

# ATS-GPU-BASE

Version 26.1.0  
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**Note:** This is the documentation for AlazarTech's ATS-GPU version 26.1.0. Please visit our [documentation homepage](#) to find documentation for other versions or products.

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## INTRODUCTION

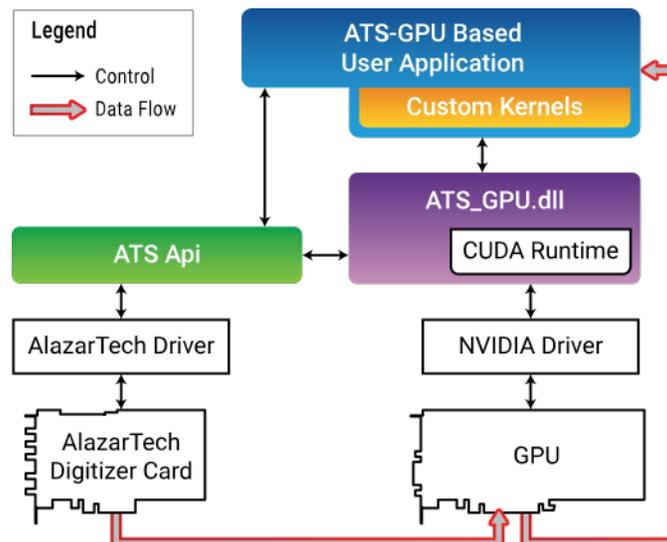
The ATS-GPU SDK provides a framework to allow real-time processing of data from AlazarTech PCIe digitizers on a CUDA-enabled GPU. This programmer's guide covers the use of ATS-GPU-BASE.

ATS-GPU-BASE internally calls ATS-CUDA, which is a wrapper library for simple CUDA calls. ATS-CUDA is described in more detail later in this guide in the section [ATS-CUDA](#).

This document assumes that the reader is familiar with ATS-SDK, the standard interface for programming AlazarTech digitizers. Having a copy of the ATS-SDK manual available can be helpful, since many references to ATSApi functions are done here. The latest version of the ATS-SDK manual can be downloaded free of charge from [AlazarTech's website](#).

In addition, expertise in CUDA programming is assumed. This is particularly important for users wishing to use ATS-GPU-BASE, because this task involves CUDA programming.

It is also essential for programmers to have in-depth knowledge of GPU architecture and parallel programming.





## PREREQUISITES

### 3.1 System requirements

This software requires a PC with a CUDA-enabled GPU, and sufficient CPU resources to supply data to the GPU at the desired data acquisition rate. It was tested with GeForce GTX Titan X (Maxwell), GeForce GTX980 and Quadro P5000. DDR4 memory and a modern chipset (X99, X299) will greatly improve transfer speed and overall performance.

#### Supported operating systems

64-bit Windows and 64-bit Linux operating systems are supported. Please verify that your Linux distribution is [supported by NVIDIA](#), which supplies the CUDA toolkit required to use ATS-GPU.

#### Compiler support

CMake is required to build C/C++ code. CMake files are provided. On Linux, a C++11 compiler is required to build the library. On older Red Hat distributions, a devtoolset can be obtained to use a more recent version of gcc that supports C++11. NVCC is required to compile the example code, this compiler is included with CUDA toolkit.

#### CUDA driver requirements

In order to use ATS-GPU, you must install the appropriate driver for your CUDA-enabled GPU. Drivers can be downloaded at <https://www.nvidia.com/Download/index.aspx>.

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**Note:** Under Windows operating systems, dynamic link libraries related to ATS-GPU-BASE are installed by default in %WINDIR%\System32. For applications to link appropriately to them, %WINDIR%\System32 must be added to the Windows PATH Environment Variable.

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## 3.2 Programming experience

Users who wish to use ATS-GPU-BASE to create high-performance custom kernels must have expertise in CUDA programming.

It is also essential for programmers to have in-depth knowledge of GPU architecture and parallel programming.

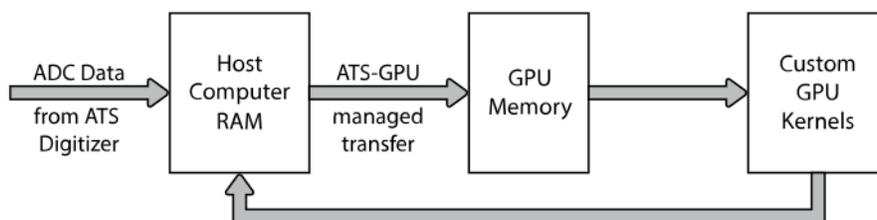
## ATS-GPU-BASE

ATS-GPU-BASE is designed to provide highly efficient code to transfer data from an ATS PCIe digitizer to a CUDA-enabled GPU for processing. This transfer is done using multiple DMA transactions. The user application, which includes custom CUDA kernels, can then access data buffers on the GPU. The user is then responsible to perform data processing and copy data back to the CPU if required. A code example is provided as an example of a user application that performs very simple signal processing (data inversion).

