGetAllocationGranularity` with the `CU_MEM_ALLOC_GRANULARITY_MINIMUM` flag.

Please note calling `cuMemMap` does not make the address accessible, the caller needs to update accessibility of a contiguous mapped VA range by calling `cuMemSetAccess`.

Once a recipient process obtains a shareable memory handle from `cuMemImportFromShareableHandle`, the process must use `cuMemMap` to map the memory into its address ranges before setting accessibility with `cuMemSetAccess`.

`cuMemMap` can only create mappings on VA range reservations that are not currently mapped.



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

## See also:

`cuMemUnmap`, `cuMemSetAccess`, `cuMemCreate`, `cuMemAddressReserve`, `cuMemImportFromShareableHandle`

## CUresult cuMemRelease (CUmemGenericAllocationHandle handle)

Release a memory handle representing a memory allocation which was previously allocated through `cuMemCreate`.

## Parameters

### handle

Value of handle which was returned previously by `cuMemCreate`.

## Returns

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_VALUE`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_PERMITTED`, `CUDA_ERROR_NOT_SUPPORTED`

## Description

Frees the memory that was allocated on a device through `cuMemCreate`.

The memory allocation will be freed when all outstanding mappings to the memory are unmapped and when all outstanding references to the handle (including its shareable counterparts) are also released. The generic memory handle can be freed when there are still outstanding mappings made with this handle. Each time a recipient process imports a shareable handle, it needs to pair it with [cuMemRelease](#) for the handle to be freed. If `handle` is not a valid handle the behavior is undefined.



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

See also:

[cuMemCreate](#)

## CUresult cuMemRetainAllocationHandle (CUmemGenericAllocationHandle \*handle, void \*addr)

Given an address `addr`, returns the allocation handle of the backing memory allocation.

### Parameters

#### **handle**

CUDA Memory handle for the backing memory allocation.

#### **addr**

Memory address to query, that has been mapped previously.

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_PERMITTED](#), [CUDA\\_ERROR\\_NOT\\_SUPPORTED](#)

### Description

The handle is guaranteed to be the same handle value used to map the memory. If the address requested is not mapped, the function will fail. The returned handle must be released with corresponding number of calls to [cuMemRelease](#).



The address `addr`, can be any address in a range previously mapped by [cuMemMap](#), and not necessarily the start address.

See also:

[cuMemCreate](#), [cuMemRelease](#), [cuMemMap](#)

## CUresult cuMemSetAccess (CUdeviceptr ptr, size\_t size, const CUmemAccessDesc \*desc, size\_t count)

Set the access flags for each location specified in `desc` for the given virtual address range.

### Parameters

#### **ptr**

- Starting address for the virtual address range

#### **size**

- Length of the virtual address range

#### **desc**

mapping for each location specified

- Array of [CUmemAccessDesc](#) that describe how to change the

#### **count**

- Number of [CUmemAccessDesc](#) in `desc`

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#),  
[CUDA\\_ERROR\\_INVALID\\_DEVICE](#), [CUDA\\_ERROR\\_NOT\\_SUPPORTED](#)

- mapping for each location specified

### Description

Given the virtual address range via `ptr` and `size`, and the locations in the array given by `desc` and `count`, set the access flags for the target locations. The range must be a fully mapped address range containing all allocations created by [cuMemMap](#) / [cuMemCreate](#).



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

### See also:

[cuMemSetAccess](#), [cuMemCreate](#), [:cuMemMap](#)



## CUresult cuMemUnmap (CUdeviceptr ptr, size\_t size)

Unmap the backing memory of a given address range.

### Parameters

#### ptr

- Starting address for the virtual address range to unmap

#### size

- Size of the virtual address range to unmap

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_PERMITTED, CUDA\_ERROR\_NOT\_SUPPORTED

### Description

The range must be the entire contiguous address range that was mapped to. In other words, [cuMemUnmap](#) cannot unmap a sub-range of an address range mapped by [cuMemCreate](#) / [cuMemMap](#). Any backing memory allocations will be freed if there are no existing mappings and there are no unreleased memory handles.

When [cuMemUnmap](#) returns successfully the address range is converted to an address reservation and can be used for a future calls to [cuMemMap](#). Any new mapping to this virtual address will need to have access granted through [cuMemSetAccess](#), as all mappings start with no accessibility setup.



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

### See also:

[cuMemCreate](#), [cuMemAddressReserve](#)

## 5.13. Unified Addressing

This section describes the unified addressing functions of the low-level CUDA driver 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 `cuDeviceGetAttribute()` with the device attribute `CU_DEVICE_ATTRIBUTE_UNIFIED_ADDRESSING`.

Unified addressing is automatically enabled in 64-bit processes

### 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 `cuPointerGetAttribute()`

Since pointers are unique, it is not necessary to specify information about the pointers specified to the various copy functions in the CUDA API. The function `cuMemcpy()` may be used to perform a copy between two pointers, ignoring whether they point to host or device memory (making `cuMemcpyHtoD()`, `cuMemcpyDtoD()`, and `cuMemcpyDtoH()` unnecessary for devices supporting unified addressing). For multidimensional copies, the memory type `CU_MEMORYTYPE_UNIFIED` may be used to specify that the CUDA driver should infer the location of the pointer from its value.

### Automatic Mapping of Host Allocated Host Memory

All host memory allocated in all contexts using `cuMemAllocHost()` and `cuMemHostAlloc()` is always directly accessible from all contexts on all devices that support unified addressing. This is the case regardless of whether or not the flags `CU_MEMHOSTALLOC_PORTABLE` and `CU_MEMHOSTALLOC_DEVICEMAP` 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, so it is not necessary to call `cuMemHostGetDevicePointer()` to get the device pointer for these allocations.

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

### Automatic Registration of Peer Memory

Upon enabling direct access from a context that supports unified addressing to another peer context that supports unified addressing using `cuCtxEnablePeerAccess()` all memory allocated in the peer context using `cuMemAlloc()` and `cuMemAllocPitch()` will

immediately be accessible by the current context. The device pointer value through which any peer memory may be accessed in the current context is the same pointer value through which that memory may be accessed in the peer context.

### 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 `cuMemHostRegister()` and host memory allocated using the flag `CU_MEMHOSTALLOC_WRITECOMBINED`. 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 contexts that support unified addressing.

This device address may be queried using `cuMemHostGetDevicePointer()` when a context using unified addressing is current. Either the host or the unified device pointer value may be used to refer to this memory through `cuMemcpy()` and similar functions using the `CU_MEMORYTYPE_UNIFIED` memory type.

## CUresult cuMemAdvise (CUdeviceptr devPtr, size\_t count, CUmem\_advise advice, CUdevice device)

Advise about the usage of a given memory range.

### Parameters

#### devPtr

- Pointer to memory to set the advice for

#### count

- Size in bytes of the memory range

#### advice

- Advice to be applied for the specified memory range

#### device

- Device to apply the advice for

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_VALUE`,  
`CUDA_ERROR_INVALID_DEVICE`

### Description

Advise the Unified Memory subsystem about the usage pattern for the memory range starting at `devPtr` with a size of `count` bytes. The start address and end address of the memory range will be rounded down and rounded up respectively to be aligned to CPU page size before the advice is applied. The memory range must refer to managed memory allocated via `cuMemAllocManaged` or declared via `__managed__` variables.

The memory range could also refer to system-allocated pageable memory provided it represents a valid, host-accessible region of memory and all additional constraints imposed by `advise` as outlined below are also satisfied. Specifying an invalid system-allocated pageable memory range results in an error being returned.

The `advise` parameter can take the following values:

- ▶ **CU\_MEM\_ADVICE\_SET\_READ\_MOSTLY**: This implies that the data is mostly going to be read from and only occasionally written to. Any read accesses from any processor to this region will create a read-only copy of at least the accessed pages in that processor's memory. Additionally, if `cuMemPrefetchAsync` is called on this region, it will create a read-only copy of the data on the destination processor. If any processor writes to this region, all copies of the corresponding page will be invalidated except for the one where the write occurred. The `device` argument is ignored for this advice. Note that for a page to be read-duplicated, the accessing processor must either be the CPU or a GPU that has a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS`. Also, if a context is created on a device that does not have the device attribute `CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS` set, then read-duplication will not occur until all such contexts are destroyed. If the memory region refers to valid system-allocated pageable memory, then the accessing device must have a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS` for a read-only copy to be created on that device. Note however that if the accessing device also has a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS_USES_HOST_PAGE_TABLES`, then setting this advice will not create a read-only copy when that device accesses this memory region.
- ▶ **CU\_MEM\_ADVICE\_UNSET\_READ\_MOSTLY**: Undoes the effect of `CU_MEM_ADVICE_SET_READ_MOSTLY` and also prevents the Unified Memory driver from attempting heuristic read-duplication on the memory range. Any read-duplicated copies of the data will be collapsed into a single copy. The location for the collapsed copy will be the preferred location if the page has a preferred location and one of the read-duplicated copies was resident at that location. Otherwise, the location chosen is arbitrary.
- ▶ **CU\_MEM\_ADVICE\_SET\_PREFERRED\_LOCATION**: This advice sets the preferred location for the data to be the memory belonging to `device`. Passing in `CU_DEVICE_CPU` for `device` sets the preferred location as host memory. If `device` is a GPU, then it must have a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS`. Setting the preferred location does not cause data to migrate to that location immediately. Instead, it guides the migration policy when a fault occurs on that memory region. If the data is already in its preferred location and the faulting processor can establish a mapping without requiring the data to be migrated, then data

migration will be avoided. On the other hand, if the data is not in its preferred location or if a direct mapping cannot be established, then it will be migrated to the processor accessing it. It is important to note that setting the preferred location does not prevent data prefetching done using `cuMemPrefetchAsync`. Having a preferred location can override the page thrash detection and resolution logic in the Unified Memory driver. Normally, if a page is detected to be constantly thrashing between for example host and device memory, the page may eventually be pinned to host memory by the Unified Memory driver. But if the preferred location is set as device memory, then the page will continue to thrash indefinitely. If `CU_MEM_ADVICE_SET_READ_MOSTLY` is also set on this memory region or any subset of it, then the policies associated with that advice will override the policies of this advice, unless read accesses from `device` will not result in a read-only copy being created on that device as outlined in description for the advice `CU_MEM_ADVICE_SET_READ_MOSTLY`. If the memory region refers to valid system-allocated pageable memory, then `device` must have a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS`. Additionally, if `device` has a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS_USES_HOST_PAGE_TABLES`, then this call has no effect. Note however that this behavior may change in the future.

- ▶ `CU_MEM_ADVICE_UNSET_PREFERRED_LOCATION`: Undoes the effect of `CU_MEM_ADVICE_SET_PREFERRED_LOCATION` and changes the preferred location to none.
- ▶ `CU_MEM_ADVICE_SET_ACCESSED_BY`: This advice implies that the data will be accessed by `device`. Passing in `CU_DEVICE_CPU` for `device` will set the advice for the CPU. If `device` is a GPU, then the device attribute `CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS` must be non-zero. This advice does not cause data migration and has no impact on the location of the data per se. Instead, it causes the data to always be mapped in the specified processor's page tables, as long as the location of the data permits a mapping to be established. If the data gets migrated for any reason, the mappings are updated accordingly. This advice is recommended in scenarios where data locality is not important, but avoiding faults is. Consider for example a system containing multiple GPUs with peer-to-peer access enabled, where the data located on one GPU is occasionally accessed by peer GPUs. In such scenarios, migrating data over to the other GPUs is not as important because the accesses are infrequent and the overhead of migration may be too high. But preventing faults can still help improve performance, and so having a mapping set up in advance is useful. Note that on CPU access of this data, the data may be migrated to host memory because the CPU typically cannot access device memory directly. Any GPU that had the `CU_MEM_ADVICE_SET_ACCESSED_BY` flag set for this data will now have its mapping updated to point to the page

in host memory. If `CU_MEM_ADVICE_SET_READ_MOSTLY` is also set on this memory region or any subset of it, then the policies associated with that advice will override the policies of this advice. Additionally, if the preferred location of this memory region or any subset of it is also `device`, then the policies associated with `CU_MEM_ADVICE_SET_PREFERRED_LOCATION` will override the policies of this advice. If the memory region refers to valid system-allocated pageable memory, then `device` must have a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS`. Additionally, if `device` has a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS_USES_HOST_PAGE_TABLES`, then this call has no effect.

- ▶ `CU_MEM_ADVICE_UNSET_ACCESSED_BY`: Undoes the effect of `CU_MEM_ADVICE_SET_ACCESSED_BY`. Any mappings to the data from `device` may be removed at any time causing accesses to result in non-fatal page faults. If the memory region refers to valid system-allocated pageable memory, then `device` must have a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS`. Additionally, if `device` has a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS_USES_HOST_PAGE_TABLES`, then this call has no effect.



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

#### See also:

`cuMemcpy`, `cuMemcpyPeer`, `cuMemcpyAsync`, `cuMemcpy3DPeerAsync`,  
`cuMemPrefetchAsync`, `cudaMemAdvise`

## `CUresult cuMemPrefetchAsync (CUdeviceptr devPtr, size_t count, CUdevice dstDevice, CUstream hStream)`

Prefetches memory to the specified destination device.

### Parameters

#### `devPtr`

- Pointer to be prefetched

#### `count`

- Size in bytes

**dstDevice**

- Destination device to prefetch to

**hStream**

- Stream to enqueue prefetch operation

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_INVALID\_DEVICE

**Description**

Prefetches memory to the specified destination device. `devPtr` is the base device pointer of the memory to be prefetched and `dstDevice` is the destination device. `count` specifies the number of bytes to copy. `hStream` is the stream in which the operation is enqueued. The memory range must refer to managed memory allocated via `cuMemAllocManaged` or declared via `__managed__` variables.

Passing in `CU_DEVICE_CPU` for `dstDevice` will prefetch the data to host memory. If `dstDevice` is a GPU, then the device attribute `CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS` must be non-zero. Additionally, `hStream` must be associated with a device that has a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS`.

The start address and end address of the memory range will be rounded down and rounded up respectively to be aligned to CPU page size before the prefetch operation is enqueued in the stream.

If no physical memory has been allocated for this region, then this memory region will be populated and mapped on the destination device. If there's insufficient memory to prefetch the desired region, the Unified Memory driver may evict pages from other `cuMemAllocManaged` allocations to host memory in order to make room. Device memory allocated using `cuMemAlloc` or `cuArrayCreate` will not be evicted.

By default, any mappings to the previous location of the migrated pages are removed and mappings for the new location are only setup on `dstDevice`. The exact behavior however also depends on the settings applied to this memory range via `cuMemAdvise` as described below:

If `CU_MEM_ADVISE_SET_READ_MOSTLY` was set on any subset of this memory range, then that subset will create a read-only copy of the pages on `dstDevice`.

If `CU_MEM_ADVISE_SET_PREFERRED_LOCATION` was called on any subset of this memory range, then the pages will be migrated to `dstDevice` even if `dstDevice` is not the preferred location of any pages in the memory range.

If `CU_MEM_ADVISE_SET_ACCESSED_BY` was called on any subset of this memory range, then mappings to those pages from all the appropriate processors are updated



to refer to the new location if establishing such a mapping is possible. Otherwise, those mappings are cleared.

Note that this API is not required for functionality and only serves to improve performance by allowing the application to migrate data to a suitable location before it is accessed. Memory accesses to this range are always coherent and are allowed even when the data is actively being migrated.

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



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

See also:

[cuMemcpy](#), [cuMemcpyPeer](#), [cuMemcpyAsync](#), [cuMemcpy3DPeerAsync](#), [cuMemAdvise](#), [cudaMemPrefetchAsync](#)

## CUresult cuMemRangeGetAttribute (void \*data, size\_t dataSize, CUmem\_range\_attribute attribute, CUdeviceptr devPtr, size\_t count)

Query an attribute of a given memory range.

### Parameters

#### **data**

- A pointers to a memory location where the result of each attribute query will be written to.

#### **dataSize**

- Array containing the size of data

#### **attribute**

- The attribute to query

#### **devPtr**

- Start of the range to query

#### **count**

- Size of the range to query



## Returns

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_INVALID\_DEVICE

## Description

Query an attribute about the memory range starting at `devPtr` with a size of `count` bytes. The memory range must refer to managed memory allocated via `cuMemAllocManaged` or declared via `__managed__` variables.

The `attribute` parameter can take the following values:

- ▶ **CU\_MEM\_RANGE\_ATTRIBUTE\_READ\_MOSTLY**: If this attribute is specified, `data` will be interpreted as a 32-bit integer, and `dataSize` must be 4. The result returned will be 1 if all pages in the given memory range have read-duplication enabled, or 0 otherwise.
- ▶ **CU\_MEM\_RANGE\_ATTRIBUTE\_PREFERRED\_LOCATION**: If this attribute is specified, `data` will be interpreted as a 32-bit integer, and `dataSize` must be 4. The result returned will be a GPU device id if all pages in the memory range have that GPU as their preferred location, or it will be `CU_DEVICE_CPU` if all pages in the memory range have the CPU as their preferred location, or it will be `CU_DEVICE_INVALID` if either all the pages don't have the same preferred location or some of the pages don't have a preferred location at all. Note that the actual location of the pages in the memory range at the time of the query may be different from the preferred location.
- ▶ **CU\_MEM\_RANGE\_ATTRIBUTE\_ACCESSED\_BY**: If this attribute is specified, `data` will be interpreted as an array of 32-bit integers, and `dataSize` must be a non-zero multiple of 4. The result returned will be a list of device ids that had **CU\_MEM\_ADVISE\_SET\_ACCESSED\_BY** set for that entire memory range. If any device does not have that advice set for the entire memory range, that device will not be included. If `data` is larger than the number of devices that have that advice set for that memory range, `CU_DEVICE_INVALID` will be returned in all the extra space provided. For ex., if `dataSize` is 12 (i.e. `data` has 3 elements) and only device 0 has the advice set, then the result returned will be { 0, `CU_DEVICE_INVALID`, `CU_DEVICE_INVALID` }. If `data` is smaller than the number of devices that have that advice set, then only as many devices will be returned as can fit in the array. There is no guarantee on which specific devices will be returned, however.
- ▶ **CU\_MEM\_RANGE\_ATTRIBUTE\_LAST\_PREFETCH\_LOCATION**: If this attribute is specified, `data` will be interpreted as a 32-bit integer, and `dataSize` must be 4. The result returned will be the last location to which all pages in the memory range were prefetched explicitly via `cuMemPrefetchAsync`. This will either be a GPU id or `CU_DEVICE_CPU` depending on whether the last location for prefetch was a GPU or the CPU respectively. If any page in the memory range was never explicitly prefetched or if all pages were not prefetched to the same location,

CUDA\_DEVICE\_INVALID will be returned. Note that this simply returns the last location that the application requested to prefetch the memory range to. It gives no indication as to whether the prefetch operation to that location has completed or even begun.



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

#### See also:

[cuMemRangeGetAttributes](#), [cuMemPrefetchAsync](#), [cuMemAdvise](#),  
[cudaMemRangeGetAttribute](#)

## CUresult cuMemRangeGetAttributes (void \*\*data, size\_t \*dataSizes, CUmem\_range\_attribute \*attributes, size\_t numAttributes, CUdeviceptr devPtr, size\_t count)

Query attributes of a given memory range.

### Parameters

#### data

- A two-dimensional array containing pointers to memory locations where the result of each attribute query will be written to.

#### dataSizes

- Array containing the sizes of each result

#### attributes

- An array of attributes to query (numAttributes and the number of attributes in this array should match)

#### numAttributes

- Number of attributes to query

#### devPtr

- Start of the range to query

#### count

- Size of the range to query

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_INVALID\_DEVICE

## Description

Query attributes of the memory range starting at `devPtr` with a size of `count` bytes. The memory range must refer to managed memory allocated via [cuMemAllocManaged](#) or declared via `__managed__` variables. The `attributes` array will be interpreted to have `numAttributes` entries. The `dataSizes` array will also be interpreted to have `numAttributes` entries. The results of the query will be stored in `data`.

The list of supported attributes are given below. Please refer to [cuMemRangeGetAttribute](#) for attribute descriptions and restrictions.

- ▶ `CU_MEM_RANGE_ATTRIBUTE_READ_MOSTLY`
- ▶ `CU_MEM_RANGE_ATTRIBUTE_PREFERRED_LOCATION`
- ▶ `CU_MEM_RANGE_ATTRIBUTE_ACCESSED_BY`
- ▶ `CU_MEM_RANGE_ATTRIBUTE_LAST_PREFETCH_LOCATION`



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

## See also:

[cuMemRangeGetAttribute](#), [cuMemAdvise](#) [cuMemPrefetchAsync](#),  
[cudaMemRangeGetAttributes](#)

## CUresult cuPointerGetAttribute (void \*data, CUpointer\_attribute attribute, CUdeviceptr ptr)

Returns information about a pointer.

### Parameters

#### **data**

- Returned pointer attribute value

#### **attribute**

- Pointer attribute to query

#### **ptr**

- Pointer

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_DEVICE`

## Description

The supported attributes are:

### ► CU\_POINTER\_ATTRIBUTE\_CONTEXT:

Returns in `*data` the `CUcontext` in which `ptr` was allocated or registered. The type of `data` must be `CUcontext *`.

If `ptr` was not allocated by, mapped by, or registered with a `CUcontext` which uses unified virtual addressing then `CUDA_ERROR_INVALID_VALUE` is returned.

### ► CU\_POINTER\_ATTRIBUTE\_MEMORY\_TYPE:

Returns in `*data` the physical memory type of the memory that `ptr` addresses as a `CUmemorytype` enumerated value. The type of `data` must be unsigned int.

If `ptr` addresses device memory then `*data` is set to `CU_MEMORYTYPE_DEVICE`. The particular `CUdevice` on which the memory resides is the `CUdevice` of the `CUcontext` returned by the `CU_POINTER_ATTRIBUTE_CONTEXT` attribute of `ptr`.

If `ptr` addresses host memory then `*data` is set to `CU_MEMORYTYPE_HOST`.

If `ptr` was not allocated by, mapped by, or registered with a `CUcontext` which uses unified virtual addressing then `CUDA_ERROR_INVALID_VALUE` is returned.

If the current `CUcontext` does not support unified virtual addressing then `CUDA_ERROR_INVALID_CONTEXT` is returned.

### ► CU\_POINTER\_ATTRIBUTE\_DEVICE\_POINTER:

Returns in `*data` the device pointer value through which `ptr` may be accessed by kernels running in the current `CUcontext`. The type of `data` must be `CUdeviceptr *`.

If there exists no device pointer value through which kernels running in the current `CUcontext` may access `ptr` then `CUDA_ERROR_INVALID_VALUE` is returned.

If there is no current `CUcontext` then `CUDA_ERROR_INVALID_CONTEXT` is returned.

Except in the exceptional disjoint addressing cases discussed below, the value returned in `*data` will equal the input value `ptr`.

### ► CU\_POINTER\_ATTRIBUTE\_HOST\_POINTER:

Returns in `*data` the host pointer value through which `ptr` may be accessed by the host program. The type of `data` must be `void **`. If there exists no host pointer value through which the host program may directly access `ptr` then `CUDA_ERROR_INVALID_VALUE` is returned.

Except in the exceptional disjoint addressing cases discussed below, the value returned in `*data` will equal the input value `ptr`.

### ► CU\_POINTER\_ATTRIBUTE\_P2P\_TOKENS:

Returns in `*data` two tokens for use with the `nv-p2p.h` Linux kernel interface. `data` must be a struct of type `CUDA_POINTER_ATTRIBUTE_P2P_TOKENS`.

`ptr` must be a pointer to memory obtained from `:cuMemAlloc()`. Note that `p2pToken` and `vaSpaceToken` are only valid for the lifetime of the source allocation. A subsequent allocation at the same address may return completely different tokens. Querying this attribute has a side effect of setting the attribute `CUDA_POINTER_ATTRIBUTE_SYNC_MEMOPS` for the region of memory that `ptr` points to.

► `CUDA_POINTER_ATTRIBUTE_SYNC_MEMOPS`:

A boolean attribute which when set, ensures that synchronous memory operations initiated on the region of memory that `ptr` points to will always synchronize. See further documentation in the section titled "API synchronization behavior" to learn more about cases when synchronous memory operations can exhibit asynchronous behavior.

► `CUDA_POINTER_ATTRIBUTE_BUFFER_ID`:

Returns in `*data` a buffer ID which is guaranteed to be unique within the process. `data` must point to an unsigned long long.

`ptr` must be a pointer to memory obtained from a CUDA memory allocation API. Every memory allocation from any of the CUDA memory allocation APIs will have a unique ID over a process lifetime. Subsequent allocations do not reuse IDs from previous freed allocations. IDs are only unique within a single process.

► `CUDA_POINTER_ATTRIBUTE_IS_MANAGED`:

Returns in `*data` a boolean that indicates whether the pointer points to managed memory or not.

If `ptr` is not a valid CUDA pointer then `CUDA_ERROR_INVALID_VALUE` is returned.

► `CUDA_POINTER_ATTRIBUTE_DEVICE_ORDINAL`:

Returns in `*data` an integer representing a device ordinal of a device against which the memory was allocated or registered.

► `CUDA_POINTER_ATTRIBUTE_IS_LEGACY_CUDA_IPC_CAPABLE`:

Returns in `*data` a boolean that indicates if this pointer maps to an allocation that is suitable for `cudaIpcGetMemHandle`.

► `CUDA_POINTER_ATTRIBUTE_RANGE_START_ADDR`:

Returns in `*data` the starting address for the allocation referenced by the device pointer `ptr`. Note that this is not necessarily the address of the mapped region, but the address of the mappable address range `ptr` references (e.g. from `cuMemAddressReserve`).

► `CUDA_POINTER_ATTRIBUTE_RANGE_SIZE`:

Returns in `*data` the size for the allocation referenced by the device pointer `ptr`. Note that this is not necessarily the size of the mapped region, but the size of the mappable address range `ptr` references (e.g. from `cuMemAddressReserve`). To retrieve the size of the mapped region, see `cuMemGetAllocationPropertyForAddress`.

► **CU\_POINTER\_ATTRIBUTE\_MAPPED:**

Returns in `*data` a boolean that indicates if this pointer is in a valid address range that is mapped to a backing allocation.

► **CU\_POINTER\_ATTRIBUTE\_ALLOWED\_HANDLE\_TYPES:**

Returns a bitmask of the allowed handle types for an allocation that may be passed to `cuMemExportToShareableHandle`.

Note that for most allocations in the unified virtual address space the host and device pointer for accessing the allocation will be the same. The exceptions to this are

- user memory registered using `cuMemHostRegister`
- host memory allocated using `cuMemHostAlloc` with the `CU_MEMHOSTALLOC_WRITECOMBINED` flag For these types of allocation there will exist separate, disjoint host and device addresses for accessing the allocation. In particular
  - The host address will correspond to an invalid unmapped device address (which will result in an exception if accessed from the device)
  - The device address will correspond to an invalid unmapped host address (which will result in an exception if accessed from the host). For these types of allocations, querying `CU_POINTER_ATTRIBUTE_HOST_POINTER` and `CU_POINTER_ATTRIBUTE_DEVICE_POINTER` may be used to retrieve the host and device addresses from either address.



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

**See also:**

`cuPointerSetAttribute`, `cuMemAlloc`, `cuMemFree`, `cuMemAllocHost`, `cuMemFreeHost`, `cuMemHostAlloc`, `cuMemHostRegister`, `cuMemHostUnregister`, `cudaPointerGetAttributes`

## CUresult cuPointerGetAttributes (unsigned int numAttributes, CUpointer\_attribute \*attributes, void \*\*data, CUdeviceptr ptr)

Returns information about a pointer.

### Parameters

#### numAttributes

- Number of attributes to query

#### attributes

- An array of attributes to query (numAttributes and the number of attributes in this array should match)

#### data

- A two-dimensional array containing pointers to memory locations where the result of each attribute query will be written to.

#### ptr

- Pointer to query

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_INVALID\_DEVICE

### Description

The supported attributes are (refer to `cuPointerGetAttribute` for attribute descriptions and restrictions):

- ▶ CU\_POINTER\_ATTRIBUTE\_CONTEXT
- ▶ CU\_POINTER\_ATTRIBUTE\_MEMORY\_TYPE
- ▶ CU\_POINTER\_ATTRIBUTE\_DEVICE\_POINTER
- ▶ CU\_POINTER\_ATTRIBUTE\_HOST\_POINTER
- ▶ CU\_POINTER\_ATTRIBUTE\_SYNC\_MEMOPS
- ▶ CU\_POINTER\_ATTRIBUTE\_BUFFER\_ID
- ▶ CU\_POINTER\_ATTRIBUTE\_IS\_MANAGED
- ▶ CU\_POINTER\_ATTRIBUTE\_DEVICE\_ORDINAL
- ▶ CU\_POINTER\_ATTRIBUTE\_RANGE\_START\_ADDR
- ▶ CU\_POINTER\_ATTRIBUTE\_RANGE\_SIZE
- ▶ CU\_POINTER\_ATTRIBUTE\_MAPPED
- ▶ CU\_POINTER\_ATTRIBUTE\_IS\_LEGACY\_CUDA\_IPC\_CAPABLE
- ▶ CU\_POINTER\_ATTRIBUTE\_ALLOWED\_HANDLE\_TYPES

Unlike `cuPointerGetAttribute`, this function will not return an error when the `ptr` encountered is not a valid CUDA pointer. Instead, the attributes are assigned default NULL values and `CUDA_SUCCESS` is returned.

If `ptr` was not allocated by, mapped by, or registered with a `CUcontext` which uses UVA (Unified Virtual Addressing), `CUDA_ERROR_INVALID_CONTEXT` is returned.



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

#### See also:

`cuPointerGetAttribute`, `cuPointerSetAttribute`, `cudaPointerGetAttributes`

## CUresult cuPointerSetAttribute (const void \*value, CUpointer\_attribute attribute, CUdeviceptr ptr)

Set attributes on a previously allocated memory region.

### Parameters

#### value

- Pointer to memory containing the value to be set

#### attribute

- Pointer attribute to set

#### ptr

- Pointer to a memory region allocated using CUDA memory allocation APIs

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_DEVICE`

### Description

The supported attributes are:

#### ► `CU_POINTER_ATTRIBUTE_SYNC_MEMOPS`:

A boolean attribute that can either be set (1) or unset (0). When set, the region of memory that `ptr` points to is guaranteed to always synchronize memory operations that are synchronous. If there are some previously initiated synchronous memory operations that are pending when this attribute is set, the function does not return until those memory operations are complete. See further documentation in the section titled "API synchronization behavior" to learn more about cases when synchronous memory



operations can exhibit asynchronous behavior. `value` will be considered as a pointer to an unsigned integer to which this attribute is to be set.



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

#### See also:

`cuPointerGetAttribute`, `cuPointerGetAttributes`, `cuMemAlloc`, `cuMemFree`, `cuMemAllocHost`, `cuMemFreeHost`, `cuMemHostAlloc`, `cuMemHostRegister`, `cuMemHostUnregister`

## 5.14. Stream Management

This section describes the stream management functions of the low-level CUDA driver application programming interface.

### CUresult cuStreamAddCallback (CUstream hStream, CUstreamCallback callback, void \*userData, unsigned int flags)

Add a callback to a compute stream.

#### Parameters

##### **hStream**

- 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

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`, `CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`, `CUDA_ERROR_INVALID_HANDLE`, `CUDA_ERROR_NOT_SUPPORTED`

## Description



This function is slated for eventual deprecation and removal. If you do not require the callback to execute in case of a device error, consider using [cuLaunchHostFunc](#). Additionally, this function is not supported with [cuStreamBeginCapture](#) and [cuStreamEndCapture](#), unlike [cuLaunchHostFunc](#).

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

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

Callbacks must not make any CUDA API calls. Attempting to use a CUDA API will result in [CUDA\\_ERROR\\_NOT\\_PERMITTED](#). 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.

For the purposes of Unified Memory, callback execution makes a number of guarantees:

- ▶ The callback stream is considered idle for the duration of the callback. Thus, for example, a callback may always use memory attached to the callback stream.
- ▶ The start of execution of a callback has the same effect as synchronizing an event recorded in the same stream immediately prior to the callback. It thus synchronizes streams which have been "joined" prior to the callback.
- ▶ Adding device work to any stream does not have the effect of making the stream active until all preceding host functions and stream callbacks have executed. Thus, for example, a callback might use global attached memory even if work has been added to another stream, if the work has been ordered behind the callback with an event.
- ▶ Completion of a callback does not cause a stream to become active except as described above. The callback stream will remain idle if no device work follows the callback, and will remain idle across consecutive callbacks without device work in between. Thus, for example, stream synchronization can be done by signaling from a callback at the end of the stream.



- ▶ This function uses standard [default stream](#) semantics.
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cuStreamCreate`, `cuStreamQuery`, `cuStreamSynchronize`, `cuStreamWaitEvent`,  
`cuStreamDestroy`, `cuMemAllocManaged`, `cuStreamAttachMemAsync`,  
`cuStreamLaunchHostFunc`, `cudaStreamAddCallback`

## CUresult cuStreamAttachMemAsync (CUstream hStream, CUdeviceptr dptr, size\_t length, unsigned int flags)

Attach memory to a stream asynchronously.

### Parameters

#### **hStream**

- Stream in which to enqueue the attach operation

#### **dptr**

- Pointer to memory (must be a pointer to managed memory or to a valid host-accessible region of system-allocated pageable memory)

#### **length**

- Length of memory

#### **flags**

- Must be one of `CUmemAttach_flags`

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_HANDLE`, `CUDA_ERROR_NOT_SUPPORTED`

### Description

Enqueues an operation in `hStream` to specify stream association of `length` bytes of memory starting from `dptr`. This function is a stream-ordered operation, meaning that it is dependent on, and will only take effect when, previous work in stream has completed. Any previous association is automatically replaced.

`dptr` must point to one of the following types of memories:

- ▶ managed memory declared using the `__managed__` keyword or allocated with `cuMemAllocManaged`.
- ▶ a valid host-accessible region of system-allocated pageable memory. This type of memory may only be specified if the device associated with the stream reports a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS`.

For managed allocations, `length` must be either zero or the entire allocation's size. Both indicate that the entire allocation's stream association is being changed. Currently, it is not possible to change stream association for a portion of a managed allocation.

For pageable host allocations, `length` must be non-zero.

The stream association is specified using `flags` which must be one of [CUmemAttach\\_flags](#). If the [CU\\_MEM\\_ATTACH\\_GLOBAL](#) flag is specified, the memory can be accessed by any stream on any device. If the [CU\\_MEM\\_ATTACH\\_HOST](#) flag is specified, the program makes a guarantee that it won't access the memory on the device from any stream on a device that has a zero value for the device attribute [CU\\_DEVICE\\_ATTRIBUTE\\_CONCURRENT\\_MANAGED\\_ACCESS](#).

If the [CU\\_MEM\\_ATTACH\\_SINGLE](#) flag is specified and `hStream` is associated with a device that has a zero value for the device attribute [CU\\_DEVICE\\_ATTRIBUTE\\_CONCURRENT\\_MANAGED\\_ACCESS](#), the program makes a guarantee that it will only access the memory on the device from `hStream`. It is illegal to attach singly to the NULL stream, because the NULL stream is a virtual global stream and not a specific stream. An error will be returned in this case.

When memory is associated with a single stream, the Unified Memory system will allow CPU access to this memory region so long as all operations in `hStream` have completed, regardless of whether other streams are active. In effect, this constrains exclusive ownership of the managed memory region by an active GPU to per-stream activity instead of whole-GPU activity.

Accessing memory on the device from streams that are not associated with it will produce undefined results. No error checking is performed by the Unified Memory system to ensure that kernels launched into other streams do not access this region.

It is a program's responsibility to order calls to [cuStreamAttachMemAsync](#) via events, synchronization or other means to ensure legal access to memory at all times. Data visibility and coherency will be changed appropriately for all kernels which follow a stream-association change.

If `hStream` is destroyed while data is associated with it, the association is removed and the association reverts to the default visibility of the allocation as specified at [cuMemAllocManaged](#). For `__managed__` variables, the default association is always [CU\\_MEM\\_ATTACH\\_GLOBAL](#). Note that destroying a stream is an asynchronous operation, and as a result, the change to default association won't happen until all work in the stream has completed.



- ▶ This function uses standard [default stream](#) semantics.
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cuStreamCreate](#), [cuStreamQuery](#), [cuStreamSynchronize](#), [cuStreamWaitEvent](#), [cuStreamDestroy](#), [cuMemAllocManaged](#), [cudaStreamAttachMemAsync](#)

## CUresult cuStreamBeginCapture (CUstream hStream, CUstreamCaptureMode mode)

Begins graph capture on a stream.

### Parameters

#### **hStream**

- Stream in which to initiate capture

#### **mode**

- Controls the interaction of this capture sequence with other API calls that are potentially unsafe. For more details see [cuThreadExchangeStreamCaptureMode](#).

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE

### Description

Begin graph capture on `hStream`. When a stream is in capture mode, all operations pushed into the stream will not be executed, but will instead be captured into a graph, which will be returned via [cuStreamEndCapture](#). Capture may not be initiated if `stream` is `CU_STREAM_LEGACY`. Capture must be ended on the same stream in which it was initiated, and it may only be initiated if the stream is not already in capture mode. The capture mode may be queried via [cuStreamIsCapturing](#). A unique id representing the capture sequence may be queried via [cuStreamGetCaptureInfo](#).

If `mode` is not `CU_STREAM_CAPTURE_MODE_RELAXED`, [cuStreamEndCapture](#) must be called on this stream from the same thread.



Kernels captured using this API must not use texture and surface references. Reading or writing through any texture or surface reference is undefined behavior. This restriction does not apply to texture and surface objects.



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

### See also:

[cuStreamCreate](#), [cuStreamIsCapturing](#), [cuStreamEndCapture](#),  
[cuThreadExchangeStreamCaptureMode](#)

## CUresult cuStreamCopyAttributes (CUstream dst, CUstream src)

Copies attributes from source stream to destination stream.

### Parameters

#### dst

Destination stream

#### src

Source stream For list of attributes see [CUstreamAttrID](#)

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#)

### Description

Copies attributes from source stream `src` to destination stream `dst`. Both streams must have the same context.



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

### See also:

[CUaccessPolicyWindow](#)

## CUresult cuStreamCreate (CUstream \*phStream, unsigned int Flags)

Create a stream.

### Parameters

#### phStream

- Returned newly created stream

#### Flags

- Parameters for stream creation

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#), [CUDA\\_ERROR\\_OUT\\_OF\\_MEMORY](#)

## Description

Creates a stream and returns a handle in `phStream`. The `Flags` argument determines behaviors of the stream.

Valid values for `Flags` are:

- ▶ `CU_STREAM_DEFAULT`: Default stream creation flag.
- ▶ `CU_STREAM_NON_BLOCKING`: 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:

`cuStreamDestroy`, `cuStreamCreateWithPriority`, `cuStreamGetPriority`, `cuStreamGetFlags`, `cuStreamWaitEvent`, `cuStreamQuery`, `cuStreamSynchronize`, `cuStreamAddCallback`, `cudaStreamCreate`, `cudaStreamCreateWithFlags`

## CUresult cuStreamCreateWithPriority (CUstream \*phStream, unsigned int flags, int priority)

Create a stream with the given priority.

### Parameters

#### `phStream`

- Returned newly created stream

#### `flags`

- Flags for stream creation. See `cuStreamCreate` for a list of valid flags

#### `priority`

- Stream priority. Lower numbers represent higher priorities. See `cuCtxGetStreamPriorityRange` for more information about meaningful stream priorities that can be passed.

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_OUT_OF_MEMORY`

## Description

Creates a stream with the specified priority and returns a handle in `phStream`. 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 `cuCtxGetStreamPriorityRange`. If the specified priority is outside the numerical range returned by `cuCtxGetStreamPriorityRange`, 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 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:

`cuStreamDestroy`, `cuStreamCreate`, `cuStreamGetPriority`, `cuCtxGetStreamPriorityRange`, `cuStreamGetFlags`, `cuStreamWaitEvent`, `cuStreamQuery`, `cuStreamSynchronize`, `cuStreamAddCallback`, `cudaStreamCreateWithPriority`

## CUresult cuStreamDestroy (CUstream hStream)

Destroys a stream.

### Parameters

#### **hStream**

- Stream to destroy

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_HANDLE`

## Description

Destroys the stream specified by `hStream`.



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



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

#### See also:

[cuStreamCreate](#), [cuStreamWaitEvent](#), [cuStreamQuery](#), [cuStreamSynchronize](#), [cuStreamAddCallback](#), [cudaStreamDestroy](#)

## CUresult cuStreamEndCapture (CUstream hStream, CUgraph \*phGraph)

Ends capture on a stream, returning the captured graph.

#### Parameters

##### **hStream**

- Stream to query

##### **phGraph**

- The captured graph

#### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#),  
[CUDA\\_ERROR\\_STREAM\\_CAPTURE\\_WRONG\\_THREAD](#)

#### Description

End capture on `hStream`, returning the captured graph via `phGraph`. Capture must have been initiated on `hStream` via a call to [cuStreamBeginCapture](#). If capture was invalidated, due to a violation of the rules of stream capture, then a NULL graph will be returned.

If the mode argument to [cuStreamBeginCapture](#) was not [CU\\_STREAM\\_CAPTURE\\_MODE\\_RELAXED](#), this call must be from the same thread as [cuStreamBeginCapture](#).



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

**See also:**

[cuStreamCreate](#), [cuStreamBeginCapture](#), [cuStreamIsCapturing](#)

## CUresult cuStreamGetAttribute (CUstream hStream, CUstreamAttrID attr, CUstreamAttrValue \*value\_out)

Queries stream attribute.

**Parameters**

**hStream**

**attr**

**value\_out**

**Returns**

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#),  
[CUDA\\_ERROR\\_INVALID\\_HANDLE](#)

**Description**

Queries attribute `attr` from `hStream` and stores it in corresponding member of `value_out`.



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

**See also:**

[CUaccessPolicyWindow](#)

## CUresult cuStreamGetCaptureInfo (CUstream hStream, CUstreamCaptureStatus \*captureStatus, cuuint64\_t \*id)

Query capture status of a stream.

**Returns**

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_STREAM\\_CAPTURE\\_IMPLICIT](#)

**Description**

Query the capture status of a stream and get an id for the capture sequence, which is unique over the lifetime of the process.

If called on `CU_STREAM_LEGACY` (the "null stream") while a stream not created with `CU_STREAM_NON_BLOCKING` is capturing, returns `CUDA_ERROR_STREAM_CAPTURE_IMPLICIT`.

A valid id is returned only if both of the following are true:

- ▶ the call returns `CUDA_SUCCESS`
- ▶ `captureStatus` is set to `CU_STREAM_CAPTURE_STATUS_ACTIVE`



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

See also:

`cuStreamBeginCapture`, `cuStreamIsCapturing`

## CUresult cuStreamGetCtx (CUstream hStream, CUcontext \*pctx)

Query the context associated with a stream.

### Parameters

#### **hStream**

- Handle to the stream to be queried

#### **pctx**

- Returned context associated with the stream

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_HANDLE`,

### Description

Returns the CUDA context that the stream is associated with.

The stream handle `hStream` can refer to any of the following:

- ▶ a stream created via any of the CUDA driver APIs such as `cuStreamCreate` and `cuStreamCreateWithPriority`, or their runtime API equivalents such as `cudaStreamCreate`, `cudaStreamCreateWithFlags` and `cudaStreamCreateWithPriority`. The returned context is the context that was active in the calling thread when the stream was created. Passing an invalid handle will result in undefined behavior.

- ▶ any of the special streams such as the NULL stream, `CU_STREAM_LEGACY` and `CU_STREAM_PER_THREAD`. The runtime API equivalents of these are also accepted, which are `NULL`, `cudaStreamLegacy` and `cudaStreamPerThread` respectively. Specifying any of the special handles will return the context current to the calling thread. If no context is current to the calling thread, `CUDA_ERROR_INVALID_CONTEXT` is returned.



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

#### See also:

`cuStreamDestroy`, `cuStreamCreateWithPriority`, `cuStreamGetPriority`, `cuStreamGetFlags`, `cuStreamWaitEvent`, `cuStreamQuery`, `cuStreamSynchronize`, `cuStreamAddCallback`, `cudaStreamCreate`, `cudaStreamCreateWithFlags`

## CUresult cuStreamGetFlags (CUstream hStream, unsigned int \*flags)

Query the flags of a given stream.

### Parameters

#### hStream

- Handle to the stream to be queried

#### flags

- Pointer to an unsigned integer in which the stream's flags are returned. The value returned in `flags` is a logical 'OR' of all flags that were used while creating this stream. See `cuStreamCreate` for the list of valid flags

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`, `CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`, `CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_HANDLE`, `CUDA_ERROR_OUT_OF_MEMORY`

### Description

Query the flags of a stream created using `cuStreamCreate` or `cuStreamCreateWithPriority` and return the flags in `flags`.



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

See also:

[cuStreamDestroy](#), [cuStreamCreate](#), [cuStreamGetPriority](#), [cudaStreamGetFlags](#)

## CUresult cuStreamGetPriority (CUstream hStream, int \*priority)

Query the priority of a given 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

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE,  
CUDA\_ERROR\_OUT\_OF\_MEMORY

### Description

Query the priority of a stream created using [cuStreamCreate](#) or [cuStreamCreateWithPriority](#) and return the priority in `priority`. Note that if the stream was created with a priority outside the numerical range returned by [cuCtxGetStreamPriorityRange](#), this function returns the clamped priority. See [cuStreamCreateWithPriority](#) for details about priority clamping.



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

See also:

[cuStreamDestroy](#), [cuStreamCreate](#), [cuStreamCreateWithPriority](#),  
[cuCtxGetStreamPriorityRange](#), [cuStreamGetFlags](#), [cudaStreamGetPriority](#)

## CUresult cuStreamIsCapturing (CUstream hStream, CUstreamCaptureStatus \*captureStatus)

Returns a stream's capture status.

### Parameters

#### hStream

- Stream to query

#### captureStatus

- Returns the stream's capture status

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_STREAM\_CAPTURE\_IMPLICIT

### Description

Return the capture status of hStream via captureStatus. After a successful call, \*captureStatus will contain one of the following:

- ▶ **CU\_STREAM\_CAPTURE\_STATUS\_NONE**: The stream is not capturing.
- ▶ **CU\_STREAM\_CAPTURE\_STATUS\_ACTIVE**: The stream is capturing.
- ▶ **CU\_STREAM\_CAPTURE\_STATUS\_INVALIDATED**: The stream was capturing but an error has invalidated the capture sequence. The capture sequence must be terminated with **cuStreamEndCapture** on the stream where it was initiated in order to continue using hStream.

Note that, if this is called on **CU\_STREAM\_LEGACY** (the "null stream") while a blocking stream in the same context is capturing, it will return **CUDA\_ERROR\_STREAM\_CAPTURE\_IMPLICIT** and \*captureStatus is unspecified after the call. The blocking stream capture is not invalidated.

When a blocking stream is capturing, the legacy stream is in an unusable state until the blocking stream capture is terminated. The legacy stream is not supported for stream capture, but attempted use would have an implicit dependency on the capturing stream(s).



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

See also:

[cuStreamCreate](#), [cuStreamBeginCapture](#), [cuStreamEndCapture](#)

## CUresult cuStreamQuery (CUstream hStream)

Determine status of a compute stream.

### Parameters

#### hStream

- Stream to query status of

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_HANDLE](#), [CUDA\\_ERROR\\_NOT\\_READY](#)

### Description

Returns [CUDA\\_SUCCESS](#) if all operations in the stream specified by `hStream` have completed, or [CUDA\\_ERROR\\_NOT\\_READY](#) if not.

For the purposes of Unified Memory, a return value of [CUDA\\_SUCCESS](#) is equivalent to having called [cuStreamSynchronize\(\)](#).



- ▶ This function uses standard [default stream](#) semantics.
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cuStreamCreate](#), [cuStreamWaitEvent](#), [cuStreamDestroy](#), [cuStreamSynchronize](#),  
[cuStreamAddCallback](#), [cudaStreamQuery](#)

## CUresult cuStreamSetAttribute (CUstream hStream, CUstreamAttrID attr, const CUstreamAttrValue \*value)

Sets stream attribute.

### Parameters

#### hStream

#### attr

#### value

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_INVALID\_HANDLE

**Description**

Sets attribute `attr` on `hStream` from corresponding attribute of `value`. The updated attribute will be applied to subsequent work submitted to the stream. It will not affect previously submitted work.



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

**See also:**

[CUaccessPolicyWindow](#)

## CUresult cuStreamSynchronize (CUstream hStream)

Wait until a stream's tasks are completed.

**Parameters****hStream**

- Stream to wait for

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_HANDLE

**Description**

Waits until the device has completed all operations in the stream specified by `hStream`. If the context was created with the [CU\\_CTX\\_SCHED\\_BLOCKING\\_SYNC](#) flag, the CPU thread will block until the stream is finished with all of its tasks.



- ▶ This function uses standard [default stream](#) semantics.
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

**See also:**



[cuStreamCreate](#), [cuStreamDestroy](#), [cuStreamWaitEvent](#), [cuStreamQuery](#),  
[cuStreamAddCallback](#), [cudaStreamSynchronize](#)

## CUresult cuStreamWaitEvent (CUstream hStream, CUevent hEvent, unsigned int Flags)

Make a compute stream wait on an event.

### Parameters

#### hStream

- Stream to wait

#### hEvent

- Event to wait on (may not be NULL)

#### Flags

- Parameters for the operation (must be 0)

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_HANDLE](#),

### Description

Makes all future work submitted to `hStream` wait for all work captured in `hEvent`. See [cuEventRecord\(\)](#) for details on what is captured by an event. The synchronization will be performed efficiently on the device when applicable. `hEvent` may be from a different context or device than `hStream`.



- ▶ This function uses standard [default stream](#) semantics.
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cuStreamCreate](#), [cuEventRecord](#), [cuStreamQuery](#), [cuStreamSynchronize](#),  
[cuStreamAddCallback](#), [cuStreamDestroy](#), [cudaStreamWaitEvent](#)

## CUresult cuThreadExchangeStreamCaptureMode (CUstreamCaptureMode \*mode)

Swaps the stream capture interaction mode for a thread.

### Parameters

#### mode

- Pointer to mode value to swap with the current mode

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE

### Description

Sets the calling thread's stream capture interaction mode to the value contained in \*mode, and overwrites \*mode with the previous mode for the thread. To facilitate deterministic behavior across function or module boundaries, callers are encouraged to use this API in a push-pop fashion:

```
↑   CUstreamCaptureMode mode = desiredMode;
    cuThreadExchangeStreamCaptureMode(&mode);
    ...
    cuThreadExchangeStreamCaptureMode(&mode); // restore previous mode
```

During stream capture (see [cuStreamBeginCapture](#)), some actions, such as a call to [cudaMalloc](#), may be unsafe. In the case of [cudaMalloc](#), the operation is not enqueued asynchronously to a stream, and is not observed by stream capture. Therefore, if the sequence of operations captured via [cuStreamBeginCapture](#) depended on the allocation being replayed whenever the graph is launched, the captured graph would be invalid.

Therefore, stream capture places restrictions on API calls that can be made within or concurrently to a [cuStreamBeginCapture](#)-[cuStreamEndCapture](#) sequence. This behavior can be controlled via this API and flags to [cuStreamBeginCapture](#).

A thread's mode is one of the following:

- ▶ **CU\_STREAM\_CAPTURE\_MODE\_GLOBAL**: This is the default mode. If the local thread has an ongoing capture sequence that was not initiated with **CU\_STREAM\_CAPTURE\_MODE\_RELAXED** at [cuStreamBeginCapture](#), or if any other thread has a concurrent capture sequence initiated with **CU\_STREAM\_CAPTURE\_MODE\_GLOBAL**, this thread is prohibited from potentially unsafe API calls.
- ▶ **CU\_STREAM\_CAPTURE\_MODE\_THREAD\_LOCAL**: If the local thread has an ongoing capture sequence not initiated with **CU\_STREAM\_CAPTURE\_MODE\_RELAXED**, it is prohibited from potentially unsafe API calls. Concurrent capture sequences in other threads are ignored.

- ▶ `CU_STREAM_CAPTURE_MODE_RELAXED`: The local thread is not prohibited from potentially unsafe API calls. Note that the thread is still prohibited from API calls which necessarily conflict with stream capture, for example, attempting `cuEventQuery` on an event that was last recorded inside a capture sequence.



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

See also:

`cuStreamBeginCapture`

## 5.15. Event Management

This section describes the event management functions of the low-level CUDA driver application programming interface.

### `CUresult cuEventCreate (CUevent *phEvent, unsigned int Flags)`

Creates an event.

#### Parameters

##### **phEvent**

- Returns newly created event

##### **Flags**

- Event creation flags

#### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_OUT_OF_MEMORY`

#### Description

Creates an event `*phEvent` for the current context with the flags specified via `Flags`. Valid flags include:

- ▶ `CU_EVENT_DEFAULT`: Default event creation flag.
- ▶ `CU_EVENT_BLOCKING_SYNC`: Specifies that the created event should use blocking synchronization. A CPU thread that uses `cuEventSynchronize()` to wait on an event created with this flag will block until the event has actually been recorded.

- ▶ **CU\_EVENT\_DISABLE\_TIMING**: Specifies that the created event does not need to record timing data. Events created with this flag specified and the **CU\_EVENT\_BLOCKING\_SYNC** flag not specified will provide the best performance when used with `cuStreamWaitEvent()` and `cuEventQuery()`.
- ▶ **CU\_EVENT\_INTERPROCESS**: Specifies that the created event may be used as an interprocess event by `cuIpcGetEventHandle()`. **CU\_EVENT\_INTERPROCESS** must be specified along with **CU\_EVENT\_DISABLE\_TIMING**.



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

#### See also:

`cuEventRecord`, `cuEventQuery`, `cuEventSynchronize`, `cuEventDestroy`, `cuEventElapsedTime`, `cudaEventCreate`, `cudaEventCreateWithFlags`

## CUresult cuEventDestroy (CUevent hEvent)

Destroys an event.

### Parameters

#### hEvent

- Event to destroy

### Returns

**CUDA\_SUCCESS**, **CUDA\_ERROR\_DEINITIALIZED**,  
**CUDA\_ERROR\_NOT\_INITIALIZED**, **CUDA\_ERROR\_INVALID\_CONTEXT**,  
**CUDA\_ERROR\_INVALID\_HANDLE**

### Description

Destroys the event specified by `hEvent`.

An event may be destroyed before it is complete (i.e., while `cuEventQuery()` would return **CUDA\_ERROR\_NOT\_READY**). In this case, the call does not block on completion of the event, and any associated resources will automatically be released asynchronously at completion.



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

#### See also:

`cuEventCreate`, `cuEventRecord`, `cuEventQuery`, `cuEventSynchronize`,  
`cuEventElapsedTime`, `cudaEventDestroy`

## CUresult cuEventElapsedTime (float \*pMilliseconds, CUevent hStart, CUevent hEnd)

Computes the elapsed time between two events.

### Parameters

#### **pMilliseconds**

- Time between `hStart` and `hEnd` in ms

#### **hStart**

- Starting event

#### **hEnd**

- Ending event

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_HANDLE`, `CUDA_ERROR_NOT_READY`

### 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 `cuEventRecord()` 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 `cuEventRecord()` has not been called on either event then `CUDA_ERROR_INVALID_HANDLE` is returned. If `cuEventRecord()` has been called on both events but one or both of them has not yet been completed (that is, `cuEventQuery()` would return `CUDA_ERROR_NOT_READY` on at least one of the events), `CUDA_ERROR_NOT_READY` is returned. If either event was created with the `CU_EVENT_DISABLE_TIMING` flag, then this function will return `CUDA_ERROR_INVALID_HANDLE`.



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

**See also:**

[cuEventCreate](#), [cuEventRecord](#), [cuEventQuery](#), [cuEventSynchronize](#), [cuEventDestroy](#), [cudaEventElapsedTime](#)

## CUresult cuEventQuery (CUevent hEvent)

Queries an event's status.

**Parameters****hEvent**

- Event to query

**Returns**

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_HANDLE](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#), [CUDA\\_ERROR\\_NOT\\_READY](#)

**Description**

Queries the status of all work currently captured by `hEvent`. See [cuEventRecord\(\)](#) for details on what is captured by an event.

Returns [CUDA\\_SUCCESS](#) if all captured work has been completed, or [CUDA\\_ERROR\\_NOT\\_READY](#) if any captured work is incomplete.

For the purposes of Unified Memory, a return value of [CUDA\\_SUCCESS](#) is equivalent to having called [cuEventSynchronize\(\)](#).



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

**See also:**

[cuEventCreate](#), [cuEventRecord](#), [cuEventSynchronize](#), [cuEventDestroy](#),  
[cuEventElapsedTime](#), [cudaEventQuery](#)

## CUresult cuEventRecord (CUevent hEvent, CUstream hStream)

Records an event.

### Parameters

#### hEvent

- Event to record

#### hStream

- Stream to record event for

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_INVALID\_VALUE

### Description

Captures in `hEvent` the contents of `hStream` at the time of this call. `hEvent` and `hStream` must be from the same context. Calls such as `cuEventQuery()` or `cuStreamWaitEvent()` will then examine or wait for completion of the work that was captured. Uses of `hStream` after this call do not modify `hEvent`. See note on default stream behavior for what is captured in the default case.

`cuEventRecord()` can be called multiple times on the same event and will overwrite the previously captured state. Other APIs such as `cuStreamWaitEvent()` use the most recently captured state at the time of the API call, and are not affected by later calls to `cuEventRecord()`. Before the first call to `cuEventRecord()`, an event represents an empty set of work, so for example `cuEventQuery()` would return `CUDA_SUCCESS`.



- ▶ This function uses standard [default stream](#) semantics.
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

### See also:

`cuEventCreate`, `cuEventQuery`, `cuEventSynchronize`, `cuStreamWaitEvent`,  
`cuEventDestroy`, `cuEventElapsedTime`, `cudaEventRecord`

## CUresult cuEventSynchronize (CUevent hEvent)

Waits for an event to complete.

### Parameters

#### hEvent

- Event to wait for

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_HANDLE

### Description

Waits until the completion of all work currently captured in hEvent. See [cuEventRecord\(\)](#) for details on what is captured by an event.

Waiting for an event that was created with the [CU\\_EVENT\\_BLOCKING\\_SYNC](#) flag will cause the calling CPU thread to block until the event has been completed by the device. If the [CU\\_EVENT\\_BLOCKING\\_SYNC](#) 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:

[cuEventCreate](#), [cuEventRecord](#), [cuEventQuery](#), [cuEventDestroy](#), [cuEventElapsedTime](#), [cudaEventSynchronize](#)

## 5.16. External Resource Interoperability

This section describes the external resource interoperability functions of the low-level CUDA driver application programming interface.



## CUresult cuDestroyExternalMemory (CUexternalMemory extMem)

Destroys an external memory object.

### Parameters

#### extMem

- External memory object to be destroyed

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_NOT\_INITIALIZED,  
CUDA\_ERROR\_INVALID\_HANDLE

### Description

Destroys the specified external memory object. Any existing buffers and CUDA mipmapped arrays mapped onto this object must no longer be used and must be explicitly freed using [cuMemFree](#) and [cuMipmappedArrayDestroy](#) respectively.



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

### See also:

[cuImportExternalMemory](#) [cuExternalMemoryGetMappedBuffer](#),  
[cuExternalMemoryGetMappedMipmappedArray](#)

## CUresult cuDestroyExternalSemaphore (CUexternalSemaphore extSem)

Destroys an external semaphore.

### Parameters

#### extSem

- External semaphore to be destroyed

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_NOT\_INITIALIZED,  
CUDA\_ERROR\_INVALID\_HANDLE

## Description

Destroys an external semaphore object and releases any references to the underlying resource. Any outstanding signals or waits must have completed before the semaphore is destroyed.



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

## See also:

[cuImportExternalSemaphore](#), [cuSignalExternalSemaphoresAsync](#),  
[cuWaitExternalSemaphoresAsync](#)

## CUresult cuExternalMemoryGetMappedBuffer (CUdeviceptr \*devPtr, CUexternalMemory extMem, const CUDA\_EXTERNAL\_MEMORY\_BUFFER\_DESC \*bufferDesc)

Maps a buffer onto an imported memory object.

## Parameters

### devPtr

- Returned device pointer to buffer

### extMem

- Handle to external memory object

### bufferDesc

- Buffer descriptor

## Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_NOT\\_INITIALIZED](#),  
[CUDA\\_ERROR\\_INVALID\\_HANDLE](#)

## Description

Maps a buffer onto an imported memory object and returns a device pointer in `devPtr`.

The properties of the buffer being mapped must be described in `bufferDesc`. The [CUDA\\_EXTERNAL\\_MEMORY\\_BUFFER\\_DESC](#) structure is defined as follows:

```
↑ typedef struct CUDA_EXTERNAL_MEMORY_BUFFER_DESC_st {
    unsigned long long offset;
    unsigned long long size;
    unsigned int flags;
} CUDA_EXTERNAL_MEMORY_BUFFER_DESC;
```

where `CUDA_EXTERNAL_MEMORY_BUFFER_DESC::offset` is the offset in the memory object where the buffer's base address is. `CUDA_EXTERNAL_MEMORY_BUFFER_DESC::size` is the size of the buffer. `CUDA_EXTERNAL_MEMORY_BUFFER_DESC::flags` must be zero.

The offset and size have to be suitably aligned to match the requirements of the external API. Mapping two buffers whose ranges overlap may or may not result in the same virtual address being returned for the overlapped portion. In such cases, the application must ensure that all accesses to that region from the GPU are volatile. Otherwise writes made via one address are not guaranteed to be visible via the other address, even if they're issued by the same thread. It is recommended that applications map the combined range instead of mapping separate buffers and then apply the appropriate offsets to the returned pointer to derive the individual buffers.

The returned pointer `devPtr` must be freed using `cuMemFree`.



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

See also:

`cuImportExternalMemory` `cuDestroyExternalMemory`,  
`cuExternalMemoryGetMappedMipmappedArray`

```
CUresult cuExternalMemoryGetMappedMipmappedArray(
    CUmipmappedArray *mipmap,
    CUexternalMemory extMem, const
    CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC
    *mipmapDesc)
```

Maps a CUDA mipmapped array onto an external memory object.

#### Parameters

##### **mipmap**

- Returned CUDA mipmapped array

##### **extMem**

- Handle to external memory object

##### **mipmapDesc**

- CUDA array descriptor

## Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_NOT\\_INITIALIZED](#),  
[CUDA\\_ERROR\\_INVALID\\_HANDLE](#)

## Description

Maps a CUDA mipmapped array onto an external object and returns a handle to it in `mipmap`.

The properties of the CUDA mipmapped array being mapped must be described in `mipmapDesc`. The structure [CUDA\\_EXTERNAL\\_MEMORY\\_MIPMAPPED\\_ARRAY\\_DESC](#) is defined as follows:

```
typedef struct CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC_st {
    unsigned long long offset;
    CUDA_ARRAY3D_DESCRIPTOR arrayDesc;
    unsigned int numLevels;
} CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC;
```

where [CUDA\\_EXTERNAL\\_MEMORY\\_MIPMAPPED\\_ARRAY\\_DESC::offset](#) is the offset in the memory object where the base level of the mipmap chain is. [CUDA\\_EXTERNAL\\_MEMORY\\_MIPMAPPED\\_ARRAY\\_DESC::arrayDesc](#) describes the format, dimensions and type of the base level of the mipmap chain. For further details on these parameters, please refer to the documentation for [cuMipmappedArrayCreate](#). Note that if the mipmapped array is bound as a color target in the graphics API, then the flag [CUDA\\_ARRAY3D\\_COLOR\\_ATTACHMENT](#) must be specified in [CUDA\\_EXTERNAL\\_MEMORY\\_MIPMAPPED\\_ARRAY\\_DESC::arrayDesc::Flags](#). [CUDA\\_EXTERNAL\\_MEMORY\\_MIPMAPPED\\_ARRAY\\_DESC::numLevels](#) specifies the total number of levels in the mipmap chain.

If `extMem` was imported from a handle of type [CU\\_EXTERNAL\\_MEMORY\\_HANDLE\\_TYPE\\_NVSCIBUF](#), then [CUDA\\_EXTERNAL\\_MEMORY\\_MIPMAPPED\\_ARRAY\\_DESC::numLevels](#) must be equal to 1.

The returned CUDA mipmapped array must be freed using [cuMipmappedArrayDestroy](#).



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

## See also:

[cuImportExternalMemory](#) [cuDestroyExternalMemory](#),  
[cuExternalMemoryGetMappedBuffer](#)

## CUresult culImportExternalMemory (CUexternalMemory \*extMem\_out, const CUDA\_EXTERNAL\_MEMORY\_HANDLE\_DESC \*memHandleDesc)

Imports an external memory object.

### Parameters

#### extMem\_out

- Returned handle to an external memory object

#### memHandleDesc

- Memory import handle descriptor

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_NOT\_INITIALIZED,  
CUDA\_ERROR\_INVALID\_HANDLE

### Description

Imports an externally allocated memory object and returns a handle to that in extMem\_out.

The properties of the handle being imported must be described in memHandleDesc. The CUDA\_EXTERNAL\_MEMORY\_HANDLE\_DESC structure is defined as follows:

```
↑ typedef struct CUDA_EXTERNAL_MEMORY_HANDLE_DESC_st {
    CUexternalMemoryHandleType type;
    union {
        int fd;
        struct {
            void *handle;
            const void *name;
        } win32;
        const void *nvSciBufObject;
    } handle;
    unsigned long long size;
    unsigned int flags;
} CUDA_EXTERNAL_MEMORY_HANDLE_DESC;
```

where CUDA\_EXTERNAL\_MEMORY\_HANDLE\_DESC::type specifies the type of handle being imported. CUexternalMemoryHandleType is defined as:

```
↑ typedef enum CUexternalMemoryHandleType_enum {
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_FD           = 1,
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_WIN32       = 2,
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_WIN32_KMT   = 3,
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D12_HEAP         = 4,
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D12_RESOURCE     = 5,
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE     = 6,
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE_KMT = 7,
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_NVSCIBUF           = 8
} CUexternalMemoryHandleType;
```

If `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type` is `CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_FD`, then `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::fd` must be a valid file descriptor referencing a memory object. Ownership of the file descriptor is transferred to the CUDA driver when the handle is imported successfully. Performing any operations on the file descriptor after it is imported results in undefined behavior.

If `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type` is `CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_WIN32`, then exactly one of `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle` and `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name` must not be NULL. If `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle` is not NULL, then it must represent a valid shared NT handle that references a memory object. Ownership of this handle is not transferred to CUDA after the import operation, so the application must release the handle using the appropriate system call. If `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name` is not NULL, then it must point to a NULL-terminated array of UTF-16 characters that refers to a memory object.

If `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type` is `CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_WIN32_KMT`, then `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle` must be non-NULL and `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name` must be NULL. The handle specified must be a globally shared KMT handle. This handle does not hold a reference to the underlying object, and thus will be invalid when all references to the memory object are destroyed.

If `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type` is `CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D12_HEAP`, then exactly one of `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle` and `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name` must not be NULL. If `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle` is not NULL, then it must represent a valid shared NT handle that is returned by `ID3D12Device::CreateSharedHandle` when referring to a `ID3D12Heap` object. This handle holds a reference to the underlying object. If `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name` is not NULL, then it must point to a NULL-terminated array of UTF-16 characters that refers to a `ID3D12Heap` object.

If `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type` is `CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D12_RESOURCE`, then exactly one of `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle` and `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name` must not be NULL. If `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle` is not NULL, then it must represent a valid shared NT handle that is returned by `ID3D12Device::CreateSharedHandle` when referring to a

ID3D12Resource object. This handle holds a reference to the underlying object. If `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name` is not NULL, then it must point to a NULL-terminated array of UTF-16 characters that refers to a ID3D12Resource object.

If `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type` is `CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE`, then `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle` must represent a valid shared NT handle that is returned by `IDXGIResource1::CreateSharedHandle` when referring to a ID3D11Resource object. If `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name` is not NULL, then it must point to a NULL-terminated array of UTF-16 characters that refers to a ID3D11Resource object.

If `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type` is `CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE_KMT`, then `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle` must represent a valid shared KMT handle that is returned by `IDXGIResource::GetSharedHandle` when referring to a ID3D11Resource object and `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name` must be NULL.

If `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type` is `CU_EXTERNAL_MEMORY_HANDLE_TYPE_NVSCIBUF`, then `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::nvSciBufObject` must be non-NULL and reference a valid NvSciBuf object. If the NvSciBuf object imported into CUDA is also mapped by other drivers, then the application must use `cuWaitExternalSemaphoresAsync` or `cuSignalExternalSemaphoresAsync` as appropriate barriers to maintain coherence between CUDA and the other drivers.

The size of the memory object must be specified in `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::size`.

Specifying the flag `CUDA_EXTERNAL_MEMORY_DEDICATED` in `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::flags` indicates that the resource is a dedicated resource. The definition of what a dedicated resource is outside the scope of this extension. This flag must be set if `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type` is one of the following: `CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D12_RESOURCE`, `CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE`, `CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE_KMT`.



- Note that this function may also return error codes from previous, asynchronous launches.
- If the Vulkan memory imported into CUDA is mapped on the CPU then the application must use `vkInvalidateMappedMemoryRanges/`

vkFlushMappedMemoryRanges as well as appropriate Vulkan pipeline barriers to maintain coherence between CPU and GPU. For more information on these APIs, please refer to "Synchronization and Cache Control" chapter from Vulkan specification.

#### See also:

[cuDestroyExternalMemory](#), [cuExternalMemoryGetMappedBuffer](#),  
[cuExternalMemoryGetMappedMipmappedArray](#)

## CUresult culImportExternalSemaphore (CUexternalSemaphore \*extSem\_out, const CUDA\_EXTERNAL\_SEMAPHORE\_HANDLE\_DESC \*semHandleDesc)

Imports an external semaphore.

#### Parameters

##### extSem\_out

- Returned handle to an external semaphore

##### semHandleDesc

- Semaphore import handle descriptor

#### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_NOT\\_INITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_SUPPORTED](#), [CUDA\\_ERROR\\_INVALID\\_HANDLE](#)

#### Description

Imports an externally allocated synchronization object and returns a handle to that in `extSem_out`.

The properties of the handle being imported must be described in `semHandleDesc`. The [CUDA\\_EXTERNAL\\_SEMAPHORE\\_HANDLE\\_DESC](#) is defined as follows:

```
typedef struct CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC_st {
    CUexternalSemaphoreHandleType type;
    union {
        int fd;
        struct {
            void *handle;
            const void *name;
        } win32;
        const void* NvSciSyncObj;
    } handle;
    unsigned int flags;
} CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC;
```



where `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type` specifies the type of handle being imported. `CUexternalSemaphoreHandleType` is defined as:

```
typedef enum CUexternalSemaphoreHandleType_enum {
    CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_FD           = 1,
    CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32        = 2,
    CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32_KMT     = 3,
    CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D12_FENCE         = 4,
    CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_FENCE         = 5,
    CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC           = 6,
    CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX    = 7,
    CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX_KMT = 8
} CUexternalSemaphoreHandleType;
```

If `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type` is `CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_FD`, then `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::fd` must be a valid file descriptor referencing a synchronization object. Ownership of the file descriptor is transferred to the CUDA driver when the handle is imported successfully. Performing any operations on the file descriptor after it is imported results in undefined behavior.

If `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type` is `CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32`, then exactly one of `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle` and `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name` must not be NULL. If `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle` is not NULL, then it must represent a valid shared NT handle that references a synchronization object. Ownership of this handle is not transferred to CUDA after the import operation, so the application must release the handle using the appropriate system call. If `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name` is not NULL, then it must name a valid synchronization object.

If `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type` is `CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32_KMT`, then `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle` must be non-NULL and `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name` must be NULL. The handle specified must be a globally shared KMT handle. This handle does not hold a reference to the underlying object, and thus will be invalid when all references to the synchronization object are destroyed.

If `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type` is `CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D12_FENCE`, then exactly one of `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle` and `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name` must not be NULL. If `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle` is not NULL, then it must represent a valid shared NT handle that is returned by `ID3D12Device::CreateSharedHandle` when referring to a `ID3D12Fence` object. This handle holds a reference to the underlying object. If

`CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name` is not NULL, then it must name a valid synchronization object that refers to a valid `ID3D12Fence` object.

If `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type` is `CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_FENCE`, then `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle` represents a valid shared NT handle that is returned by `ID3D11Fence::CreateSharedHandle`. If `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name` is not NULL, then it must name a valid synchronization object that refers to a valid `ID3D11Fence` object.

If `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type` is `CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC`, then `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::nvSciSyncObj` represents a valid `NvSciSyncObj`.

`CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX`, then `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle` represents a valid shared NT handle that is returned by `IDXGIResource1::CreateSharedHandle` when referring to a `IDXGIKeyedMutex` object. If `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name` is not NULL, then it must name a valid synchronization object that refers to a valid `IDXGIKeyedMutex` object.

If `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type` is `CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX_KMT`, then `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle` represents a valid shared KMT handle that is returned by `IDXGIResource::GetSharedHandle` when referring to a `IDXGIKeyedMutex` object and `CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name` must be NULL.



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

#### See also:

`cuDestroyExternalSemaphore`, `cuSignalExternalSemaphoresAsync`,  
`cuWaitExternalSemaphoresAsync`

## CUresult cuSignalExternalSemaphoresAsync (const CUexternalSemaphore \*extSemArray, const

## CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_PARAMS \*paramsArray, unsigned int numExtSems, CUstream stream)

Signals a set of external semaphore objects.

### Parameters

#### extSemArray

- Set of external semaphores to be signaled

#### paramsArray

- Array of semaphore parameters

#### numExtSems

- Number of semaphores to signal

#### stream

- Stream to enqueue the signal operations in

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_NOT\_INITIALIZED,  
CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_NOT\_SUPPORTED

### Description

Enqueues a signal operation on a set of externally allocated semaphore object in the specified stream. The operations will be executed when all prior operations in the stream complete.

The exact semantics of signaling a semaphore depends on the type of the object.

If the semaphore object is any one of the following types:

CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_OPAQUE\_FD,  
CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_OPAQUE\_WIN32,  
CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_OPAQUE\_WIN32\_KMT then  
signaling the semaphore will set it to the signaled state.

If the semaphore object is any one of the following types:

CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_D3D12\_FENCE,  
CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_D3D11\_FENCE  
then the semaphore will be set to the value specified in  
CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_PARAMS::params::fence::value.

If the semaphore object is of the type

CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_NVSCISYNC this API sets  
CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_PARAMS::params::nvSciSync::fence  
to a value that can be used by subsequent waiters of the same  
NvSciSync object to order operations with those currently submitted

in `stream`. Such an update will overwrite previous contents of `CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS::params::nvSciSync::fence`. By default, signaling such an external semaphore object causes appropriate memory synchronization operations to be performed over all external memory objects that are imported as `CU_EXTERNAL_MEMORY_HANDLE_TYPE_NVSCIBUF`. This ensures that any subsequent accesses made by other importers of the same set of `NvSciBuf` memory object(s) are coherent. These operations can be skipped by specifying the flag `CUDA_EXTERNAL_SEMAPHORE_SIGNAL_SKIP_NVSCIBUF_MEMSYNC`, which can be used as a performance optimization when data coherency is not required. But specifying this flag in scenarios where data coherency is required results in undefined behavior. Also, for semaphore object of the type `CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC`, if the `NvSciSyncAttrList` used to create the `NvSciSyncObj` had not set the flags in `cuDeviceGetNvSciSyncAttributes` to `CUDA_NVSCISYNC_ATTR_SIGNAL`, this API will return `CUDA_ERROR_NOT_SUPPORTED`.

If the semaphore object is any one of the following types:  
`CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX`,  
`CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX_KMT`  
 then the keyed mutex will be released with the key specified in `CUDA_EXTERNAL_SEMAPHORE_PARAMS::params::keyedmutex::key`.



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

#### See also:

`cuImportExternalSemaphore`, `cuDestroyExternalSemaphore`,  
`cuWaitExternalSemaphoresAsync`

**CUresult cuWaitExternalSemaphoresAsync (const CUexternalSemaphore \*extSemArray, const CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_PARAMS \*paramsArray, unsigned int numExtSems, CUstream stream)**

Waits on a set of external semaphore objects.

#### Parameters

##### **extSemArray**

- External semaphores to be waited on

**paramsArray**

- Array of semaphore parameters

**numExtSems**

- Number of semaphores to wait on

**stream**

- Stream to enqueue the wait operations in

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_NOT\_INITIALIZED,  
 CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_NOT\_SUPPORTED,  
 CUDA\_ERROR\_TIMEOUT

**Description**

Enqueues a wait operation on a set of externally allocated semaphore object in the specified stream. The operations will be executed when all prior operations in the stream complete.

The exact semantics of waiting on a semaphore depends on the type of the object.

If the semaphore object is any one of the following types:

CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_OPAQUE\_FD,  
 CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_OPAQUE\_WIN32,  
 CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_OPAQUE\_WIN32\_KMT then  
 waiting on the semaphore will wait until the semaphore reaches the signaled state.  
 The semaphore will then be reset to the unsignaled state. Therefore for every signal  
 operation, there can only be one wait operation.

If the semaphore object is any one of the following types:

CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_D3D12\_FENCE,  
 CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_D3D11\_FENCE then waiting on  
 the semaphore will wait until the value of the semaphore is greater than or equal to  
 CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_PARAMS::params::fence::value.

If the semaphore object is of the type

CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_NVSCISYNC

then, waiting on the semaphore will wait until the  
 CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_PARAMS::params::nvSciSync::fence is  
 signaled by the signaler of the NvSciSyncObj that was associated with this semaphore  
 object. By default, waiting on such an external semaphore object causes appropriate  
 memory synchronization operations to be performed over all external memory objects  
 that are imported as CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_NVSCIBUF. This  
 ensures that any subsequent accesses made by other importers of the same set of  
 NvSciBuf memory object(s) are coherent. These operations can be skipped by specifying  
 the flag CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_SKIP\_NVSCIBUF\_MEMSYNC,  
 which can be used as a performance optimization when data coherency is

not required. But specifying this flag in scenarios where data coherency is required results in undefined behavior. Also, for semaphore object of the type `CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC`, if the `NvSciSyncAttrList` used to create the `NvSciSyncObj` had not set the flags in `cuDeviceGetNvSciSyncAttributes` to `CUDA_NVSCISYNC_ATTR_WAIT`, this API will return `CUDA_ERROR_NOT_SUPPORTED`.

If the semaphore object is any one of the following types:  
`CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX`,  
`CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX_KMT`  
 then the keyed mutex will be acquired when it is released with the key specified in `CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS::params::keyedmutex::key` or until the timeout specified by `CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS::params::keyedmutex::timeoutMs` has lapsed. The timeout interval can either be a finite value specified in milliseconds or an infinite value. In case an infinite value is specified the timeout never elapses. The windows `INFINITE` macro must be used to specify infinite timeout.



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

**See also:**

`cuImportExternalSemaphore`, `cuDestroyExternalSemaphore`,  
`cuSignalExternalSemaphoresAsync`

## 5.17. Stream memory operations

This section describes the stream memory operations of the low-level CUDA driver application programming interface.

The whole set of operations is disabled by default. Users are required to explicitly enable them, e.g. on Linux by passing the kernel module parameter shown below: `modprobe nvidia NVreg_EnableStreamMemOps=1` There is currently no way to enable these operations on other operating systems.

Users can programmatically query whether the device supports these operations with `cuDeviceGetAttribute()` and `CU_DEVICE_ATTRIBUTE_CAN_USE_STREAM_MEM_OPS`.

Support for the `CU_STREAM_WAIT_VALUE_NOR` flag can be queried with `CU_DEVICE_ATTRIBUTE_CAN_USE_STREAM_WAIT_VALUE_NOR`.

Support for the `cuStreamWriteValue64()` and `cuStreamWaitValue64()` functions, as well as for the `CU_STREAM_MEM_OP_WAIT_VALUE_64` and `CU_STREAM_MEM_OP_WRITE_VALUE_64` flags, can be queried with `CU_DEVICE_ATTRIBUTE_CAN_USE_64_BIT_STREAM_MEM_OPS`.

Support for both `CU_STREAM_WAIT_VALUE_FLUSH` and `CU_STREAM_MEM_OP_FLUSH_REMOTE_WRITES` requires dedicated platform hardware features and can be queried with `cuDeviceGetAttribute()` and `CU_DEVICE_ATTRIBUTE_CAN_FLUSH_REMOTE_WRITES`.

Note that all memory pointers passed as parameters to these operations are device pointers. Where necessary a device pointer should be obtained, for example with `cuMemHostGetDevicePointer()`.

None of the operations accepts pointers to managed memory buffers (`cuMemAllocManaged`).

## **CUresult cuStreamBatchMemOp (CUstream stream, unsigned int count, CUstreamBatchMemOpParams \*paramArray, unsigned int flags)**

Batch operations to synchronize the stream via memory operations.

### **Parameters**

#### **stream**

The stream to enqueue the operations in.

#### **count**

The number of operations in the array. Must be less than 256.

#### **paramArray**

The types and parameters of the individual operations.

#### **flags**

Reserved for future expansion; must be 0.

### **Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_VALUE`,  
`CUDA_ERROR_NOT_SUPPORTED`

### **Description**

This is a batch version of `cuStreamWaitValue32()` and `cuStreamWriteValue32()`. Batching operations may avoid some performance overhead in both the API call and the device execution versus adding them to the stream in separate API calls. The operations are enqueued in the order they appear in the array.



See `CUstreamBatchMemOpType` for the full set of supported operations, and `cuStreamWaitValue32()`, `cuStreamWaitValue64()`, `cuStreamWriteValue32()`, and `cuStreamWriteValue64()` for details of specific operations.

Basic support for this can be queried with `cuDeviceGetAttribute()` and `CU_DEVICE_ATTRIBUTE_CAN_USE_STREAM_MEM_OPS`. See related APIs for details on querying support for specific operations.



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

See also:

`cuStreamWaitValue32`, `cuStreamWaitValue64`, `cuStreamWriteValue32`, `cuStreamWriteValue64`, `cuMemHostRegister`

## CUresult cuStreamWaitValue32 (CUstream stream, CUdeviceptr addr, cuuint32\_t value, unsigned int flags)

Wait on a memory location.

### Parameters

#### **stream**

The stream to synchronize on the memory location.

#### **addr**

The memory location to wait on.

#### **value**

The value to compare with the memory location.

#### **flags**

See `CUstreamWaitValue_flags`.

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_NOT_SUPPORTED`

### Description

Enqueues a synchronization of the stream on the given memory location. Work ordered after the operation will block until the given condition on the memory is satisfied. By default, the condition is to wait for  $(\text{int32\_t})(*\text{addr} - \text{value}) \geq 0$ , a cyclic greater-or-equal. Other condition types can be specified via `flags`.



If the memory was registered via `cuMemHostRegister()`, the device pointer should be obtained with `cuMemHostGetDevicePointer()`. This function cannot be used with managed memory (`cuMemAllocManaged`).

Support for this can be queried with `cuDeviceGetAttribute()` and `CU_DEVICE_ATTRIBUTE_CAN_USE_STREAM_MEM_OPS`.

Support for `CU_STREAM_WAIT_VALUE_NOR` can be queried with `cuDeviceGetAttribute()` and `CU_DEVICE_ATTRIBUTE_CAN_USE_STREAM_WAIT_VALUE_NOR`.