### Sample programs installation path

- Windows: “C:\AlazarTech\ATS-GPU\26.1.0\base”
- Linux: “/usr/local/AlazarTech/ATS-GPU/26.1.0/base”

## 4.1 Usage



**ATS-GPU Data Flow**

ATS-GPU-BASE offers several functions that behave similarly to ATSSapi functions. Please refer to the ATS-SDK guide for more details about these APIs. Obtaining a board handle and configuring the board (sampling rate, trigger, input channels, etc.) is performed directly using functions from the ATS-SDK. By convention, the code samples define a `ConfigureBoard()` function that handles all these tasks.

```
if (!ConfigureBoard(boardHandle)) {  
    // Error handling  
}
```

During the lifetime of an application, multiple acquisitions can take place. If the board configuration parameters do not change, it is not necessary to call `ConfigureBoard()` again.

The next step is to select the CUDA-enabled GPU to use for the data transfer. This call is optional. If you only have one CUDA capable GPU on your computer, you can skip it.

```
rc = ATS_GPU_SetCUDAComputeDevice(boardHandle, deviceIndex);  
// Error handling
```

We must then setup parameters of the acquisition to GPU. This function replaces the call to `AlazarBeforeAsyncRead()` in normal programs. Parameters were kept as close as possible to those of `AlazarBeforeAsyncRead()` to ease transition between standard acquisitions and ATS-GPU acquisitions. To maximize performance, sample interleave should be enabled with `ADMA_INTERLEAVE_SAMPLES`.

```
rc = ATS_GPU_Setup(boardHandle, channelSelect, transferOffset,  
                  transferLength, recordsPerBuffer, recordsPerAcquisition,  
                  autoDMAFlags, ATSGPUFlags);  
// Error handling
```

We then allocate memory on the GPU for data to be transferred to, and we post those buffers to the board. For this purpose, we use `ATS_GPU_AllocBuffer()`. This function allocates a buffer on the GPU and sets up all the intermediary state necessary for ATS-GPU to successfully transfer data. Please note that if you would like to send data back from the GPU to your computer's RAM after having processed it, you will need to allocate memory independently of the AlazarTech APIs.

```
for (size_t i = 0; i < buffers_to_allocate; i++)  
{  
    buffers[i] = ATS_GPU_AllocBuffer(boardHandle, bytesPerBuffer);  
  
    rc = ATS_GPU_PostBuffer(boardHandle,  
                           buffers[i],  
                           bytesPerBuffer);  
  
    // Error handling  
}
```

We can then start the acquisition. The board will directly start acquiring data, assuming it receives triggers, and data transfer to posted GPU buffers will also start immediately.

```
rc = ATS_GPU_StartCapture(HANDLE boardHandle);  
// Error handling
```

Once acquisition is started, `ATS_GPU_GetBuffer()` must be called as often as possible to retrieve a buffer containing data already copied on the GPU. This buffer can then be processed by your custom kernel on the GPU. When a buffer is done being used (either data has been copied to a different buffer or processing is complete), the buffer needs to be posted back to the board.

```
for (size_t i; i < buffers_per_acquisition; i++)  
{  
    rc = ATS_GPU_GetBuffer(boardHandle,  
                          buffers[i],
```

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```

        timeout_ms,
        nullptr);

// TODO: Error handling

// TODO: Process buffer. This is where you can call your own processing
//       function that launches the GPU kernels, such as ProcessBuffer()
//       in the code samples.
ProcessBuffer(buffers[i], bytesPerBuffer);

rc = ATS_GPU_PostBuffer(boardHandle, buffer, bytesPerBuffer);
}

```

When acquisition is complete, `ATS_GPU_AbortCapture()` must be called. Buffers allocated with `ATS_GPU_AllocBuffer()` should then be freed with `ATS_GPU_FreeBuffer()`.

```

RETURN_CODE ATS_GPU_AbortCapture(HANDLE boardHandle);

for (size_t i = 0; i < number_of_buffers; i++)
{
    rc = ATS_GPU_FreeBuffer(boardHandle, buffers[i]);
    // Error handling
}

```

Here is an example of what the function to process data on the GPU can look like. Since this contains code that is executed on the GPU, it needs to be located in a file with a `.cu` extension:

```

extern "C"__global__ void ProcessBuffer(void* buffer, bytesPerBuffer)
{
    int idx = blockDim.x * blockIdx.x + threadIdx.x;

    // TODO: Do processing here
}

Bool ProcessBuffer(void* buffer, U32 bytesPerBuffer)
{
    // Launch ProcessBuffer CUDA kernel
    ProcessBuffer<<<threadsPerBlock, BlocksPerGrid>>>(buffer, bytesPerBuffer);