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

See also:

`cuStreamWaitValue64`, `cuStreamWriteValue32`, `cuStreamWriteValue64`  
`cuStreamBatchMemOp`, `cuMemHostRegister`, `cuStreamWaitEvent`

## CUresult cuStreamWaitValue64 (CUstream stream, CUdeviceptr addr, cuuint64\_t value, unsigned int flags)

Wait on a memory location.

### Parameters

#### stream

The stream to synchronize on the memory location.

#### addr

The memory location to wait on.

#### value

The value to compare with the memory location.

#### flags

See `CUstreamWaitValue_flags`.

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_VALUE`,  
`CUDA_ERROR_NOT_SUPPORTED`

### Description

Enqueues a synchronization of the stream on the given memory location. Work ordered after the operation will block until the given condition on the memory is satisfied. By

default, the condition is to wait for  $(\text{int64\_t})(*\text{addr} - \text{value}) \geq 0$ , a cyclic greater-or-equal. Other condition types can be specified via `flags`.

If the memory was registered via `cuMemHostRegister()`, the device pointer should be obtained with `cuMemHostGetDevicePointer()`.

Support for this can be queried with `cuDeviceGetAttribute()` and `CU_DEVICE_ATTRIBUTE_CAN_USE_64_BIT_STREAM_MEM_OPS`.



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

See also:

`cuStreamWaitValue32`, `cuStreamWriteValue32`, `cuStreamWriteValue64`,  
`cuStreamBatchMemOp`, `cuMemHostRegister`, `cuStreamWaitEvent`

## CUresult cuStreamWriteValue32 (CUstream stream, CUdeviceptr addr, cuuint32\_t value, unsigned int flags)

Write a value to memory.

### Parameters

#### **stream**

The stream to do the write in.

#### **addr**

The device address to write to.

#### **value**

The value to write.

#### **flags**

See `CUstreamWriteValue_flags`.

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_VALUE`,  
`CUDA_ERROR_NOT_SUPPORTED`

### Description

Write a value to memory. Unless the `CU_STREAM_WRITE_VALUE_NO_MEMORY_BARRIER` flag is passed, the write is preceded by a system-wide memory fence, equivalent to a `__threadfence_system()` but scoped to the stream rather than a CUDA thread.

If the memory was registered via `cuMemHostRegister()`, the device pointer should be obtained with `cuMemHostGetDevicePointer()`. This function cannot be used with managed memory (`cuMemAllocManaged`).

Support for this can be queried with `cuDeviceGetAttribute()` and `CU_DEVICE_ATTRIBUTE_CAN_USE_STREAM_MEM_OPS`.



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

#### See also:

`cuStreamWriteValue64`, `cuStreamWaitValue32`, `cuStreamWaitValue64`, `cuStreamBatchMemOp`, `cuMemHostRegister`, `cuEventRecord`

## CUresult cuStreamWriteValue64 (CUstream stream, CUdeviceptr addr, cuuint64\_t value, unsigned int flags)

Write a value to memory.

### Parameters

#### **stream**

The stream to do the write in.

#### **addr**

The device address to write to.

#### **value**

The value to write.

#### **flags**

See `CUstreamWriteValue_flags`.

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_NOT_SUPPORTED`

### Description

Write a value to memory. Unless the `CU_STREAM_WRITE_VALUE_NO_MEMORY_BARRIER` flag is passed, the write is preceded by a system-wide memory fence, equivalent to a `__threadfence_system()` but scoped to the stream rather than a CUDA thread.

If the memory was registered via `cuMemHostRegister()`, the device pointer should be obtained with `cuMemHostGetDevicePointer()`.

Support for this can be queried with `cuDeviceGetAttribute()` and `CU_DEVICE_ATTRIBUTE_CAN_USE_64_BIT_STREAM_MEM_OPS`.



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

See also:

`cuStreamWriteValue32`, `cuStreamWaitValue32`, `cuStreamWaitValue64`,  
`cuStreamBatchMemOp`, `cuMemHostRegister`, `cuEventRecord`

## 5.18. Execution Control

This section describes the execution control functions of the low-level CUDA driver application programming interface.

### `CUresult cuFuncGetAttribute (int *pi, CUfunction_attribute attrib, CUfunction hfunc)`

Returns information about a function.

#### Parameters

**pi**

- Returned attribute value

**attrib**

- Attribute requested

**hfunc**

- Function to query attribute of

#### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_HANDLE`, `CUDA_ERROR_INVALID_VALUE`

#### Description

Returns in `*pi` the integer value of the attribute `attrib` on the kernel given by `hfunc`. The supported attributes are:

- `CU_FUNC_ATTRIBUTE_MAX_THREADS_PER_BLOCK`: 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.

- ▶ **CU\_FUNC\_ATTRIBUTE\_SHARED\_SIZE\_BYTES**: 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.
- ▶ **CU\_FUNC\_ATTRIBUTE\_CONST\_SIZE\_BYTES**: The size in bytes of user-allocated constant memory required by this function.
- ▶ **CU\_FUNC\_ATTRIBUTE\_LOCAL\_SIZE\_BYTES**: The size in bytes of local memory used by each thread of this function.
- ▶ **CU\_FUNC\_ATTRIBUTE\_NUM\_REGS**: The number of registers used by each thread of this function.
- ▶ **CU\_FUNC\_ATTRIBUTE\_PTX\_VERSION**: 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. Note that this may return the undefined value of 0 for cubins compiled prior to CUDA 3.0.
- ▶ **CU\_FUNC\_ATTRIBUTE\_BINARY\_VERSION**: 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. Note that this will return a value of 10 for legacy cubins that do not have a properly-encoded binary architecture version.
- ▶ **CU\_FUNC\_CACHE\_MODE\_CA**: The attribute to indicate whether the function has been compiled with user specified option "-Xptxas --dlcm=ca" set .
- ▶ **CU\_FUNC\_ATTRIBUTE\_MAX\_DYNAMIC\_SHARED\_SIZE\_BYTES**: The maximum size in bytes of dynamically-allocated shared memory.
- ▶ **CU\_FUNC\_ATTRIBUTE\_PREFERRED\_SHARED\_MEMORY\_CARVEOUT**: Preferred shared memory-L1 cache split ratio in percent of total shared memory.



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

#### See also:

[cuCtxGetCacheConfig](#), [cuCtxSetCacheConfig](#), [cuFuncSetCacheConfig](#), [cuLaunchKernel](#), [cudaFuncGetAttributes](#) [cudaFuncSetAttribute](#)

## CUresult cuFuncSetAttribute (CUfunction hfunc, CUfunction\_attribute attrib, int value)

Sets information about a function.

### Parameters

#### **hfunc**

- Function to query attribute of

#### **attrib**

- Attribute requested

#### **value**

- The value to set

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_INVALID\_VALUE

### Description

This call sets the value of a specified attribute `attrib` on the kernel given by `hfunc` to an integer value specified by `val`. This function returns `CUDA_SUCCESS` if the new value of the attribute could be successfully set. If the set fails, this call will return an error. Not all attributes can have values set. Attempting to set a value on a read-only attribute will result in an error (`CUDA_ERROR_INVALID_VALUE`).

Supported attributes for the `cuFuncSetAttribute` call are:

- ▶ **CU\_FUNC\_ATTRIBUTE\_MAX\_DYNAMIC\_SHARED\_SIZE\_BYTES:**  
This maximum size in bytes of dynamically-allocated shared memory. The value should contain the requested maximum size of dynamically-allocated shared memory. The sum of this value and the function attribute `CU_FUNC_ATTRIBUTE_SHARED_SIZE_BYTES` cannot exceed the device attribute `CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_BLOCK_OPTIN`. The maximal size of requestable dynamic shared memory may differ by GPU architecture.
- ▶ **CU\_FUNC\_ATTRIBUTE\_PREFERRED\_SHARED\_MEMORY\_CARVEOUT:**  
On devices where the L1 cache and shared memory use the same hardware resources, this sets the shared memory carveout preference, in percent of the total shared memory. See `CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_MULTIPROCESSOR`. This is only a hint, and the driver can choose a different ratio if required to execute the function.



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

#### See also:

[cuCtxGetCacheConfig](#), [cuCtxSetCacheConfig](#), [cuFuncSetCacheConfig](#), [cuLaunchKernel](#), [cudaFuncGetAttributes](#) [cudaFuncSetAttribute](#)

## CUresult cuFuncSetCacheConfig (CUfunction hfunc, CUfunc\_cache config)

Sets the preferred cache configuration for a device function.

### Parameters

#### **hfunc**

- Kernel to configure cache for

#### **config**

- Requested cache configuration

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#),  
[CUDA\\_ERROR\\_DEINITIALIZED](#), [CUDA\\_ERROR\\_NOT\\_INITIALIZED](#),  
[CUDA\\_ERROR\\_INVALID\\_CONTEXT](#)

### Description

On devices where the L1 cache and shared memory use the same hardware resources, this sets through `config` the preferred cache configuration for the device function `hfunc`. This is only a preference. The driver will use the requested configuration if possible, but it is free to choose a different configuration if required to execute `hfunc`. Any context-wide preference set via [cuCtxSetCacheConfig\(\)](#) will be overridden by this per-function setting unless the per-function setting is [CU\\_FUNC\\_CACHE\\_PREFER\\_NONE](#). In that case, the current context-wide setting will be used.

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:

- ▶ `CU_FUNC_CACHE_PREFER_NONE`: no preference for shared memory or L1 (default)
- ▶ `CU_FUNC_CACHE_PREFER_SHARED`: prefer larger shared memory and smaller L1 cache
- ▶ `CU_FUNC_CACHE_PREFER_L1`: prefer larger L1 cache and smaller shared memory
- ▶ `CU_FUNC_CACHE_PREFER_EQUAL`: prefer equal sized L1 cache and shared memory



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

#### See also:

`cuCtxGetCacheConfig`, `cuCtxSetCacheConfig`, `cuFuncGetAttribute`, `cuLaunchKernel`, `cudaFuncSetCacheConfig`

## CUresult cuFuncSetSharedMemConfig (CUfunction hfunc, CUsharedconfig config)

Sets the shared memory configuration for a device function.

### Parameters

#### **hfunc**

- kernel to be given a shared memory config

#### **config**

- requested shared memory configuration

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_VALUE`,  
`CUDA_ERROR_DEINITIALIZED`, `CUDA_ERROR_NOT_INITIALIZED`,  
`CUDA_ERROR_INVALID_CONTEXT`

### 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 `cuFuncSetSharedMemConfig` will override the context wide setting set with `cuCtxSetSharedMemConfig`.

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:

- ▶ `CU_SHARED_MEM_CONFIG_DEFAULT_BANK_SIZE`: use the context's shared memory configuration when launching this function.
- ▶ `CU_SHARED_MEM_CONFIG_FOUR_BYTE_BANK_SIZE`: set shared memory bank width to be natively four bytes when launching this function.
- ▶ `CU_SHARED_MEM_CONFIG_EIGHT_BYTE_BANK_SIZE`: set shared memory bank width to be natively eight bytes when launching this function.



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

See also:

`cuCtxGetCacheConfig`, `cuCtxSetCacheConfig`, `cuCtxGetSharedMemConfig`,  
`cuCtxSetSharedMemConfig`, `cuFuncGetAttribute`, `cuLaunchKernel`,  
`cudaFuncSetSharedMemConfig`

**CUresult cuLaunchCooperativeKernel (CUfunction f, unsigned int gridDimX, unsigned int gridDimY, unsigned int gridDimZ, unsigned int blockDimX, unsigned int blockDimY, unsigned int blockDimZ, unsigned int sharedMemBytes, CUstream hStream, void \*\*kernelParams)**

Launches a CUDA function where thread blocks can cooperate and synchronize as they execute.

#### Parameters

**f**

- Kernel to launch

**gridDimX**

- Width of grid in blocks

**gridDimY**

- Height of grid in blocks

**gridDimZ**

- Depth of grid in blocks

**blockDimX**

- X dimension of each thread block

**blockDimY**

- Y dimension of each thread block

**blockDimZ**

- Z dimension of each thread block

**sharedMemBytes**

- Dynamic shared-memory size per thread block in bytes

**hStream**

- Stream identifier

**kernelParams**

- Array of pointers to kernel parameters

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_INVALID\_IMAGE,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_LAUNCH\_FAILED,  
 CUDA\_ERROR\_LAUNCH\_OUT\_OF\_RESOURCES,  
 CUDA\_ERROR\_LAUNCH\_TIMEOUT,  
 CUDA\_ERROR\_LAUNCH\_INCOMPATIBLE\_TEXTURING,  
 CUDA\_ERROR\_COOPERATIVE\_LAUNCH\_TOO\_LARGE,  
 CUDA\_ERROR\_SHARED\_OBJECT\_INIT\_FAILED

**Description**

Invokes the kernel `f` on a `gridDimX x gridDimY x gridDimZ` grid of blocks. Each block contains `blockDimX x blockDimY x blockDimZ` threads.

`sharedMemBytes` sets the amount of dynamic shared memory that will be available to each thread block.

The device on which this kernel is invoked must have a non-zero value for the device attribute `CU_DEVICE_ATTRIBUTE_COOPERATIVE_LAUNCH`.

The total number of blocks launched cannot exceed the maximum number of blocks per multiprocessor as returned by `cuOccupancyMaxActiveBlocksPerMultiprocessor` (or `cuOccupancyMaxActiveBlocksPerMultiprocessorWithFlags`) times

the number of multiprocessors as specified by the device attribute `CU_DEVICE_ATTRIBUTE_MULTIPROCESSOR_COUNT`.

The kernel cannot make use of CUDA dynamic parallelism.

Kernel parameters must be specified via `kernelParams`. If `f` has `N` parameters, then `kernelParams` needs to be an array of `N` pointers. Each of `kernelParams[0]` through `kernelParams[N-1]` must point to a region of memory from which the actual kernel parameter will be copied. The number of kernel parameters and their offsets and sizes do not need to be specified as that information is retrieved directly from the kernel's image.

Calling `cuLaunchCooperativeKernel()` sets persistent function state that is the same as function state set through `cuLaunchKernel` API

When the kernel `f` is launched via `cuLaunchCooperativeKernel()`, the previous block shape, shared size and parameter info associated with `f` is overwritten.

Note that to use `cuLaunchCooperativeKernel()`, the kernel `f` must either have been compiled with toolchain version 3.2 or later so that it will contain kernel parameter information, or have no kernel parameters. If either of these conditions is not met, then `cuLaunchCooperativeKernel()` will return `CUDA_ERROR_INVALID_IMAGE`.



- ▶ This function uses standard `default stream` semantics.
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cuCtxGetCacheConfig`, `cuCtxSetCacheConfig`, `cuFuncSetCacheConfig`,  
`cuFuncGetAttribute`, `cuLaunchCooperativeKernelMultiDevice`,  
`cudaLaunchCooperativeKernel`

## CUresult cuLaunchCooperativeKernelMultiDevice (CUDA\_LAUNCH\_PARAMS \*launchParamsList, unsigned int numDevices, unsigned int flags)

Launches CUDA functions on multiple devices where thread blocks can cooperate and synchronize as they execute.

### Parameters

#### `launchParamsList`

- List of launch parameters, one per device

**numDevices**

- Size of the `launchParamsList` array

**flags**

- Flags to control launch behavior

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_INVALID\_IMAGE,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_LAUNCH\_FAILED,  
 CUDA\_ERROR\_LAUNCH\_OUT\_OF\_RESOURCES,  
 CUDA\_ERROR\_LAUNCH\_TIMEOUT,  
 CUDA\_ERROR\_LAUNCH\_INCOMPATIBLE\_TEXTURING,  
 CUDA\_ERROR\_COOPERATIVE\_LAUNCH\_TOO\_LARGE,  
 CUDA\_ERROR\_SHARED\_OBJECT\_INIT\_FAILED

**Description**

Invokes kernels as specified in the `launchParamsList` array where each element of the array specifies all the parameters required to perform a single kernel launch. These kernels can cooperate and synchronize as they execute. The size of the array is specified by `numDevices`.

No two kernels can be launched on the same device. All the devices targeted by this multi-device launch must be identical.

All devices must have a non-zero value for the device attribute

`CU_DEVICE_ATTRIBUTE_COOPERATIVE_MULTI_DEVICE_LAUNCH`.

All kernels launched must be identical with respect to the compiled code. Note that any `__device__`, `__constant__` or `__managed__` variables present in the module that owns the kernel launched on each device, are independently instantiated on every device. It is the application's responsibility to ensure these variables are initialized and used appropriately.

The size of the grids as specified in blocks, the size of the blocks themselves and the amount of shared memory used by each thread block must also match across all launched kernels.

The streams used to launch these kernels must have been created via either `cuStreamCreate` or `cuStreamCreateWithPriority`. The NULL stream or `CU_STREAM_LEGACY` or `CU_STREAM_PER_THREAD` cannot be used.

The total number of blocks launched per kernel cannot exceed the maximum number of blocks per multiprocessor as returned by `cuOccupancyMaxActiveBlocksPerMultiprocessor` (or `cuOccupancyMaxActiveBlocksPerMultiprocessorWithFlags`) times

the number of multiprocessors as specified by the device attribute `CU_DEVICE_ATTRIBUTE_MULTIPROCESSOR_COUNT`. Since the total number of blocks launched per device has to match across all devices, the maximum number of blocks that can be launched per device will be limited by the device with the least number of multiprocessors.

The kernels cannot make use of CUDA dynamic parallelism.

The `CUDA_LAUNCH_PARAMS` structure is defined as:

```
↑
typedef struct CUDA_LAUNCH_PARAMS_st
{
    CUfunction function;
    unsigned int gridDimX;
    unsigned int gridDimY;
    unsigned int gridDimZ;
    unsigned int blockDimX;
    unsigned int blockDimY;
    unsigned int blockDimZ;
    unsigned int sharedMemBytes;
    CUstream hStream;
    void **kernelParams;
} CUDA_LAUNCH_PARAMS;
```

where:

- ▶ `CUDA_LAUNCH_PARAMS::function` specifies the kernel to be launched. All functions must be identical with respect to the compiled code.
- ▶ `CUDA_LAUNCH_PARAMS::gridDimX` is the width of the grid in blocks. This must match across all kernels launched.
- ▶ `CUDA_LAUNCH_PARAMS::gridDimY` is the height of the grid in blocks. This must match across all kernels launched.
- ▶ `CUDA_LAUNCH_PARAMS::gridDimZ` is the depth of the grid in blocks. This must match across all kernels launched.
- ▶ `CUDA_LAUNCH_PARAMS::blockDimX` is the X dimension of each thread block. This must match across all kernels launched.
- ▶ `CUDA_LAUNCH_PARAMS::blockDimY` is the Y dimension of each thread block. This must match across all kernels launched.
- ▶ `CUDA_LAUNCH_PARAMS::blockDimZ` is the Z dimension of each thread block. This must match across all kernels launched.
- ▶ `CUDA_LAUNCH_PARAMS::sharedMemBytes` is the dynamic shared-memory size per thread block in bytes. This must match across all kernels launched.
- ▶ `CUDA_LAUNCH_PARAMS::hStream` is the handle to the stream to perform the launch in. This cannot be the NULL stream or `CU_STREAM_LEGACY` or `CU_STREAM_PER_THREAD`. The CUDA context associated with this stream must match that associated with `CUDA_LAUNCH_PARAMS::function`.
- ▶ `CUDA_LAUNCH_PARAMS::kernelParams` is an array of pointers to kernel parameters. If `CUDA_LAUNCH_PARAMS::function` has N parameters, then `CUDA_LAUNCH_PARAMS::kernelParams` needs to be an array of N pointers. Each of `CUDA_LAUNCH_PARAMS::kernelParams[0]` through

`CUDA_LAUNCH_PARAMS::kernelParams[N-1]` must point to a region of memory from which the actual kernel parameter will be copied. The number of kernel parameters and their offsets and sizes do not need to be specified as that information is retrieved directly from the kernel's image.

By default, the kernel won't begin execution on any GPU until all prior work in all the specified streams has completed. This behavior can be overridden by specifying the flag `CUDA_COOPERATIVE_LAUNCH_MULTI_DEVICE_NO_PRE_LAUNCH_SYNC`. When this flag is specified, each kernel will only wait for prior work in the stream corresponding to that GPU to complete before it begins execution.

Similarly, by default, any subsequent work pushed in any of the specified streams will not begin execution until the kernels on all GPUs have completed. This behavior can be overridden by specifying the flag `CUDA_COOPERATIVE_LAUNCH_MULTI_DEVICE_NO_POST_LAUNCH_SYNC`. When this flag is specified, any subsequent work pushed in any of the specified streams will only wait for the kernel launched on the GPU corresponding to that stream to complete before it begins execution.

Calling `cuLaunchCooperativeKernelMultiDevice()` sets persistent function state that is the same as function state set through `cuLaunchKernel` API when called individually for each element in `launchParamsList`.

When kernels are launched via `cuLaunchCooperativeKernelMultiDevice()`, the previous block shape, shared size and parameter info associated with each `CUDA_LAUNCH_PARAMS::function` in `launchParamsList` is overwritten.

Note that to use `cuLaunchCooperativeKernelMultiDevice()`, the kernels must either have been compiled with toolchain version 3.2 or later so that it will contain kernel parameter information, or have no kernel parameters. If either of these conditions is not met, then `cuLaunchCooperativeKernelMultiDevice()` will return `CUDA_ERROR_INVALID_IMAGE`.



- ▶ This function uses standard **default stream** semantics.
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

`cuCtxGetCacheConfig`, `cuCtxSetCacheConfig`, `cuFuncSetCacheConfig`,  
`cuFuncGetAttribute`, `cuLaunchCooperativeKernel`,  
`cudaLaunchCooperativeKernelMultiDevice`

## CUresult cuLaunchHostFunc (CUstream hStream, CUhostFn fn, void \*userData)

Enqueues a host function call in a stream.

### Parameters

#### **hStream**

- Stream to enqueue function call in

#### **fn**

- The function to call once preceding stream operations are complete

#### **userData**

- User-specified data to be passed to the function

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_NOT\_SUPPORTED

### Description

Enqueues a host function to run in a stream. The function will be called after currently enqueued work and will block work added after it.

The host function must not make any CUDA API calls. Attempting to use a CUDA API may result in [CUDA\\_ERROR\\_NOT\\_PERMITTED](#), but this is not required. The host function must not perform any synchronization that may depend on outstanding CUDA work not mandated to run earlier. Host functions without a mandated order (such as in independent streams) execute in undefined order and may be serialized.

For the purposes of Unified Memory, execution makes a number of guarantees:

- ▶ The stream is considered idle for the duration of the function's execution. Thus, for example, the function may always use memory attached to the stream it was enqueued in.
- ▶ The start of execution of the function has the same effect as synchronizing an event recorded in the same stream immediately prior to the function. It thus synchronizes streams which have been "joined" prior to the function.
- ▶ Adding device work to any stream does not have the effect of making the stream active until all preceding host functions and stream callbacks have executed. Thus, for example, a function might use global attached memory even if work has been added to another stream, if the work has been ordered behind the function call with an event.
- ▶ Completion of the function does not cause a stream to become active except as described above. The stream will remain idle if no device work follows the function,

and will remain idle across consecutive host functions or stream callbacks without device work in between. Thus, for example, stream synchronization can be done by signaling from a host function at the end of the stream.

Note that, in contrast to [cuStreamAddCallback](#), the function will not be called in the event of an error in the CUDA context.



- ▶ This function uses standard [default stream](#) semantics.
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cuStreamCreate](#), [cuStreamQuery](#), [cuStreamSynchronize](#), [cuStreamWaitEvent](#),  
[cuStreamDestroy](#), [cuMemAllocManaged](#), [cuStreamAttachMemAsync](#),  
[cuStreamAddCallback](#)

**CUresult cuLaunchKernel** (CUfunction f, unsigned int gridDimX, unsigned int gridDimY, unsigned int gridDimZ, unsigned int blockDimX, unsigned int blockDimY, unsigned int blockDimZ, unsigned int sharedMemBytes, CUstream hStream, void \*\*kernelParams, void \*\*extra)

Launches a CUDA function.

#### Parameters

**f**

- Kernel to launch

**gridDimX**

- Width of grid in blocks

**gridDimY**

- Height of grid in blocks

**gridDimZ**

- Depth of grid in blocks

**blockDimX**

- X dimension of each thread block

**blockDimY**

- Y dimension of each thread block

**blockDimZ**

- Z dimension of each thread block



**sharedMemBytes**

- Dynamic shared-memory size per thread block in bytes

**hStream**

- Stream identifier

**kernelParams**

- Array of pointers to kernel parameters

**extra**

- Extra options

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_INVALID\_IMAGE,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_LAUNCH\_FAILED,  
 CUDA\_ERROR\_LAUNCH\_OUT\_OF\_RESOURCES,  
 CUDA\_ERROR\_LAUNCH\_TIMEOUT,  
 CUDA\_ERROR\_LAUNCH\_INCOMPATIBLE\_TEXTURING,  
 CUDA\_ERROR\_SHARED\_OBJECT\_INIT\_FAILED

**Description**

Invokes the kernel `f` on a `gridDimX x gridDimY x gridDimZ` grid of blocks. Each block contains `blockDimX x blockDimY x blockDimZ` threads.

`sharedMemBytes` sets the amount of dynamic shared memory that will be available to each thread block.

Kernel parameters to `f` can be specified in one of two ways:

- 1) Kernel parameters can be specified via `kernelParams`. If `f` has `N` parameters, then `kernelParams` needs to be an array of `N` pointers. Each of `kernelParams[0]` through `kernelParams[N-1]` must point to a region of memory from which the actual kernel parameter will be copied. The number of kernel parameters and their offsets and sizes do not need to be specified as that information is retrieved directly from the kernel's image.
- 2) Kernel parameters can also be packaged by the application into a single buffer that is passed in via the `extra` parameter. This places the burden on the application of

knowing each kernel parameter's size and alignment/padding within the buffer. Here is an example of using the `extra` parameter in this manner:

```
size_t argBufferSize;
char argBuffer[256];

// populate argBuffer and argBufferSize

void *config[] = {
    CU_LAUNCH_PARAM_BUFFER_POINTER, argBuffer,
    CU_LAUNCH_PARAM_BUFFER_SIZE, &argBufferSize,
    CU_LAUNCH_PARAM_END
};
status = cuLaunchKernel(f, gx, gy, gz, bx, by, bz, sh, s, NULL,
config);
```

The `extra` parameter exists to allow `cuLaunchKernel` to take additional less commonly used arguments. `extra` specifies a list of names of extra settings and their corresponding values. Each extra setting name is immediately followed by the corresponding value. The list must be terminated with either `NULL` or `CU_LAUNCH_PARAM_END`.

- ▶ `CU_LAUNCH_PARAM_END`, which indicates the end of the `extra` array;
- ▶ `CU_LAUNCH_PARAM_BUFFER_POINTER`, which specifies that the next value in `extra` will be a pointer to a buffer containing all the kernel parameters for launching kernel `f`;
- ▶ `CU_LAUNCH_PARAM_BUFFER_SIZE`, which specifies that the next value in `extra` will be a pointer to a `size_t` containing the size of the buffer specified with `CU_LAUNCH_PARAM_BUFFER_POINTER`;

The error `CUDA_ERROR_INVALID_VALUE` will be returned if kernel parameters are specified with both `kernelParams` and `extra` (i.e. both `kernelParams` and `extra` are non-`NULL`).

Calling `cuLaunchKernel()` invalidates the persistent function state set through the following deprecated APIs: `cuFuncSetBlockShape()`, `cuFuncSetSharedSize()`, `cuParamSetSize()`, `cuParamSeti()`, `cuParamSetf()`, `cuParamSetv()`.

Note that to use `cuLaunchKernel()`, the kernel `f` must either have been compiled with toolchain version 3.2 or later so that it will contain kernel parameter information, or have no kernel parameters. If either of these conditions is not met, then `cuLaunchKernel()` will return `CUDA_ERROR_INVALID_IMAGE`.



- ▶ This function uses standard `default stream` semantics.
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cuCtxGetCacheConfig`, `cuCtxSetCacheConfig`, `cuFuncSetCacheConfig`,  
`cuFuncGetAttribute`, `cudaLaunchKernel`

## 5.19. Execution Control [DEPRECATED]

This section describes the deprecated execution control functions of the low-level CUDA driver application programming interface.

### CUresult cuFuncSetBlockShape (CUfunction hfunc, int x, int y, int z)

Sets the block-dimensions for the function.

#### Parameters

##### **hfunc**

- Kernel to specify dimensions of

**x**

- X dimension

**y**

- Y dimension

**z**

- Z dimension

#### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_HANDLE`, `CUDA_ERROR_INVALID_VALUE`

#### Description

##### Deprecated

Specifies the *x*, *y*, and *z* dimensions of the thread blocks that are created when the kernel given by *hfunc* is launched.



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

See also:

`cuFuncSetSharedSize`, `cuFuncSetCacheConfig`, `cuFuncGetAttribute`, `cuParamSetSize`, `cuParamSeti`, `cuParamSetf`, `cuParamSetv`, `cuLaunch`, `cuLaunchGrid`, `cuLaunchGridAsync`, `cuLaunchKernel`

## CUresult cuFuncSetSharedSize (CUfunction hfunc, unsigned int bytes)

Sets the dynamic shared-memory size for the function.

### Parameters

#### **hfunc**

- Kernel to specify dynamic shared-memory size for

#### **bytes**

- Dynamic shared-memory size per thread in bytes

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`, `CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`, `CUDA_ERROR_INVALID_HANDLE`, `CUDA_ERROR_INVALID_VALUE`

### Description

#### Deprecated

Sets through `bytes` the amount of dynamic shared memory that will be available to each thread block when the kernel given by `hfunc` is launched.



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

### See also:

`cuFuncSetBlockShape`, `cuFuncSetCacheConfig`, `cuFuncGetAttribute`, `cuParamSetSize`, `cuParamSeti`, `cuParamSetf`, `cuParamSetv`, `cuLaunch`, `cuLaunchGrid`, `cuLaunchGridAsync`, `cuLaunchKernel`

## CUresult cuLaunch (CUfunction f)

Launches a CUDA function.

### Parameters

#### **f**

- Kernel to launch

## Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_LAUNCH\_FAILED,  
 CUDA\_ERROR\_LAUNCH\_OUT\_OF\_RESOURCES,  
 CUDA\_ERROR\_LAUNCH\_TIMEOUT,  
 CUDA\_ERROR\_LAUNCH\_INCOMPATIBLE\_TEXTURING,  
 CUDA\_ERROR\_SHARED\_OBJECT\_INIT\_FAILED

## Description

### Deprecated

Invokes the kernel `f` on a  $1 \times 1 \times 1$  grid of blocks. The block contains the number of threads specified by a previous call to `cuFuncSetBlockShape()`.

The block shape, dynamic shared memory size, and parameter information must be set using `cuFuncSetBlockShape()`, `cuFuncSetSharedSize()`, `cuParamSetSize()`, `cuParamSeti()`, `cuParamSetf()`, and `cuParamSetv()` prior to calling this function.

Launching a function via `cuLaunchKernel()` invalidates the function's block shape, dynamic shared memory size, and parameter information. After launching via `cuLaunchKernel`, this state must be re-initialized prior to calling this function. Failure to do so results in undefined behavior.



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

### See also:

`cuFuncSetBlockShape`, `cuFuncSetSharedSize`, `cuFuncGetAttribute`, `cuParamSetSize`,  
`cuParamSetf`, `cuParamSeti`, `cuParamSetv`, `cuLaunchGrid`, `cuLaunchGridAsync`,  
`cuLaunchKernel`

## CUresult cuLaunchGrid (CUfunction f, int grid\_width, int grid\_height)

Launches a CUDA function.

### Parameters

**f**

- Kernel to launch

**grid\_width**

- Width of grid in blocks

**grid\_height**

- Height of grid in blocks

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_LAUNCH\_FAILED,  
 CUDA\_ERROR\_LAUNCH\_OUT\_OF\_RESOURCES,  
 CUDA\_ERROR\_LAUNCH\_TIMEOUT,  
 CUDA\_ERROR\_LAUNCH\_INCOMPATIBLE\_TEXTURING,  
 CUDA\_ERROR\_SHARED\_OBJECT\_INIT\_FAILED

**Description****Deprecated**

Invokes the kernel `f` on a `grid_width` x `grid_height` grid of blocks. Each block contains the number of threads specified by a previous call to `cuFuncSetBlockShape()`.

The block shape, dynamic shared memory size, and parameter information must be set using `cuFuncSetBlockShape()`, `cuFuncSetSharedSize()`, `cuParamSetSize()`, `cuParamSeti()`, `cuParamSetf()`, and `cuParamSetv()` prior to calling this function.

Launching a function via `cuLaunchKernel()` invalidates the function's block shape, dynamic shared memory size, and parameter information. After launching via `cuLaunchKernel`, this state must be re-initialized prior to calling this function. Failure to do so results in undefined behavior.



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

**See also:**

`cuFuncSetBlockShape`, `cuFuncSetSharedSize`, `cuFuncGetAttribute`, `cuParamSetSize`,  
`cuParamSetf`, `cuParamSeti`, `cuParamSetv`, `cuLaunch`, `cuLaunchGridAsync`,  
`cuLaunchKernel`

## CUresult cuLaunchGridAsync (CUfunction f, int grid\_width, int grid\_height, CUstream hStream)

Launches a CUDA function.

### Parameters

**f**

- Kernel to launch

**grid\_width**

- Width of grid in blocks

**grid\_height**

- Height of grid in blocks

**hStream**

- Stream identifier

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_INVALID\_VALUE,  
 CUDA\_ERROR\_LAUNCH\_FAILED,  
 CUDA\_ERROR\_LAUNCH\_OUT\_OF\_RESOURCES,  
 CUDA\_ERROR\_LAUNCH\_TIMEOUT,  
 CUDA\_ERROR\_LAUNCH\_INCOMPATIBLE\_TEXTURING,  
 CUDA\_ERROR\_SHARED\_OBJECT\_INIT\_FAILED

### Description

#### Deprecated

Invokes the kernel `f` on a `grid_width` x `grid_height` grid of blocks. Each block contains the number of threads specified by a previous call to [cuFuncSetBlockShape\(\)](#).

The block shape, dynamic shared memory size, and parameter information must be set using [cuFuncSetBlockShape\(\)](#), [cuFuncSetSharedSize\(\)](#), [cuParamSetSize\(\)](#), [cuParamSeti\(\)](#), [cuParamSetf\(\)](#), and [cuParamSetv\(\)](#) prior to calling this function.

Launching a function via [cuLaunchKernel\(\)](#) invalidates the function's block shape, dynamic shared memory size, and parameter information. After launching via [cuLaunchKernel](#), this state must be re-initialized prior to calling this function. Failure to do so results in undefined behavior.



► In certain cases where cubins are created with no ABI (i.e., using `ptxas --abi-compile no`), this function may serialize kernel launches. The CUDA

driver retains asynchronous behavior by growing the per-thread stack as needed per launch and not shrinking it afterwards.

- ▶ This function uses standard [default stream](#) semantics.
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cuFuncSetBlockShape](#), [cuFuncSetSharedSize](#), [cuFuncGetAttribute](#), [cuParamSetSize](#), [cuParamSetf](#), [cuParamSeti](#), [cuParamSetv](#), [cuLaunch](#), [cuLaunchGrid](#), [cuLaunchKernel](#)

## CUresult cuParamSetf (CUfunction hfunc, int offset, float value)

Adds a floating-point parameter to the function's argument list.

### Parameters

#### **hfunc**

- Kernel to add parameter to

#### **offset**

- Offset to add parameter to argument list

#### **value**

- Value of parameter

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#)

### Description

#### Deprecated

Sets a floating-point parameter that will be specified the next time the kernel corresponding to `hfunc` will be invoked. `offset` is a byte offset.



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

#### See also:



[cuFuncSetBlockShape](#), [cuFuncSetSharedSize](#), [cuFuncGetAttribute](#), [cuParamSetSize](#), [cuParamSeti](#), [cuParamSetv](#), [cuLaunch](#), [cuLaunchGrid](#), [cuLaunchGridAsync](#), [cuLaunchKernel](#)

## CUresult cuParamSeti (CUfunction hfunc, int offset, unsigned int value)

Adds an integer parameter to the function's argument list.

### Parameters

#### **hfunc**

- Kernel to add parameter to

#### **offset**

- Offset to add parameter to argument list

#### **value**

- Value of parameter

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#)

### Description

#### Deprecated

Sets an integer parameter that will be specified the next time the kernel corresponding to `hfunc` will be invoked. `offset` is a byte offset.



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

### See also:

[cuFuncSetBlockShape](#), [cuFuncSetSharedSize](#), [cuFuncGetAttribute](#), [cuParamSetSize](#), [cuParamSetf](#), [cuParamSetv](#), [cuLaunch](#), [cuLaunchGrid](#), [cuLaunchGridAsync](#), [cuLaunchKernel](#)

## CUresult cuParamSetSize (CUfunction hfunc, unsigned int numbytes)

Sets the parameter size for the function.

### Parameters

#### hfunc

- Kernel to set parameter size for

#### numbytes

- Size of parameter list in bytes

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

#### Deprecated

Sets through `numbytes` the total size in bytes needed by the function parameters of the kernel corresponding to `hfunc`.



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

### See also:

`cuFuncSetBlockShape`, `cuFuncSetSharedSize`, `cuFuncGetAttribute`, `cuParamSetf`,  
`cuParamSeti`, `cuParamSetv`, `cuLaunch`, `cuLaunchGrid`, `cuLaunchGridAsync`,  
`cuLaunchKernel`

## CUresult cuParamSetTexRef (CUfunction hfunc, int texunit, CUtexref hTexRef)

Adds a texture-reference to the function's argument list.

### Parameters

#### hfunc

- Kernel to add texture-reference to

#### texunit

- Texture unit (must be `CU_PARAM_TR_DEFAULT`)

**hTexRef**

- Texture-reference to add to argument list

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description**

## Deprecated

Makes the CUDA array or linear memory bound to the texture reference `hTexRef` available to a device program as a texture. In this version of CUDA, the texture-reference must be obtained via `cuModuleGetTexRef()` and the `texunit` parameter must be set to `CU_PARAM_TR_DEFAULT`.



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

## CUresult cuParamSetv (CUfunction hfunc, int offset, void \*ptr, unsigned int numbytes)

Adds arbitrary data to the function's argument list.

**Parameters****hfunc**

- Kernel to add data to

**offset**

- Offset to add data to argument list

**ptr**

- Pointer to arbitrary data

**numbytes**

- Size of data to copy in bytes

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description**

## Deprecated

Copies an arbitrary amount of data (specified in `numbytes`) from `ptr` into the parameter space of the kernel corresponding to `hfunc`. `offset` is a byte offset.



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

See also:

`cuFuncSetBlockShape`, `cuFuncSetSharedSize`, `cuFuncGetAttribute`, `cuParamSetSize`, `cuParamSetf`, `cuParamSeti`, `cuLaunch`, `cuLaunchGrid`, `cuLaunchGridAsync`, `cuLaunchKernel`

## 5.20. Graph Management

This section describes the graph management functions of the low-level CUDA driver application programming interface.

**CUresult cuGraphAddChildGraphNode (CUgraphNode \*phGraphNode, CUgraph hGraph, const CUgraphNode \*dependencies, size\_t numDependencies, CUgraph childGraph)**

Creates a child graph node and adds it to a graph.

### Parameters

#### **phGraphNode**

- Returns newly created node

#### **hGraph**

- Graph to which to add the node

#### **dependencies**

- Dependencies of the node

#### **numDependencies**

- Number of dependencies

#### **childGraph**

- The graph to clone into this node

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_VALUE`,

## Description

Creates a new node which executes an embedded graph, and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the graph. `dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

The node executes an embedded child graph. The child graph is cloned in this call.



- Graph objects are not threadsafe. [More here.](#)
- Note that this function may also return error codes from previous, asynchronous launches.

## See also:

[cuGraphChildGraphNodeGetGraph](#), [cuGraphCreate](#), [cuGraphDestroyNode](#), [cuGraphAddEmptyNode](#), [cuGraphAddKernelNode](#), [cuGraphAddHostNode](#), [cuGraphAddMemcpyNode](#), [cuGraphAddMemsetNode](#), [cuGraphClone](#)

## CUresult cuGraphAddDependencies (CUgraph hGraph, const CUGraphNode \*from, const CUGraphNode \*to, size\_t numDependencies)

Adds dependency edges to a graph.

### Parameters

#### **hGraph**

- Graph to which dependencies are added

#### **from**

- Array of nodes that provide the dependencies

#### **to**

- Array of dependent nodes

#### **numDependencies**

- Number of dependencies to be added

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#)

## Description

The number of dependencies to be added is defined by `numDependencies`. Elements in `from` and `to` at corresponding indices define a dependency. Each node in `from` and `to` must belong to `hGraph`.

If `numDependencies` is 0, elements in `from` and `to` will be ignored. Specifying an existing dependency will return an error.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

## See also:

[cuGraphRemoveDependencies](#), [cuGraphGetEdges](#), [cuGraphNodeGetDependencies](#), [cuGraphNodeGetDependentNodes](#)

## CUresult cuGraphAddEmptyNode (CUgraphNode \*phGraphNode, CUgraph hGraph, const CUgraphNode \*dependencies, size\_t numDependencies)

Creates an empty node and adds it to a graph.

## Parameters

### phGraphNode

- Returns newly created node

### hGraph

- Graph to which to add the node

### dependencies

- Dependencies of the node

### numDependencies

- Number of dependencies

## Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#),

## Description

Creates a new node which performs no operation, and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the

`graph.dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

An empty node performs no operation during execution, but can be used for transitive ordering. For example, a phased execution graph with 2 groups of  $n$  nodes with a barrier between them can be represented using an empty node and  $2*n$  dependency edges, rather than no empty node and  $n^2$  dependency edges.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

`cuGraphCreate`, `cuGraphDestroyNode`, `cuGraphAddChildGraphNode`,  
`cuGraphAddKernelNode`, `cuGraphAddHostNode`, `cuGraphAddMemcpyNode`,  
`cuGraphAddMemsetNode`

## CUresult cuGraphAddHostNode (CUgraphNode \*phGraphNode, CUgraph hGraph, const CUgraphNode \*dependencies, size\_t numDependencies, const CUDA\_HOST\_NODE\_PARAMS \*nodeParams)

Creates a host execution node and adds it to a graph.