    // Copy result from GPU memory to CPU memory
    cudaMemcpy(resultBuffer,buffer,bytesPerBuffer);
}

```

## 4.2 Performance guidelines

While GPU solutions are highly customizable and can reach very high processing speeds, care must be taken to preserve performance. The provided libraries use streams to maximise concurrency and hide latency associated with data transfers. The processing functions are optimized to provide the best performance and modifying them can result in a loss of performance. Refer to the [CUDA best practices guide](#) for more information on how to improve performance.

**Warning:** When developing CUDA code, it is very important to check memory accesses with a dedicated tool, as bad memory accesses will not necessarily trigger an error but will lead to bad behavior and can cause a crash. The CUDA toolkit provides the necessary memory checking utilities.

Because data is DMA'd from ATS board to host memory then to GPU memory, speed of host computer memory will influence performance. DDR4 memory and a modern chipset (X99, X299, etc.) will greatly improve transfer speed and overall performance.

## 4.3 Benchmarks

Performance benchmarks using the optional OCT signal processing library and NVIDIA GeForce GTX Titan X (Maxwell) GPU on an ASUS X99 Deluxe motherboard with an Intel i9-7900X 3.3 GHz CPU, and 2133 MHz DDR4 memory (32 GB RAM):

PCIe Link Speed	Transfer Rate
Gen 3x8: ATS9373, ATS9371	Up to 6.9 GB/s
Gen 2x8: ATS9360, ATS9416	Up to 3.5 GB/s
Gen 2x4: ATS9352 Gen 1x8: ATS9870, ATS9350, ATS9351, ATS9625, ATS9626, ATS9440	Up to 1.6 GB/s
Gen 1x4: ATS9462	Up to 720 MB/s
Gen 1x1: ATS9146, ATS9130, ATS9120	Up to 200 MB/s

## 4.4 API Reference

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**Note:** Errors from ATS-GPU-BASE will be logged in `ATS_GPU.log`. Relevant information about the error will be logged here and can be useful for debugging. For Windows users log file is located in `%TEMP%`. For Linux users log file is located in `/tmp/`.

---

RETURN\_CODE **ATS\_GPU\_AbortCapture**(HANDLE boardHandle)

Stops the acquisition.

Aborts an acquisition, stops data processing, and releases resources allocated by [ATS\\_GPU\\_Setup\(\)](#)

**Parameters**

**boardHandle** – Handle to the board

**Returns**

ApiSuccess

RETURN\_CODE **ATS\_GPU\_AddProcessingKernel**(HANDLE boardHandle, KERNEL \*kernel)

Adds a kernel to an internal list of processing kernels that will be used by API function `ATS_GPU_SetProcessingPipeline`.

This function must be called after [ATS\\_GPU\\_Setup](#) and before [ATS\\_GPU\\_SetProcessingPipeline](#).

If this function is called at least once, input parameters “kernelList” and “numberOfKernels” of function `ATS_GPU_SetProcessingPipeline` are ignored.

#### Parameters

- **boardHandle** – Handle to the board.
- **kernel** – Pointer to a kernel to add to the list of processing kernels.

See [ATS-GPU-HPC](#) for more information on types of kernels that can be launched on the GPU.

void \***ATS\_GPU\_AllocBuffer**(HANDLE boardHandle, U32 bytesPerBuffer, cudaStream\_t \*stream)

Allocates page-aligned pinned memory for ATS and GPU boards.

This function can be called after `ATS_GPU_Setup` to perform the necessary memory allocations. This function returns a GPU or CPU buffer pointer depending on [\*ATS\\_GPU\\_SETUP\\_FLAG\*](#) values used in the setup.

#### Parameters

- **boardHandle** – Handle to the board
- **bytesPerBuffer** – Total number of bytes to allocate per buffer
- **stream** – CUDA stream associated to the allocated buffer.

RETURN\_CODE **ATS\_GPU\_FreeBuffer**(HANDLE boardHandle, void \*buffer)

Free buffers allocated with [ATS\\_GPU\\_AllocBuffer\(\)](#);

**Parameters**

- **boardHandle** – Handle to the board
- **buffer** – Buffer pointer allocated by [ATS\\_GPU\\_AllocBuffer\(\)](#)

RETURN\_CODE ATS\_GPU\_GenerateCPUBoxcarFunction(float \*boxcarFunction, U32 samplesPerRecord, U32 gateDelay, U32 gateWidth)

Generates a boxcar gate on the CPU, of length samplesPerRecord.

**Parameters**

- **boxcarFunction** – Array to be filled with the boxcar function. It must have a length of samplesPerRecord.
- **samplesPerRecord** – Samples per record.
- **gateDelay** – Delay of the boxcar gate in number of samples.
- **gateWidth** – Width of the boxcar gate in number of samples.

**Returns**

Pointer to an array of float elements that contains the boxcar window generated on the CPU.

RETURN\_CODE **ATS\_GPU\_GetBuffer**(HANDLE boardHandle, void \*buffer, U32 timeout\_ms, cudaStream\_t \*stream)

Get processed buffer.

This function must be called at average rate that is equal to or greater than the rate at which DMA buffers complete. This function returns the GPU-processed buffer.

**Parameters**

- **boardHandle** – Handle to the board
- **buffer** – Pointer to the buffer
- **timeout\_ms** – Time the board will wait for a trigger before throwing an error.
- **stream** – CUDA stream associated to the processed buffer. Subsequent processing of processed buffer should occurs on this CUDA stream.

**Returns**

ApiSuccess (512) if the board received sufficient triggers to fill a DMA buffer.

**Returns**

ApiNotInitialized if `ATS_StartCapture` was not called before calling this function, or it was called and failed.

**Returns**

ApiInvalidHandle The boardHandle parameter is not valid.

**Returns**

ApiBufferOverflow if the board filled all the available DMA buffers and its on-board memory. This may happen if the acquisition rate exceeds the bus bandwidth or the GPU processing bandwidth.

**Returns**

ApiWaitTimeout if the timeout interval expired before the board received a sufficient number of triggers to fill a buffer.

**Returns**

ApiFailed if a system of internal error occurred.

RETURN\_CODE ATS\_GPU\_GetNumberOfPendingFullDmaBuffers(HANDLE boardHandle, unsigned  
int \*numberOfBuffersFull)

Returns the number of buffers ready to be consumed.

RETURN\_CODE **ATS\_GPU\_GetVersion**(U8 \*major, U8 \*minor, U8 \*revision)

Get ATS-GPU version number.

**Parameters**

- **major** – ATS-GPU major version number.
- **minor** – ATS-GPU minor version number.
- **revision** – ATS-GPU revision number.

RETURN\_CODE **ATS\_GPU\_ManageGetBuffer**(HANDLE boardHandle, void \*buffer, U32 bytesToCopy, U32 timeout\_ms)

Query a buffer through the managed DMA buffer API. For LabVIEW programmers view LabVIEW Programming section.

**Parameters**

- **boardHandle** – Handle to the board
- **buffer** – Pointer to a user-allocated buffer to receive data
- **bytesToCopy** – Number of bytes to copy to the user buffer
- **timeout\_ms** – Maximum time to wait for data to be ready to be copied to buffer before returning ApiWaitTimeout.

RETURN\_CODE **ATS\_GPU\_PostBuffer**(HANDLE boardHandle, void \*buffer, U32 bytesPerBuffer)

Signal the library a particular buffer can be used for data transfer.

This function is the equivalent of AlazarPostAsyncBuffer for ATS\_GPU. Buffers posted must have previously been allocated with ATS\_GPU\_AllocBuffer.

**Parameters**

- **boardHandle** – Handle to the board
- **buffer** – Pointer to a previously allocated buffer
- **bytesPerBuffer** – Size in bytes of the buffer, must be the same size as setup for the acquisition.

RETURN\_CODE **ATS\_GPU\_QueryCUDADeviceCount**(U32 \*pDeviceCount)

Function to get the number of available CUDA devices.

**Parameters**

**pDeviceCount** – Outputs the number of devices detected on the system.

**Returns**

ApiSuccess if it succeeded.

**Returns**

ApiFailed if the GPU driver returned an error.

RETURN\_CODE ATS\_GPU\_QueryCUDADeviceName(U32 deviceIndex, char \*deviceName, int maxChars)

Function to get the name of a specific CUDA device.

**Parameters**

- **deviceIndex** – 0-based index to the device.
- **deviceName** – Char array to output the name of the device.
- **maxChars** – Size of the char array.

**Returns**

ApiSuccess if it succeeded.

**Returns**

ApiFailed if the GPU driver returned an error.

**Returns**

ApiInvalidIndex if the index provided is greater than the number of platforms or devices available.

RETURN\_CODE **ATS\_GPU\_QueryCUDADeviceSerialNumber**(U32 deviceIndex, char  
\*deviceSerialNumber, int maxChars)

Function to get the serial number of a specific CUDA device.

**Parameters**

- **deviceIndex** – 0-based index to the device.
- **deviceName** – Char array to output the serial number of the device.
- **maxChars** – Size of the char array.

**Returns**

ApiSuccess if it succeeded.

**Returns**

ApiFailed if the GPU driver returned an error.

**Returns**

ApiInvalidIndex if the index provided is greater than the number of platforms or devices available.

RETURN\_CODE **ATS\_GPU\_SetCUDAComputeDevice**(HANDLE boardHandle, U32 deviceIndex)

CUDA-specific function used to associate a CUDA-enabled GPU device with a digitizer board.

Allows you to specify which GPU should be used to process sample data from a digitizer, if more than one GPU is available.

**Parameters**

- **boardHandle** – Handle to the ATS board.
- **deviceIndex** – 0-based index to the CUDA device.

**Returns**

ApiSuccess if it succeeded.

**Returns**

ApiFailed if it failed. See %TEMP%/ATS\_GPU.log (/tmp/ATS\_GPU.log under Linux) for more information.

RETURN\_CODE **ATS\_GPU\_SetLogging**(BOOL activateLogging)

Activate/deactivate logging of calls made to ATS-GPU libraries.

Calls are logged in ATS-GPU.log. Independent of logging state, errors in ATS-GPU calls will always be logged.

**Parameters**

**activateLogging** – True activates logging. False deactivates logging.

**Returns**

ApiSuccess if it succeeded.

**Returns**

ApiFailed if it failed.