#### Parameters

##### **phGraphNode**

- Returns newly created node

##### **hGraph**

- Graph to which to add the node

##### **dependencies**

- Dependencies of the node

##### **numDependencies**

- Number of dependencies

##### **nodeParams**

- Parameters for the host node

#### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_NOT_SUPPORTED`,  
`CUDA_ERROR_INVALID_VALUE`

## Description

Creates a new CPU execution node and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies` and arguments specified in `nodeParams`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the graph. `dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

When the graph is launched, the node will invoke the specified CPU function. Host nodes are not supported under MPS with pre-Volta GPUs.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

## See also:

`cuLaunchHostFunc`, `cuGraphHostNodeGetParams`, `cuGraphHostNodeSetParams`, `cuGraphCreate`, `cuGraphDestroyNode`, `cuGraphAddChildGraphNode`, `cuGraphAddEmptyNode`, `cuGraphAddKernelNode`, `cuGraphAddMemcpyNode`, `cuGraphAddMemsetNode`

## CUresult cuGraphAddKernelNode (CUGraphNode \*phGraphNode, CUgraph hGraph, const CUgraphNode \*dependencies, size\_t numDependencies, const CUDA\_KERNEL\_NODE\_PARAMS \*nodeParams)

Creates a kernel execution node and adds it to a graph.

## Parameters

### **phGraphNode**

- Returns newly created node

### **hGraph**

- Graph to which to add the node

### **dependencies**

- Dependencies of the node

### **numDependencies**

- Number of dependencies

### **nodeParams**

- Parameters for the GPU execution node



## Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE

## Description

Creates a new kernel execution node and adds it to hGraph with numDependencies dependencies specified via dependencies and arguments specified in nodeParams. It is possible for numDependencies to be 0, in which case the node will be placed at the root of the graph. dependencies may not have any duplicate entries. A handle to the new node will be returned in phGraphNode.

The CUDA\_KERNEL\_NODE\_PARAMS structure is defined as:

```
typedef struct CUDA_KERNEL_NODE_PARAMS_st {
    CUfunction func;
    unsigned int gridDimX;
    unsigned int gridDimY;
    unsigned int gridDimZ;
    unsigned int blockDimX;
    unsigned int blockDimY;
    unsigned int blockDimZ;
    unsigned int sharedMemBytes;
    void **kernelParams;
    void **extra;
} CUDA_KERNEL_NODE_PARAMS;
```

When the graph is launched, the node will invoke kernel func on a (gridDimX x gridDimY x gridDimZ) grid of blocks. Each block contains (blockDimX x blockDimY x blockDimZ) threads.

sharedMemBytes sets the amount of dynamic shared memory that will be available to each thread block.

Kernel parameters to func can be specified in one of two ways:

- 1) Kernel parameters can be specified via kernelParams. If the kernel has N parameters, then kernelParams needs to be an array of N pointers. Each pointer, from kernelParams[0] to kernelParams[N-1], points to the region of memory from which the actual parameter will be copied. The number of kernel parameters and their offsets and sizes do not need to be specified as that information is retrieved directly from the kernel's image.
- 2) Kernel parameters for non-cooperative kernels can also be packaged by the application into a single buffer that is passed in via extra. This places the burden on the application of knowing each kernel parameter's size and alignment/padding within the buffer. The extra parameter exists to allow this function to take additional less commonly used arguments. extra specifies a list of names of extra settings and their corresponding values. Each extra setting name is immediately followed by the corresponding value. The list must be terminated with either NULL or CU\_LAUNCH\_PARAM\_END.

- ▶ `CUDA_LAUNCH_PARAM_END`, which indicates the end of the `extra` array;
- ▶ `CUDA_LAUNCH_PARAM_BUFFER_POINTER`, which specifies that the next value in `extra` will be a pointer to a buffer containing all the kernel parameters for launching kernel `func`;
- ▶ `CUDA_LAUNCH_PARAM_BUFFER_SIZE`, which specifies that the next value in `extra` will be a pointer to a `size_t` containing the size of the buffer specified with `CUDA_LAUNCH_PARAM_BUFFER_POINTER`;

The error `CUDA_ERROR_INVALID_VALUE` will be returned if kernel parameters are specified with both `kernelParams` and `extra` (i.e. both `kernelParams` and `extra` are non-NULL). `CUDA_ERROR_INVALID_VALUE` will be returned if `extra` is used for a cooperative kernel.

The `kernelParams` or `extra` array, as well as the argument values it points to, are copied during this call.



Kernels launched using graphs must not use texture and surface references. Reading or writing through any texture or surface reference is undefined behavior. This restriction does not apply to texture and surface objects.



- ▶ Graph objects are not threadsafe. [More here](#).
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cuLaunchKernel`, `cuLaunchCooperativeKernel`, `cuGraphKernelNodeGetParams`, `cuGraphKernelNodeSetParams`, `cuGraphCreate`, `cuGraphDestroyNode`, `cuGraphAddChildGraphNode`, `cuGraphAddEmptyNode`, `cuGraphAddHostNode`, `cuGraphAddMemcpyNode`, `cuGraphAddMemsetNode`

**CUresult cuGraphAddMemcpyNode (CUgraphNode \*phGraphNode, CUgraph hGraph, const CUgraphNode \*dependencies, size\_t numDependencies, const CUDA\_MEMCPY3D \*copyParams, CUcontext ctx)**

Creates a memcpy node and adds it to a graph.

### Parameters

#### **phGraphNode**

- Returns newly created node

**hGraph**

- Graph to which to add the node

**dependencies**

- Dependencies of the node

**numDependencies**

- Number of dependencies

**copyParams**

- Parameters for the memory copy

**ctx**

- Context on which to run the node

**Returns**

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#)

**Description**

Creates a new memcpy node and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the graph. `dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

When the graph is launched, the node will perform the memcpy described by `copyParams`. See [cuMemcpy3D\(\)](#) for a description of the structure and its restrictions.

Memcpy nodes have some additional restrictions with regards to managed memory, if the system contains at least one device which has a zero value for the device attribute [CU\\_DEVICE\\_ATTRIBUTE\\_CONCURRENT\\_MANAGED\\_ACCESS](#). If one or more of the operands refer to managed memory, then using the memory type [CU\\_MEMORYTYPE\\_UNIFIED](#) is disallowed for those operand(s). The managed memory will be treated as residing on either the host or the device, depending on which memory type is specified.



- ▶ Graph objects are not threadsafe. [More here](#).
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

[cuMemcpy3D](#), [cuGraphMemcpyNodeGetParams](#), [cuGraphMemcpyNodeSetParams](#),  
[cuGraphCreate](#), [cuGraphDestroyNode](#), [cuGraphAddChildGraphNode](#),  
[cuGraphAddEmptyNode](#), [cuGraphAddKernelNode](#), [cuGraphAddHostNode](#),  
[cuGraphAddMemsetNode](#)

```
CUresult cuGraphAddMemsetNode (CUgraphNode
*phGraphNode, CUgraph hGraph, const CUgraphNode
*dependencies, size_t numDependencies, const
CUDA_MEMSET_NODE_PARAMS *memsetParams,
CUcontext ctx)
```

Creates a memset node and adds it to a graph.

### Parameters

#### **phGraphNode**

- Returns newly created node

#### **hGraph**

- Graph to which to add the node

#### **dependencies**

- Dependencies of the node

#### **numDependencies**

- Number of dependencies

#### **memsetParams**

- Parameters for the memory set

#### **ctx**

- Context on which to run the node

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_INVALID\_CONTEXT

### Description

Creates a new memset node and adds it to hGraph with numDependencies dependencies specified via dependencies. It is possible for numDependencies to be 0, in which case the node will be placed at the root of the graph. dependencies may not have any duplicate entries. A handle to the new node will be returned in phGraphNode.

The element size must be 1, 2, or 4 bytes. When the graph is launched, the node will perform the memset described by memsetParams.



► Graph objects are not threadsafe. [More here.](#)

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

#### See also:

[cuMemsetD2D32](#), [cuGraphMemsetNodeGetParams](#), [cuGraphMemsetNodeSetParams](#), [cuGraphCreate](#), [cuGraphDestroyNode](#), [cuGraphAddChildGraphNode](#), [cuGraphAddEmptyNode](#), [cuGraphAddKernelNode](#), [cuGraphAddHostNode](#), [cuGraphAddMemcpyNode](#)

## CUresult cuGraphChildGraphNodeGetGraph (CUgraphNode hNode, CUgraph \*phGraph)

Gets a handle to the embedded graph of a child graph node.

#### Parameters

##### **hNode**

- Node to get the embedded graph for

##### **phGraph**

- Location to store a handle to the graph

#### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#),

#### Description

Gets a handle to the embedded graph in a child graph node. This call does not clone the graph. Changes to the graph will be reflected in the node, and the node retains ownership of the graph.



- Graph objects are not threadsafe. [More here](#).
- Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cuGraphAddChildGraphNode](#), [cuGraphNodeFindInClone](#)

## CUresult cuGraphClone (CUgraph \*phGraphClone, CUgraph originalGraph)

Clones a graph.

### Parameters

#### phGraphClone

- Returns newly created cloned graph

#### originalGraph

- Graph to clone

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_OUT\_OF\_MEMORY

### Description

This function creates a copy of `originalGraph` and returns it in `* phGraphClone`. All parameters are copied into the cloned graph. The original graph may be modified after this call without affecting the clone.

Child graph nodes in the original graph are recursively copied into the clone.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cuGraphCreate](#), [cuGraphNodeFindInClone](#)

## CUresult cuGraphCreate (CUgraph \*phGraph, unsigned int flags)

Creates a graph.

### Parameters

#### phGraph

- Returns newly created graph

#### flags

- Graph creation flags, must be 0

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE,  
 CUDA\_ERROR\_OUT\_OF\_MEMORY

**Description**

Creates an empty graph, which is returned via `phGraph`.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

`cuGraphAddChildGraphNode`, `cuGraphAddEmptyNode`, `cuGraphAddKernelNode`,  
`cuGraphAddHostNode`, `cuGraphAddMemcpyNode`, `cuGraphAddMemsetNode`,  
`cuGraphInstantiate`, `cuGraphDestroy`, `cuGraphGetNodes`, `cuGraphGetRootNodes`,  
`cuGraphGetEdges`, `cuGraphClone`

## CUresult cuGraphDestroy (CUgraph hGraph)

Destroys a graph.

**Parameters****hGraph**

- Graph to destroy

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE

**Description**

Destroys the graph specified by `hGraph`, as well as all of its nodes.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

`cuGraphCreate`

## CUresult cuGraphDestroyNode (CUgraphNode hNode)

Remove a node from the graph.

### Parameters

#### hNode

- Node to remove

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_VALUE`

### Description

Removes `hNode` from its graph. This operation also severs any dependencies of other nodes on `hNode` and vice versa.



- ▶ Graph objects are not threadsafe. [More here](#).
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

### See also:

`cuGraphAddChildGraphNode`, `cuGraphAddEmptyNode`, `cuGraphAddKernelNode`, `cuGraphAddHostNode`, `cuGraphAddMemcpyNode`, `cuGraphAddMemsetNode`

## CUresult cuGraphExecDestroy (CUgraphExec hGraphExec)

Destroys an executable graph.

### Parameters

#### hGraphExec

- Executable graph to destroy

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_VALUE`



## Description

Destroys the executable graph specified by `hGraphExec`, as well as all of its executable nodes. If the executable graph is in-flight, it will not be terminated, but rather freed asynchronously on completion.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

## See also:

[cuGraphInstantiate](#), [cuGraphLaunch](#)

## CUresult cuGraphExecHostNodeSetParams (CUgraphExec hGraphExec, CUgraphNode hNode, const CUDA\_HOST\_NODE\_PARAMS \*nodeParams)

Sets the parameters for a host node in the given `graphExec`.

## Parameters

### **hGraphExec**

- The executable graph in which to set the specified node

### **hNode**

- Host node from the graph which was used to instantiate `graphExec`

### **nodeParams**

- The updated parameters to set

## Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#),

## Description

Updates the work represented by `hNode` in `hGraphExec` as though `hNode` had contained `nodeParams` at instantiation. `hNode` must remain in the graph which was used to instantiate `hGraphExec`. Changed edges to and from `hNode` are ignored.

The modifications only affect future launches of `hGraphExec`. Already enqueued or running launches of `hGraphExec` are not affected by this call. `hNode` is also not modified by this call.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

[cuGraphInstantiate](#), [cuGraphExecKernelNodeSetParams](#)

[cuGraphExecMemcpyNodeSetParams](#) [cuGraphExecMemsetNodeSetParams](#)

## CUresult cuGraphExecKernelNodeSetParams (CUgraphExec hGraphExec, CUgraphNode hNode, const CUDA\_KERNEL\_NODE\_PARAMS \*nodeParams)

Sets the parameters for a kernel node in the given graphExec.

**Parameters****hGraphExec**

- The executable graph in which to set the specified node

**hNode**

- kernel node from the graph from which graphExec was instantiated

**nodeParams**

- Updated Parameters to set

**Returns**

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#),

**Description**

Sets the parameters of a kernel node in an executable graph `hGraphExec`. The node is identified by the corresponding node `hNode` in the non-executable graph, from which the executable graph was instantiated.

`hNode` must not have been removed from the original graph. The `func` field of `nodeParams` cannot be modified and must match the original value. All other values can be modified.

The modifications only affect future launches of `hGraphExec`. Already enqueued or running launches of `hGraphExec` are not affected by this call. `hNode` is also not modified by this call.



- ▶ Graph objects are not threadsafe. [More here.](#)

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

See also:

[cuGraphAddKernelNode](#), [cuGraphKernelNodeSetParams](#), [cuGraphInstantiate](#)

## CUresult cuGraphExecMemcpyNodeSetParams (CUgraphExec hGraphExec, CUgraphNode hNode, const CUDA\_MEMCPY3D \*copyParams, CUcontext ctx)

Sets the parameters for a memcpy node in the given graphExec.

### Parameters

#### **hGraphExec**

- The executable graph in which to set the specified node

#### **hNode**

- Memcpy node from the graph which was used to instantiate graphExec

#### **copyParams**

- The updated parameters to set

#### **ctx**

- Context on which to run the node

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#),

### Description

Updates the work represented by hNode in hGraphExec as though hNode had contained copyParams at instantiation. hNode must remain in the graph which was used to instantiate hGraphExec. Changed edges to and from hNode are ignored.

The source and destination memory in copyParams must be allocated from the same contexts as the original source and destination memory. Both the instantiation-time memory operands and the memory operands in copyParams must be 1-dimensional. Zero-length operations are not supported.

The modifications only affect future launches of hGraphExec. Already enqueued or running launches of hGraphExec are not affected by this call. hNode is also not modified by this call.

Returns CUDA\_ERROR\_INVALID\_VALUE if the memory operands' mappings changed or either the original or new memory operands are multidimensional.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

`cuGraphInstantiate`, `cuGraphExecKernelNodeSetParams`  
`cuGraphExecMemsetNodeSetParams` `cuGraphExecHostNodeSetParams`

## CUresult cuGraphExecMemsetNodeSetParams (CUgraphExec hGraphExec, CUgraphNode hNode, const CUDA\_MEMSET\_NODE\_PARAMS \*memsetParams, CUcontext ctx)

Sets the parameters for a memset node in the given graphExec.

#### Parameters

##### **hGraphExec**

- The executable graph in which to set the specified node

##### **hNode**

- Memset node from the graph which was used to instantiate graphExec

##### **memsetParams**

- The updated parameters to set

##### **ctx**

- Context on which to run the node

#### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_VALUE`,

#### Description

Updates the work represented by `hNode` in `hGraphExec` as though `hNode` had contained `memsetParams` at instantiation. `hNode` must remain in the graph which was used to instantiate `hGraphExec`. Changed edges to and from `hNode` are ignored.

The destination memory in `memsetParams` must be allocated from the same contexts as the original destination memory. Both the instantiation-time memory operand and the memory operand in `memsetParams` must be 1-dimensional. Zero-length operations are not supported.

The modifications only affect future launches of `hGraphExec`. Already enqueued or running launches of `hGraphExec` are not affected by this call. `hNode` is also not modified by this call.

Returns `CUDA_ERROR_INVALID_VALUE` if the memory operand's mappings changed or either the original or new memory operand are multidimensional.



- ▶ Graph objects are not threadsafe. [More here](#).
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cuGraphInstantiate`, `cuGraphExecKernelNodeSetParams`  
`cuGraphExecMemcpyNodeSetParams` `cuGraphExecHostNodeSetParams`

## CUresult cuGraphExecUpdate (CUgraphExec hGraphExec, CUgraph hGraph, CUgraphNode \*hErrorNode\_out, CUgraphExecUpdateResult \*updateResult\_out)

Check whether an executable graph can be updated with a graph and perform the update if possible.

### Parameters

#### **hGraphExec**

The instantiated graph to be updated

#### **hGraph**

The graph containing the updated parameters

#### **hErrorNode\_out**

The node which caused the permissibility check to forbid the update, if any

#### **updateResult\_out**

Whether the graph update was permitted. If was forbidden, the reason why

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_GRAPH_EXEC_UPDATE_FAILURE`,

### Description

Updates the node parameters in the instantiated graph specified by `hGraphExec` with the node parameters in a topologically identical graph specified by `hGraph`.

Limitations:

- ▶ Kernel nodes:
  - ▶ The function must not change (same restriction as `cuGraphExecKernelNodeSetParams()`)
- ▶ Memset and memcpy nodes:
  - ▶ The CUDA device(s) to which the operand(s) was allocated/mapped cannot change.
  - ▶ The source/destination memory must be allocated from the same contexts as the original source/destination memory.
  - ▶ Only 1D memsets can be changed.
- ▶ Additional memcpy node restrictions:
  - ▶ Changing either the source or destination memory type(i.e. `CU_MEMORYTYPE_DEVICE`, `CU_MEMORYTYPE_ARRAY`, etc.) is not supported.

Note: The API may add further restrictions in future releases. The return code should always be checked.

Some node types are not currently supported:

- ▶ Empty graph nodes(`CU_GRAPH_NODE_TYPE_EMPTY`)
- ▶ Child graphs(`CU_GRAPH_NODE_TYPE_GRAPH`).

`cuGraphExecUpdate` sets `updateResult_out` to `CU_GRAPH_EXEC_UPDATE_ERROR_TOPOLOGY_CHANGED` under the following conditions:

- ▶ The count of nodes directly in `hGraphExec` and `hGraph` differ, in which case `hErrorNode_out` is `NULL`.
- ▶ A node is deleted in `hGraph` but not its pair from `hGraphExec`, in which case `hErrorNode_out` is `NULL`.
- ▶ A node is deleted in `hGraphExec` but not its pair from `hGraph`, in which case `hErrorNode_out` is the pairless node from `hGraph`.
- ▶ The dependent nodes of a pair differ, in which case `hErrorNode_out` is the node from `hGraph`.

`cuGraphExecUpdate` sets `updateResult_out` to:

- ▶ `CU_GRAPH_EXEC_UPDATE_ERROR` if passed an invalid value.
- ▶ `CU_GRAPH_EXEC_UPDATE_ERROR_TOPOLOGY_CHANGED` if the graph topology changed
- ▶ `CU_GRAPH_EXEC_UPDATE_ERROR_NODE_TYPE_CHANGED` if the type of a node changed, in which case `hErrorNode_out` is set to the node from `hGraph`.
- ▶ `CU_GRAPH_EXEC_UPDATE_ERROR_FUNCTION_CHANGED` if the `func` field of a kernel changed, in which case `hErrorNode_out` is set to the node from `hGraph`

- ▶ `CU_GRAPH_EXEC_UPDATE_ERROR_PARAMETERS_CHANGED` if any parameters to a node changed in a way that is not supported, in which case `hErrorNode_out` is set to the node from `hGraph`.
- ▶ `CU_GRAPH_EXEC_UPDATE_ERROR_NOT_SUPPORTED` if something about a node is unsupported, like the node's type or configuration, in which case `hErrorNode_out` is set to the node from `hGraph`.

If `updateResult_out` isn't set in one of the situations described above, the update check passes and `cuGraphExecUpdate` updates `hGraphExec` to match the contents of `hGraph`. If an error happens during the update, `updateResult_out` will be set to `CU_GRAPH_EXEC_UPDATE_ERROR`; otherwise, `updateResult_out` is set to `CU_GRAPH_EXEC_UPDATE_SUCCESS`.

`cuGraphExecUpdate` returns `CUDA_SUCCESS` when the update was performed successfully. It returns `CUDA_ERROR_GRAPH_EXEC_UPDATE_FAILURE` if the graph update was not performed because it included changes which violated constraints specific to instantiated graph update.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cuGraphInstantiate](#),

## CUresult cuGraphGetEdges (CUgraph hGraph, CUgraphNode \*from, CUgraphNode \*to, size\_t \*numEdges)

Returns a graph's dependency edges.

### Parameters

#### **hGraph**

- Graph to get the edges from

#### **from**

- Location to return edge endpoints

#### **to**

- Location to return edge endpoints

#### **numEdges**

- See description

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE

**Description**

Returns a list of `hGraph`'s dependency edges. Edges are returned via corresponding indices in `from` and `to`; that is, the node in `to[i]` has a dependency on the node in `from[i]`. `from` and `to` may both be `NULL`, in which case this function only returns the number of edges in `numEdges`. Otherwise, `numEdges` entries will be filled in. If `numEdges` is higher than the actual number of edges, the remaining entries in `from` and `to` will be set to `NULL`, and the number of edges actually returned will be written to `numEdges`.



- ▶ Graph objects are not threadsafe. [More here](#).
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

`cuGraphGetNodes`, `cuGraphGetRootNodes`, `cuGraphAddDependencies`,  
`cuGraphRemoveDependencies`, `cuGraphNodeGetDependencies`,  
`cuGraphNodeGetDependentNodes`

## CUresult cuGraphGetNodes (CUgraph hGraph, CUGraphNode \*nodes, size\_t \*numNodes)

Returns a graph's nodes.

**Parameters****hGraph**

- Graph to query

**nodes**

- Pointer to return the nodes

**numNodes**

- See description

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE



## Description

Returns a list of `hGraph`'s nodes. `nodes` may be `NULL`, in which case this function will return the number of nodes in `numNodes`. Otherwise, `numNodes` entries will be filled in. If `numNodes` is higher than the actual number of nodes, the remaining entries in `nodes` will be set to `NULL`, and the number of nodes actually obtained will be returned in `numNodes`.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

## See also:

[cuGraphCreate](#), [cuGraphGetRootNodes](#), [cuGraphGetEdges](#), [cuGraphNodeGetType](#), [cuGraphNodeGetDependencies](#), [cuGraphNodeGetDependentNodes](#)

## CUresult cuGraphGetRootNodes (CUgraph hGraph, CUGraphNode \*rootNodes, size\_t \*numRootNodes)

Returns a graph's root nodes.

### Parameters

#### **hGraph**

- Graph to query

#### **rootNodes**

- Pointer to return the root nodes

#### **numRootNodes**

- See description

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#)

## Description

Returns a list of `hGraph`'s root nodes. `rootNodes` may be `NULL`, in which case this function will return the number of root nodes in `numRootNodes`. Otherwise, `numRootNodes` entries will be filled in. If `numRootNodes` is higher than the actual number of root nodes, the remaining entries in `rootNodes` will be set to `NULL`, and the number of nodes actually obtained will be returned in `numRootNodes`.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cuGraphCreate](#), [cuGraphGetNodes](#), [cuGraphGetEdges](#), [cuGraphNodeGetType](#),  
[cuGraphNodeGetDependencies](#), [cuGraphNodeGetDependentNodes](#)

## CUresult cuGraphHostNodeGetParams (CUgraphNode hNode, CUDA\_HOST\_NODE\_PARAMS \*nodeParams)

Returns a host node's parameters.

#### Parameters

##### **hNode**

- Node to get the parameters for

##### **nodeParams**

- Pointer to return the parameters

#### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#)

#### Description

Returns the parameters of host node `hNode` in `nodeParams`.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cuLaunchHostFunc](#), [cuGraphAddHostNode](#), [cuGraphHostNodeSetParams](#)

## CUresult cuGraphHostNodeSetParams (CUgraphNode hNode, const CUDA\_HOST\_NODE\_PARAMS \*nodeParams)

Sets a host node's parameters.

### Parameters

#### hNode

- Node to set the parameters for

#### nodeParams

- Parameters to copy

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE

### Description

Sets the parameters of host node hNode to nodeParams.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cuLaunchHostFunc](#), [cuGraphAddHostNode](#), [cuGraphHostNodeGetParams](#)

## CUresult cuGraphInstantiate (CUgraphExec \*phGraphExec, CUgraph hGraph, CUgraphNode \*phErrorNode, char \*logBuffer, size\_t bufferSize)

Creates an executable graph from a graph.

### Parameters

#### phGraphExec

- Returns instantiated graph

#### hGraph

- Graph to instantiate

#### phErrorNode

- In case of an instantiation error, this may be modified to indicate a node contributing to the error

**logBuffer**

- A character buffer to store diagnostic messages

**bufferSize**

- Size of the log buffer in bytes

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE

**Description**

Instantiates `hGraph` as an executable graph. The graph is validated for any structural constraints or intra-node constraints which were not previously validated. If instantiation is successful, a handle to the instantiated graph is returned in `graphExec`.

If there are any errors, diagnostic information may be returned in `errorNode` and `logBuffer`. This is the primary way to inspect instantiation errors. The output will be null terminated unless the diagnostics overflow the buffer. In this case, they will be truncated, and the last byte can be inspected to determine if truncation occurred.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

[cuGraphCreate](#), [cuGraphLaunch](#), [cuGraphExecDestroy](#)

## CUresult cuGraphKernelNodeCopyAttributes (CUgraphNode dst, CUgraphNode src)

Copies attributes from source node to destination node.

**Parameters****dst**

Destination node

**src**

Source node For list of attributes see [CUkernelNodeAttrID](#)

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE

## Description

Copies attributes from source node `src` to destination node `dst`. Both node must have the same context.



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

## See also:

[CUaccessPolicyWindow](#)

## CUresult cuGraphKernelNodeGetAttribute (CUgraphNode hNode, CUkernelNodeAttrID attr, CUkernelNodeAttrValue \*value\_out)

Queries node attribute.

## Parameters

**hNode**

**attr**

**value\_out**

## Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#),  
[CUDA\\_ERROR\\_INVALID\\_HANDLE](#)

## Description

Queries attribute `attr` from node `hNode` and stores it in corresponding member of `value_out`.



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

## See also:

[CUaccessPolicyWindow](#)

## CUresult cuGraphKernelNodeGetParams (CUgraphNode hNode, CUDA\_KERNEL\_NODE\_PARAMS \*nodeParams)

Returns a kernel node's parameters.

### Parameters

#### hNode

- Node to get the parameters for

#### nodeParams

- Pointer to return the parameters

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE

### Description

Returns the parameters of kernel node `hNode` in `nodeParams`. The `kernelParams` or `extra` array returned in `nodeParams`, as well as the argument values it points to, are owned by the node. This memory remains valid until the node is destroyed or its parameters are modified, and should not be modified directly. Use [cuGraphKernelNodeSetParams](#) to update the parameters of this node.

The params will contain either `kernelParams` or `extra`, according to which of these was most recently set on the node.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cuLaunchKernel](#), [cuGraphAddKernelNode](#), [cuGraphKernelNodeSetParams](#)

## CUresult cuGraphKernelNodeSetAttribute (CUgraphNode hNode, CUkernelNodeAttrID attr, const CUkernelNodeAttrValue \*value)

Sets node attribute.

### Parameters

**hNode**

**attr**

**value**

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_INVALID\_HANDLE

### Description

Sets attribute `attr` on node `hNode` from corresponding attribute of `value`.



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

### See also:

[CUaccessPolicyWindow](#)

## CUresult cuGraphKernelNodeSetParams (CUgraphNode hNode, const CUDA\_KERNEL\_NODE\_PARAMS \*nodeParams)

Sets a kernel node's parameters.

### Parameters

**hNode**

- Node to set the parameters for

**nodeParams**

- Parameters to copy

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_OUT\_OF\_MEMORY

**Description**

Sets the parameters of kernel node `hNode` to `nodeParams`.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

`cuLaunchKernel`, `cuGraphAddKernelNode`, `cuGraphKernelNodeGetParams`

## CUresult cuGraphLaunch (CUgraphExec hGraphExec, CUstream hStream)

Launches an executable graph in a stream.

**Parameters****hGraphExec**

- Executable graph to launch

**hStream**

- Stream in which to launch the graph

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE

**Description**

Executes `hGraphExec` in `hStream`. Only one instance of `hGraphExec` may be executing at a time. Each launch is ordered behind both any previous work in `hStream` and any previous launches of `hGraphExec`. To execute a graph concurrently, it must be instantiated multiple times into multiple executable graphs.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.



See also:

[cuGraphInstantiate](#), [cuGraphExecDestroy](#)

## CUresult cuGraphMemcpyNodeGetParams (CUgraphNode hNode, CUDA\_MEMCPY3D \*nodeParams)

Returns a memcpy node's parameters.

### Parameters

#### hNode

- Node to get the parameters for

#### nodeParams

- Pointer to return the parameters

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#)

### Description

Returns the parameters of memcpy node hNode in nodeParams.



- ▶ Graph objects are not threadsafe. [More here](#).
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cuMemcpy3D](#), [cuGraphAddMemcpyNode](#), [cuGraphMemcpyNodeSetParams](#)

## CUresult cuGraphMemcpyNodeSetParams (CUgraphNode hNode, const CUDA\_MEMCPY3D \*nodeParams)

Sets a memcpy node's parameters.

### Parameters

#### hNode

- Node to set the parameters for

#### nodeParams

- Parameters to copy

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE,

**Description**

Sets the parameters of memcpy node `hNode` to `nodeParams`.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

`cuMemcpy3D`, `cuGraphAddMemcpyNode`, `cuGraphMemcpyNodeGetParams`

## CUresult cuGraphMemsetNodeGetParams (CUgraphNode hNode, CUDA\_MEMSET\_NODE\_PARAMS \*nodeParams)

Returns a memset node's parameters.

**Parameters****hNode**

- Node to get the parameters for

**nodeParams**

- Pointer to return the parameters

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE

**Description**

Returns the parameters of memset node `hNode` in `nodeParams`.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

`cuMemsetD2D32`, `cuGraphAddMemsetNode`, `cuGraphMemsetNodeSetParams`

## CUresult cuGraphMemsetNodeSetParams (CUgraphNode hNode, const CUDA\_MEMSET\_NODE\_PARAMS \*nodeParams)

Sets a memset node's parameters.

### Parameters

#### hNode

- Node to set the parameters for

#### nodeParams

- Parameters to copy

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE

### Description

Sets the parameters of memset node hNode to nodeParams.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cuMemsetD2D32](#), [cuGraphAddMemsetNode](#), [cuGraphMemsetNodeGetParams](#)

## CUresult cuGraphNodeFindInClone (CUgraphNode \*phNode, CUgraphNode hOriginalNode, CUgraph hClonedGraph)

Finds a cloned version of a node.

### Parameters

#### phNode

- Returns handle to the cloned node

#### hOriginalNode

- Handle to the original node

#### hClonedGraph

- Cloned graph to query

**Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_VALUE`,

**Description**

This function returns the node in `hClonedGraph` corresponding to `hOriginalNode` in the original graph.

`hClonedGraph` must have been cloned from `hOriginalGraph` via [cuGraphClone](#). `hOriginalNode` must have been in `hOriginalGraph` at the time of the call to [cuGraphClone](#), and the corresponding cloned node in `hClonedGraph` must not have been removed. The cloned node is then returned via `phClonedNode`.



- ▶ Graph objects are not threadsafe. [More here](#).
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

[cuGraphClone](#)

## CUresult cuGraphNodeGetDependencies (CUgraphNode hNode, CUgraphNode \*dependencies, size\_t \*numDependencies)

Returns a node's dependencies.

**Parameters****hNode**

- Node to query

**dependencies**

- Pointer to return the dependencies

**numDependencies**

- See description

**Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_VALUE`

**Description**

Returns a list of node's dependencies. `dependencies` may be NULL, in which case this function will return the number of dependencies in `numDependencies`.

Otherwise, `numDependencies` entries will be filled in. If `numDependencies` is higher than the actual number of dependencies, the remaining entries in `dependencies` will be set to `NULL`, and the number of nodes actually obtained will be returned in `numDependencies`.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

`cuGraphNodeGetDependentNodes`, `cuGraphGetNodes`, `cuGraphGetRootNodes`, `cuGraphGetEdges`, `cuGraphAddDependencies`, `cuGraphRemoveDependencies`

## CUresult cuGraphNodeGetDependentNodes (CUgraphNode hNode, CUgraphNode \*dependentNodes, size\_t \*numDependentNodes)

Returns a node's dependent nodes.

### Parameters

#### **hNode**

- Node to query

#### **dependentNodes**

- Pointer to return the dependent nodes

#### **numDependentNodes**

- See description

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_VALUE`

### Description

Returns a list of node's dependent nodes. `dependentNodes` may be `NULL`, in which case this function will return the number of dependent nodes in `numDependentNodes`. Otherwise, `numDependentNodes` entries will be filled in. If `numDependentNodes` is higher than the actual number of dependent nodes, the remaining entries in `dependentNodes` will be set to `NULL`, and the number of nodes actually obtained will be returned in `numDependentNodes`.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cuGraphNodeGetDependencies](#), [cuGraphGetNodes](#), [cuGraphGetRootNodes](#),  
[cuGraphGetEdges](#), [cuGraphAddDependencies](#), [cuGraphRemoveDependencies](#)

## CUresult cuGraphNodeGetType (CUgraphNode hNode, CUgraphNodeType \*type)

Returns a node's type.

#### Parameters

##### hNode

- Node to query

##### type

- Pointer to return the node type

#### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#)

#### Description

Returns the node type of hNode in type.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cuGraphGetNodes](#), [cuGraphGetRootNodes](#), [cuGraphChildGraphNodeGetGraph](#),  
[cuGraphKernelNodeGetParams](#), [cuGraphKernelNodeSetParams](#),  
[cuGraphHostNodeGetParams](#), [cuGraphHostNodeSetParams](#),  
[cuGraphMemcpyNodeGetParams](#), [cuGraphMemcpyNodeSetParams](#),  
[cuGraphMemsetNodeGetParams](#), [cuGraphMemsetNodeSetParams](#)

## CUresult cuGraphRemoveDependencies (CUgraph hGraph, const CUgraphNode \*from, const CUgraphNode \*to, size\_t numDependencies)

Removes dependency edges from a graph.

### Parameters

#### hGraph

- Graph from which to remove dependencies

#### from

- Array of nodes that provide the dependencies

#### to

- Array of dependent nodes

#### numDependencies

- Number of dependencies to be removed

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_VALUE

### Description

The number of dependencies to be removed is defined by numDependencies.

Elements in from and to at corresponding indices define a dependency. Each node in from and to must belong to hGraph.

If numDependencies is 0, elements in from and to will be ignored. Specifying a non-existing dependency will return an error.



- ▶ Graph objects are not threadsafe. [More here.](#)
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cuGraphAddDependencies](#), [cuGraphGetEdges](#), [cuGraphNodeGetDependencies](#), [cuGraphNodeGetDependentNodes](#)

## 5.21. Occupancy

This section describes the occupancy calculation functions of the low-level CUDA driver application programming interface.

### CUresult cuOccupancyAvailableDynamicSMemPerBlock (size\_t \*dynamicSmemSize, CUfunction func, int numBlocks, int blockSize)

Returns dynamic shared memory available per block when launching `numBlocks` blocks on SM.

#### Parameters

##### **dynamicSmemSize**

- Returned maximum dynamic shared memory

##### **func**

- Kernel function for which occupancy is calculated

##### **numBlocks**

- Number of blocks to fit on SM

##### **blockSize**

- Size of the blocks

#### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_UNKNOWN

#### Description

Returns in `*dynamicSmemSize` the maximum size of dynamic shared memory to allow `numBlocks` blocks per SM.



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

See also:



## CUresult cuOccupancyMaxActiveBlocksPerMultiprocessor (int \*numBlocks, CUfunction func, int blockSize, size\_t dynamicSMemSize)

Returns occupancy of a function.

### Parameters

#### numBlocks

- Returned occupancy

#### func

- Kernel for which occupancy is calculated

#### blockSize

- Block size the kernel is intended to be launched with

#### dynamicSMemSize

- Per-block dynamic shared memory usage intended, in bytes

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_UNKNOWN

### Description

Returns in \*numBlocks the number of the maximum active blocks per streaming multiprocessor.



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

### See also:

[cudaOccupancyMaxActiveBlocksPerMultiprocessor](#)

## CUresult cuOccupancyMaxActiveBlocksPerMultiprocessorWithFlags

(int \*numBlocks, CUfunction func, int blockSize, size\_t dynamicSMemSize, unsigned int flags)

Returns occupancy of a function.

### Parameters

#### numBlocks

- Returned occupancy

#### func

- Kernel for which occupancy is calculated

#### blockSize

- Block size the kernel is intended to be launched with

#### dynamicSMemSize

- Per-block dynamic shared memory usage intended, in bytes

#### flags

- Requested behavior for the occupancy calculator

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_UNKNOWN

### Description

Returns in \*numBlocks the number of the maximum active blocks per streaming multiprocessor.

The Flags parameter controls how special cases are handled. The valid flags are:

- ▶ **CU\_OCCUPANCY\_DEFAULT**, which maintains the default behavior as `cuOccupancyMaxActiveBlocksPerMultiprocessor`;
- ▶ **CU\_OCCUPANCY\_DISABLE\_CACHING\_OVERRIDE**, which suppresses the default behavior on platform where global caching affects occupancy. On such platforms, if caching is enabled, but per-block SM resource usage would result in zero occupancy, the occupancy calculator will calculate the occupancy as if caching is disabled. Setting **CU\_OCCUPANCY\_DISABLE\_CACHING\_OVERRIDE** makes the occupancy calculator to return 0 in such cases. More information can be found about this feature in the "Unified L1/Texture Cache" section of the Maxwell tuning guide.



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

See also:

[cudaOccupancyMaxActiveBlocksPerMultiprocessorWithFlags](#)

**CUresult cuOccupancyMaxPotentialBlockSize (int \*minGridSize, int \*blockSize, CUfunction func, CUoccupancyB2DSize blockSizeToDynamicSMemSize, size\_t dynamicSMemSize, int blockSizeLimit)**

Suggest a launch configuration with reasonable occupancy.

### Parameters

#### **minGridSize**

- Returned minimum grid size needed to achieve the maximum occupancy

#### **blockSize**

- Returned maximum block size that can achieve the maximum occupancy

#### **func**

- Kernel for which launch configuration is calculated

#### **blockSizeToDynamicSMemSize**

- A function that calculates how much per-block dynamic shared memory `func` uses based on the block size

#### **dynamicSMemSize**

- Dynamic shared memory usage intended, in bytes

#### **blockSizeLimit**

- The maximum block size `func` is designed to handle

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#), [CUDA\\_ERROR\\_UNKNOWN](#)

### Description

Returns in `*blockSize` a reasonable block size that can achieve the maximum occupancy (or, the maximum number of active warps with the fewest blocks per multiprocessor), and in `*minGridSize` the minimum grid size to achieve the maximum occupancy.

If `blockSizeLimit` is 0, the configurator will use the maximum block size permitted by the device / function instead.

If per-block dynamic shared memory allocation is not needed, the user should leave both `blockSizeToDynamicSMemSize` and `dynamicSMemSize` as 0.

If per-block dynamic shared memory allocation is needed, then if the dynamic shared memory size is constant regardless of block size, the size should be passed through `dynamicSMemSize`, and `blockSizeToDynamicSMemSize` should be `NULL`.

Otherwise, if the per-block dynamic shared memory size varies with different block sizes, the user needs to provide a unary function through `blockSizeToDynamicSMemSize` that computes the dynamic shared memory needed by `func` for any given block size. `dynamicSMemSize` is ignored. An example signature is:

```
↑ // Take block size, returns dynamic shared memory needed
   size_t blockSizeToSmem(int blockSize);
```



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

See also:

[cudaOccupancyMaxPotentialBlockSize](#)

## CUresult cuOccupancyMaxPotentialBlockSizeWithFlags (int \*minGridSize, int \*blockSize, CUfunction func, CUoccupancyB2DSize blockSizeToDynamicSMemSize, size\_t dynamicSMemSize, int blockSizeLimit, unsigned int flags)

Suggest a launch configuration with reasonable occupancy.

### Parameters

#### **minGridSize**

- Returned minimum grid size needed to achieve the maximum occupancy

#### **blockSize**

- Returned maximum block size that can achieve the maximum occupancy

#### **func**

- Kernel for which launch configuration is calculated

#### **blockSizeToDynamicSMemSize**

- A function that calculates how much per-block dynamic shared memory `func` uses based on the block size

#### **dynamicSMemSize**

- Dynamic shared memory usage intended, in bytes

#### **blockSizeLimit**

- The maximum block size `func` is designed to handle

**flags**

- Options

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_UNKNOWN

**Description**

An extended version of `cuOccupancyMaxPotentialBlockSize`. In addition to arguments passed to `cuOccupancyMaxPotentialBlockSize`, `cuOccupancyMaxPotentialBlockSizeWithFlags` also takes a `Flags` parameter.