RETURN\_CODE **ATS\_GPU\_SetProcessingPipeline**(HANDLE boardHandle, KERNEL \*kernelList,  
U32 numberOfKernels, U32  
\*bytesPerResultBuffer)

Prepares the processing pipeline to be performed on the GPU.

This function must be called after [ATS\\_GPU\\_Setup](#) and before [ATS\\_GPU\\_AllocBuffer](#)

**Parameters**

- **boardHandle** – Handle to the board.
- **kernelList** – Pointer to a list of kernels to launch.
- **numberOfKernels** – Number of kernels in kernelList
- **bytesPerResultBuffer** – Returns the size of a result buffer

See [ATS-GPU-HPC](#) for more information on types of kernels that can be launched on the GPU.

RETURN\_CODE **ATS\_GPU\_Setup**(HANDLE boardHandle, U32 channelSelect, long transferOffset, U32 transferLength, U32 recordsPerBuffer, U32 recordsPerAcquisition, U32 autoDMAFlags, U32 ATSGPUFlags)

Prepares the ATS board and GPU for acquisition.

This function calls `AlazarBeforeAsyncRead()` internally and most parameters are passed directly to it. In addition, it sets up the GPU for DMA transfers

#### Parameters

- **boardHandle** – Handle to the board.
- **channelSelect** – Channel mask with each channel identifier OR'd
- **transferOffset** – pass a negative integer for pretrigger samples
- **transferLength** – Number of samples in a record or transfer
- **recordsPerBuffer** – Number of records in a buffer, 1 for triggered streaming and continuous streaming modes.
- **recordsPerAcquisition** – Total number of records in the acquisition. Pass `0x7FFFFFFF` for infinite.
- **autoDMAFlags** – ATSApi flags for `AlazarBeforeAsyncRead`
- **ATSGPUFlags** – Combination of elements from [\*ATS\\_GPU\\_SETUP\\_FLAG\*](#) OR'd together. Pass 0 for default

RETURN\_CODE **ATS\_GPU\_StartCapture**(HANDLE boardHandle)

Start the acquisition and data transfer to GPU if required.

Use this function in replacement of AlazarStartCapture(). The application must be ready to call [ATS\\_GPU\\_GetBuffer\(\)](#) to prevent data overflows

**Parameters**

**boardHandle** – Handle to the board

**enum ATS\_GPU\_SETUP\_FLAG**

GPU data transfer configuration options.

*Values:*

**enumerator ATS\_GPU\_SETUP\_FLAG\_CPU\_BUFFER**

Makes ATS-GPU deliver CPU buffers instead of GPU ones. Useful for debugging

**enumerator ATS\_GPU\_SETUP\_FLAG\_DEINTERLEAVE**

De-interleave the data in the returned GPU buffer. Does not apply in conjunction with ATS\_GPU\_SETUP\_FLAG\_CPU\_BUFFER

**enumerator ATS\_GPU\_SETUP\_FLAG\_UNPACK**

Unpack the data in the returned GPU buffer. It is required for the allocated buffers to be large enough to accommodate unpacked data. Does not apply in conjunction with ATS\_GPU\_SETUP\_FLAG\_CPU\_BUFFER

**struct \_InputRange**

Structure used to convert data to volts.

**Public Members**

float **maxValue**

Maximum input range value in volts.

float **minValue**

Minimum input range value in volts.

## 4.5 ATS-GPU-HPC

ATS-GPU-HPC is designed to allow users to create their custom processing pipeline with simple structure declarations. These structures contain all the information necessary for the library to perform the desired kernel.

ATS-GPU-HPC is designed to be used by passing a list of `KERNEL` structures to `ATS_GPU_SetProcessingPipeline()` from the ATS-GPU-BASE library. Some processing kernels require the installation of additional libraries in order to run.

Instead of passing a list of `KERNEL` structures, it is also possible to use `ATS_GPU_AddProcessingKernel()` to add a kernel to an internal list of processing kernels that will be used by `ATS_GPU_SetProcessingPipeline`. If this function is called at least once, input parameters “kernelList” and “numberOfKernels” of function `ATS_GPU_SetProcessingPipeline` are ignored.

### 4.5.1 Kernel description

enum `_KERNEL_TYPE`

Types of processing kernels.

*Values:*

enumerator `KERNEL_TYPE_PRE_FFT`

enumerator `KERNEL_TYPE_FFT`

enumerator `KERNEL_TYPE_POST_FFT`

enumerator `KERNEL_TYPE_OCT`

enumerator `KERNEL_TYPE_OUTPUT`

enumerator `KERNEL_TYPE_AVERAGE_RECORDS`

enumerator `KERNEL_TYPE_CONVERT_TO_VOLTS`

enumerator `KERNEL_TYPE_MULTIPLY_RECORDS`

enumerator `KERNEL_TYPE_BOXCAR_AVERAGING`

enumerator `KERNEL_TYPE_AVERAGE_BUFFERS`

enumerator **KERNEL\_TYPE\_NUFFT**

enumerator **KERNEL\_TYPE\_NUOCT**

struct **\_KERNEL**

Struct to pass to `ATS_GPU_SetProcessingPipeline`. The first parameter is used to describe the type of processing kernel in the union.

### Public Members

**KERNEL\_TYPE type**

Can be any value of see [\\_KERNEL\\_TYPE](#).

**PRE\_FFT\_KERNEL pre\_fft**

pre fft

**FFT\_KERNEL fft**

fft

**POST\_FFT\_KERNEL post\_fft**

post fft

**OCT\_KERNEL oct**

oct

**NUFFT\_KERNEL nufft**

nufft

**NUOCT\_KERNEL nuoct**

nuoct

**OUTPUT\_KERNEL output**

output kernel

**AVERAGE\_RECORDS\_KERNEL average\_records**

average records kernel

**CONVERT\_TO\_VOLTS\_KERNEL convert\_to\_volts**

convert to volts kernel

`MULTIPLY_RECORDS_KERNEL` **multiply\_records**  
multiply records kernel

`BOXCAR_AVERAGING_KERNEL` **boxcar\_averaging**  
boxcar averaging kernel

`AVERAGE_BUFFERS_KERNEL` **average\_buffers**  
buffer averaging kernel

union `_KERNEL::`[anonymous] [**anonymous**]  
union

struct `_KERNEL_DATA`

Structure that describes the source of the kernel's input data. Processing kernels require information as to what data is inputted to the kernel. This data can be the raw outputted data from the board or data outputted from a previously ran kernel.

### Public Members

int `kernel_id`

Kernel id. Can be any one the the previous kernels. -1 implies using the data outputted from the previous kernel. 0 implies using the raw output data. 1 implies using the data outputted from the first kernel.

int `output_id`

Output id. Can be any one of the outputs from the selected kernel id. 0 based. This parameter is ignored if using data outputted from raw data.

## 4.5.2 Processing kernels

struct `_PRE_FFT_KERNEL`

Pre FFT kernel that prepares a data for FFT processing. Having ATS-CUDA-OCT is required to run this kernel.

### Output data description:

- Number of outputs: 1
- Record length per channel: `FFTLength*2`
- Record count per channel: `recordsPerBuffer`
- Channels: determined by channels passed to `channelSelect`

- Data type: float32
- Data organization in each buffer: If two channels are selected, all records from channel A followed by all records from channel B

## Public Members

### KERNEL\_DATA **input\_data**

Input Data see [\\_KERNEL\\_DATA](#).

### U32 **samplesPerRecordPerChannel**

Samples per record per channel.

### U32 **FFTLength**

Length of the FFT to perform. Equal to the sum of samplesPerRecordPerChannel and the length of zero padding.

### U32 **recordsPerBuffer**

Records per buffer per channel.

### U32 **channelSelect**

Select the channel(s) to control. This can be one or more of the channels of ALAZAR\_CHANNELS, assembled with the OR bitwise operator.

### float \***realWindowArray**

Pointer to array of size samplesPerRecord that contains the real part of the window. Passing null is equivalent to passing an array filled with ones.

### float \***imagWindowArray**

Pointer to array of size samplesPerRecord that contains the imaginary part of the window. Passing null is equivalent to passing an array filled with zeros.

### struct **\_FFT\_KERNEL**

FFT kernel does FFT processing. Having ATS-CUDA-OCT is required to run this kernel.

#### **Output data description:**

- Number of outputs: 1
- Record length per channel: FFTLength/2
- Record count per channel: recordsPerBuffer
- Channels: determined by channels passed to channelSelect
- Data type: float32

- Data organization in each buffer: If two channels are selected, all records from channel A followed by all records from channel B

## Public Members

### KERNEL\_DATA input\_data

Input Data see [\\_KERNEL\\_DATA](#).

### U32 FFTLength

Length of the FFT to perform. Equal to the sum of samplesPerRecordPerChannel and the length of zero padding.

### U32 recordsPerBuffer

Records per buffer per channel.

### U32 channelSelect

Select the channel(s) to control. This can be one or more of the channels of ALAZAR\_CHANNELS, assembled with the OR bitwise operator.

### struct \_POST\_FFT\_KERNEL

Post FFT kernel does Post FFT processing. Having ATS-CUDA-OCT is required to run this kernel.

#### Output data description:

- Number of outputs: if Amplitude flag is combined to Log and/or Sqrt flags, there is only one output generated. Otherwise, each of the other flags (raw data, phase, real, imaginary) generates one output per flag.
- Record length per channel: FFTLength/2 (Except for raw data output: record length = samplesPerRecordPerChannel)
- Record count per channel: recordsPerBuffer
- Channels: determined by channels passed to channelSelect
- Data type: float32 (Except for raw data output, where the data type depends on the ATS digitizer. Output data type for most ATS digitizers is uint16. )
- Data organization in each buffer: If two channels are selected, all records from channel A followed by all records from channel B. When multiple outputs are selected, they are placed in the buffer in the following order: 1.Raw data 2.Amplitude (combined or not with Log and/or Sqrt) 3.Phase 4.Real 5.Imaginary

## Public Members

### KERNEL\_DATA `input_data`

Input Data see [\\_KERNEL\\_DATA](#).

### U32 `FFTLength`

Length of the FFT to perform. Equal to the sum of `samplesPerRecordPerChannel` and the length of zero padding.

### U32 `recordsPerBuffer`

Records per buffer per channel.

### U32 `channelSelect`

Select the channel(s) to control. This can be one or more of the channels of `ALAZAR_CHANNELS`, assembled with the OR bitwise operator.