The `Flags` parameter controls how special cases are handled. The valid flags are:

- ▶ `CU_OCCUPANCY_DEFAULT`, which maintains the default behavior as `cuOccupancyMaxPotentialBlockSize`;
- ▶ `CU_OCCUPANCY_DISABLE_CACHING_OVERRIDE`, which suppresses the default behavior on platform where global caching affects occupancy. On such platforms, the launch configurations that produces maximal occupancy might not support global caching. Setting `CU_OCCUPANCY_DISABLE_CACHING_OVERRIDE` guarantees that the the produced launch configuration is global caching compatible at a potential cost of occupancy. More information can be found about this feature in the "Unified L1/Texture Cache" section of the Maxwell tuning guide.



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

**See also:**

`cudaOccupancyMaxPotentialBlockSizeWithFlags`

## 5.22. Texture Reference Management [DEPRECATED]

This section describes the deprecated texture reference management functions of the low-level CUDA driver application programming interface.

## CUresult cuTexRefCreate (CUtexref \*pTexRef)

Creates a texture reference.

### Parameters

#### pTexRef

- Returned texture reference

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

#### Deprecated

Creates a texture reference and returns its handle in \*pTexRef. Once created, the application must call [cuTexRefSetArray\(\)](#) or [cuTexRefSetAddress\(\)](#) to associate the reference with allocated memory. Other texture reference functions are used to specify the format and interpretation (addressing, filtering, etc.) to be used when the memory is read through this texture reference.

### See also:

[cuTexRefDestroy](#)

## CUresult cuTexRefDestroy (CUtexref hTexRef)

Destroys a texture reference.

### Parameters

#### hTexRef

- Texture reference to destroy

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

#### Deprecated

Destroys the texture reference specified by hTexRef.

See also:

[cuTexRefCreate](#)

## CUresult cuTexRefGetAddress (CUdeviceptr \*pdptr, CUtexref hTexRef)

Gets the address associated with a texture reference.

### Parameters

**pdptr**

- Returned device address

**hTexRef**

- Texture reference

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

Deprecated

Returns in \*pdptr the base address bound to the texture reference hTexRef, or returns [CUDA\\_ERROR\\_INVALID\\_VALUE](#) if the texture reference is not bound to any device memory range.

See also:

[cuTexRefSetAddress](#), [cuTexRefSetAddress2D](#), [cuTexRefSetAddressMode](#),  
[cuTexRefSetArray](#), [cuTexRefSetFilterMode](#), [cuTexRefSetFlags](#), [cuTexRefSetFormat](#),  
[cuTexRefGetAddressMode](#), [cuTexRefGetArray](#), [cuTexRefGetFilterMode](#),  
[cuTexRefGetFlags](#), [cuTexRefGetFormat](#)

## CUresult cuTexRefGetAddressMode (CUaddress\_mode \*pam, CUtexref hTexRef, int dim)

Gets the addressing mode used by a texture reference.

### Parameters

**pam**

- Returned addressing mode

**hTexRef**

- Texture reference

**dim**

- Dimension

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

**Description**

Deprecated

Returns in \*pam the addressing mode corresponding to the dimension dim of the texture reference hTexRef. Currently, the only valid value for dim are 0 and 1.

**See also:**

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode,  
cuTexRefSetArray, cuTexRefSetFilterMode, cuTexRefSetFlags, cuTexRefSetFormat,  
cuTexRefGetAddress, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags,  
cuTexRefGetFormat

## CUresult cuTexRefGetArray (CUarray \*phArray, CUtexref hTexRef)

Gets the array bound to a texture reference.

**Parameters****phArray**

- Returned array

**hTexRef**

- Texture reference

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

**Description**

Deprecated



Returns in `*pArray` the CUDA array bound to the texture reference `hTexRef`, or returns `CUDA_ERROR_INVALID_VALUE` if the texture reference is not bound to any CUDA array.

**See also:**

`cuTexRefSetAddress`, `cuTexRefSetAddress2D`, `cuTexRefSetAddressMode`,  
`cuTexRefSetArray`, `cuTexRefSetFilterMode`, `cuTexRefSetFlags`, `cuTexRefSetFormat`,  
`cuTexRefGetAddress`, `cuTexRefGetAddressMode`, `cuTexRefGetFilterMode`,  
`cuTexRefGetFlags`, `cuTexRefGetFormat`

## CUresult cuTexRefGetBorderColor (float \*pBorderColor, CUtexref hTexRef)

Gets the border color used by a texture reference.

**Parameters**

**pBorderColor**

- Returned Type and Value of RGBA color

**hTexRef**

- Texture reference

**Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`

**Description**

Deprecated

Returns in `pBorderColor`, values of the RGBA color used by the texture reference `hTexRef`. The color value is of type float and holds color components in the following sequence: `pBorderColor[0]` holds 'R' component `pBorderColor[1]` holds 'G' component `pBorderColor[2]` holds 'B' component `pBorderColor[3]` holds 'A' component

**See also:**

`cuTexRefSetAddressMode`, `cuTexRefSetAddressMode`, `cuTexRefSetBorderColor`

## CUresult cuTexRefGetFilterMode (CUfilter\_mode \*pfm, CUtexref hTexRef)

Gets the filter-mode used by a texture reference.

### Parameters

#### **pfm**

- Returned filtering mode

#### **hTexRef**

- Texture reference

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

Deprecated

Returns in \*pfm the filtering mode of the texture reference hTexRef.

### See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode,  
cuTexRefSetArray, cuTexRefSetFilterMode, cuTexRefSetFlags, cuTexRefSetFormat,  
cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFlags,  
cuTexRefGetFormat

## CUresult cuTexRefGetFlags (unsigned int \*pFlags, CUtexref hTexRef)

Gets the flags used by a texture reference.

### Parameters

#### **pFlags**

- Returned flags

#### **hTexRef**

- Texture reference

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description**

Deprecated

Returns in `*pFlags` the flags of the texture reference `hTexRef`.

**See also:**

`cuTexRefSetAddress`, `cuTexRefSetAddress2D`, `cuTexRefSetAddressMode`,  
`cuTexRefSetArray`, `cuTexRefSetFilterMode`, `cuTexRefSetFlags`, `cuTexRefSetFormat`,  
`cuTexRefGetAddress`, `cuTexRefGetAddressMode`, `cuTexRefGetArray`,  
`cuTexRefGetFilterMode`, `cuTexRefGetFormat`

## CUresult cuTexRefGetFormat (CUarray\_format \*pFormat, int \*pNumChannels, CUtexref hTexRef)

Gets the format used by a texture reference.

**Parameters****pFormat**

- Returned format

**pNumChannels**

- Returned number of components

**hTexRef**

- Texture reference

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description**

Deprecated

Returns in `*pFormat` and `*pNumChannels` the format and number of components of the CUDA array bound to the texture reference `hTexRef`. If `pFormat` or `pNumChannels` is NULL, it will be ignored.

**See also:**

`cuTexRefSetAddress`, `cuTexRefSetAddress2D`, `cuTexRefSetAddressMode`,  
`cuTexRefSetArray`, `cuTexRefSetFilterMode`, `cuTexRefSetFlags`, `cuTexRefSetFormat`,  
`cuTexRefGetAddress`, `cuTexRefGetAddressMode`, `cuTexRefGetArray`,  
`cuTexRefGetFilterMode`, `cuTexRefGetFlags`

## **CUresult cuTexRefGetMaxAnisotropy (int \*pmaxAniso, CUtexref hTexRef)**

Gets the maximum anisotropy for a texture reference.

### **Parameters**

#### **pmaxAniso**

- Returned maximum anisotropy

#### **hTexRef**

- Texture reference

### **Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`

### **Description**

#### **Deprecated**

Returns the maximum anisotropy in `pmaxAniso` that's used when reading memory through the texture reference `hTexRef`.

### **See also:**

`cuTexRefSetAddress`, `cuTexRefSetAddress2D`, `cuTexRefSetAddressMode`,  
`cuTexRefSetArray`, `cuTexRefSetFlags`, `cuTexRefSetFormat`, `cuTexRefGetAddress`,  
`cuTexRefGetAddressMode`, `cuTexRefGetArray`, `cuTexRefGetFilterMode`,  
`cuTexRefGetFlags`, `cuTexRefGetFormat`

## **CUresult cuTexRefGetMipmapFilterMode (CUfilter\_mode \*pfm, CUtexref hTexRef)**

Gets the mipmap filtering mode for a texture reference.

### **Parameters**

#### **pfm**

- Returned mipmap filtering mode

**hTexRef**

- Texture reference

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

**Description**

Deprecated

Returns the mipmap filtering mode in `pfm` that's used when reading memory through the texture reference `hTexRef`.

**See also:**

`cuTexRefSetAddress`, `cuTexRefSetAddress2D`, `cuTexRefSetAddressMode`,  
`cuTexRefSetArray`, `cuTexRefSetFlags`, `cuTexRefSetFormat`, `cuTexRefGetAddress`,  
`cuTexRefGetAddressMode`, `cuTexRefGetArray`, `cuTexRefGetFilterMode`,  
`cuTexRefGetFlags`, `cuTexRefGetFormat`

## CUresult cuTexRefGetMipmapLevelBias (float \*pbias, CUtexref hTexRef)

Gets the mipmap level bias for a texture reference.

**Parameters****pbias**

- Returned mipmap level bias

**hTexRef**

- Texture reference

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

**Description**

Deprecated

Returns the mipmap level bias in `pBias` that's added to the specified mipmap level when reading memory through the texture reference `hTexRef`.

**See also:**

[cuTexRefSetAddress](#), [cuTexRefSetAddress2D](#), [cuTexRefSetAddressMode](#),  
[cuTexRefSetArray](#), [cuTexRefSetFlags](#), [cuTexRefSetFormat](#), [cuTexRefGetAddress](#),  
[cuTexRefGetAddressMode](#), [cuTexRefGetArray](#), [cuTexRefGetFilterMode](#),  
[cuTexRefGetFlags](#), [cuTexRefGetFormat](#)

## CUresult cuTexRefGetMipmapLevelClamp (float \*pminMipmapLevelClamp, float \*pmaxMipmapLevelClamp, CUtexref hTexRef)

Gets the min/max mipmap level clamps for a texture reference.

**Parameters****pminMipmapLevelClamp**

- Returned mipmap min level clamp

**pmaxMipmapLevelClamp**

- Returned mipmap max level clamp

**hTexRef**

- Texture reference

**Returns**

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#)

**Description****Deprecated**

Returns the min/max mipmap level clamps in `pminMipmapLevelClamp` and `pmaxMipmapLevelClamp` that's used when reading memory through the texture reference `hTexRef`.

**See also:**

[cuTexRefSetAddress](#), [cuTexRefSetAddress2D](#), [cuTexRefSetAddressMode](#),  
[cuTexRefSetArray](#), [cuTexRefSetFlags](#), [cuTexRefSetFormat](#), [cuTexRefGetAddress](#),  
[cuTexRefGetAddressMode](#), [cuTexRefGetArray](#), [cuTexRefGetFilterMode](#),  
[cuTexRefGetFlags](#), [cuTexRefGetFormat](#)

## CUresult cuTexRefGetMipmappedArray (CUmipmappedArray \*phMipmappedArray, CUtexref hTexRef)

Gets the mipmapped array bound to a texture reference.

### Parameters

#### phMipmappedArray

- Returned mipmapped array

#### hTexRef

- Texture reference

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

#### Deprecated

Returns in \*phMipmappedArray the CUDA mipmapped array bound to the texture reference hTexRef, or returns [CUDA\\_ERROR\\_INVALID\\_VALUE](#) if the texture reference is not bound to any CUDA mipmapped array.

### See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode,  
cuTexRefSetArray, cuTexRefSetFilterMode, cuTexRefSetFlags, cuTexRefSetFormat,  
cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetFilterMode,  
cuTexRefGetFlags, cuTexRefGetFormat

## CUresult cuTexRefSetAddress (size\_t \*ByteOffset, CUtexref hTexRef, CUdeviceptr dptr, size\_t bytes)

Binds an address as a texture reference.

### Parameters

#### ByteOffset

- Returned byte offset

#### hTexRef

- Texture reference to bind

**dptr**

- Device pointer to bind

**bytes**

- Size of memory to bind in bytes

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description****Deprecated**

Binds a linear address range to the texture reference `hTexRef`. Any previous address or CUDA array state associated with the texture reference is superseded by this function. Any memory previously bound to `hTexRef` is unbound.

Since the hardware enforces an alignment requirement on texture base addresses, `cuTexRefSetAddress()` passes back a byte offset in `*ByteOffset` 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 `cuMemAlloc()`, the offset is guaranteed to be 0 and NULL may be passed as the `ByteOffset` parameter.

The total number of elements (or texels) in the linear address range cannot exceed `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_LINEAR_WIDTH`. The number of elements is computed as  $(\text{bytes} / \text{bytesPerElement})$ , where `bytesPerElement` is determined from the data format and number of components set using `cuTexRefSetFormat()`.

**See also:**

`cuTexRefSetAddress2D`, `cuTexRefSetAddressMode`, `cuTexRefSetArray`,  
`cuTexRefSetFilterMode`, `cuTexRefSetFlags`, `cuTexRefSetFormat`, `cuTexRefGetAddress`,  
`cuTexRefGetAddressMode`, `cuTexRefGetArray`, `cuTexRefGetFilterMode`,  
`cuTexRefGetFlags`, `cuTexRefGetFormat`, `cudaBindTexture`



## CUresult cuTexRefSetAddress2D (CUtexref hTexRef, const CUDA\_ARRAY\_DESCRIPTOR \*desc, CUdeviceptr dptr, size\_t Pitch)

Binds an address as a 2D texture reference.

### Parameters

#### **hTexRef**

- Texture reference to bind

#### **desc**

- Descriptor of CUDA array

#### **dptr**

- Device pointer to bind

#### **Pitch**

- Line pitch in bytes

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_VALUE

### Description

#### Deprecated

Binds a linear address range to the texture reference `hTexRef`. Any previous address or CUDA array state associated with the texture reference is superseded by this function. Any memory previously bound to `hTexRef` is unbound.

Using a `tex2D()` function inside a kernel requires a call to either `cuTexRefSetArray()` to bind the corresponding texture reference to an array, or `cuTexRefSetAddress2D()` to bind the texture reference to linear memory.

Function calls to `cuTexRefSetFormat()` cannot follow calls to `cuTexRefSetAddress2D()` for the same texture reference.

It is required that `dptr` be aligned to the appropriate hardware-specific texture alignment. You can query this value using the device attribute `CU_DEVICE_ATTRIBUTE_TEXTURE_ALIGNMENT`. If an unaligned `dptr` is supplied, `CUDA_ERROR_INVALID_VALUE` is returned.

`Pitch` has to be aligned to the hardware-specific texture pitch alignment. This value can be queried using the device attribute `CU_DEVICE_ATTRIBUTE_TEXTURE_PITCH_ALIGNMENT`. If an unaligned `Pitch` is supplied, `CUDA_ERROR_INVALID_VALUE` is returned.

Width and Height, which are specified in elements (or texels), cannot exceed `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_WIDTH` and `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_HEIGHT` respectively. Pitch, which is specified in bytes, cannot exceed `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_PITCH`.

#### See also:

`cuTexRefSetAddress`, `cuTexRefSetAddressMode`, `cuTexRefSetArray`,  
`cuTexRefSetFilterMode`, `cuTexRefSetFlags`, `cuTexRefSetFormat`, `cuTexRefGetAddress`,  
`cuTexRefGetAddressMode`, `cuTexRefGetArray`, `cuTexRefGetFilterMode`,  
`cuTexRefGetFlags`, `cuTexRefGetFormat`, `cudaBindTexture2D`

## CUresult cuTexRefSetAddressMode (CUtexref hTexRef, int dim, CUaddress\_mode am)

Sets the addressing mode for a texture reference.

#### Parameters

##### hTexRef

- Texture reference

##### dim

- Dimension

##### am

- Addressing mode to set

#### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`

#### Description

##### Deprecated

Specifies the addressing mode `am` for the given dimension `dim` of the texture reference `hTexRef`. If `dim` is zero, the addressing mode is applied to the first parameter of the functions used to fetch from the texture; if `dim` is 1, the second, and so on.

`CUaddress_mode` is defined as:

```
↑ typedef enum CUaddress_mode_enum {
    CU_TR_ADDRESS_MODE_WRAP = 0,
    CU_TR_ADDRESS_MODE_CLAMP = 1,
    CU_TR_ADDRESS_MODE_MIRROR = 2,
    CU_TR_ADDRESS_MODE_BORDER = 3
} CUaddress_mode;
```

Note that this call has no effect if `hTexRef` is bound to linear memory. Also, if the flag, `CU_TRSF_NORMALIZED_COORDINATES`, is not set, the only supported address mode is `CU_TR_ADDRESS_MODE_CLAMP`.

**See also:**

`cuTexRefSetAddress`, `cuTexRefSetAddress2D`, `cuTexRefSetArray`,  
`cuTexRefSetFilterMode`, `cuTexRefSetFlags`, `cuTexRefSetFormat`, `cuTexRefGetAddress`,  
`cuTexRefGetAddressMode`, `cuTexRefGetArray`, `cuTexRefGetFilterMode`,  
`cuTexRefGetFlags`, `cuTexRefGetFormat`, `cudaBindTexture`, `cudaBindTexture2D`,  
`cudaBindTextureToArray`, `cudaBindTextureToMipmappedArray`

## CUresult cuTexRefSetArray (CUtexref hTexRef, CUarray hArray, unsigned int Flags)

Binds an array as a texture reference.

### Parameters

#### **hTexRef**

- Texture reference to bind

#### **hArray**

- Array to bind

#### **Flags**

- Options (must be `CU_TRSA_OVERRIDE_FORMAT`)

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`

### Description

#### Deprecated

Binds the CUDA array `hArray` to the texture reference `hTexRef`. Any previous address or CUDA array state associated with the texture reference is superseded by this function. `Flags` must be set to `CU_TRSA_OVERRIDE_FORMAT`. Any CUDA array previously bound to `hTexRef` is unbound.

**See also:**

`cuTexRefSetAddress`, `cuTexRefSetAddress2D`, `cuTexRefSetAddressMode`,  
`cuTexRefSetFilterMode`, `cuTexRefSetFlags`, `cuTexRefSetFormat`, `cuTexRefGetAddress`,

[cuTexRefGetAddressMode](#), [cuTexRefGetArray](#), [cuTexRefGetFilterMode](#),  
[cuTexRefGetFlags](#), [cuTexRefGetFormat](#), [cudaBindTextureToArray](#)

## CUresult cuTexRefSetBorderColor (CUtexref hTexRef, float \*pBorderColor)

Sets the border color for a texture reference.

### Parameters

#### **hTexRef**

- Texture reference

#### **pBorderColor**

- RGBA color

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#)

### Description

#### Deprecated

Specifies the value of the RGBA color via the `pBorderColor` to the texture reference `hTexRef`. The color value supports only float type and holds color components in the following sequence: `pBorderColor[0]` holds 'R' component `pBorderColor[1]` holds 'G' component `pBorderColor[2]` holds 'B' component `pBorderColor[3]` holds 'A' component

Note that the color values can be set only when the Address mode is set to `CU_TR_ADDRESS_MODE_BORDER` using [cuTexRefSetAddressMode](#). Applications using integer border color values have to "reinterpret\_cast" their values to float.

### See also:

[cuTexRefSetAddressMode](#), [cuTexRefGetAddressMode](#), [cuTexRefGetBorderColor](#),  
[cudaBindTexture](#), [cudaBindTexture2D](#), [cudaBindTextureToArray](#),  
[cudaBindTextureToMipmappedArray](#)

## CUresult cuTexRefSetFilterMode (CUtexref hTexRef, CUfilter\_mode fm)

Sets the filtering mode for a texture reference.

### Parameters

#### hTexRef

- Texture reference

#### fm

- Filtering mode to set

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

#### Deprecated

Specifies the filtering mode `fm` to be used when reading memory through the texture reference `hTexRef`. `CUfilter_mode_enum` is defined as:

```
typedef enum CUfilter_mode_enum {
    CU_TR_FILTER_MODE_POINT = 0,
    CU_TR_FILTER_MODE_LINEAR = 1
} CUfilter_mode;
```

Note that this call has no effect if `hTexRef` is bound to linear memory.

### See also:

`cuTexRefSetAddress`, `cuTexRefSetAddress2D`, `cuTexRefSetAddressMode`,  
`cuTexRefSetArray`, `cuTexRefSetFlags`, `cuTexRefSetFormat`, `cuTexRefGetAddress`,  
`cuTexRefGetAddressMode`, `cuTexRefGetArray`, `cuTexRefGetFilterMode`,  
`cuTexRefGetFlags`, `cuTexRefGetFormat`, `cudaBindTextureToArray`

## CUresult cuTexRefSetFlags (CUtexref hTexRef, unsigned int Flags)

Sets the flags for a texture reference.

### Parameters

#### hTexRef

- Texture reference

**Flags**

- Optional flags to set

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

**Description****Deprecated**

Specifies optional flags via `Flags` to specify the behavior of data returned through the texture reference `hTexRef`. The valid flags are:

- ▶ `CU_TRSF_READ_AS_INTEGER`, which suppresses the default behavior of having the texture promote integer data to floating point data in the range [0, 1]. Note that texture with 32-bit integer format would not be promoted, regardless of whether or not this flag is specified;
- ▶ `CU_TRSF_NORMALIZED_COORDINATES`, which suppresses the default behavior of having the texture coordinates range from [0, Dim) where Dim is the width or height of the CUDA array. Instead, the texture coordinates [0, 1.0) reference the entire breadth of the array dimension;
- ▶ `CU_TRSF_DISABLE_TRILINEAR_OPTIMIZATION`, which disables any trilinear filtering optimizations. Trilinear optimizations improve texture filtering performance by allowing bilinear filtering on textures in scenarios where it can closely approximate the expected results.

**See also:**

`cuTexRefSetAddress`, `cuTexRefSetAddress2D`, `cuTexRefSetAddressMode`,  
`cuTexRefSetArray`, `cuTexRefSetFilterMode`, `cuTexRefSetFormat`, `cuTexRefGetAddress`,  
`cuTexRefGetAddressMode`, `cuTexRefGetArray`, `cuTexRefGetFilterMode`,  
`cuTexRefGetFlags`, `cuTexRefGetFormat`, `cudaBindTexture`, `cudaBindTexture2D`,  
`cudaBindTextureToArray`, `cudaBindTextureToMipmappedArray`

## CUresult cuTexRefSetFormat (CUtexref hTexRef, CUarray\_format fmt, int NumPackedComponents)

Sets the format for a texture reference.

**Parameters****hTexRef**

- Texture reference

**fmt**

- Format to set

**NumPackedComponents**

- Number of components per array element

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description****Deprecated**

Specifies the format of the data to be read by the texture reference `hTexRef`. `fmt` and `NumPackedComponents` are exactly analogous to the `Format` and `NumChannels` members of the `CUDA_ARRAY_DESCRIPTOR` structure: They specify the format of each component and the number of components per array element.

**See also:**

`cuTexRefSetAddress`, `cuTexRefSetAddress2D`, `cuTexRefSetAddressMode`,  
`cuTexRefSetArray`, `cuTexRefSetFilterMode`, `cuTexRefSetFlags`, `cuTexRefGetAddress`,  
`cuTexRefGetAddressMode`, `cuTexRefGetArray`, `cuTexRefGetFilterMode`,  
`cuTexRefGetFlags`, `cuTexRefGetFormat`, `cudaCreateChannelDesc`, `cudaBindTexture`,  
`cudaBindTexture2D`, `cudaBindTextureToArray`, `cudaBindTextureToMipmappedArray`

## CUresult cuTexRefSetMaxAnisotropy (CUtexref hTexRef, unsigned int maxAniso)

Sets the maximum anisotropy for a texture reference.

**Parameters****hTexRef**

- Texture reference

**maxAniso**

- Maximum anisotropy

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description****Deprecated**

Specifies the maximum anisotropy `maxAniso` to be used when reading memory through the texture reference `hTexRef`.

Note that this call has no effect if `hTexRef` is bound to linear memory.

**See also:**

`cuTexRefSetAddress`, `cuTexRefSetAddress2D`, `cuTexRefSetAddressMode`, `cuTexRefSetArray`, `cuTexRefSetFlags`, `cuTexRefSetFormat`, `cuTexRefGetAddress`, `cuTexRefGetAddressMode`, `cuTexRefGetArray`, `cuTexRefGetFilterMode`, `cuTexRefGetFlags`, `cuTexRefGetFormat`, `cudaBindTextureToArray`, `cudaBindTextureToMipmappedArray`

## CUresult cuTexRefSetMipmapFilterMode (CUtexref hTexRef, CUfilter\_mode fm)

Sets the mipmap filtering mode for a texture reference.

**Parameters****hTexRef**

- Texture reference

**fm**

- Filtering mode to set

**Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`, `CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`, `CUDA_ERROR_INVALID_VALUE`

**Description****Deprecated**

Specifies the mipmap filtering mode `fm` to be used when reading memory through the texture reference `hTexRef`. `CUfilter_mode_enum` is defined as:

```
↑ typedef enum CUfilter_mode_enum {
    CU_TR_FILTER_MODE_POINT = 0,
    CU_TR_FILTER_MODE_LINEAR = 1
} CUfilter_mode;
```

Note that this call has no effect if `hTexRef` is not bound to a mipmapped array.

**See also:**



[cuTexRefSetAddress](#), [cuTexRefSetAddress2D](#), [cuTexRefSetAddressMode](#),  
[cuTexRefSetArray](#), [cuTexRefSetFlags](#), [cuTexRefSetFormat](#), [cuTexRefGetAddress](#),  
[cuTexRefGetAddressMode](#), [cuTexRefGetArray](#), [cuTexRefGetFilterMode](#),  
[cuTexRefGetFlags](#), [cuTexRefGetFormat](#), [cudaBindTextureToMipmappedArray](#)

## CUresult cuTexRefSetMipmapLevelBias (CUtexref hTexRef, float bias)

Sets the mipmap level bias for a texture reference.

### Parameters

#### **hTexRef**

- Texture reference

#### **bias**

- Mipmap level bias

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#)

### Description

#### Deprecated

Specifies the mipmap level bias `bias` to be added to the specified mipmap level when reading memory through the texture reference `hTexRef`.

Note that this call has no effect if `hTexRef` is not bound to a mipmapped array.

### See also:

[cuTexRefSetAddress](#), [cuTexRefSetAddress2D](#), [cuTexRefSetAddressMode](#),  
[cuTexRefSetArray](#), [cuTexRefSetFlags](#), [cuTexRefSetFormat](#), [cuTexRefGetAddress](#),  
[cuTexRefGetAddressMode](#), [cuTexRefGetArray](#), [cuTexRefGetFilterMode](#),  
[cuTexRefGetFlags](#), [cuTexRefGetFormat](#), [cudaBindTextureToMipmappedArray](#)

## CUresult cuTexRefSetMipmapLevelClamp (CUtexref hTexRef, float minMipmapLevelClamp, float maxMipmapLevelClamp)

Sets the mipmap min/max mipmap level clamps for a texture reference.

### Parameters

#### **hTexRef**

- Texture reference

#### **minMipmapLevelClamp**

- Mipmap min level clamp

#### **maxMipmapLevelClamp**

- Mipmap max level clamp

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

#### Deprecated

Specifies the min/max mipmap level clamps, minMipmapLevelClamp and maxMipmapLevelClamp respectively, to be used when reading memory through the texture reference hTexRef.

Note that this call has no effect if hTexRef is not bound to a mipmapped array.

### See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode,  
cuTexRefSetArray, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress,  
cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode,  
cuTexRefGetFlags, cuTexRefGetFormat, cudaBindTextureToMipmappedArray

## CUresult cuTexRefSetMipmappedArray (CUtexref hTexRef, CUmipmappedArray hMipmappedArray, unsigned int Flags)

Binds a mipmapped array to a texture reference.

### Parameters

#### hTexRef

- Texture reference to bind

#### hMipmappedArray

- Mipmapped array to bind

#### Flags

- Options (must be `CU_TRSA_OVERRIDE_FORMAT`)

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`

### Description

#### Deprecated

Binds the CUDA mipmapped array `hMipmappedArray` to the texture reference `hTexRef`. Any previous address or CUDA array state associated with the texture reference is superseded by this function. Flags must be set to `CU_TRSA_OVERRIDE_FORMAT`. Any CUDA array previously bound to `hTexRef` is unbound.

### See also:

`cuTexRefSetAddress`, `cuTexRefSetAddress2D`, `cuTexRefSetAddressMode`,  
`cuTexRefSetFilterMode`, `cuTexRefSetFlags`, `cuTexRefSetFormat`, `cuTexRefGetAddress`,  
`cuTexRefGetAddressMode`, `cuTexRefGetArray`, `cuTexRefGetFilterMode`,  
`cuTexRefGetFlags`, `cuTexRefGetFormat`, `cudaBindTextureToMipmappedArray`

## 5.23. Surface Reference Management [DEPRECATED]

This section describes the surface reference management functions of the low-level CUDA driver application programming interface.

## CUresult cuSurfRefGetArray (CUarray \*phArray, CUsurfref hSurfRef)

Passes back the CUDA array bound to a surface reference.

### Parameters

#### phArray

- Surface reference handle

#### hSurfRef

- Surface reference handle

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

#### Deprecated

Returns in \*phArray the CUDA array bound to the surface reference hSurfRef, or returns CUDA\_ERROR\_INVALID\_VALUE if the surface reference is not bound to any CUDA array.

### See also:

cuModuleGetSurfRef, cuSurfRefSetArray

## CUresult cuSurfRefSetArray (CUsurfref hSurfRef, CUarray hArray, unsigned int Flags)

Sets the CUDA array for a surface reference.

### Parameters

#### hSurfRef

- Surface reference handle

#### hArray

- CUDA array handle

#### Flags

- set to 0

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description****Deprecated**

Sets the CUDA array `hArray` to be read and written by the surface reference `hSurfRef`. Any previous CUDA array state associated with the surface reference is superseded by this function. `Flags` must be set to 0. The `CUDA_ARRAY3D_SURFACE_LDST` flag must have been set for the CUDA array. Any CUDA array previously bound to `hSurfRef` is unbound.

**See also:**

`cuModuleGetSurfRef`, `cuSurfRefGetArray`, `cudaBindSurfaceToArray`

## 5.24. Texture Object Management

This section describes the texture object management functions of the low-level CUDA driver application programming interface. The texture object API is only supported on devices of compute capability 3.0 or higher.

**CUresult cuTexObjectCreate (CUtexObject  
 \*pTexObject, const CUDA\_RESOURCE\_DESC \*pResDesc,  
 const CUDA\_TEXTURE\_DESC \*pTexDesc, const  
 CUDA\_RESOURCE\_VIEW\_DESC \*pResViewDesc)**

Creates a texture object.

**Parameters****pTexObject**

- Texture object to create

**pResDesc**

- Resource descriptor

**pTexDesc**

- Texture descriptor

**pResViewDesc**

- Resource view descriptor

## Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

## 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. Additionally, a texture object is an opaque value, and, as such, should only be accessed through CUDA API calls.

The `CUDA_RESOURCE_DESC` structure is defined as:

```
typedef struct CUDA_RESOURCE_DESC_st
{
    CUresourcetype resType;

    union {
        struct {
            CUarray hArray;
        } array;
        struct {
            CUmipmappedArray hMipmappedArray;
        } mipmap;
        struct {
            CUdeviceptr devPtr;
            CUarray_format format;
            unsigned int numChannels;
            size_t sizeInBytes;
        } linear;
        struct {
            CUdeviceptr devPtr;
            CUarray_format format;
            unsigned int numChannels;
            size_t width;
            size_t height;
            size_t pitchInBytes;
        } pitch2D;
    } res;

    unsigned int flags;
} CUDA_RESOURCE_DESC;
```

where:

- `CUDA_RESOURCE_DESC::resType` specifies the type of resource to texture from. `CUresourceType` is defined as:

```
typedef enum CUresourceType_enum {
    CU_RESOURCE_TYPE_ARRAY           = 0x00,
    CU_RESOURCE_TYPE_MIPMAPPED_ARRAY = 0x01,
    CU_RESOURCE_TYPE_LINEAR          = 0x02,
    CU_RESOURCE_TYPE_PITCH2D        = 0x03
} CUresourceType;
```

If `CUDA_RESOURCE_DESC::resType` is set to `CU_RESOURCE_TYPE_ARRAY`, `CUDA_RESOURCE_DESC::res::array::hArray` must be set to a valid CUDA array handle.

If `CUDA_RESOURCE_DESC::resType` is set to `CU_RESOURCE_TYPE_MIPMAPPED_ARRAY`, `CUDA_RESOURCE_DESC::res::mipmap::hMipmappedArray` must be set to a valid CUDA mipmapped array handle.

If `CUDA_RESOURCE_DESC::resType` is set to `CU_RESOURCE_TYPE_LINEAR`, `CUDA_RESOURCE_DESC::res::linear::devPtr` must be set to a valid device pointer, that is aligned to `CU_DEVICE_ATTRIBUTE_TEXTURE_ALIGNMENT`. `CUDA_RESOURCE_DESC::res::linear::format` and `CUDA_RESOURCE_DESC::res::linear::numChannels` describe the format of each component and the number of components per array element. `CUDA_RESOURCE_DESC::res::linear::sizeInBytes` specifies the size of the array in bytes. The total number of elements in the linear address range cannot exceed `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_LINEAR_WIDTH`. The number of elements is computed as  $(\text{sizeInBytes} / (\text{sizeof}(\text{format}) * \text{numChannels}))$ .

If `CUDA_RESOURCE_DESC::resType` is set to `CU_RESOURCE_TYPE_PITCH2D`, `CUDA_RESOURCE_DESC::res::pitch2D::devPtr` must be set to a valid device pointer, that is aligned to `CU_DEVICE_ATTRIBUTE_TEXTURE_ALIGNMENT`. `CUDA_RESOURCE_DESC::res::pitch2D::format` and `CUDA_RESOURCE_DESC::res::pitch2D::numChannels` describe the format of each component and the number of components per array element. `CUDA_RESOURCE_DESC::res::pitch2D::width` and `CUDA_RESOURCE_DESC::res::pitch2D::height` specify the width and height of the array in elements, and cannot exceed `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_WIDTH` and `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_HEIGHT` respectively. `CUDA_RESOURCE_DESC::res::pitch2D::pitchInBytes` specifies the pitch between two rows in bytes and has to be aligned to `CU_DEVICE_ATTRIBUTE_TEXTURE_PITCH_ALIGNMENT`. Pitch cannot exceed `CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_PITCH`.

- `flags` must be set to zero.

The `CUDA_TEXTURE_DESC` struct is defined as

```
typedef struct CUDA_TEXTURE_DESC_st {
    CUaddress_mode addressMode[3];
    CUfilter_mode filterMode;
    unsigned int flags;
    unsigned int maxAnisotropy;
    CUfilter_mode mipmapFilterMode;
    float mipmapLevelBias;
    float minMipmapLevelClamp;
    float maxMipmapLevelClamp;
} CUDA_TEXTURE_DESC;
```

where

- ▶ `CUDA_TEXTURE_DESC::addressMode` specifies the addressing mode for each dimension of the texture data. `CUaddress_mode` is defined as:

```
typedef enum CUaddress_mode_enum {
    CU_TR_ADDRESS_MODE_WRAP = 0,
    CU_TR_ADDRESS_MODE_CLAMP = 1,
    CU_TR_ADDRESS_MODE_MIRROR = 2,
    CU_TR_ADDRESS_MODE_BORDER = 3
} CUaddress_mode;
```

This is ignored if `CUDA_RESOURCE_DESC::resType` is `CU_RESOURCE_TYPE_LINEAR`. Also, if the flag, `CU_TRSF_NORMALIZED_COORDINATES` is not set, the only supported address mode is `CU_TR_ADDRESS_MODE_CLAMP`.

- ▶ `CUDA_TEXTURE_DESC::filterMode` specifies the filtering mode to be used when fetching from the texture. `CUfilter_mode` is defined as:

```
typedef enum CUfilter_mode_enum {
    CU_TR_FILTER_MODE_POINT = 0,
    CU_TR_FILTER_MODE_LINEAR = 1
} CUfilter_mode;
```

This is ignored if `CUDA_RESOURCE_DESC::resType` is `CU_RESOURCE_TYPE_LINEAR`.

- ▶ `CUDA_TEXTURE_DESC::flags` can be any combination of the following:
  - ▶ `CU_TRSF_READ_AS_INTEGER`, which suppresses the default behavior of having the texture promote integer data to floating point data in the range [0, 1]. Note that texture with 32-bit integer format would not be promoted, regardless of whether or not this flag is specified.
  - ▶ `CU_TRSF_NORMALIZED_COORDINATES`, which suppresses the default behavior of having the texture coordinates range from [0, Dim) where Dim is the width or height of the CUDA array. Instead, the texture coordinates [0, 1.0) reference the entire breadth of the array dimension; Note that for CUDA mipmapped arrays, this flag has to be set.
  - ▶ `CU_TRSF_DISABLE_TRILINEAR_OPTIMIZATION`, which disables any trilinear filtering optimizations. Trilinear optimizations improve texture filtering performance by allowing bilinear filtering on textures in scenarios where it can closely approximate the expected results.



- ▶ `CUDA_TEXTURE_DESC::maxAnisotropy` specifies the maximum anisotropy ratio to be used when doing anisotropic filtering. This value will be clamped to the range [1,16].
- ▶ `CUDA_TEXTURE_DESC::mipmapFilterMode` specifies the filter mode when the calculated mipmap level lies between two defined mipmap levels.
- ▶ `CUDA_TEXTURE_DESC::mipmapLevelBias` specifies the offset to be applied to the calculated mipmap level.
- ▶ `CUDA_TEXTURE_DESC::minMipmapLevelClamp` specifies the lower end of the mipmap level range to clamp access to.
- ▶ `CUDA_TEXTURE_DESC::maxMipmapLevelClamp` specifies the upper end of the mipmap level range to clamp access to.

The `CUDA_RESOURCE_VIEW_DESC` struct is defined as

```
↑
typedef struct CUDA_RESOURCE_VIEW_DESC_st
{
    CUresourceViewFormat format;
    size_t width;
    size_t height;
    size_t depth;
    unsigned int firstMipmapLevel;
    unsigned int lastMipmapLevel;
    unsigned int firstLayer;
    unsigned int lastLayer;
} CUDA_RESOURCE_VIEW_DESC;
```

where:

- ▶ `CUDA_RESOURCE_VIEW_DESC::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 base of format `CU_AD_FORMAT_UNSIGNED_INT32` with 2 or 4 channels, depending on the block compressed format. For ex., BC1 and BC4 require the underlying CUDA array to have a format of `CU_AD_FORMAT_UNSIGNED_INT32` with 2 channels. The other BC formats require the underlying resource to have the same base format but with 4 channels.
- ▶ `CUDA_RESOURCE_VIEW_DESC::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.
- ▶ `CUDA_RESOURCE_VIEW_DESC::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.

- ▶ `CUDA_RESOURCE_VIEW_DESC::depth` specifies the new depth of the texture data. This value has to be equal to that of the original resource.
- ▶ `CUDA_RESOURCE_VIEW_DESC::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. `CUDA_TEXTURE_DESC::minMipmapLevelClamp` and `CUDA_TEXTURE_DESC::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.
- ▶ `CUDA_RESOURCE_VIEW_DESC::lastMipmapLevel` specifies the least detailed mipmap level. For non-mipmapped resources, this value has to be zero.
- ▶ `CUDA_RESOURCE_VIEW_DESC::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.
- ▶ `CUDA_RESOURCE_VIEW_DESC::lastLayer` specifies the last layer index for layered textures. For non-layered resources, this value has to be zero.

See also:

`cuTexObjectDestroy`, `cudaCreateTextureObject`

## CUresult cuTexObjectDestroy (CUtexObject texObject)

Destroys a texture object.

### Parameters

#### texObject

- Texture object to destroy

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`

### Description

Destroys the texture object specified by `texObject`.

See also:

`cuTexObjectCreate`, `cudaDestroyTextureObject`

## CUresult cuTexObjectGetResourceDesc (CUDA\_RESOURCE\_DESC \*pResDesc, CUtexObject texObject)

Returns a texture object's resource descriptor.

### Parameters

#### pResDesc

- Resource descriptor

#### texObject

- Texture object

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

Returns the resource descriptor for the texture object specified by texObject.

### See also:

cuTexObjectCreate, cudaGetTextureObjectResourceDesc,

## CUresult cuTexObjectGetResourceViewDesc (CUDA\_RESOURCE\_VIEW\_DESC \*pResViewDesc, CUtexObject texObject)

Returns a texture object's resource view descriptor.

### Parameters

#### pResViewDesc

- Resource view descriptor

#### texObject

- Texture object

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

**Description**

Returns the resource view descriptor for the texture object specified by `texObject`. If no resource view was set for `texObject`, the `CUDA_ERROR_INVALID_VALUE` is returned.

**See also:**

`cuTexObjectCreate`, `cudaGetTextureObjectResourceViewDesc`

## **CUresult cuTexObjectGetTextureDesc (CUDA\_TEXTURE\_DESC \*pTexDesc, CUtexObject texObject)**

Returns a texture object's texture descriptor.

**Parameters****pTexDesc**

- Texture descriptor

**texObject**

- Texture object

**Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`

**Description**

Returns the texture descriptor for the texture object specified by `texObject`.

**See also:**

`cuTexObjectCreate`, `cudaGetTextureObjectTextureDesc`

## **5.25. Surface Object Management**

This section describes the surface object management functions of the low-level CUDA driver application programming interface. The surface object API is only supported on devices of compute capability 3.0 or higher.

## CUresult cuSurfObjectCreate (CUsurfObject \*pSurfObject, const CUDA\_RESOURCE\_DESC \*pResDesc)

Creates a surface object.