### U32 `OCTFlags`

Defines the types of data outputs to be obtained. This parameter can receive one or more elements of `ATS_GPU_OCT_OPTIONS`, OR'd with the binary OR operator.

## struct `_OCT_KERNEL`

OCT kernel does PreFFT-FFT-PostFFT processing. Having `ATS-CUDA-OCT` is required to run this kernel.

### Output data description:

- Number of outputs: if Amplitude flag is combined to Log and/or Sqrt flags, there is only one output generated. Otherwise, each of the other flags (raw data, phase, real, imaginary) generates one output per flag.
- Record length per channel:  $\text{FFTLength}/2$  (Except for raw data output: record length = `samplesPerRecordPerChannel`)
- Record count per channel: `recordsPerBuffer`
- Channels: determined by channels passed to `channelSelect`
- Data type: float32 (Except for raw data output, where the data type depends on the ATS digitizer. Output data type for most ATS digitizers is uint16. )
- Data organization in each buffer: If two channels are selected, all records from channel A followed by all records from channel B. When multiple outputs are selected, they are placed in the buffer in the following order: 1.Raw data 2.Amplitude (combined or not with Log and/or Sqrt) 3.Phase 4.Real 5.Imaginary

## Public Members

### KERNEL\_DATA **input\_data**

Input Data see [\\_KERNEL\\_DATA](#).

### U32 **samplesPerRecordPerChannel**

Samples per record per channel.

### U32 **FFTLength**

Length of the FFT to perform. Equal to the sum of samplesPerRecordPerChannel and the length of zero padding.

### U32 **recordsPerBuffer**

Records per buffer per channel.

### U32 **channelSelect**

Select the channel(s) to control. This can be one or more of the channels of ALAZAR\_CHANNELS, assembled with the OR bitwise operator.

### U32 **OCTFlags**

Defines the types of data outputs to be obtained. This parameter can receive one or more elements of ATS\_GPU\_OCT\_OPTIONS, OR'd with the binary OR operator.

### float \***realWindowArray**

Pointer to array of size samplesPerRecordPerChannel that contains the real part of the window. Passing null is equivalent to passing an array filled with ones.

### float \***imagWindowArray**

Pointer to array of size samplesPerRecordPerChannel that contains the imaginary part of the window. Passing null is equivalent to passing an array filled with zeros.

### struct **\_OUTPUT\_KERNEL**

Output kernel combines a list of outputs into a single output buffer.

#### **Output data description:**

- Number of outputs: Determined by parameter number\_of\_inputs.
- Data organization in each buffer: Outputs are placed in the same order as they are passed in parameter input\_data\_list.

## Public Members

`KERNEL_DATA *input_data_list`

List of data buffers to assemble in the output buffer see [\\_KERNEL\\_DATA](#).

`int number_of_inputs`

Length of `input_data_list`.

`struct _AVERAGE_RECORDS_KERNEL`

Average Records kernel averages the records in a buffer.

Records are converted to floating points, then summed (co-added) and divided by the number of averages (ratio between `RecordsPerBufferIn` and `RecordsPerBufferOut`). The averaged records are converted back to the same data type as input data.

### Output data description:

- Number of outputs: 1
- Record length per channel: `samplesPerRecordPerChannel`
- Record count per channel: `recordsPerBufferOut`
- Channels: determined by channels passed to `channelSelect`
- Data type: same data type as input data
- Data organization in each buffer: If two channels are selected, all records from channel A followed by all records from channel B

## Public Members

`KERNEL_DATA input_data`

Input Data see [\\_KERNEL\\_DATA](#).

`U32 samplesPerRecordPerChannel`

Samples per record per channel.

`U32 recordsPerBufferIn`

Number of records in the input GPU buffer.

`U32 recordsPerBufferOut`

Desired number of records in the averaged GPU buffer.

**U32 channelSelect**

Select the channel(s) to control. This can be one or more of the channels of ALAZAR\_CHANNELS, assembled with the OR bitwise operator.

**struct \_CONVERT\_TO\_VOLTS\_KERNEL**

Convert To Volts kernel converts raw data to float32, and optionally convert the data to volts.

**Output data description:**

- Number of outputs: 1
- Record length per channel: samplesPerRecordPerChannel
- Record count per channel: recordsPerBuffer
- Channels: determined by channels passed to channelSelect
- Data type: float32
- Data organization in each buffer: If two channels are selected, all records from channel A followed by all records from channel B

**Public Members****KERNEL\_DATA input\_data**

Input Data see [\\_KERNEL\\_DATA](#).

**U32 samplesPerRecordPerChannel**

Samples per record per channel.

**U32 recordsPerBuffer**

Records per buffer.

**U32 channelSelect**

Select the channel(s) to control. This can be one or more of the channels of ALAZAR\_CHANNELS, assembled with the OR bitwise operator.