### Parameters

#### pSurfObject

- Surface object to create

#### pResDesc

- Resource descriptor

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

Creates a surface object and returns it in pSurfObject. pResDesc describes the data to perform surface load/stores on. CUDA\_RESOURCE\_DESC::resType must be CU\_RESOURCE\_TYPE\_ARRAY and CUDA\_RESOURCE\_DESC::res::array::hArray must be set to a valid CUDA array handle. CUDA\_RESOURCE\_DESC::flags must be set to zero.

Surface objects are only supported on devices of compute capability 3.0 or higher. Additionally, a surface object is an opaque value, and, as such, should only be accessed through CUDA API calls.

### See also:

[cuSurfObjectDestroy](#), [cudaCreateSurfaceObject](#)

## CUresult cuSurfObjectDestroy (CUsurfObject surfObject)

Destroys a surface object.

### Parameters

#### surfObject

- Surface object to destroy

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

**Description**

Destroys the surface object specified by `surfObject`.

**See also:**

[cuSurfObjectCreate](#), [cudaDestroySurfaceObject](#)

## CUresult cuSurfObjectGetResourceDesc (CUDA\_RESOURCE\_DESC \*pResDesc, CUsurfObject surfObject)

Returns a surface object's resource descriptor.

**Parameters****pResDesc**

- Resource descriptor

**surfObject**

- Surface object

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

**Description**

Returns the resource descriptor for the surface object specified by `surfObject`.

**See also:**

[cuSurfObjectCreate](#), [cudaGetSurfaceObjectResourceDesc](#)

## 5.26. Peer Context Memory Access

This section describes the direct peer context memory access functions of the low-level CUDA driver application programming interface.

## CUresult cuCtxDisablePeerAccess (CUcontext peerContext)

Disables direct access to memory allocations in a peer context and unregisters any registered allocations.

### Parameters

#### peerContext

- Peer context to disable direct access to

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED,  
CUDA\_ERROR\_PEER\_ACCESS\_NOT\_ENABLED,  
CUDA\_ERROR\_INVALID\_CONTEXT,

### Description

Returns [CUDA\\_ERROR\\_PEER\\_ACCESS\\_NOT\\_ENABLED](#) if direct peer access has not yet been enabled from `peerContext` to the current context.

Returns [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#) if there is no current context, or if `peerContext` is not a valid context.



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

### See also:

[cuDeviceCanAccessPeer](#), [cuCtxEnablePeerAccess](#), [cudaDeviceDisablePeerAccess](#)

## CUresult cuCtxEnablePeerAccess (CUcontext peerContext, unsigned int Flags)

Enables direct access to memory allocations in a peer context.

### Parameters

#### peerContext

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

#### Flags

- Reserved for future use and must be set to 0

## Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED,  
 CUDA\_ERROR\_PEER\_ACCESS\_ALREADY\_ENABLED,  
 CUDA\_ERROR\_TOO\_MANY\_PEERS, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_PEER\_ACCESS\_UNSUPPORTED, CUDA\_ERROR\_INVALID\_VALUE

## Description

If both the current context and `peerContext` are on devices which support unified addressing (as may be queried using [CU\\_DEVICE\\_ATTRIBUTE\\_UNIFIED\\_ADDRESSING](#)) and same major compute capability, then on success all allocations from `peerContext` will immediately be accessible by the current context. See [Unified Addressing](#) for additional details.

Note that access granted by this call is unidirectional and that in order to access memory from the current context in `peerContext`, a separate symmetric call to [cuCtxEnablePeerAccess\(\)](#) is required.

Note that there are both device-wide and system-wide limitations per system configuration, as noted in the CUDA Programming Guide under the section "Peer-to-Peer Memory Access".

Returns [CUDA\\_ERROR\\_PEER\\_ACCESS\\_UNSUPPORTED](#) if [cuDeviceCanAccessPeer\(\)](#) indicates that the [CUdevice](#) of the current context cannot directly access memory from the [CUdevice](#) of `peerContext`.

Returns [CUDA\\_ERROR\\_PEER\\_ACCESS\\_ALREADY\\_ENABLED](#) if direct access of `peerContext` from the current context has already been enabled.

Returns [CUDA\\_ERROR\\_TOO\\_MANY\\_PEERS](#) if direct peer access is not possible because hardware resources required for peer access have been exhausted.

Returns [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#) if there is no current context, `peerContext` is not a valid context, or if the current context is `peerContext`.

Returns [CUDA\\_ERROR\\_INVALID\\_VALUE](#) if `Flags` is not 0.



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

## See also:

[cuDeviceCanAccessPeer](#), [cuCtxDisablePeerAccess](#), [cudaDeviceEnablePeerAccess](#)



## CUresult cuDeviceCanAccessPeer (int \*canAccessPeer, CUdevice dev, CUdevice peerDev)

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

### Parameters

#### canAccessPeer

- Returned access capability

#### dev

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

#### peerDev

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

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_DEVICE

### Description

Returns in `*canAccessPeer` a value of 1 if contexts on `dev` are capable of directly accessing memory from contexts on `peerDev` and 0 otherwise. If direct access of `peerDev` from `dev` is possible, then access may be enabled on two specific contexts by calling `cuCtxEnablePeerAccess()`.



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

### See also:

`cuCtxEnablePeerAccess`, `cuCtxDisablePeerAccess`, `cudaDeviceCanAccessPeer`

## CUresult cuDeviceGetP2PAttribute (int \*value, CUdevice\_P2PAttribute attrib, CUdevice srcDevice, CUdevice dstDevice)

Queries attributes of the link between two devices.

### Parameters

#### value

- Returned value of the requested attribute

**attrib**

- The requested attribute of the link between `srcDevice` and `dstDevice`.

**srcDevice**

- The source device of the target link.

**dstDevice**

- The destination device of the target link.

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_DEVICE,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description**

Returns in `*value` the value of the requested attribute `attrib` of the link between `srcDevice` and `dstDevice`. The supported attributes are:

- ▶ **CU\_DEVICE\_P2P\_ATTRIBUTE\_PERFORMANCE\_RANK**: A relative value indicating the performance of the link between two devices.
- ▶ **CU\_DEVICE\_P2P\_ATTRIBUTE\_ACCESS\_SUPPORTED** P2P: 1 if P2P Access is enable.
- ▶ **CU\_DEVICE\_P2P\_ATTRIBUTE\_NATIVE\_ATOMIC\_SUPPORTED**: 1 if Atomic operations over the link are supported.
- ▶ **CU\_DEVICE\_P2P\_ATTRIBUTE\_CUDA\_ARRAY\_ACCESS\_SUPPORTED**: 1 if `cudaArray` can be accessed over the link.

Returns **CUDA\_ERROR\_INVALID\_DEVICE** if `srcDevice` or `dstDevice` are not valid or if they represent the same device.

Returns **CUDA\_ERROR\_INVALID\_VALUE** if `attrib` is not valid or if `value` is a null pointer.



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

**See also:**

[cuCtxEnablePeerAccess](#), [cuCtxDisablePeerAccess](#), [cuDeviceCanAccessPeer](#),  
[cudaDeviceGetP2PAttribute](#)

## 5.27. Graphics Interoperability

This section describes the graphics interoperability functions of the low-level CUDA driver application programming interface.

### CUresult cuGraphicsMapResources (unsigned int count, CUgraphicsResource \*resources, CUstream hStream)

Map graphics resources for access by CUDA.

#### Parameters

##### count

- Number of resources to map

##### resources

- Resources to map for CUDA usage

##### hStream

- Stream with which to synchronize

#### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_ALREADY\_MAPPED,  
CUDA\_ERROR\_UNKNOWN

#### 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 `cuGraphicsMapResources()` will complete before any subsequent CUDA work issued in `stream` begins.

If `resources` includes any duplicate entries then `CUDA_ERROR_INVALID_HANDLE` is returned. If any of `resources` are presently mapped for access by CUDA then `CUDA_ERROR_ALREADY_MAPPED` is returned.



► This function uses standard `default stream` semantics.

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

See also:

`cuGraphicsResourceGetMappedPointer`, `cuGraphicsSubResourceGetMappedArray`,  
`cuGraphicsUnmapResources`, `cudaGraphicsMapResources`

## CUresult

### `cuGraphicsResourceGetMappedMipmappedArray` (CUmipmappedArray \*pMipmappedArray, CUgraphicsResource resource)

Get a mipmapped array through which to access a mapped graphics resource.

#### Parameters

##### **pMipmappedArray**

- Returned mipmapped array through which `resource` may be accessed

##### **resource**

- Mapped resource to access

#### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_HANDLE`,  
`CUDA_ERROR_NOT_MAPPED`, `CUDA_ERROR_NOT_MAPPED_AS_ARRAY`

#### Description

Returns in `*pMipmappedArray` a mipmapped array through which the mapped graphics resource `resource`. The value set in `*pMipmappedArray` may change every time that `resource` is mapped.

If `resource` is not a texture then it cannot be accessed via a mipmapped array and `CUDA_ERROR_NOT_MAPPED_AS_ARRAY` is returned. If `resource` is not mapped then `CUDA_ERROR_NOT_MAPPED` is returned.



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

See also:

`cuGraphicsResourceGetMappedPointer,`  
`cudaGraphicsResourceGetMappedMipmappedArray`

## **CUresult cuGraphicsResourceGetMappedPointer** **(CUdeviceptr \*pDevPtr, size\_t \*pSize,** **CUgraphicsResource resource)**

Get a device pointer through which to access a mapped graphics resource.

### **Parameters**

#### **pDevPtr**

- Returned pointer through which `resource` may be accessed

#### **pSize**

- Returned size of the buffer accessible starting at `*pPointer`

#### **resource**

- Mapped resource to access

### **Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_HANDLE`,  
`CUDA_ERROR_NOT_MAPPED`, `CUDA_ERROR_NOT_MAPPED_AS_POINTER`

### **Description**

Returns in `*pDevPtr` a pointer through which the mapped graphics resource `resource` may be accessed. Returns in `pSize` the size of the memory in bytes which may be accessed from that pointer. The value set in `pPointer` may change every time that `resource` is mapped.

If `resource` is not a buffer then it cannot be accessed via a pointer and `CUDA_ERROR_NOT_MAPPED_AS_POINTER` is returned. If `resource` is not mapped then `CUDA_ERROR_NOT_MAPPED` is returned. \*



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

### **See also:**

`cuGraphicsMapResources`, `cuGraphicsSubResourceGetMappedArray`,  
`cudaGraphicsResourceGetMappedPointer`

## CUresult cuGraphicsResourceSetMapFlags (CUgraphicsResource 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

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE,  
CUDA\_ERROR\_ALREADY\_MAPPED

### 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:

- ▶ `CU_GRAPHICS_MAP_RESOURCE_FLAGS_NONE`: 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.
- ▶ `CU_GRAPHICS_MAP_RESOURCE_FLAGS_READONLY`: Specifies that CUDA kernels which access this resource will not write to this resource.
- ▶ `CU_GRAPHICS_MAP_RESOURCE_FLAGS_WRITEDISCARD`: 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 `resource` is presently mapped for access by CUDA then `CUDA_ERROR_ALREADY_MAPPED` is returned. If `flags` is not one of the above values then `CUDA_ERROR_INVALID_VALUE` is returned.



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

See also:

`cuGraphicsMapResources`, `cudaGraphicsResourceSetMapFlags`

## CUresult cuGraphicsSubResourceGetMappedArray (CUarray \*pArray, CUgraphicsResource resource, unsigned int arrayIndex, unsigned int mipLevel)

Get an array through which to access a subresource of a mapped graphics resource.

### Parameters

#### **pArray**

- 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 `CUarray_cubemap_face` for cubemap textures for the subresource to access

#### **mipLevel**

- Mipmap level for the subresource to access

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_HANDLE`,  
`CUDA_ERROR_NOT_MAPPED`, `CUDA_ERROR_NOT_MAPPED_AS_ARRAY`

### Description

Returns in `*pArray` 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 `*pArray` may change every time that `resource` is mapped.

If `resource` is not a texture then it cannot be accessed via an array and `CUDA_ERROR_NOT_MAPPED_AS_ARRAY` is returned. If `arrayIndex` is not a valid array index for `resource` then `CUDA_ERROR_INVALID_VALUE` is returned. If `mipLevel` is not a valid mipmap level for `resource` then `CUDA_ERROR_INVALID_VALUE` is returned. If `resource` is not mapped then `CUDA_ERROR_NOT_MAPPED` is returned.



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

See also:

[cuGraphicsResourceGetMappedPointer](#), [cudaGraphicsSubResourceGetMappedArray](#)

## CUresult cuGraphicsUnmapResources (unsigned int count, CUgraphicsResource \*resources, CUstream hStream)

Unmap graphics resources.

### Parameters

#### count

- Number of resources to unmap

#### resources

- Resources to unmap

#### hStream

- Stream with which to synchronize

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_NOT\_MAPPED, CUDA\_ERROR\_UNKNOWN

### 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 [cuGraphicsUnmapResources\(\)](#) will complete before any subsequently issued graphics work begins.

If `resources` includes any duplicate entries then [CUDA\\_ERROR\\_INVALID\\_HANDLE](#) is returned. If any of `resources` are not presently mapped for access by CUDA then [CUDA\\_ERROR\\_NOT\\_MAPPED](#) is returned.



- ▶ This function uses standard [default stream](#) semantics.
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

See also:



[cuGraphicsMapResources](#), [cudaGraphicsUnmapResources](#)

## CUresult cuGraphicsUnregisterResource (CUgraphicsResource resource)

Unregisters a graphics resource for access by CUDA.

### Parameters

#### **resource**

- Resource to unregister

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_HANDLE](#), [CUDA\\_ERROR\\_UNKNOWN](#)

### Description

Unregisters the graphics resource `resource` so it is not accessible by CUDA unless registered again.

If `resource` is invalid then [CUDA\\_ERROR\\_INVALID\\_HANDLE](#) is returned.



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

### See also:

[cuGraphicsD3D9RegisterResource](#), [cuGraphicsD3D10RegisterResource](#),  
[cuGraphicsD3D11RegisterResource](#), [cuGraphicsGLRegisterBuffer](#),  
[cuGraphicsGLRegisterImage](#), [cudaGraphicsUnregisterResource](#)

## 5.28. Profiler Control [DEPRECATED]

This section describes the profiler control functions of the low-level CUDA driver application programming interface.

## CUresult cuProfilerInitialize (const char \*configFile, const char \*outputFile, CUoutput\_mode outputMode)

Initialize the profiling.

### 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 CU\_OUT\_KEY\_VALUE\_PAIR or CU\_OUT\_CSV.

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_PROFILER\_DISABLED

### Description

#### Deprecated

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 `CUDA_ERROR_PROFILER_DISABLED` return code.

Typical usage of the profiling APIs is as follows:

```
for each set of counters/options { cuProfilerInitialize(); //Initialize profiling, set
the counters or options in the config file ... cuProfilerStart(); // code to be profiled
cuProfilerStop(); ... cuProfilerStart(); // code to be profiled cuProfilerStop(); ... }
```



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

### See also:

`cuProfilerStart`, `cuProfilerStop`, `cudaProfilerInitialize`

## 5.29. Profiler Control

This section describes the profiler control functions of the low-level CUDA driver application programming interface.

### CUresult cuProfilerStart (void)

Enable profiling.

#### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_CONTEXT

#### Description

Enables profile collection by the active profiling tool for the current context. If profiling is already enabled, then `cuProfilerStart()` has no effect.

`cuProfilerStart` and `cuProfilerStop` 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:

`cuProfilerInitialize`, `cuProfilerStop`, `cudaProfilerStart`

### CUresult cuProfilerStop (void)

Disable profiling.

#### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_CONTEXT

#### Description

Disables profile collection by the active profiling tool for the current context. If profiling is already disabled, then `cuProfilerStop()` has no effect.

`cuProfilerStart` and `cuProfilerStop` 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:

[cuProfilerInitialize](#), [cuProfilerStart](#), [cudaProfilerStop](#)

## 5.30. OpenGL Interoperability

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

### OpenGL Interoperability [DEPRECATED]

#### enum CUGLDeviceList

CUDA devices corresponding to an OpenGL device

##### Values

**CU\_GL\_DEVICE\_LIST\_ALL = 0x01**

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

**CU\_GL\_DEVICE\_LIST\_CURRENT\_FRAME = 0x02**

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

**CU\_GL\_DEVICE\_LIST\_NEXT\_FRAME = 0x03**

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

**CUresult cuGLGetDevices (unsigned int \*pCudaDeviceCount, CUdevice \*pCudaDevices, unsigned int cudaDeviceCount, CUGLDeviceList deviceList)**

Gets the CUDA devices associated with the current OpenGL context.

##### Parameters

**pCudaDeviceCount**

- Returned number of CUDA devices.

**pCudaDevices**

- Returned CUDA devices.

**cudaDeviceCount**

- The size of the output device array pCudaDevices.

**deviceList**

- The set of devices to return.

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_NO\_DEVICE,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_GRAPHICS\_CONTEXT

**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 CUDA\_ERROR\_NO\_DEVICE.

The deviceList argument may be any of the following:

- ▶ **CU\_GL\_DEVICE\_LIST\_ALL**: Query all devices used by the current OpenGL context.
- ▶ **CU\_GL\_DEVICE\_LIST\_CURRENT\_FRAME**: Query the devices used by the current OpenGL context to render the current frame (in SLI).
- ▶ **CU\_GL\_DEVICE\_LIST\_NEXT\_FRAME**: Query the devices used by the current OpenGL context to render the next frame (in SLI). Note that this is a prediction, it can't be guaranteed that this is correct in all cases.



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

**See also:**

[cuWGLGetDevice](#), [cudaGLGetDevices](#)

## CUresult cuGraphicsGLRegisterBuffer (CUgraphicsResource \*pCudaResource, GLuint buffer, unsigned int Flags)

Registers an OpenGL buffer object.

### Parameters

#### **pCudaResource**

- Pointer to the returned object handle

#### **buffer**

- name of buffer object to be registered

#### **Flags**

- Register flags

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_HANDLE,  
CUDA\_ERROR\_ALREADY\_MAPPED, CUDA\_ERROR\_INVALID\_CONTEXT,

### Description

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

- ▶ `CU_GRAPHICS_REGISTER_FLAGS_NONE`: 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.
- ▶ `CU_GRAPHICS_REGISTER_FLAGS_READ_ONLY`: Specifies that CUDA will not write to this resource.
- ▶ `CU_GRAPHICS_REGISTER_FLAGS_WRITE_DISCARD`: 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:

`cuGraphicsUnregisterResource`, `cuGraphicsMapResources`,  
`cuGraphicsResourceGetMappedPointer`, `cudaGraphicsGLRegisterBuffer`

## CUresult cuGraphicsGLRegisterImage (CUgraphicsResource \*pCudaResource, GLuint image, GLenum target, unsigned int Flags)

Register an OpenGL texture or renderbuffer object.

### Parameters

#### pCudaResource

- 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

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_HANDLE,  
CUDA\_ERROR\_ALREADY\_MAPPED, CUDA\_ERROR\_INVALID\_CONTEXT,

### Description

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

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:

- ▶ CU\_GRAPHICS\_REGISTER\_FLAGS\_NONE: 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.
- ▶ CU\_GRAPHICS\_REGISTER\_FLAGS\_READ\_ONLY: Specifies that CUDA will not write to this resource.
- ▶ CU\_GRAPHICS\_REGISTER\_FLAGS\_WRITE\_DISCARD: 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.
- ▶ CU\_GRAPHICS\_REGISTER\_FLAGS\_SURFACE\_LDST: Specifies that CUDA will bind this resource to a surface reference.
- ▶ CU\_GRAPHICS\_REGISTER\_FLAGS\_TEXTURE\_GATHER: 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:

[cuGraphicsUnregisterResource](#), [cuGraphicsMapResources](#),  
[cuGraphicsSubResourceGetMappedArray](#), [cudaGraphicsGLRegisterImage](#)

## CUresult cuWGLGetDevice (CUdevice \*pDevice, HGPUNV hGpu)

Gets the CUDA device associated with hGpu.

### Parameters

#### pDevice

- Device associated with hGpu

#### hGpu

- Handle to a GPU, as queried via WGL\_NV\_gpu\_affinity()

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE

### Description

Returns in \*pDevice the CUDA device associated with a hGpu, if applicable.





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

#### See also:

`cuGLMapBufferObject`, `cuGLRegisterBufferObject`, `cuGLUnmapBufferObject`,  
`cuGLUnregisterBufferObject`, `cuGLUnmapBufferObjectAsync`,  
`cuGLSetBufferObjectMapFlags`, `cudaWGLGetDevice`

## 5.30.1. OpenGL Interoperability [DEPRECATED]

### OpenGL Interoperability

This section describes deprecated OpenGL interoperability functionality.

### enum `CUGLmap_flags`

Flags to map or unmap a resource

#### Values

`CU_GL_MAP_RESOURCE_FLAGS_NONE` = 0x00

`CU_GL_MAP_RESOURCE_FLAGS_READ_ONLY` = 0x01

`CU_GL_MAP_RESOURCE_FLAGS_WRITE_DISCARD` = 0x02

### `CUresult cuGLCtxCreate (CUcontext *pCtx, unsigned int Flags, CUdevice device)`

Create a CUDA context for interoperability with OpenGL.

#### Parameters

##### `pCtx`

- Returned CUDA context

##### `Flags`

- Options for CUDA context creation

##### `device`

- Device on which to create the context

#### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_OUT_OF_MEMORY`

## 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 context 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:

[cuCtxCreate](#), [cuGLInit](#), [cuGLMapBufferObject](#), [cuGLRegisterBufferObject](#), [cuGLUnmapBufferObject](#), [cuGLUnregisterBufferObject](#), [cuGLMapBufferObjectAsync](#), [cuGLUnmapBufferObjectAsync](#), [cuGLSetBufferObjectMapFlags](#), [cuWGLGetDevice](#)

## CUresult cuGLInit (void)

Initializes OpenGL interoperability.

## Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_UNKNOWN](#)

## Description

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

Initializes OpenGL interoperability. This function is deprecated and calling it is no longer required. It may fail if the needed OpenGL driver facilities are not available.



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

## See also:

[cuGLMapBufferObject](#), [cuGLRegisterBufferObject](#), [cuGLUnmapBufferObject](#),  
[cuGLUnregisterBufferObject](#), [cuGLMapBufferObjectAsync](#),  
[cuGLUnmapBufferObjectAsync](#), [cuGLSetBufferObjectMapFlags](#), [cuWGLGetDevice](#)

## CUresult cuGLMapBufferObject (CUdeviceptr \*dptr, size\_t \*size, GLuint buffer)

Maps an OpenGL buffer object.

### Parameters

#### **dptr**

- Returned mapped base pointer

#### **size**

- Returned size of mapping

#### **buffer**

- The name of the buffer object to map

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_MAP\_FAILED

### Description

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

Maps the buffer object specified by `buffer` into the address space of the current CUDA context and returns in `*dptr` and `*size` the base pointer and size of the resulting mapping.

There must be a valid OpenGL context bound to the current thread when this function is called. This must be the same context, or a member of the same shareGroup, as the context that was bound when the buffer was registered.

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



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

### See also:

[cuGraphicsMapResources](#)

**CUresult cuGLMapBufferObjectAsync (CUdeviceptr \*dptr, size\_t \*size, GLuint buffer, CUstream hStream)**

Maps an OpenGL buffer object.

### Parameters

#### **dptr**

- Returned mapped base pointer

#### **size**

- Returned size of mapping

#### **buffer**

- The name of the buffer object to map

#### **hStream**

- Stream to synchronize

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_MAP\_FAILED

### Description

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

Maps the buffer object specified by `buffer` into the address space of the current CUDA context and returns in `*dptr` and `*size` the base pointer and size of the resulting mapping.

There must be a valid OpenGL context bound to the current thread when this function is called. This must be the same context, or a member of the same shareGroup, as the context that was bound when the buffer was registered.

Stream `hStream` in the current CUDA context is synchronized with the current GL context.



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

### See also:

[cuGraphicsMapResources](#)

## CUresult cuGLRegisterBufferObject (GLuint buffer)

Registers an OpenGL buffer object.

### Parameters

#### buffer

- The name of the buffer object to register.

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_ALREADY\_MAPPED

### Description

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

Registers the buffer object specified by `buffer` for access by CUDA. This function must be called before CUDA can map the buffer object. There must be a valid OpenGL context bound to the current thread when this function is called, and the buffer name is resolved by that context.



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

### See also:

[cuGraphicsGLRegisterBuffer](#)

## CUresult cuGLSetBufferObjectMapFlags (GLuint buffer, unsigned int Flags)

Set the map flags for an OpenGL buffer object.

### Parameters

#### buffer

- Buffer object to unmap

#### Flags

- Map flags

## Returns

CUDA\_SUCCESS, CUDA\_ERROR\_NOT\_INITIALIZED,  
 CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_ALREADY\_MAPPED,  
 CUDA\_ERROR\_INVALID\_CONTEXT,

## Description

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

Sets the map flags for the buffer object specified by `buffer`.

Changes to `Flags` will take effect the next time `buffer` is mapped. The `Flags` argument may be any of the following:

- ▶ `CU_GL_MAP_RESOURCE_FLAGS_NONE`: 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.
- ▶ `CU_GL_MAP_RESOURCE_FLAGS_READ_ONLY`: Specifies that CUDA kernels which access this resource will not write to this resource.
- ▶ `CU_GL_MAP_RESOURCE_FLAGS_WRITE_DISCARD`: 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 `buffer` has not been registered for use with CUDA, then `CUDA_ERROR_INVALID_HANDLE` is returned. If `buffer` is presently mapped for access by CUDA, then `CUDA_ERROR_ALREADY_MAPPED` is returned.

There must be a valid OpenGL context bound to the current thread when this function is called. This must be the same context, or a member of the same `shareGroup`, as the context that was bound when the buffer was registered.



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

## See also:

[cuGraphicsResourceSetMapFlags](#)

## CUresult cuGLUnmapBufferObject (GLuint buffer)

Unmaps an OpenGL buffer object.

## Parameters

### **buffer**

- Buffer object to unmap

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description**

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

Unmaps the buffer object specified by `buffer` for access by CUDA.

There must be a valid OpenGL context bound to the current thread when this function is called. This must be the same context, or a member of the same shareGroup, as the context that was bound when the buffer was registered.

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



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

**See also:**

[cuGraphicsUnmapResources](#)

## CUresult cuGLUnmapBufferObjectAsync (GLuint buffer, CUstream hStream)

Unmaps an OpenGL buffer object.

**Parameters****buffer**

- Name of the buffer object to unmap

**hStream**

- Stream to synchronize

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE

**Description**

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

Unmaps the buffer object specified by `buffer` for access by CUDA.

There must be a valid OpenGL context bound to the current thread when this function is called. This must be the same context, or a member of the same shareGroup, as the context that was bound when the buffer was registered.

Stream `hStream` in the current CUDA context is synchronized with the current GL context.



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

**See also:**

[cuGraphicsUnmapResources](#)

## CUresult cuGLUnregisterBufferObject (GLuint buffer)

Unregister an OpenGL buffer object.

### Parameters

#### **buffer**

- Name of the buffer object to unregister

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#)

### Description

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

Unregisters the buffer object specified by `buffer`. This releases any resources associated with the registered buffer. After this call, the buffer may no longer be mapped for access by CUDA.

There must be a valid OpenGL context bound to the current thread when this function is called. This must be the same context, or a member of the same shareGroup, as the context that was bound when the buffer was registered.



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

**See also:**



[cuGraphicsUnregisterResource](#)

## 5.31. Direct3D 9 Interoperability

This section describes the Direct3D 9 interoperability functions of the low-level CUDA driver application programming interface. Note that mapping of Direct3D 9 resources is performed with the graphics API agnostic, resource mapping interface described in [Graphics Interoperability](#).

### Direct3D 9 Interoperability [DEPRECATED]

#### enum CUd3d9DeviceList

CUDA devices corresponding to a D3D9 device

##### Values

**CU\_D3D9\_DEVICE\_LIST\_ALL = 0x01**

The CUDA devices for all GPUs used by a D3D9 device

**CU\_D3D9\_DEVICE\_LIST\_CURRENT\_FRAME = 0x02**

The CUDA devices for the GPUs used by a D3D9 device in its currently rendering frame

**CU\_D3D9\_DEVICE\_LIST\_NEXT\_FRAME = 0x03**

The CUDA devices for the GPUs to be used by a D3D9 device in the next frame

#### CUresult cuD3D9CtxCreate (CUcontext \*pCtx, CUdevice \*pCudaDevice, unsigned int Flags, IDirect3DDevice9 \*pD3DDevice)

Create a CUDA context for interoperability with Direct3D 9.

##### Parameters

###### pCtx

- Returned newly created CUDA context

###### pCudaDevice

- Returned pointer to the device on which the context was created

###### Flags

- Context creation flags (see [cuCtxCreate\(\)](#) for details)

###### pD3DDevice

- Direct3D device to create interoperability context with

## Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE,  
 CUDA\_ERROR\_OUT\_OF\_MEMORY, CUDA\_ERROR\_UNKNOWN

## Description

Creates a new CUDA context, enables interoperability for that context with the Direct3D device `pD3DDevice`, and associates the created CUDA context with the calling thread. The created **CUcontext** will be returned in `*pCtx`. Direct3D resources from this device may be registered and mapped through the lifetime of this CUDA context. If `pCudaDevice` is non-NULL then the **CUdevice** on which this CUDA context was created will be returned in `*pCudaDevice`.

On success, this call will increase the internal reference count on `pD3DDevice`. This reference count will be decremented upon destruction of this context through **cuCtxDestroy()**. This context will cease to function if `pD3DDevice` is destroyed or encounters an error.

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:

[cuD3D9GetDevice](#), [cuGraphicsD3D9RegisterResource](#)

## CUresult cuD3D9CtxCreateOnDevice (CUcontext \*pCtx, unsigned int flags, IDirect3DDevice9 \*pD3DDevice, CUdevice cudaDevice)

Create a CUDA context for interoperability with Direct3D 9.

## Parameters

### `pCtx`

- Returned newly created CUDA context

### `flags`

- Context creation flags (see [cuCtxCreate\(\)](#) for details)

**pD3DDevice**

- Direct3D device to create interoperability context with

**cudaDevice**

- The CUDA device on which to create the context. This device must be among the devices returned when querying CU\_D3D9\_DEVICES\_ALL from [cuD3D9GetDevices](#).

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE,  
 CUDA\_ERROR\_OUT\_OF\_MEMORY, CUDA\_ERROR\_UNKNOWN

**Description**

Creates a new CUDA context, enables interoperability for that context with the Direct3D device pD3DDevice, and associates the created CUDA context with the calling thread. The created CUcontext will be returned in \*pCtx. Direct3D resources from this device may be registered and mapped through the lifetime of this CUDA context.

On success, this call will increase the internal reference count on pD3DDevice. This reference count will be decremented upon destruction of this context through [cuCtxDestroy\(\)](#). This context will cease to function if pD3DDevice is destroyed or encounters an error.

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:**

[cuD3D9GetDevices](#), [cuGraphicsD3D9RegisterResource](#)

## CUresult cuD3D9GetDevice (CUdevice \*pCudaDevice, const char \*pszAdapterName)

Gets the CUDA device corresponding to a display adapter.

**Parameters****pCudaDevice**

- Returned CUDA device corresponding to pszAdapterName

**pszAdapterName**

- Adapter name to query for device

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE,  
 CUDA\_ERROR\_NOT\_FOUND, CUDA\_ERROR\_UNKNOWN

**Description**

Returns in \*pCudaDevice 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:**

cuD3D9CtxCreate, cudaD3D9GetDevice

## CUresult cuD3D9GetDevices (unsigned int \*pCudaDeviceCount, CUdevice \*pCudaDevices, unsigned int cudaDeviceCount, IDirect3DDevice9 \*pD3D9Device, CUd3d9DeviceList 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 `CU_D3D9_DEVICE_LIST_ALL` for all devices, `CU_D3D9_DEVICE_LIST_CURRENT_FRAME` for the devices used to render the current frame (in SLI), or `CU_D3D9_DEVICE_LIST_NEXT_FRAME` for the devices used to render the next frame (in SLI).

**Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_NO_DEVICE`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_NOT_FOUND`,  
`CUDA_ERROR_UNKNOWN`

**Description**

Returns in `*pCudaDeviceCount` the number of CUDA-compatible device corresponding to the Direct3D 9 device `pD3D9Device`. Also returns in `*pCudaDevices` at most `cudaDeviceCount` of 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 `CUDA_ERROR_NO_DEVICE`.



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

**See also:**

`cuD3D9CtxCreate`, `cudaD3D9GetDevices`

## CUresult cuD3D9GetDirect3DDevice (IDirect3DDevice9 **\*\*ppD3DDevice)**

Get the Direct3D 9 device against which the current CUDA context was created.

**Parameters****ppD3DDevice**

- Returned Direct3D device corresponding to CUDA context

**Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`  
`CUDA_ERROR_INVALID_GRAPHICS_CONTEXT`

## Description

Returns in `*ppD3DDevice` the Direct3D device against which this CUDA context was created in `cuD3D9CtxCreate()`.



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

## See also:

`cuD3D9GetDevice`, `cudaD3D9GetDirect3DDevice`

## CUresult cuGraphicsD3D9RegisterResource (CUgraphicsResource \*pCudaResource, IDirect3DResource9 \*pD3DResource, unsigned int Flags)

Register a Direct3D 9 resource for access by CUDA.

## Parameters

### pCudaResource

- Returned graphics resource handle

### pD3DResource

- Direct3D resource to register

### Flags

- Parameters for resource registration

## Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_HANDLE`,  
`CUDA_ERROR_OUT_OF_MEMORY`, `CUDA_ERROR_UNKNOWN`

## Description

Registers the Direct3D 9 resource `pD3DResource` for access by CUDA and returns a CUDA handle to `pD3DResource` in `pCudaResource`. The handle returned in `pCudaResource` may be used to map and unmap this resource until it is unregistered. On success this call will increase the internal reference count on `pD3DResource`. This reference count will be decremented when this resource is unregistered through `cuGraphicsUnregisterResource()`.

This call is potentially 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

- ▶ `CU_GRAPHICS_REGISTER_FLAGS_NONE`: Specifies no hints about how this resource will be used.
- ▶ `CU_GRAPHICS_REGISTER_FLAGS_SURFACE_LDST`: Specifies that CUDA will bind this resource to a surface reference.
- ▶ `CU_GRAPHICS_REGISTER_FLAGS_TEXTURE_GATHER`: 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 Direct3D interoperability is not initialized for this context using `cuD3D9CtxCreate` then `CUDA_ERROR_INVALID_CONTEXT` is returned. If `pD3DResource` is of incorrect type or is already registered then `CUDA_ERROR_INVALID_HANDLE` is returned. If `pD3DResource` cannot be registered then `CUDA_ERROR_UNKNOWN` is returned. If `Flags` is not one of the above specified value then `CUDA_ERROR_INVALID_VALUE` is returned.



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

#### See also:

`cuD3D9CtxCreate`, `cuGraphicsUnregisterResource`, `cuGraphicsMapResources`, `cuGraphicsSubResourceGetMappedArray`, `cuGraphicsResourceGetMappedPointer`, `cudaGraphicsD3D9RegisterResource`

## 5.31.1. Direct3D 9 Interoperability [DEPRECATED]

### Direct3D 9 Interoperability

This section describes deprecated Direct3D 9 interoperability functionality.

#### enum CUd3d9map\_flags

Flags to map or unmap a resource

##### Values

`CU_D3D9_MAPRESOURCE_FLAGS_NONE` = 0x00  
`CU_D3D9_MAPRESOURCE_FLAGS_READONLY` = 0x01  
`CU_D3D9_MAPRESOURCE_FLAGS_WRITEDISCARD` = 0x02

#### enum CUd3d9register\_flags

Flags to register a resource

##### Values

`CU_D3D9_REGISTER_FLAGS_NONE` = 0x00  
`CU_D3D9_REGISTER_FLAGS_ARRAY` = 0x01



## CUresult cuD3D9MapResources (unsigned int count, IDirect3DResource9 \*\*ppResource)

Map Direct3D resources for access by CUDA.

### Parameters

#### count

- Number of resources in ppResource

#### ppResource

- Resources to map for CUDA usage

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_ALREADY\_MAPPED, CUDA\_ERROR\_UNKNOWN

### Description

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

Maps the count Direct3D resources in ppResource for access by CUDA.

The resources in ppResource 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 cuD3D9MapResources() will complete before any CUDA kernels issued after cuD3D9MapResources() begin.

If any of ppResource have not been registered for use with CUDA or if ppResource contains any duplicate entries, then CUDA\_ERROR\_INVALID\_HANDLE is returned. If any of ppResource are presently mapped for access by CUDA, then CUDA\_ERROR\_ALREADY\_MAPPED is returned.



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

### See also:

cuGraphicsMapResources

## CUresult cuD3D9RegisterResource (IDirect3DResource9 \*pResource, unsigned int Flags)

Register a Direct3D resource for access by CUDA.

### Parameters

#### pResource

- Resource to register for CUDA access

#### Flags

- Flags for resource registration

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_OUT\_OF\_MEMORY, CUDA\_ERROR\_UNKNOWN

### 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 [cuD3D9UnregisterResource\(\)](#). 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 [cuD3D9UnregisterResource\(\)](#).

This call is potentially high-overhead and should not be called every frame in interactive applications.

The type of pResource must be one of the following.

- ▶ IDirect3DVertexBuffer9: Cannot be used with Flags set to CU\_D3D9\_REGISTER\_FLAGS\_ARRAY.
- ▶ IDirect3DIndexBuffer9: Cannot be used with Flags set to CU\_D3D9\_REGISTER\_FLAGS\_ARRAY.
- ▶ 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. For restrictions on the Flags parameter, see type IDirect3DBaseTexture9.
- ▶ IDirect3DBaseTexture9: When a texture is registered, all surfaces associated with the 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 values are allowed.

- ▶ `CUDA_D3D9_REGISTER_FLAGS_NONE`: Specifies that CUDA will access this resource through a `CUDAdeviceptr`. The pointer, size, and (for textures), pitch for each subresource of this allocation may be queried through `cuD3D9ResourceGetMappedPointer()`, `cuD3D9ResourceGetMappedSize()`, and `cuD3D9ResourceGetMappedPitch()` respectively. This option is valid for all resource types.
- ▶ `CUDA_D3D9_REGISTER_FLAGS_ARRAY`: Specifies that CUDA will access this resource through a `CUDAarray` queried on a sub-resource basis through `cuD3D9ResourceGetMappedArray()`. This option is only valid for resources of type `IDirect3DSurface9` and subtypes of `IDirect3DBaseTexture9`.

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 `CUDA_ERROR_INVALID_CONTEXT` is returned. If `pResource` is of incorrect type (e.g. is a non-stand-alone `IDirect3DSurface9`) or is already registered, then `CUDA_ERROR_INVALID_HANDLE` is returned. If `pResource` cannot be registered then `CUDA_ERROR_UNKNOWN` is returned.



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

See also:

[cuGraphicsD3D9RegisterResource](#)

## CUresult cuD3D9ResourceGetMappedArray (CUarray \*pArray, 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

#### pArray

- Returned array corresponding to subresource

#### pResource

- Mapped resource to access

#### Face

- Face of resource to access

#### Level

- Level of resource to access

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_NOT\_MAPPED

### 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 CUDA\_ERROR\_INVALID\_HANDLE is returned. If pResource was not registered with usage flags CU\_D3D9\_REGISTER\_FLAGS\_ARRAY then CUDA\_ERROR\_INVALID\_HANDLE is returned. If pResource is not mapped then CUDA\_ERROR\_NOT\_MAPPED is returned.

For usage requirements of Face and Level parameters, see cuD3D9ResourceGetMappedPointer().



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

See also:

`cuGraphicsSubResourceGetMappedArray`

**CUresult cuD3D9ResourceGetMappedPitch (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

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_HANDLE`,  
`CUDA_ERROR_NOT_MAPPED`

### 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:

$$y * \text{pitch} + (\text{bytes per pixel}) * x$$

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 `IDirect3DBaseTexture9` or one of its subtypes or if `pResource` has not been registered for use with CUDA, then `cudaErrorInvalidResourceHandle` is returned. If `pResource` was not registered with usage flags `CU_D3D9_REGISTER_FLAGS_NONE`, then `CUDA_ERROR_INVALID_HANDLE` is returned. If `pResource` is not mapped for access by CUDA then `CUDA_ERROR_NOT_MAPPED` is returned.

For usage requirements of `Face` and `Level` parameters, see `cuD3D9ResourceGetMappedPointer()`.



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

See also:

`cuGraphicsSubResourceGetMappedArray`

**CUresult cuD3D9ResourceGetMappedPointer (CUdeviceptr \*pDevPtr, IDirect3DResource9 \*pResource, unsigned int Face, unsigned int Level)**

Get the pointer through which to access a subresource of a Direct3D resource which has been mapped for access by CUDA.

### Parameters

#### **pDevPtr**

- Returned pointer corresponding to subresource

#### **pResource**

- Mapped resource to access

#### **Face**

- Face of resource to access

#### **Level**

- Level of resource to access

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_HANDLE`,  
`CUDA_ERROR_NOT_MAPPED`

## Description

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

Returns in `*pDevPtr` the base pointer of the subresource of the mapped Direct3D resource `pResource`, which corresponds to `Face` and `Level`. The value set in `pDevPtr` may change every time that `pResource` is mapped.

If `pResource` is not registered, then `CUDA_ERROR_INVALID_HANDLE` is returned. If `pResource` was not registered with usage flags `CU_D3D9_REGISTER_FLAGS_NONE`, then `CUDA_ERROR_INVALID_HANDLE` is returned. If `pResource` is not mapped, then `CUDA_ERROR_NOT_MAPPED` 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 `CUDA_ERROR_INVALID_VALUE` is returned.

If `pResource` is of type `IDirect3DBaseTexture9`, then `Level` must correspond to a valid mipmap level. At present only mipmap level 0 is supported. For all other types `Level` must be 0. If `Level` is invalid, then `CUDA_ERROR_INVALID_VALUE` is returned.



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

## See also:

[cuGraphicsResourceGetMappedPointer](#)

**CUresult cuD3D9ResourceGetMappedSize (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**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE,  
 CUDA\_ERROR\_NOT\_MAPPED

**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 CUDA\_ERROR\_INVALID\_HANDLE is returned. If pResource was not registered with usage flags CU\_D3D9\_REGISTER\_FLAGS\_NONE, then CUDA\_ERROR\_INVALID\_HANDLE is returned. If pResource is not mapped for access by CUDA, then CUDA\_ERROR\_NOT\_MAPPED is returned.

For usage requirements of Face and Level parameters, see cuD3D9ResourceGetMappedPointer.



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

**See also:**

cuGraphicsResourceGetMappedPointer

**CUresult cuD3D9ResourceGetSurfaceDimensions (size\_t \*pWidth, size\_t \*pHeight, size\_t \*pDepth, IDirect3DResource9 \*pResource, unsigned int Face, unsigned int Level)**

Get the dimensions of a registered 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**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE

**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.

Because 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 CUDA\_ERROR\_INVALID\_HANDLE is returned.

For usage requirements of Face and Level parameters, see cuD3D9ResourceGetMappedPointer().



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

**See also:**

cuGraphicsSubResourceGetMappedArray

## CUresult cuD3D9ResourceSetMapFlags (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

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE,  
CUDA\_ERROR\_ALREADY\_MAPPED

### 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:

- ▶ CU\_D3D9\_MAPRESOURCE\_FLAGS\_NONE: 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.
- ▶ CU\_D3D9\_MAPRESOURCE\_FLAGS\_READONLY: Specifies that CUDA kernels which access this resource will not write to this resource.
- ▶ CU\_D3D9\_MAPRESOURCE\_FLAGS\_WRITEDISCARD: 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 CUDA\_ERROR\_INVALID\_HANDLE is returned. If pResource is presently mapped for access by CUDA, then CUDA\_ERROR\_ALREADY\_MAPPED is returned.



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

See also:

`cuGraphicsResourceSetMapFlags`

## `CUresult cuD3D9UnmapResources (unsigned int count, IDirect3DResource9 **ppResource)`

Unmaps Direct3D resources.

### Parameters

#### **count**

- Number of resources to unmap for CUDA

#### **ppResource**

- Resources to unmap for CUDA

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_HANDLE`, `CUDA_ERROR_NOT_MAPPED`,  
`CUDA_ERROR_UNKNOWN`

### Description

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

Unmaps the `count` Direct3D resources in `ppResource`.

This function provides the synchronization guarantee that any CUDA kernels issued before `cuD3D9UnmapResources()` will complete before any Direct3D calls issued after `cuD3D9UnmapResources()` begin.

If any of `ppResource` have not been registered for use with CUDA or if `ppResource` contains any duplicate entries, then `CUDA_ERROR_INVALID_HANDLE` is returned. If any of `ppResource` are not presently mapped for access by CUDA, then `CUDA_ERROR_NOT_MAPPED` is returned.



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

### See also:

`cuGraphicsUnmapResources`

## CUresult cuD3D9UnregisterResource (IDirect3DResource9 \*pResource)

Unregister a Direct3D resource.

### Parameters

#### pResource

- Resource to unregister

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_UNKNOWN

### 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 CUDA\_ERROR\_INVALID\_HANDLE is returned.



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

See also:

[cuGraphicsUnregisterResource](#)

## 5.32. Direct3D 10 Interoperability

This section describes the Direct3D 10 interoperability functions of the low-level CUDA driver application programming interface. Note that mapping of Direct3D 10 resources is performed with the graphics API agnostic, resource mapping interface described in [Graphics Interoperability](#).

### Direct3D 10 Interoperability [DEPRECATED]

#### enum CUd3d10DeviceList

CUDA devices corresponding to a D3D10 device

**Values****CU\_D3D10\_DEVICE\_LIST\_ALL = 0x01**

The CUDA devices for all GPUs used by a D3D10 device

**CU\_D3D10\_DEVICE\_LIST\_CURRENT\_FRAME = 0x02**

The CUDA devices for the GPUs used by a D3D10 device in its currently rendering frame

**CU\_D3D10\_DEVICE\_LIST\_NEXT\_FRAME = 0x03**

The CUDA devices for the GPUs to be used by a D3D10 device in the next frame

**CUresult cuD3D10GetDevice (CUdevice \*pCudaDevice, IDXGIAdapter \*pAdapter)**

Gets the CUDA device corresponding to a display adapter.

**Parameters****pCudaDevice**

- Returned CUDA device corresponding to pAdapter

**pAdapter**

- Adapter to query for CUDA device

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE,  
 CUDA\_ERROR\_NOT\_FOUND, CUDA\_ERROR\_UNKNOWN

**Description**

Returns in \*pCudaDevice the CUDA-compatible device corresponding to the adapter pAdapter obtained from IDXGIFactory::EnumAdapters.

If no device on pAdapter is CUDA-compatible then the call will fail.



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

**See also:**

[cuD3D10GetDevices](#), [cudaD3D10GetDevice](#)

**CUresult cuD3D10GetDevices (unsigned int \*pCudaDeviceCount, CUdevice \*pCudaDevices, unsigned**

## int cudaDeviceCount, ID3D10Device \*pD3D10Device, CUd3d10DeviceList 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 [CU\\_D3D10\\_DEVICE\\_LIST\\_ALL](#) for all devices, [CU\\_D3D10\\_DEVICE\\_LIST\\_CURRENT\\_FRAME](#) for the devices used to render the current frame (in SLI), or [CU\\_D3D10\\_DEVICE\\_LIST\\_NEXT\\_FRAME](#) for the devices used to render the next frame (in SLI).

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_NO\\_DEVICE](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#), [CUDA\\_ERROR\\_NOT\\_FOUND](#),  
[CUDA\\_ERROR\\_UNKNOWN](#)

### Description

Returns in \*pCudaDeviceCount the number of CUDA-compatible device corresponding to the Direct3D 10 device pD3D10Device. Also returns in \*pCudaDevices at most cudaDeviceCount of 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 [CUDA\\_ERROR\\_NO\\_DEVICE](#).



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

### See also:

[cuD3D10GetDevice](#), [cudaD3D10GetDevices](#)

## CUresult cuGraphicsD3D10RegisterResource (CUgraphicsResource \*pCudaResource, ID3D10Resource \*pD3DResource, unsigned int Flags)

Register a Direct3D 10 resource for access by CUDA.

### Parameters

#### pCudaResource

- Returned graphics resource handle

#### pD3DResource

- Direct3D resource to register

#### Flags

- Parameters for resource registration

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE,  
CUDA\_ERROR\_OUT\_OF\_MEMORY, CUDA\_ERROR\_UNKNOWN

### Description

Registers the Direct3D 10 resource pD3DResource for access by CUDA and returns a CUDA handle to pD3DResource in pCudaResource. The handle returned in pCudaResource may be used to map and unmap this resource until it is unregistered. On success this call will increase the internal reference count on pD3DResource. This reference count will be decremented when this resource is unregistered through [cuGraphicsUnregisterResource\(\)](#).

This call is potentially 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 through 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

- ▶ CU\_GRAPHICS\_REGISTER\_FLAGS\_NONE: Specifies no hints about how this resource will be used.

- ▶ `CU_GRAPHICS_REGISTER_FLAGS_SURFACE_LDST`: Specifies that CUDA will bind this resource to a surface reference.
- ▶ `CU_GRAPHICS_REGISTER_FLAGS_TEXTURE_GATHER`: 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.
- ▶ 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 `CUDA_ERROR_INVALID_HANDLE` is returned. If `pD3DResource` cannot be registered then `CUDA_ERROR_UNKNOWN` is returned. If `Flags` is not one of the above specified value then `CUDA_ERROR_INVALID_VALUE` is returned.



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

See also:



`cuGraphicsUnregisterResource`, `cuGraphicsMapResources`,  
`cuGraphicsSubResourceGetMappedArray`, `cuGraphicsResourceGetMappedPointer`,  
`cudaGraphicsD3D10RegisterResource`

## 5.32.1. Direct3D 10 Interoperability [DEPRECATED]

Direct3D 10 Interoperability

This section describes deprecated Direct3D 10 interoperability functionality.

### enum CUD3D10map\_flags

Flags to map or unmap a resource

#### Values

`CU_D3D10_MAPRESOURCE_FLAGS_NONE` = 0x00

`CU_D3D10_MAPRESOURCE_FLAGS_READONLY` = 0x01

`CU_D3D10_MAPRESOURCE_FLAGS_WRITEDISCARD` = 0x02

### enum CUD3D10register\_flags

Flags to register a resource

#### Values

`CU_D3D10_REGISTER_FLAGS_NONE` = 0x00

`CU_D3D10_REGISTER_FLAGS_ARRAY` = 0x01

**CUresult cuD3D10CtxCreate (CUcontext \*pCtx, CUdevice  
 \*pCudaDevice, unsigned int Flags, ID3D10Device \*pD3DDevice)**

Create a CUDA context for interoperability with Direct3D 10.

#### Parameters

##### pCtx

- Returned newly created CUDA context

##### pCudaDevice

- Returned pointer to the device on which the context was created

##### Flags

- Context creation flags (see `cuCtxCreate()` for details)

##### pD3DDevice

- Direct3D device to create interoperability context with

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE,  
 CUDA\_ERROR\_OUT\_OF\_MEMORY, CUDA\_ERROR\_UNKNOWN

**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 context 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:**

[cuD3D10GetDevice](#), [cuGraphicsD3D10RegisterResource](#)

**CUresult cuD3D10CtxCreateOnDevice (CUcontext \*pCtx, unsigned int flags, ID3D10Device \*pD3DDevice, CUdevice cudaDevice)**

Create a CUDA context for interoperability with Direct3D 10.

**Parameters****pCtx**

- Returned newly created CUDA context

**flags**

- Context creation flags (see [cuCtxCreate\(\)](#) for details)

**pD3DDevice**

- Direct3D device to create interoperability context with

**cudaDevice**

- The CUDA device on which to create the context. This device must be among the devices returned when querying CU\_D3D10\_DEVICES\_ALL from [cuD3D10GetDevices](#).

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE,  
 CUDA\_ERROR\_OUT\_OF\_MEMORY, CUDA\_ERROR\_UNKNOWN

## 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 context 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:

[cuD3D10GetDevices](#), [cuGraphicsD3D10RegisterResource](#)

## CUresult cuD3D10GetDirect3DDevice (ID3D10Device \*\*ppD3DDevice)

Get the Direct3D 10 device against which the current CUDA context was created.

## Parameters

### ppD3DDevice

- Returned Direct3D device corresponding to CUDA context

## Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#)

## 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 context 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:

[cuD3D10GetDevice](#)

## CUresult cuD3D10MapResources (unsigned int count, ID3D10Resource \*\*ppResources)

Map Direct3D resources for access by CUDA.

### Parameters

#### count

- Number of resources to map for CUDA

#### ppResources

- Resources to map for CUDA

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_ALREADY\_MAPPED,  
CUDA\_ERROR\_UNKNOWN

### 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 `cuD3D10MapResources()` will complete before any CUDA kernels issued after `cuD3D10MapResources()` begin.

If any of `ppResources` have not been registered for use with CUDA or if `ppResources` contains any duplicate entries, then `CUDA_ERROR_INVALID_HANDLE` is returned. If any of `ppResources` are presently mapped for access by CUDA, then `CUDA_ERROR_ALREADY_MAPPED` is returned.



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

### See also:

`cuGraphicsMapResources`

## CUresult cuD3D10RegisterResource (ID3D10Resource \*pResource, unsigned int Flags)

Register a Direct3D resource for access by CUDA.

### Parameters

#### pResource

- Resource to register

#### Flags

- Parameters for resource registration

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE,  
CUDA\_ERROR\_OUT\_OF\_MEMORY, CUDA\_ERROR\_UNKNOWN

### 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 [cuD3D10UnregisterResource\(\)](#). 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 [cuD3D10UnregisterResource\(\)](#).

This call is potentially 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 CU\_D3D10\_REGISTER\_FLAGS\_ARRAY.
- ▶ 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.

- ▶ CU\_D3D10\_REGISTER\_FLAGS\_NONE: Specifies that CUDA will access this resource through a [CUdeviceptr](#). The pointer, size, and (for textures), pitch for each subresource of this allocation may be queried through [cuD3D10ResourceGetMappedPointer\(\)](#), [cuD3D10ResourceGetMappedSize\(\)](#),

and `cuD3D10ResourceGetMappedPitch()` respectively. This option is valid for all resource types.

- ▶ `CU_D3D10_REGISTER_FLAGS_ARRAY`: Specifies that CUDA will access this resource through a `CUarray` queried on a sub-resource basis through `cuD3D10ResourceGetMappedArray()`. 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 `CUDA_ERROR_INVALID_CONTEXT` is returned. If `pResource` is of incorrect type or is already registered, then `CUDA_ERROR_INVALID_HANDLE` is returned. If `pResource` cannot be registered, then `CUDA_ERROR_UNKNOWN` is returned.



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

See also:

`cuGraphicsD3D10RegisterResource`

## `CUresult cuD3D10ResourceGetMappedArray (CUarray *pArray, ID3D10Resource *pResource, unsigned int SubResource)`

Get an array through which to access a subresource of a Direct3D resource which has been mapped for access by CUDA.

### Parameters

#### **pArray**

- Returned array corresponding to subresource

#### **pResource**

- Mapped resource to access

#### **SubResource**

- Subresource of `pResource` to access

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE,  
 CUDA\_ERROR\_NOT\_MAPPED

**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 `SubResource` may be accessed. The value set in `pArray` may change every time that `pResource` is mapped.

If `pResource` is not registered, then `CUDA_ERROR_INVALID_HANDLE` is returned. If `pResource` was not registered with usage flags `CU_D3D10_REGISTER_FLAGS_ARRAY`, then `CUDA_ERROR_INVALID_HANDLE` is returned. If `pResource` is not mapped, then `CUDA_ERROR_NOT_MAPPED` is returned.

For usage requirements of the `SubResource` parameter, see `cuD3D10ResourceGetMappedPointer()`.



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

**See also:**

`cuGraphicsSubResourceGetMappedArray`

**CUresult cuD3D10ResourceGetMappedPitch** (`size_t *pPitch`, `size_t *pPitchSlice`, `ID3D10Resource *pResource`, `unsigned int SubResource`)

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

**SubResource**

- Subresource of `pResource` to access

## Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE,  
 CUDA\_ERROR\_NOT\_MAPPED

## 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 `IDirect3DBaseTexture10` or one of its sub-types or if `pResource` has not been registered for use with CUDA, then `CUDA_ERROR_INVALID_HANDLE` is returned. If `pResource` was not registered with usage flags `CU_D3D10_REGISTER_FLAGS_NONE`, then `CUDA_ERROR_INVALID_HANDLE` is returned. If `pResource` is not mapped for access by CUDA, then `CUDA_ERROR_NOT_MAPPED` is returned.

For usage requirements of the `SubResource` parameter, see `cuD3D10ResourceGetMappedPointer()`.



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

## See also:

`cuGraphicsSubResourceGetMappedArray`



## CUresult cuD3D10ResourceGetMappedPointer (CUdeviceptr \*pDevPtr, ID3D10Resource \*pResource, unsigned int SubResource)

Get a pointer through which to access a subresource of a Direct3D resource which has been mapped for access by CUDA.

### Parameters

#### pDevPtr

- Returned pointer corresponding to subresource

#### pResource

- Mapped resource to access

#### SubResource

- Subresource of pResource to access

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_NOT\_MAPPED

### Description

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

Returns in \*pDevPtr the base pointer of the subresource of the mapped Direct3D resource pResource, which corresponds to SubResource. The value set in pDevPtr may change every time that pResource is mapped.

If pResource is not registered, then **CUDA\_ERROR\_INVALID\_HANDLE** is returned. If pResource was not registered with usage flags CU\_D3D10\_REGISTER\_FLAGS\_NONE, then **CUDA\_ERROR\_INVALID\_HANDLE** is returned. If pResource is not mapped, then **CUDA\_ERROR\_NOT\_MAPPED** 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:

[cuGraphicsResourceGetMappedPointer](#)

## CUresult cuD3D10ResourceGetMappedSize (size\_t \*pSize, ID3D10Resource \*pResource, unsigned int SubResource)

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

#### SubResource

- Subresource of pResource to access

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_NOT\_MAPPED

### 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 CUDA\_ERROR\_INVALID\_HANDLE is returned. If pResource was not registered with usage flags CU\_D3D10\_REGISTER\_FLAGS\_NONE, then CUDA\_ERROR\_INVALID\_HANDLE is returned. If pResource is not mapped for access by CUDA, then CUDA\_ERROR\_NOT\_MAPPED is returned.

For usage requirements of the SubResource parameter, see cuD3D10ResourceGetMappedPointer().



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

### See also:

[cuGraphicsResourceGetMappedPointer](#)

**CUresult cuD3D10ResourceGetSurfaceDimensions** (size\_t \*pWidth, size\_t \*pHeight, size\_t \*pDepth, ID3D10Resource \*pResource, unsigned int SubResource)

Get the dimensions of a registered 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

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED, CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT, CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE

### 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.

Because 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 IDirect3DBaseTexture10 or IDirect3DSurface10 or if pResource has not been registered for use with CUDA, then **CUDA\_ERROR\_INVALID\_HANDLE** is returned.

For usage requirements of the SubResource parameter, see [cuD3D10ResourceGetMappedPointer\(\)](#).



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

See also:

[cuGraphicsSubResourceGetMappedArray](#)

## CUresult cuD3D10ResourceSetMapFlags (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

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE,  
CUDA\_ERROR\_ALREADY\_MAPPED

### 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.

- ▶ CU\_D3D10\_MAPRESOURCE\_FLAGS\_NONE: 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.
- ▶ CU\_D3D10\_MAPRESOURCE\_FLAGS\_READONLY: Specifies that CUDA kernels which access this resource will not write to this resource.
- ▶ CU\_D3D10\_MAPRESOURCE\_FLAGS\_WRITEDISCARD: 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 `CUDA_ERROR_INVALID_HANDLE` is returned. If `pResource` is presently mapped for access by CUDA then `CUDA_ERROR_ALREADY_MAPPED` is returned.



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

See also:

[cuGraphicsResourceSetMapFlags](#)

## CUresult cuD3D10UnmapResources (unsigned int count, ID3D10Resource \*\*ppResources)

Unmap Direct3D resources.

### Parameters

#### count

- Number of resources to unmap for CUDA

#### ppResources

- Resources to unmap for CUDA

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_HANDLE`,  
`CUDA_ERROR_NOT_MAPPED`, `CUDA_ERROR_UNKNOWN`

### 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 `cuD3D10UnmapResources()` will complete before any Direct3D calls issued after `cuD3D10UnmapResources()` begin.

If any of `ppResources` have not been registered for use with CUDA or if `ppResources` contains any duplicate entries, then `CUDA_ERROR_INVALID_HANDLE` is returned. If any of `ppResources` are not presently mapped for access by CUDA, then `CUDA_ERROR_NOT_MAPPED` is returned.



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

See also:

[cuGraphicsUnmapResources](#)

## CUresult cuD3D10UnregisterResource (ID3D10Resource \*pResource)

Unregister a Direct3D resource.

### Parameters

#### pResource

- Resources to unregister

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_HANDLE, CUDA\_ERROR\_UNKNOWN

### 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 `CUDA_ERROR_INVALID_HANDLE` is returned.



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

See also:

[cuGraphicsUnregisterResource](#)

## 5.33. Direct3D 11 Interoperability

This section describes the Direct3D 11 interoperability functions of the low-level CUDA driver application programming interface. Note that mapping of Direct3D 11 resources is performed with the graphics API agnostic, resource mapping interface described in [Graphics Interoperability](#).

## Direct3D 11 Interoperability [DEPRECATED]

### enum CUd3d11DeviceList

CUDA devices corresponding to a D3D11 device

#### Values

**CU\_D3D11\_DEVICE\_LIST\_ALL = 0x01**

The CUDA devices for all GPUs used by a D3D11 device

**CU\_D3D11\_DEVICE\_LIST\_CURRENT\_FRAME = 0x02**

The CUDA devices for the GPUs used by a D3D11 device in its currently rendering frame

**CU\_D3D11\_DEVICE\_LIST\_NEXT\_FRAME = 0x03**

The CUDA devices for the GPUs to be used by a D3D11 device in the next frame

### CUresult cuD3D11GetDevice (CUdevice \*pCudaDevice, IDXGIAdapter \*pAdapter)

Gets the CUDA device corresponding to a display adapter.

#### Parameters

##### pCudaDevice

- Returned CUDA device corresponding to pAdapter

##### pAdapter

- Adapter to query for CUDA device

#### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_NO\_DEVICE,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_NOT\_FOUND,  
CUDA\_ERROR\_UNKNOWN

#### Description

Returns in \*pCudaDevice the CUDA-compatible device corresponding to the adapter pAdapter obtained from IDXGIFactory::EnumAdapters.

If no device on pAdapter is CUDA-compatible the call will return CUDA\_ERROR\_NO\_DEVICE.



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

See also:

[cuD3D11GetDevices](#), [cudaD3D11GetDevice](#)

**CUresult cuD3D11GetDevices (unsigned int \*pCudaDeviceCount, CUdevice \*pCudaDevices, unsigned int cudaDeviceCount, ID3D11Device \*pD3D11Device, CUd3d11DeviceList 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 [CU\\_D3D11\\_DEVICE\\_LIST\\_ALL](#) for all devices, [CU\\_D3D11\\_DEVICE\\_LIST\\_CURRENT\\_FRAME](#) for the devices used to render the current frame (in SLI), or [CU\\_D3D11\\_DEVICE\\_LIST\\_NEXT\\_FRAME](#) for the devices used to render the next frame (in SLI).

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#), [CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_NO\\_DEVICE](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#), [CUDA\\_ERROR\\_NOT\\_FOUND](#), [CUDA\\_ERROR\\_UNKNOWN](#)

### Description

Returns in \*pCudaDeviceCount the number of CUDA-compatible device corresponding to the Direct3D 11 device pD3D11Device. Also returns in \*pCudaDevices at most cudaDeviceCount of 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 `CUDA_ERROR_NO_DEVICE`.



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

See also:

`cuD3D11GetDevice`, `cudaD3D11GetDevices`

## CUresult cuGraphicsD3D11RegisterResource (CUgraphicsResource \*pCudaResource, ID3D11Resource \*pD3DResource, unsigned int Flags)

Register a Direct3D 11 resource for access by CUDA.

### Parameters

#### **pCudaResource**

- Returned graphics resource handle

#### **pD3DResource**

- Direct3D resource to register

#### **Flags**

- Parameters for resource registration

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_INVALID_HANDLE`,  
`CUDA_ERROR_OUT_OF_MEMORY`, `CUDA_ERROR_UNKNOWN`

### Description

Registers the Direct3D 11 resource `pD3DResource` for access by CUDA and returns a CUDA handle to `pD3DResource` in `pCudaResource`. The handle returned in `pCudaResource` may be used to map and unmap this resource until it is unregistered. On success this call will increase the internal reference count on `pD3DResource`. This reference count will be decremented when this resource is unregistered through `cuGraphicsUnregisterResource()`.

This call is potentially 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 through 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

- ▶ `CU_GRAPHICS_REGISTER_FLAGS_NONE`: Specifies no hints about how this resource will be used.
- ▶ `CU_GRAPHICS_REGISTER_FLAGS_SURFACE_LDST`: Specifies that CUDA will bind this resource to a surface reference.
- ▶ `CU_GRAPHICS_REGISTER_FLAGS_TEXTURE_GATHER`: 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.
- ▶ 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

`CUDA_ERROR_INVALID_HANDLE` is returned. If `pD3DResource` cannot be registered then `CUDA_ERROR_UNKNOWN` is returned. If `Flags` is not one of the above specified value then `CUDA_ERROR_INVALID_VALUE` is returned.



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

#### See also:

[cuGraphicsUnregisterResource](#), [cuGraphicsMapResources](#),  
[cuGraphicsSubResourceGetMappedArray](#), [cuGraphicsResourceGetMappedPointer](#),  
[cudaGraphicsD3D11RegisterResource](#)

## 5.33.1. Direct3D 11 Interoperability [DEPRECATED]

### Direct3D 11 Interoperability

This section describes deprecated Direct3D 11 interoperability functionality.

**CUresult cuD3D11CtxCreate (CUcontext \*pCtx, CUdevice \*pCudaDevice, unsigned int Flags, ID3D11Device \*pD3DDevice)**

Create a CUDA context for interoperability with Direct3D 11.

#### Parameters

##### **pCtx**

- Returned newly created CUDA context

##### **pCudaDevice**

- Returned pointer to the device on which the context was created

##### **Flags**

- Context creation flags (see [cuCtxCreate\(\)](#) for details)

##### **pD3DDevice**

- Direct3D device to create interoperability context with

#### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_VALUE](#),  
[CUDA\\_ERROR\\_OUT\\_OF\\_MEMORY](#), [CUDA\\_ERROR\\_UNKNOWN](#)

#### 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 context 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:

[cuD3D11GetDevice](#), [cuGraphicsD3D11RegisterResource](#)

## CUresult cuD3D11CtxCreateOnDevice (CUcontext \*pCtx, unsigned int flags, ID3D11Device \*pD3DDevice, CUdevice cudaDevice)

Create a CUDA context for interoperability with Direct3D 11.

### Parameters

#### pCtx

- Returned newly created CUDA context

#### flags

- Context creation flags (see [cuCtxCreate\(\)](#) for details)

#### pD3DDevice

- Direct3D device to create interoperability context with

#### cudaDevice

- The CUDA device on which to create the context. This device must be among the devices returned when querying CU\_D3D11\_DEVICES\_ALL from [cuD3D11GetDevices](#).

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_VALUE,  
CUDA\_ERROR\_OUT\_OF\_MEMORY, CUDA\_ERROR\_UNKNOWN

### 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 context 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:

[cuD3D11GetDevices](#), [cuGraphicsD3D11RegisterResource](#)

## CUresult cuD3D11GetDirect3DDevice (ID3D11Device \*\*ppD3DDevice)

Get the Direct3D 11 device against which the current CUDA context was created.

### Parameters

#### ppD3DDevice

- Returned Direct3D device corresponding to CUDA context

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#)

### 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 context 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:

[cuD3D11GetDevice](#)

## 5.34. VDPAU Interoperability

This section describes the VDPAU interoperability functions of the low-level CUDA driver application programming interface.

## CUresult cuGraphicsVDPAURegisterOutputSurface (CUgraphicsResource \*pCudaResource, VdpOutputSurface vdpSurface, unsigned int flags)

Registers a VDPAU VdpOutputSurface object.

### Parameters

#### pCudaResource

- Pointer to the returned object handle

#### vdpSurface

- The VdpOutputSurface to be registered

#### flags

- Map flags

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_HANDLE,  
CUDA\_ERROR\_ALREADY\_MAPPED, CUDA\_ERROR\_INVALID\_CONTEXT,

### Description

Registers the VdpOutputSurface specified by vdpSurface for access by CUDA. A handle to the registered object is returned as pCudaResource. The surface's intended usage is specified using flags, as follows:

- ▶ CU\_GRAPHICS\_MAP\_RESOURCE\_FLAGS\_NONE: 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.
- ▶ CU\_GRAPHICS\_MAP\_RESOURCE\_FLAGS\_READ\_ONLY: Specifies that CUDA will not write to this resource.
- ▶ CU\_GRAPHICS\_MAP\_RESOURCE\_FLAGS\_WRITE\_DISCARD: 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.

The VdpOutputSurface is presented as an array of subresources that may be accessed using pointers returned by [cuGraphicsSubResourceGetMappedArray](#). The exact number of valid arrayIndex values depends on the VDPAU surface format. The mapping is shown in the table below. mipLevel must be 0.



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

**See also:**

[cuCtxCreate](#), [cuVDPAUCtxCreate](#), [cuGraphicsVDPAURegisterVideoSurface](#),  
[cuGraphicsUnregisterResource](#), [cuGraphicsResourceSetMapFlags](#),  
[cuGraphicsMapResources](#), [cuGraphicsUnmapResources](#),  
[cuGraphicsSubResourceGetMappedArray](#), [cuVDPAUGetDevice](#),  
[cudaGraphicsVDPAURegisterOutputSurface](#)

## CUresult cuGraphicsVDPAURegisterVideoSurface (CUgraphicsResource \*pCudaResource, VdpVideoSurface vdpSurface, unsigned int flags)

Registers a VDPAU VdpVideoSurface object.

**Parameters****pCudaResource**

- Pointer to the returned object handle

**vdpSurface**

- The VdpVideoSurface to be registered

**flags**

- Map flags

**Returns**

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_HANDLE](#),  
[CUDA\\_ERROR\\_ALREADY\\_MAPPED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),

**Description**

Registers the VdpVideoSurface specified by vdpSurface for access by CUDA. A handle to the registered object is returned as pCudaResource. The surface's intended usage is specified using flags, as follows:

- ▶ [CU\\_GRAPHICS\\_MAP\\_RESOURCE\\_FLAGS\\_NONE](#): 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.
- ▶ [CU\\_GRAPHICS\\_MAP\\_RESOURCE\\_FLAGS\\_READ\\_ONLY](#): Specifies that CUDA will not write to this resource.
- ▶ [CU\\_GRAPHICS\\_MAP\\_RESOURCE\\_FLAGS\\_WRITE\\_DISCARD](#): 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.

The VdpVideoSurface is presented as an array of subresources that may be accessed using pointers returned by [cuGraphicsSubResourceGetMappedArray](#). The exact number

of valid `arrayIndex` values depends on the VDPAU surface format. The mapping is shown in the table below. `mipLevel` must be 0.



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

#### See also:

`cuCtxCreate`, `cuVDPAUCtxCreate`, `cuGraphicsVDPAURegisterOutputSurface`,  
`cuGraphicsUnregisterResource`, `cuGraphicsResourceSetMapFlags`,  
`cuGraphicsMapResources`, `cuGraphicsUnmapResources`,  
`cuGraphicsSubResourceGetMappedArray`, `cuVDPAUGetDevice`,  
`cudaGraphicsVDPAURegisterVideoSurface`

## CUresult cuVDPAUCtxCreate (CUcontext \*pCtx, unsigned int flags, CUdevice device, VdpDevice vdpDevice, VdpGetProcAddress \*vdpGetProcAddress)

Create a CUDA context for interoperability with VDPAU.

### Parameters

#### **pCtx**

- Returned CUDA context

#### **flags**

- Options for CUDA context creation

#### **device**

- Device on which to create the context

#### **vdpDevice**

- The VdpDevice to interop with

#### **vdpGetProcAddress**

- VDPAU's VdpGetProcAddress function pointer

### Returns

`CUDA_SUCCESS`, `CUDA_ERROR_DEINITIALIZED`,  
`CUDA_ERROR_NOT_INITIALIZED`, `CUDA_ERROR_INVALID_CONTEXT`,  
`CUDA_ERROR_INVALID_VALUE`, `CUDA_ERROR_OUT_OF_MEMORY`

### Description

Creates a new CUDA context, initializes VDPAU interoperability, and associates the CUDA context with the calling thread. It must be called before performing any other



VDPAU interoperability operations. It may fail if the needed VDPAU driver facilities are not available. For usage of the `flags` parameter, see [cuCtxCreate\(\)](#).



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

#### See also:

[cuCtxCreate](#), [cuGraphicsVDPAURegisterVideoSurface](#),  
[cuGraphicsVDPAURegisterOutputSurface](#), [cuGraphicsUnregisterResource](#),  
[cuGraphicsResourceSetMapFlags](#), [cuGraphicsMapResources](#),  
[cuGraphicsUnmapResources](#), [cuGraphicsSubResourceGetMappedArray](#),  
[cuVDPAUGetDevice](#)

## CUresult cuVDPAUGetDevice (CUdevice \*pDevice, VdpDevice vdpDevice, VdpGetProcAddress \*vdpGetProcAddress)

Gets the CUDA device associated with a VDPAU device.

#### Parameters

##### **pDevice**

- Device associated with `vdpDevice`

##### **vdpDevice**

- A `VdpDevice` handle

##### **vdpGetProcAddress**

- VDPAU's `VdpGetProcAddress` function pointer

#### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_DEINITIALIZED](#),  
[CUDA\\_ERROR\\_NOT\\_INITIALIZED](#), [CUDA\\_ERROR\\_INVALID\\_CONTEXT](#),  
[CUDA\\_ERROR\\_INVALID\\_VALUE](#)

#### Description

Returns in `*pDevice` the CUDA device associated with a `vdpDevice`, if applicable.



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

**See also:**

`cuCtxCreate`, `cuVDPAUCtxCreate`, `cuGraphicsVDPAURegisterVideoSurface`,  
`cuGraphicsVDPAURegisterOutputSurface`, `cuGraphicsUnregisterResource`,  
`cuGraphicsResourceSetMapFlags`, `cuGraphicsMapResources`,  
`cuGraphicsUnmapResources`, `cuGraphicsSubResourceGetMappedArray`,  
`cudaVDPAUGetDevice`

## 5.35. EGL Interoperability

This section describes the EGL interoperability functions of the low-level CUDA driver application programming interface.

**CUresult cuEGLStreamConsumerAcquireFrame**  
 (CUeglStreamConnection \*conn, CUgraphicsResource  
 \*pCudaResource, CUstream \*pStream, unsigned int  
 timeout)

Acquire an image frame from the EGLStream with CUDA as a consumer.

**Parameters****conn**

- Connection on which to acquire

**pCudaResource**

- CUDA resource on which the stream frame will be mapped for use.

**pStream**

- CUDA stream for synchronization and any data migrations implied by  
`CUeglResourceLocationFlags`.

**timeout**

- Desired timeout in usec.

**Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_HANDLE`,  
`CUDA_ERROR_LAUNCH_TIMEOUT`,

**Description**

Acquire an image frame from EGLStreamKHR.

`cuGraphicsResourceGetMappedEglFrame` can be called on `pCudaResource` to get  
`CUeglFrame`.

**See also:**

`cuEGLStreamConsumerConnect`, `cuEGLStreamConsumerDisconnect`,  
`cuEGLStreamConsumerAcquireFrame`, `cuEGLStreamConsumerReleaseFrame`,  
`cudaEGLStreamConsumerAcquireFrame`

## **CUresult cuEGLStreamConsumerConnect (CUeglStreamConnection \*conn, EGLStreamKHR stream)**

Connect CUDA to EGLStream as a consumer.

### **Parameters**

#### **conn**

- Pointer to the returned connection handle

#### **stream**

- EGLStreamKHR handle

### **Returns**

`CUDA_SUCCESS`, `CUDA_ERROR_INVALID_HANDLE`,  
`CUDA_ERROR_INVALID_CONTEXT`,

### **Description**

Connect CUDA as a consumer to EGLStreamKHR specified by `stream`.

The EGLStreamKHR is an EGL object that transfers a sequence of image frames from one API to another.

### **See also:**

`cuEGLStreamConsumerConnect`, `cuEGLStreamConsumerDisconnect`,  
`cuEGLStreamConsumerAcquireFrame`, `cuEGLStreamConsumerReleaseFrame`,  
`cudaEGLStreamConsumerConnect`

## **CUresult cuEGLStreamConsumerConnectWithFlags (CUeglStreamConnection \*conn, EGLStreamKHR stream, unsigned int flags)**

Connect CUDA to EGLStream as a consumer with given flags.

### **Parameters**

#### **conn**

- Pointer to the returned connection handle

#### **stream**

- EGLStreamKHR handle

**flags**

- Flags denote intended location - system or video.

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_HANDLE,  
CUDA\_ERROR\_INVALID\_CONTEXT,

**Description**

Connect CUDA as a consumer to EGLStreamKHR specified by `stream` with specified `flags` defined by `CUeglResourceLocationFlags`.

The flags specify whether the consumer wants to access frames from system memory or video memory. Default is `CU_EGL_RESOURCE_LOCATION_VIDMEM`.

**See also:**

`cuEGLStreamConsumerConnect`, `cuEGLStreamConsumerDisconnect`,  
`cuEGLStreamConsumerAcquireFrame`, `cuEGLStreamConsumerReleaseFrame`,  
`cudaEGLStreamConsumerConnectWithFlags`

## CUresult cuEGLStreamConsumerDisconnect (CUeglStreamConnection \*conn)

Disconnect CUDA as a consumer to EGLStream .

**Parameters****conn**

- Conection to disconnect.

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_HANDLE,  
CUDA\_ERROR\_INVALID\_CONTEXT,

**Description**

Disconnect CUDA as a consumer to EGLStreamKHR.

The EGLStreamKHR is an EGL object that transfers a sequence of image frames from one API to another.

**See also:**

[cuEGLStreamConsumerConnect](#), [cuEGLStreamConsumerDisconnect](#),  
[cuEGLStreamConsumerAcquireFrame](#), [cuEGLStreamConsumerReleaseFrame](#),  
[cudaEGLStreamConsumerDisconnect](#)

## CUresult cuEGLStreamConsumerReleaseFrame (CUeglStreamConnection \*conn, CUgraphicsResource pCudaResource, CUstream \*pStream)

Releases the last frame acquired from the EGLStream.

### Parameters

#### **conn**

- Connection on which to release

#### **pCudaResource**

- CUDA resource whose corresponding frame is to be released

#### **pStream**

- CUDA stream on which release will be done.

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_HANDLE](#),

### Description

Release the acquired image frame specified by pCudaResource to EGLStreamKHR.

The EGLStreamKHR is an EGL object that transfers a sequence of image frames from one API to another.

### See also:

[cuEGLStreamConsumerConnect](#), [cuEGLStreamConsumerDisconnect](#),  
[cuEGLStreamConsumerAcquireFrame](#), [cuEGLStreamConsumerReleaseFrame](#),  
[cudaEGLStreamConsumerReleaseFrame](#)

## CUresult cuEGLStreamProducerConnect (CUeglStreamConnection \*conn, EGLStreamKHR stream, EGLint width, EGLint height)

Connect CUDA to EGLStream as a producer.

### Parameters

#### **conn**

- Pointer to the returned connection handle

**stream**

- EGLStreamKHR handle

**width**

- width of the image to be submitted to the stream

**height**

- height of the image to be submitted to the stream

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_HANDLE,  
CUDA\_ERROR\_INVALID\_CONTEXT,

**Description**

Connect CUDA as a producer to EGLStreamKHR specified by `stream`.

The EGLStreamKHR is an EGL object that transfers a sequence of image frames from one API to another.

**See also:**

cuEGLStreamProducerConnect, cuEGLStreamProducerDisconnect,  
cuEGLStreamProducerPresentFrame, cudaEGLStreamProducerConnect

## CUresult cuEGLStreamProducerDisconnect (CUeglStreamConnection \*conn)

Disconnect CUDA as a producer to EGLStream .

**Parameters****conn**

- Conection to disconnect.

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_HANDLE,  
CUDA\_ERROR\_INVALID\_CONTEXT,

**Description**

Disconnect CUDA as a producer to EGLStreamKHR.

The EGLStreamKHR is an EGL object that transfers a sequence of image frames from one API to another.

**See also:**

[cuEGLStreamProducerConnect](#), [cuEGLStreamProducerDisconnect](#),  
[cuEGLStreamProducerPresentFrame](#), [cudaEGLStreamProducerDisconnect](#)

## CUresult cuEGLStreamProducerPresentFrame (CUeglStreamConnection \*conn, CUeglFrame eglframe, CUstream \*pStream)

Present a CUDA eglFrame to the EGLStream with CUDA as a producer.

### Parameters

#### conn

- Connection on which to present the CUDA array

#### eglframe

- CUDA Eglstream Proucer Frame handle to be sent to the consumer over EglStream.

#### pStream

- CUDA stream on which to present the frame.

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_HANDLE](#),

### Description

The EGLStreamKHR is an EGL object that transfers a sequence of image frames from one API to another.

The [CUeglFrame](#) is defined as:

```
typedef struct CUeglFrame_st {
    union {
        CUarray pArray[MAX_PLANES];
        void* pPitch[MAX_PLANES];
    } frame;
    unsigned int width;
    unsigned int height;
    unsigned int depth;
    unsigned int pitch;
    unsigned int planeCount;
    unsigned int numChannels;
    CUeglFrameType frameType;
    CUeglColorFormat eglColorFormat;
    CUarray_format cuFormat;
} CUeglFrame;
```

For [CUeglFrame](#) of type [CU\\_EGL\\_FRAME\\_TYPE\\_PITCH](#), the application may present sub-region of a memory allocation. In that case, the pitched pointer will specify the start address of the sub-region in the allocation and corresponding [CUeglFrame](#) fields will specify the dimensions of the sub-region.

See also:

[cuEGLStreamProducerConnect](#), [cuEGLStreamProducerDisconnect](#),  
[cuEGLStreamProducerReturnFrame](#), [cudaEGLStreamProducerPresentFrame](#)

## CUresult cuEGLStreamProducerReturnFrame (CUeglStreamConnection \*conn, CUeglFrame \*eglframe, CUstream \*pStream)

Return the CUDA eglFrame to the EGLStream released by the consumer.

### Parameters

#### conn

- Connection on which to return

#### eglframe

- CUDA Eglstream Proucer Frame handle returned from the consumer over EglStream.

#### pStream

- CUDA stream on which to return the frame.

### Returns

[CUDA\\_SUCCESS](#), [CUDA\\_ERROR\\_INVALID\\_HANDLE](#),  
[CUDA\\_ERROR\\_LAUNCH\\_TIMEOUT](#)

### Description

The EGLStreamKHR is an EGL object that transfers a sequence of image frames from one API to another.

This API can potentially return [CUDA\\_ERROR\\_LAUNCH\\_TIMEOUT](#) if the consumer has not returned a frame to EGL stream. If timeout is returned the application can retry.

### See also:

[cuEGLStreamProducerConnect](#), [cuEGLStreamProducerDisconnect](#),  
[cuEGLStreamProducerPresentFrame](#), [cudaEGLStreamProducerReturnFrame](#)

## CUresult cuEventCreateFromEGLSync (CUevent \*phEvent, EGLSyncKHR eglSync, unsigned int flags)

Creates an event from EGLSync object.

### Parameters

#### phEvent

- Returns newly created event



**eglSync**

- Opaque handle to EGLSync object

**flags**

- Event creation flags

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
 CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
 CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_OUT\_OF\_MEMORY

**Description**

Creates an event \*phEvent from an EGLSyncKHR eglSync with the flags specified via flags. Valid flags include:

- ▶ **CU\_EVENT\_DEFAULT**: Default event creation flag.
- ▶ **CU\_EVENT\_BLOCKING\_SYNC**: Specifies that the created event should use blocking synchronization. A CPU thread that uses **cuEventSynchronize()** to wait on an event created with this flag will block until the event has actually been completed.

Once the eglSync gets destroyed, **cuEventDestroy** is the only API that can be invoked on the event.

**cuEventRecord** and **TimingData** are not supported for events created from EGLSync.

The EGLSyncKHR is an opaque handle to an EGL sync object. typedef void\* EGLSyncKHR

**See also:**

**cuEventQuery**, **cuEventSynchronize**, **cuEventDestroy**

## CUresult cuGraphicsEGLRegisterImage (CUgraphicsResource \*pCudaResource, EGLImageKHR image, unsigned int flags)

Registers an EGL image.

**Parameters****pCudaResource**

- Pointer to the returned object handle

**image**

- An EGLImageKHR image which can be used to create target resource.

**flags**

- Map flags

**Returns**

CUDA\_SUCCESS, CUDA\_ERROR\_INVALID\_HANDLE,  
CUDA\_ERROR\_ALREADY\_MAPPED, CUDA\_ERROR\_INVALID\_CONTEXT,

**Description**

Registers the EGLImageKHR specified by `image` for access by CUDA. A handle to the registered object is returned as `pCudaResource`. Additional Mapping/Unmapping is not required for the registered resource and `cuGraphicsResourceGetMappedEglFrame` can be directly called on the `pCudaResource`.

The application will be responsible for synchronizing access to shared objects. The application must ensure that any pending operation which access the objects have completed before passing control to CUDA. This may be accomplished by issuing and waiting for `glFinish` command on all GLcontexts (for OpenGL and likewise for other APIs). The application will be also responsible for ensuring that any pending operation on the registered CUDA resource has completed prior to executing subsequent commands in other APIs accesing the same memory objects. This can be accomplished by calling `cuCtxSynchronize` or `cuEventSynchronize` (preferably).

The surface's intended usage is specified using `flags`, as follows:

- ▶ `CU_GRAPHICS_MAP_RESOURCE_FLAGS_NONE`: 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.
- ▶ `CU_GRAPHICS_MAP_RESOURCE_FLAGS_READ_ONLY`: Specifies that CUDA will not write to this resource.
- ▶ `CU_GRAPHICS_MAP_RESOURCE_FLAGS_WRITE_DISCARD`: 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.

The `EGLImageKHR` is an object which can be used to create `EGLImage` target resource. It is defined as a void pointer. `typedef void* EGLImageKHR`

**See also:**

`cuGraphicsEGLRegisterImage`, `cuGraphicsUnregisterResource`,  
`cuGraphicsResourceSetMapFlags`, `cuGraphicsMapResources`,  
`cuGraphicsUnmapResources`, `cudaGraphicsEGLRegisterImage`

## CUresult cuGraphicsResourceGetMappedEglFrame (CUeglFrame \*eglFrame, CUgraphicsResource resource, unsigned int index, unsigned int mipLevel)

Get an eglFrame through which to access a registered EGL graphics resource.

### Parameters

#### eglFrame

- Returned eglFrame.

#### resource

- Registered resource to access.

#### index

- Index for cubemap surfaces.

#### mipLevel

- Mipmap level for the subresource to access.

### Returns

CUDA\_SUCCESS, CUDA\_ERROR\_DEINITIALIZED,  
CUDA\_ERROR\_NOT\_INITIALIZED, CUDA\_ERROR\_INVALID\_CONTEXT,  
CUDA\_ERROR\_INVALID\_VALUE, CUDA\_ERROR\_INVALID\_HANDLE,  
CUDA\_ERROR\_NOT\_MAPPED

### Description

Returns in \*eglFrame an eglFrame pointer through which the registered graphics resource resource may be accessed. This API can only be called for EGL graphics resources.

The CUeglFrame is defined as:

```
typedef struct CUeglFrame_st {
    union {
        CUarray pArray[MAX_PLANES];
        void* pPitch[MAX_PLANES];
    } frame;
    unsigned int width;
    unsigned int height;
    unsigned int depth;
    unsigned int pitch;
    unsigned int planeCount;
    unsigned int numChannels;
    CUeglFrameType frameType;
    CUeglColorFormat eglColorFormat;
    CUarray_format cuFormat;
} CUeglFrame;
```

If resource is not registered then CUDA\_ERROR\_NOT\_MAPPED is returned. \*

See also:

`cuGraphicsMapResources`, `cuGraphicsSubResourceGetMappedArray`,  
`cuGraphicsResourceGetMappedPointer`, `cudaGraphicsResourceGetMappedEglFrame`

# Chapter 6.

## DATA STRUCTURES

Here are the data structures with brief descriptions:

**CUaccessPolicyWindow**  
**CUDA\_ARRAY3D\_DESCRIPTOR**  
**CUDA\_ARRAY\_DESCRIPTOR**  
**CUDA\_EXTERNAL\_MEMORY\_BUFFER\_DESC**  
**CUDA\_EXTERNAL\_MEMORY\_HANDLE\_DESC**  
**CUDA\_EXTERNAL\_MEMORY\_MIPMAPPED\_ARRAY\_DESC**  
**CUDA\_EXTERNAL\_SEMAPHORE\_HANDLE\_DESC**  
**CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_PARAMS**  
**CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_PARAMS**  
**CUDA\_HOST\_NODE\_PARAMS**  
**CUDA\_KERNEL\_NODE\_PARAMS**  
**CUDA\_LAUNCH\_PARAMS**  
**CUDA\_MEMCPY2D**  
**CUDA\_MEMCPY3D**  
**CUDA\_MEMCPY3D\_PEER**  
**CUDA\_MEMSET\_NODE\_PARAMS**  
**CUDA\_POINTER\_ATTRIBUTE\_P2P\_TOKENS**  
**CUDA\_RESOURCE\_DESC**  
**CUDA\_RESOURCE\_VIEW\_DESC**  
**CUDA\_TEXTURE\_DESC**  
**CUdevprop**  
**CUeglFrame**  
**CUipcEventHandle**  
**CUipcMemHandle**  
**CUkernelNodeAttrValue**  
**CUmемAccessDesc**  
**CUmемAllocationProp**  
**CUmемLocation**  
**CUstreamAttrValue**

## CUstreamBatchMemOpParams

### 6.1. CUaccessPolicyWindow Struct Reference

Specifies an access policy for a window, a contiguous extent of memory beginning at `base_ptr` and ending at `base_ptr + num_bytes`. `num_bytes` is limited by `CU_DEVICE_ATTRIBUTE_MAX_ACCESS_POLICY_WINDOW_SIZE`. Partition into many segments and assign segments such that:  $\text{sum of "hit segments"} / \text{window} \approx \text{ratio}$ .  $\text{sum of "miss segments"} / \text{window} \approx 1 - \text{ratio}$ . Segments and ratio specifications are fitted to the capabilities of the architecture. Accesses in a hit segment apply the `hitProp` access policy. Accesses in a miss segment apply the `missProp` access policy.

**void \*CUaccessPolicyWindow::base\_ptr**

Starting address of the access policy window. CUDA driver may align it.

**CUaccessProperty CUaccessPolicyWindow::hitProp**

`CUaccessProperty` set for hit.

**float CUaccessPolicyWindow::hitRatio**

`hitRatio` specifies percentage of lines assigned `hitProp`, rest are assigned `missProp`.

**CUaccessProperty CUaccessPolicyWindow::missProp**

`CUaccessProperty` set for miss. Must be either `NORMAL` or `STREAMING`

**size\_t CUaccessPolicyWindow::num\_bytes**

Size in bytes of the window policy. CUDA driver may restrict the maximum size and alignment.

### 6.2. CUDA\_ARRAY3D\_DESCRIPTOR Struct Reference

3D array descriptor

**size\_t CUDA\_ARRAY3D\_DESCRIPTOR::Depth**

Depth of 3D array

`unsigned int CUDA_ARRAY3D_DESCRIPTOR::Flags`

Flags

`CUarray_format CUDA_ARRAY3D_DESCRIPTOR::Format`

Array format

`size_t CUDA_ARRAY3D_DESCRIPTOR::Height`

Height of 3D array

`unsigned int CUDA_ARRAY3D_DESCRIPTOR::NumChannels`

Channels per array element

`size_t CUDA_ARRAY3D_DESCRIPTOR::Width`

Width of 3D array

## 6.3. CUDA\_ARRAY\_DESCRIPTOR Struct Reference

Array descriptor

`CUarray_format CUDA_ARRAY_DESCRIPTOR::Format`

Array format

`size_t CUDA_ARRAY_DESCRIPTOR::Height`

Height of array

`unsigned int CUDA_ARRAY_DESCRIPTOR::NumChannels`

Channels per array element

`size_t CUDA_ARRAY_DESCRIPTOR::Width`

Width of array

## 6.4. CUDA\_EXTERNAL\_MEMORY\_BUFFER\_DESC Struct Reference

External memory buffer descriptor

unsigned int

`CUDA_EXTERNAL_MEMORY_BUFFER_DESC::flags`

Flags reserved for future use. Must be zero.

unsigned long long

`CUDA_EXTERNAL_MEMORY_BUFFER_DESC::offset`

Offset into the memory object where the buffer's base is

unsigned long long

`CUDA_EXTERNAL_MEMORY_BUFFER_DESC::size`

Size of the buffer

## 6.5. CUDA\_EXTERNAL\_MEMORY\_HANDLE\_DESC Struct Reference

External memory handle descriptor

int `CUDA_EXTERNAL_MEMORY_HANDLE_DESC::fd`

File descriptor referencing the memory object. Valid when type is

`CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_FD`

unsigned int

`CUDA_EXTERNAL_MEMORY_HANDLE_DESC::flags`

Flags must either be zero or `CUDA_EXTERNAL_MEMORY_DEDICATED`

void \*`CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle`

Valid NT handle. Must be NULL if 'name' is non-NULL



const void

\*CUDA\_EXTERNAL\_MEMORY\_HANDLE\_DESC::name

Name of a valid memory object. Must be NULL if 'handle' is non-NULL.

const void

\*CUDA\_EXTERNAL\_MEMORY\_HANDLE\_DESC::nvSciBufObject

A handle representing an NvSciBuf Object. Valid when type is  
CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_NVSCIBUF

unsigned long long

CUDA\_EXTERNAL\_MEMORY\_HANDLE\_DESC::size

Size of the memory allocation

CUexternalMemoryHandleType

CUDA\_EXTERNAL\_MEMORY\_HANDLE\_DESC::type

Type of the handle

CUDA\_EXTERNAL\_MEMORY\_HANDLE\_DESC::@10::@11

CUDA\_EXTERNAL\_MEMORY\_HANDLE\_DESC::win32

Win32 handle referencing the semaphore object. Valid when type is one of the following:

- ▶ CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_OPAQUE\_WIN32
- ▶ CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_OPAQUE\_WIN32\_KMT
- ▶ CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_D3D12\_HEAP
- ▶ CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_D3D12\_RESOURCE
- ▶ CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_D3D11\_RESOURCE
- ▶ CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_D3D11\_RESOURCE\_KMT

Exactly one of 'handle' and 'name' must be non-NULL. If type is one of the following: CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_OPAQUE\_WIN32\_KMT CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_D3D11\_RESOURCE\_KMT then 'name' must be NULL.

## 6.6. CUDA\_EXTERNAL\_MEMORY\_MIPMAPPED\_ARRAY\_DESC Struct Reference

External memory mipmap descriptor

```
struct CUDA_ARRAY3D_DESCRIPTOR
CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC::arrayDesc
```

Format, dimension and type of base level of the mipmap chain

```
unsigned int
CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC::numLevels
```

Total number of levels in the mipmap chain

```
unsigned long long
CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC::offset
```

Offset into the memory object where the base level of the mipmap chain is.

## 6.7. CUDA\_EXTERNAL\_SEMAPHORE\_HANDLE\_DESC Struct Reference

External semaphore handle descriptor

```
int CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::fd
```

File descriptor referencing the semaphore object. Valid when type is  
`CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_FD`

```
unsigned int
CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::flags
```

Flags reserved for the future. Must be zero.

```
void
*CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle
```

Valid NT handle. Must be NULL if 'name' is non-NULL

const void

\*CUDA\_EXTERNAL\_SEMAPHORE\_HANDLE\_DESC::name

Name of a valid synchronization primitive. Must be NULL if 'handle' is non-NULL.

const void

\*CUDA\_EXTERNAL\_SEMAPHORE\_HANDLE\_DESC::nvSciSyncObj

Valid NvSciSyncObj. Must be non NULL

CUexternalSemaphoreHandleType

CUDA\_EXTERNAL\_SEMAPHORE\_HANDLE\_DESC::type

Type of the handle

CUDA\_EXTERNAL\_SEMAPHORE\_HANDLE\_DESC::@12::@13

CUDA\_EXTERNAL\_SEMAPHORE\_HANDLE\_DESC::win32

Win32 handle referencing the semaphore object. Valid when type is one of the following:

- ▶ CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_OPAQUE\_WIN32
- ▶ CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_OPAQUE\_WIN32\_KMT
- ▶ CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_D3D12\_FENCE
- ▶ CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_D3D11\_FENCE
- ▶ CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_D3D11\_KEYED\_MUTEX Exactly one of 'handle' and 'name' must be non-NULL. If type is one of the following:  
CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_OPAQUE\_WIN32\_KMT  
CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_D3D11\_KEYED\_MUTEX\_KMT  
then 'name' must be NULL.

## 6.8. CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_PARAMS Struct Reference

External semaphore signal parameters

void

\*CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_PARAMS::fence

Pointer to NvSciSyncFence. Valid if CUexternalSemaphoreHandleType is of type CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_NVSCISYNC.

**CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_PARAMS::@14::@15**  
**CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_PARAMS::fence**

Parameters for fence objects

**unsigned int**

**CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_PARAMS::flags**

Only when **CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_PARAMS** is used to signal a **CUexternalSemaphore** of type **CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_NVSCISYNC**, the valid flag is **CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_SKIP\_NVSCIBUF\_MEMSYNC** which indicates that while signaling the **CUexternalSemaphore**, no memory synchronization operations should be performed for any external memory object imported as **CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_NVSCIBUF**. For all other types of **CUexternalSemaphore**, flags must be zero.

**unsigned long long**

**CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_PARAMS::key**

Value of key to release the mutex with

**CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_PARAMS::@14::@17**  
**CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_PARAMS::keyedMutex**

Parameters for keyed mutex objects

**unsigned long long**

**CUDA\_EXTERNAL\_SEMAPHORE\_SIGNAL\_PARAMS::value**

Value of fence to be signaled

## 6.9. CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_PARAMS Struct Reference

External semaphore wait parameters

**CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_PARAMS::@18::@19**  
**CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_PARAMS::fence**

Parameters for fence objects

**unsigned int**

**CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_PARAMS::flags**

Only when **CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_PARAMS** is used to wait on a **CUexternalSemaphore** of type **CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_NVSCISYNC**, the valid flag is **CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_SKIP\_NVSCIBUF\_MEMSYNC** which indicates that while waiting for the **CUexternalSemaphore**, no memory synchronization operations should be performed for any external memory object imported as **CU\_EXTERNAL\_MEMORY\_HANDLE\_TYPE\_NVSCIBUF**. For all other types of **CUexternalSemaphore**, flags must be zero.

**unsigned long long**

**CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_PARAMS::key**

Value of key to acquire the mutex with

**CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_PARAMS::@18::@21**  
**CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_PARAMS::keyedMutex**

Parameters for keyed mutex objects

**CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_PARAMS::@18::@20**  
**CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_PARAMS::nvSciSync**

Pointer to **NvSciSyncFence**. Valid if **CUexternalSemaphoreHandleType** is of type **CU\_EXTERNAL\_SEMAPHORE\_HANDLE\_TYPE\_NVSCISYNC**.

**unsigned int**

**CUDA\_EXTERNAL\_SEMAPHORE\_WAIT\_PARAMS::timeoutMs**

Timeout in milliseconds to wait to acquire the mutex

`unsigned long long  
CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS::value`

Value of fence to be waited on

## 6.10. CUDA\_HOST\_NODE\_PARAMS Struct Reference

Host node parameters

`CUhostFn CUDA_HOST_NODE_PARAMS::fn`

The function to call when the node executes

`void *CUDA_HOST_NODE_PARAMS::userData`

Argument to pass to the function

## 6.11. CUDA\_KERNEL\_NODE\_PARAMS Struct Reference

GPU kernel node parameters

`unsigned int CUDA_KERNEL_NODE_PARAMS::blockDimX`

X dimension of each thread block

`unsigned int CUDA_KERNEL_NODE_PARAMS::blockDimY`

Y dimension of each thread block

`unsigned int CUDA_KERNEL_NODE_PARAMS::blockDimZ`

Z dimension of each thread block

`**CUDA_KERNEL_NODE_PARAMS::extra`

Extra options

`CUfunction CUDA_KERNEL_NODE_PARAMS::func`

Kernel to launch

**unsigned int CUDA\_KERNEL\_NODE\_PARAMS::gridDimX**

Width of grid in blocks

**unsigned int CUDA\_KERNEL\_NODE\_PARAMS::gridDimY**

Height of grid in blocks

**unsigned int CUDA\_KERNEL\_NODE\_PARAMS::gridDimZ**

Depth of grid in blocks

**\*\*CUDA\_KERNEL\_NODE\_PARAMS::kernelParams**

Array of pointers to kernel parameters

**unsigned int  
CUDA\_KERNEL\_NODE\_PARAMS::sharedMemBytes**

Dynamic shared-memory size per thread block in bytes

## 6.12. CUDA\_LAUNCH\_PARAMS Struct Reference

Kernel launch parameters

**unsigned int CUDA\_LAUNCH\_PARAMS::blockDimX**

X dimension of each thread block

**unsigned int CUDA\_LAUNCH\_PARAMS::blockDimY**

Y dimension of each thread block

**unsigned int CUDA\_LAUNCH\_PARAMS::blockDimZ**

Z dimension of each thread block

**CUfunction CUDA\_LAUNCH\_PARAMS::function**

Kernel to launch

**unsigned int CUDA\_LAUNCH\_PARAMS::gridDimX**

Width of grid in blocks

**unsigned int CUDA\_LAUNCH\_PARAMS::gridDimY**

Height of grid in blocks

**unsigned int CUDA\_LAUNCH\_PARAMS::gridDimZ**

Depth of grid in blocks

**CUstream CUDA\_LAUNCH\_PARAMS::hStream**

Stream identifier

**\*\*CUDA\_LAUNCH\_PARAMS::kernelParams**

Array of pointers to kernel parameters

**unsigned int CUDA\_LAUNCH\_PARAMS::sharedMemBytes**

Dynamic shared-memory size per thread block in bytes

## 6.13. CUDA\_MEMCPY2D Struct Reference

2D memory copy parameters

**CUarray CUDA\_MEMCPY2D::dstArray**

Destination array reference

**CUdeviceptr CUDA\_MEMCPY2D::dstDevice**

Destination device pointer

**void \*CUDA\_MEMCPY2D::dstHost**

Destination host pointer

**CUmemorytype CUDA\_MEMCPY2D::dstMemoryType**

Destination memory type (host, device, array)



**size\_t CUDA\_MEMCPY2D::dstPitch**

Destination pitch (ignored when dst is array)

**size\_t CUDA\_MEMCPY2D::dstXInBytes**

Destination X in bytes

**size\_t CUDA\_MEMCPY2D::dstY**

Destination Y

**size\_t CUDA\_MEMCPY2D::Height**

Height of 2D memory copy

**CUarray CUDA\_MEMCPY2D::srcArray**

Source array reference

**CUdeviceptr CUDA\_MEMCPY2D::srcDevice**

Source device pointer

**const void \*CUDA\_MEMCPY2D::srcHost**

Source host pointer

**CUmemorytype CUDA\_MEMCPY2D::srcMemoryType**

Source memory type (host, device, array)

**size\_t CUDA\_MEMCPY2D::srcPitch**

Source pitch (ignored when src is array)

**size\_t CUDA\_MEMCPY2D::srcXInBytes**

Source X in bytes

**size\_t CUDA\_MEMCPY2D::srcY**

Source Y

## `size_t CUDA_MEMCPY2D::WidthInBytes`

Width of 2D memory copy in bytes

## 6.14. CUDA\_MEMCPY3D Struct Reference

3D memory copy parameters

### `size_t CUDA_MEMCPY3D::Depth`

Depth of 3D memory copy

### `CUarray CUDA_MEMCPY3D::dstArray`

Destination array reference

### `CUdeviceptr CUDA_MEMCPY3D::dstDevice`

Destination device pointer

### `size_t CUDA_MEMCPY3D::dstHeight`

Destination height (ignored when dst is array; may be 0 if Depth==1)

### `void *CUDA_MEMCPY3D::dstHost`

Destination host pointer

### `size_t CUDA_MEMCPY3D::dstLOD`

Destination LOD

### `CUmemorytype CUDA_MEMCPY3D::dstMemoryType`

Destination memory type (host, device, array)

### `size_t CUDA_MEMCPY3D::dstPitch`

Destination pitch (ignored when dst is array)

### `size_t CUDA_MEMCPY3D::dstXInBytes`

Destination X in bytes

**size\_t CUDA\_MEMCPY3D::dstY**

Destination Y

**size\_t CUDA\_MEMCPY3D::dstZ**

Destination Z

**size\_t CUDA\_MEMCPY3D::Height**

Height of 3D memory copy

**void \*CUDA\_MEMCPY3D::reserved0**

Must be NULL

**void \*CUDA\_MEMCPY3D::reserved1**

Must be NULL

**CUarray CUDA\_MEMCPY3D::srcArray**

Source array reference

**CUdeviceptr CUDA\_MEMCPY3D::srcDevice**

Source device pointer

**size\_t CUDA\_MEMCPY3D::srcHeight**

Source height (ignored when src is array; may be 0 if Depth==1)

**const void \*CUDA\_MEMCPY3D::srcHost**

Source host pointer

**size\_t CUDA\_MEMCPY3D::srcLOD**

Source LOD

**CUmemorytype CUDA\_MEMCPY3D::srcMemoryType**

Source memory type (host, device, array)

**size\_t CUDA\_MEMCPY3D::srcPitch**

Source pitch (ignored when src is array)

**size\_t CUDA\_MEMCPY3D::srcXInBytes**

Source X in bytes

**size\_t CUDA\_MEMCPY3D::srcY**

Source Y

**size\_t CUDA\_MEMCPY3D::srcZ**

Source Z

**size\_t CUDA\_MEMCPY3D::WidthInBytes**

Width of 3D memory copy in bytes

## 6.15. CUDA\_MEMCPY3D\_PEER Struct Reference

3D memory cross-context copy parameters

**size\_t CUDA\_MEMCPY3D\_PEER::Depth**

Depth of 3D memory copy

**CUarray CUDA\_MEMCPY3D\_PEER::dstArray**

Destination array reference

**CUcontext CUDA\_MEMCPY3D\_PEER::dstContext**

Destination context (ignored with dstMemoryType is [CU\\_MEMORYTYPE\\_ARRAY](#))

**CUdeviceptr CUDA\_MEMCPY3D\_PEER::dstDevice**

Destination device pointer

**size\_t CUDA\_MEMCPY3D\_PEER::dstHeight**

Destination height (ignored when dst is array; may be 0 if Depth==1)

**void \*CUDA\_MEMCPY3D\_PEER::dstHost**

Destination host pointer

**size\_t CUDA\_MEMCPY3D\_PEER::dstLOD**

Destination LOD

**CUmemorytype CUDA\_MEMCPY3D\_PEER::dstMemoryType**

Destination memory type (host, device, array)

**size\_t CUDA\_MEMCPY3D\_PEER::dstPitch**

Destination pitch (ignored when dst is array)

**size\_t CUDA\_MEMCPY3D\_PEER::dstXInBytes**

Destination X in bytes

**size\_t CUDA\_MEMCPY3D\_PEER::dstY**

Destination Y

**size\_t CUDA\_MEMCPY3D\_PEER::dstZ**

Destination Z

**size\_t CUDA\_MEMCPY3D\_PEER::Height**

Height of 3D memory copy

**CUarray CUDA\_MEMCPY3D\_PEER::srcArray**

Source array reference

**CUcontext CUDA\_MEMCPY3D\_PEER::srcContext**

Source context (ignored with srcMemoryType is [CU\\_MEMORYTYPE\\_ARRAY](#))

**CUdeviceptr CUDA\_MEMCPY3D\_PEER::srcDevice**

Source device pointer

**size\_t CUDA\_MEMCPY3D\_PEER::srcHeight**

Source height (ignored when src is array; may be 0 if Depth==1)

**const void \*CUDA\_MEMCPY3D\_PEER::srcHost**

Source host pointer

**size\_t CUDA\_MEMCPY3D\_PEER::srcLOD**

Source LOD

**CUmemorytype CUDA\_MEMCPY3D\_PEER::srcMemoryType**

Source memory type (host, device, array)

**size\_t CUDA\_MEMCPY3D\_PEER::srcPitch**

Source pitch (ignored when src is array)

**size\_t CUDA\_MEMCPY3D\_PEER::srcXInBytes**

Source X in bytes

**size\_t CUDA\_MEMCPY3D\_PEER::srcY**

Source Y

**size\_t CUDA\_MEMCPY3D\_PEER::srcZ**

Source Z

**size\_t CUDA\_MEMCPY3D\_PEER::WidthInBytes**

Width of 3D memory copy in bytes

## 6.16. CUDA\_MEMSET\_NODE\_PARAMS Struct Reference

Memset node parameters

**CUdeviceptr CUDA\_MEMSET\_NODE\_PARAMS::dst**

Destination device pointer

**unsigned int CUDA\_MEMSET\_NODE\_PARAMS::elementSize**

Size of each element in bytes. Must be 1, 2, or 4.

**size\_t CUDA\_MEMSET\_NODE\_PARAMS::height**

Number of rows

**size\_t CUDA\_MEMSET\_NODE\_PARAMS::pitch**

Pitch of destination device pointer. Unused if height is 1

**unsigned int CUDA\_MEMSET\_NODE\_PARAMS::value**

Value to be set

**size\_t CUDA\_MEMSET\_NODE\_PARAMS::width**

Width in bytes, of the row

## 6.17. CUDA\_POINTER\_ATTRIBUTE\_P2P\_TOKENS Struct Reference

GPU Direct v3 tokens

## 6.18. CUDA\_RESOURCE\_DESC Struct Reference

CUDA Resource descriptor

**CUdeviceptr CUDA\_RESOURCE\_DESC::devPtr**

Device pointer

**unsigned int CUDA\_RESOURCE\_DESC::flags**

Flags (must be zero)

**CUarray\_format CUDA\_RESOURCE\_DESC::format**

Array format

**CUarray CUDA\_RESOURCE\_DESC::hArray**

CUDA array

**size\_t CUDA\_RESOURCE\_DESC::height**

Height of the array in elements

**CUmipmappedArray**

**CUDA\_RESOURCE\_DESC::hMipmappedArray**

CUDA mipmapped array

**unsigned int CUDA\_RESOURCE\_DESC::numChannels**

Channels per array element

**size\_t CUDA\_RESOURCE\_DESC::pitchInBytes**

Pitch between two rows in bytes

**CUresourcetype CUDA\_RESOURCE\_DESC::resType**

Resource type

**size\_t CUDA\_RESOURCE\_DESC::sizeInBytes**

Size in bytes

**size\_t CUDA\_RESOURCE\_DESC::width**

Width of the array in elements

## 6.19. CUDA\_RESOURCE\_VIEW\_DESC Struct Reference

Resource view descriptor



**size\_t CUDA\_RESOURCE\_VIEW\_DESC::depth**

Depth of the resource view

**unsigned int CUDA\_RESOURCE\_VIEW\_DESC::firstLayer**

First layer index

**unsigned int  
CUDA\_RESOURCE\_VIEW\_DESC::firstMipmapLevel**

First defined mipmap level

**CUresourceViewFormat  
CUDA\_RESOURCE\_VIEW\_DESC::format**

Resource view format

**size\_t CUDA\_RESOURCE\_VIEW\_DESC::height**

Height of the resource view

**unsigned int CUDA\_RESOURCE\_VIEW\_DESC::lastLayer**

Last layer index

**unsigned int  
CUDA\_RESOURCE\_VIEW\_DESC::lastMipmapLevel**

Last defined mipmap level

**size\_t CUDA\_RESOURCE\_VIEW\_DESC::width**

Width of the resource view

## 6.20. CUDA\_TEXTURE\_DESC Struct Reference

Texture descriptor

**CUaddress\_mode CUDA\_TEXTURE\_DESC::addressMode**

Address modes

**float CUDA\_TEXTURE\_DESC::borderColor**

Border Color

**CUfilter\_mode CUDA\_TEXTURE\_DESC::filterMode**

Filter mode

**unsigned int CUDA\_TEXTURE\_DESC::flags**

Flags

**unsigned int CUDA\_TEXTURE\_DESC::maxAnisotropy**

Maximum anisotropy ratio

**float CUDA\_TEXTURE\_DESC::maxMipmapLevelClamp**

Mipmap maximum level clamp

**float CUDA\_TEXTURE\_DESC::minMipmapLevelClamp**

Mipmap minimum level clamp

**CUfilter\_mode**

**CUDA\_TEXTURE\_DESC::mipmapFilterMode**

Mipmap filter mode

**float CUDA\_TEXTURE\_DESC::mipmapLevelBias**

Mipmap level bias

## 6.21. CUdevprop Struct Reference

Legacy device properties

**int CUdevprop::clockRate**

Clock frequency in kilohertz

## `int CUdevprop::maxGridSize`

Maximum size of each dimension of a grid

## `int CUdevprop::maxThreadsDim`

Maximum size of each dimension of a block

## `int CUdevprop::maxThreadsPerBlock`

Maximum number of threads per block

## `int CUdevprop::memPitch`

Maximum pitch in bytes allowed by memory copies

## `int CUdevprop::regsPerBlock`

32-bit registers available per block

## `int CUdevprop::sharedMemPerBlock`

Shared memory available per block in bytes

## `int CUdevprop::SIMDWidth`

Warp size in threads

## `int CUdevprop::textureAlign`

Alignment requirement for textures

## `int CUdevprop::totalConstantMemory`

Constant memory available on device in bytes

## 6.22. CUeglFrame Struct Reference

CUDA EGLFrame structure Descriptor - structure defining one frame of EGL.

Each frame may contain one or more planes depending on whether the surface \* is Multiplanar or not.

## **CUarray\_format CUeglFrame::cuFormat**

CUDA Array Format

## **unsigned int CUeglFrame::depth**

Depth of first plane

## **CUeglColorFormat CUeglFrame::eglColorFormat**

CUDA EGL Color Format

## **CUeglFrameType CUeglFrame::frameType**

Array or Pitch

## **unsigned int CUeglFrame::height**

Height of first plane

## **unsigned int CUeglFrame::numChannels**

Number of channels for the plane

## **CUarray CUeglFrame::pArray**

Array of CUarray corresponding to each plane

## **unsigned int CUeglFrame::pitch**

Pitch of first plane

## **unsigned int CUeglFrame::planeCount**

Number of planes

## **void \*CUeglFrame::pPitch**

Array of Pointers corresponding to each plane

## **unsigned int CUeglFrame::width**

Width of first plane

## 6.23. CUipcEventHandle Struct Reference

CUDA IPC event handle

## 6.24. CUipcMemHandle Struct Reference

CUDA IPC mem handle

## 6.25. CUkernelNodeAttrValue Union Reference

Graph attributes union, used with `cuKernelNodeSetAttribute/`  
`cuKernelNodeGetAttribute`

**struct CUaccessPolicyWindow**  
**CUkernelNodeAttrValue::accessPolicyWindow**

Attribute `CUaccessPolicyWindow`.

**int CUkernelNodeAttrValue::cooperative**

Nonzero indicates a cooperative kernel (see `cuLaunchCooperativeKernel`).

## 6.26. CUmемAccessDesc Struct Reference

Memory access descriptor

**CUmемAccess\_flags CUmемAccessDesc::flags**

CUmемProt accessibility flags to set on the request

**struct CUmемLocation CUmемAccessDesc::location**

Location on which the request is to change it's accessibility

## 6.27. CUmемAllocationProp Struct Reference

Specifies the allocation properties for a allocation.

## unsigned char CUmemAllocationProp::compressionType

Additional allocation hint for requesting compressible memory. Compressed memory allows higher bandwidth, but may cause compression resource thrashing, and compressed memory may not be mappable on all devices.

## struct CUmemLocation CUmemAllocationProp::location

Location of allocation

## CUmemAllocationHandleType

## CUmemAllocationProp::requestedHandleTypes

requested [CUmemAllocationHandleType](#)

## CUmemAllocationType CUmemAllocationProp::type

Allocation type

## void \*CUmemAllocationProp::win32HandleMetaData

Windows-specific LPSECURITY\_ATTRIBUTES required when [CU\\_MEM\\_HANDLE\\_TYPE\\_WIN32](#) is specified. This security attribute defines the scope of which exported allocations may be transferred to other processes. In all other cases, this field is required to be zero.

## 6.28. CUmemLocation Struct Reference

Specifies a location for an allocation.

### int CUmemLocation::id

identifier for a given this location's [CUmemLocationType](#).

### CUmemLocationType CUmemLocation::type

Specifies the location type, which modifies the meaning of id.

## 6.29. CUstreamAttrValue Union Reference

Stream attributes union, used with [cuStreamSetAttribute/cuStreamGetAttribute](#)

`struct CUaccessPolicyWindow`  
`CUstreamAttrValue::accessPolicyWindow`

Attribute `CUaccessPolicyWindow`.

`CUsynchronizationPolicy CUstreamAttrValue::syncPolicy`

Value for `CU_STREAM_ATTRIBUTE_SYNCHRONIZATION_POLICY`.

## 6.30. CUstreamBatchMemOpParams Union Reference

Per-operation parameters for `cuStreamBatchMemOp`

# Chapter 7.

## DATA FIELDS

Here is a list of all documented struct and union fields with links to the struct/union documentation for each field:

### A

#### **accessPolicyWindow**

[CUkernelNodeAttrValue](#)

[CUstreamAttrValue](#)

#### **addressMode**

[CUDA\\_TEXTURE\\_DESC](#)

#### **arrayDesc**

[CUDA\\_EXTERNAL\\_MEMORY\\_MIPMAPPED\\_ARRAY\\_DESC](#)

### B

#### **base\_ptr**

[CUaccessPolicyWindow](#)

#### **blockDimX**

[CUDA\\_KERNEL\\_NODE\\_PARAMS](#)

[CUDA\\_LAUNCH\\_PARAMS](#)

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## Chapter 8.

# DEPRECATED LIST

### **Global CU\_CTX\_BLOCKING\_SYNC**

This flag was deprecated as of CUDA 4.0 and was replaced with CU\_CTX\_SCHED\_BLOCKING\_SYNC.

### **Global CU\_DEVICE\_P2P\_ATTRIBUTE\_ACCESS\_ACCESS\_SUPPORTED**

use CU\_DEVICE\_P2P\_ATTRIBUTE\_CUDA\_ARRAY\_ACCESS\_SUPPORTED instead

### **Global CUDA\_ERROR\_PROFILER\_NOT\_INITIALIZED**

This error return is deprecated as of CUDA 5.0. It is no longer an error to attempt to enable/disable the profiling via cuProfilerStart or cuProfilerStop without initialization.

### **Global CUDA\_ERROR\_PROFILER\_ALREADY\_STARTED**

This error return is deprecated as of CUDA 5.0. It is no longer an error to call cuProfilerStart() when profiling is already enabled.

### **Global CUDA\_ERROR\_PROFILER\_ALREADY\_STOPPED**

This error return is deprecated as of CUDA 5.0. It is no longer an error to call cuProfilerStop() when profiling is already disabled.

### **Global CUDA\_ERROR\_CONTEXT\_ALREADY\_CURRENT**

This error return is deprecated as of CUDA 3.2. It is no longer an error to attempt to push the active context via cuCtxPushCurrent().

**Global cuDeviceComputeCapability**

**Global cuDeviceGetProperties**

**Global cuCtxAttach**

**Global cuCtxDetach**

**Global cuFuncSetBlockShape**

**Global cuFuncSetSharedSize**

**Global cuLaunch**

**Global cuLaunchGrid**

**Global cuLaunchGridAsync**

**Global cuParamSetf**

**Global cuParamSeti**

**Global cuParamSetSize**

**Global cuParamSetTexRef**

**Global cuParamSetv**

**Global cuTexRefCreate**

**Global cuTexRefDestroy**

**Global cuTexRefGetAddress**

**Global cuTexRefGetAddressMode**

**Global cuTexRefGetArray**

**Global cuTexRefGetBorderColor**

**Global cuTexRefGetFilterMode**

**Global cuTexRefGetFlags**

**Global cuTexRefGetFormat**

**Global cuTexRefGetMaxAnisotropy**

**Global cuTexRefGetMipmapFilterMode**

**Global cuTexRefGetMipmapLevelBias**

**Global cuTexRefGetMipmapLevelClamp**

**Global cuTexRefGetMipmappedArray**

**Global cuTexRefSetAddress**

**Global cuTexRefSetAddress2D**

**Global cuTexRefSetAddressMode**

**Global cuTexRefSetArray**

**Global cuTexRefSetBorderColor**

**Global cuTexRefSetFilterMode**

**Global cuTexRefSetFlags**

**Global cuTexRefSetFormat**

**Global cuTexRefSetMaxAnisotropy**

**Global cuTexRefSetMipmapFilterMode**

**Global cuTexRefSetMipmapLevelBias**

### **Global cuTexRefSetMipmapLevelClamp**

### **Global cuTexRefSetMipmappedArray**

### **Global cuSurfRefGetArray**

### **Global cuSurfRefSetArray**

### **Global cuProfilerInitialize**

### **Global cuGLCtxCreate**

This function is deprecated as of Cuda 5.0.

### **Global cuGLInit**

This function is deprecated as of Cuda 3.0.

### **Global cuGLMapBufferObject**

This function is deprecated as of Cuda 3.0.

### **Global cuGLMapBufferObjectAsync**

This function is deprecated as of Cuda 3.0.

### **Global cuGLRegisterBufferObject**

This function is deprecated as of Cuda 3.0.

### **Global cuGLSetBufferObjectMapFlags**

This function is deprecated as of Cuda 3.0.

**Global cuGLUnmapBufferObject**

This function is deprecated as of Cuda 3.0.

**Global cuGLUnmapBufferObjectAsync**

This function is deprecated as of Cuda 3.0.

**Global cuGLUnregisterBufferObject**

This function is deprecated as of Cuda 3.0.

**Global cuD3D9MapResources**

This function is deprecated as of CUDA 3.0.

**Global cuD3D9RegisterResource**

This function is deprecated as of CUDA 3.0.

**Global cuD3D9ResourceGetMappedArray**

This function is deprecated as of CUDA 3.0.

**Global cuD3D9ResourceGetMappedPitch**

This function is deprecated as of CUDA 3.0.

**Global cuD3D9ResourceGetMappedPointer**

This function is deprecated as of CUDA 3.0.

**Global cuD3D9ResourceGetMappedSize**

This function is deprecated as of CUDA 3.0.

**Global cuD3D9ResourceGetSurfaceDimensions**

This function is deprecated as of CUDA 3.0.

**Global cuD3D9ResourceSetMapFlags**

This function is deprecated as of Cuda 3.0.

**Global cuD3D9UnmapResources**

This function is deprecated as of CUDA 3.0.

**Global cuD3D9UnregisterResource**

This function is deprecated as of CUDA 3.0.

**Global cuD3D10CtxCreate**

This function is deprecated as of CUDA 5.0.

**Global cuD3D10CtxCreateOnDevice**

This function is deprecated as of CUDA 5.0.

**Global cuD3D10GetDirect3DDevice**

This function is deprecated as of CUDA 5.0.

**Global cuD3D10MapResources**

This function is deprecated as of CUDA 3.0.

**Global cuD3D10RegisterResource**

This function is deprecated as of CUDA 3.0.

**Global cuD3D10ResourceGetMappedArray**

This function is deprecated as of CUDA 3.0.

**Global cuD3D10ResourceGetMappedPitch**

This function is deprecated as of CUDA 3.0.



### **Global cuD3D10ResourceGetMappedPointer**

This function is deprecated as of CUDA 3.0.

### **Global cuD3D10ResourceGetMappedSize**

This function is deprecated as of CUDA 3.0.

### **Global cuD3D10ResourceGetSurfaceDimensions**

This function is deprecated as of CUDA 3.0.

### **Global cuD3D10ResourceSetMapFlags**

This function is deprecated as of CUDA 3.0.

### **Global cuD3D10UnmapResources**

This function is deprecated as of CUDA 3.0.

### **Global cuD3D10UnregisterResource**

This function is deprecated as of CUDA 3.0.

### **Global cuD3D11CtxCreate**

This function is deprecated as of CUDA 5.0.

### **Global cuD3D11CtxCreateOnDevice**

This function is deprecated as of CUDA 5.0.

### **Global cuD3D11GetDirect3DDevice**

This function is deprecated as of CUDA 5.0.

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