**InputRange \*Ranges**

Pointer to the structure with maximum and minimum input range values in volts for each input channel. See InputRange. If nullptr is passed, just convert data to float.

**struct \_MULTIPLY\_RECORDS\_KERNEL**

Multiply Records kernel multiplies the records by a reference record. The input data must have data type float32.

**Output data description:**

- Number of outputs: 1
- Record length per channel: samplesPerRecordPerChannel
- Record count per channel: recordsPerBuffer
- Channels: determined by channels passed to channelSelect
- Data type: float32
- Data organization in each buffer: If two channels are selected, all records from channel A followed by all records from channel B

## Public Members

### KERNEL\_DATA input\_data

Input Data see [\\_KERNEL\\_DATA](#).

### float \*multiplierRecord

Pointer to array of size samplesPerRecordPerChannel that contains the reference record multiplier

### U32 samplesPerRecordPerChannel

Samples per record per channel.

### U32 recordsPerBuffer

Records per buffer.

### U32 channelSelect

Select the channel(s) to control. This can be one or more of the channels of ALAZAR\_CHANNELS, assembled with the OR bitwise operator.

### struct \_BOXCAR\_AVERAGING\_KERNEL

Boxcar Averaging kernel does AverageRecords - ConvertToVolts - MultiplyRecords processing.

#### Output data description:

- Number of outputs: 1
- Record length per channel: samplesPerRecordPerChannel
- Record count per channel: recordsPerBufferOut
- Channels: determined by channels passed to channelSelect
- Data type: float32
- Data organization in each buffer: If two channels are selected, all records from channel A followed by all records from channel B

## Public Members

### KERNEL\_DATA **input\_data**

Input Data see [\\_KERNEL\\_DATA](#).

### float \***multiplierRecord**

Pointer to array of size `samplesPerRecordPerChannel` that contains the boxcar window.

### U32 **samplesPerRecordPerChannel**

Samples per record per channel.

### U32 **recordsPerBufferIn**

Number of records in the input GPU buffer.

### U32 **recordsPerBufferOut**

Desired number of records in the averaged GPU buffer.

### U32 **channelSelect**

Select the channel(s) to control. This can be one or more of the channels of `ALAZAR_CHANNELS`, assembled with the OR bitwise operator.

### InputRange \***Ranges**

Pointer to the structure with maximum and minimum input range values in volts for each input channel. See `InputRange`. If `nullptr` is passed, just convert data to float.

### struct **\_AVERAGE\_BUFFERS\_KERNEL**

Average Buffers kernel averages multiple buffers.

#### **Output data description:**

- Number of outputs: 1
- Samples per output: `samplesPerBuffer`
- Data type: same data type as input data
- Data organization in each buffer: Same as the input buffers

## Public Members

KERNEL\_DATA **input\_data**

Input Data see [\\_KERNEL\\_DATA](#).

U32 **samplesPerBuffer**

Number of samples per buffer.

U32 **buffersToAverage**

Number of buffers to average.

## ATS-CUDA

The ATS-CUDA SDK provides a framework to allow users to perform simple manipulations on CUDA-enabled GPUs. ATS-CUDA is designed to be used with ATS-GPU-BASE, but can also be used independently. This section of the programmer's guide covers the use of ATS-CUDA.

As with ATS-GPU-BASE, using ATS-CUDA requires expertise in CUDA programming because this involves writing custom CUDA kernels.

It is also essential for programmers to have in-depth knowledge of GPU architecture and parallel programming.

### 5.1 API Reference

---

**Note:** Errors from ATS-CUDA-BASE will be logged in `ATS_GPU.log`. Relevant information about the error will be logged here and can be useful for debugging. For Windows users log file is located in `%TEMP%`. For Linux users log file is located in `/tmp/`.

---

enum `ATS_CUDA_Input_DataType`

Input data types that can be provided.

*Values:*

enumerator `ATS_CUDA_INPUT_FORMAT_U8`

enumerator `ATS_CUDA_INPUT_FORMAT_U16`

enumerator `ATS_CUDA_INPUT_FORMAT_U32`

enumerator `ATS_CUDA_INPUT_FORMAT_U64`

enumerator `ATS_CUDA_INPUT_FORMAT_S8`

enumerator `ATS_CUDA_INPUT_FORMAT_S16`

enumerator `ATS_CUDA_INPUT_FORMAT_S32`

enumerator `ATS_CUDA_INPUT_FORMAT_S64`

enumerator `ATS_CUDA_INPUT_FORMAT_FLOAT32`

enumerator `ATS_CUDA_INPUT_FORMAT_FLOAT`

enumerator `ATS_CUDA_INPUT_FORMAT_COMPLEXFLOAT32`

enumerator `ATS_CUDA_INPUT_FORMAT_FLOAT64`

enumerator `ATS_CUDA_INPUT_FORMAT_COMPLEXFLOAT64`

enum **ALAZAR\_PACKING**

Types of data packing.

*Values:*

enumerator **PACKING\_16\_BITS\_PER\_SAMPLE**

enumerator **PACKING\_12\_BITS\_PER\_SAMPLE**

enumerator **PACKING\_8\_BITS\_PER\_SAMPLE**

struct **UNPACK\_DEINTERLEAVE\_OPTIONS**

Structure used to set up unpacking and deinterleaving kernel used in `ATS_CUDA_BaseProcessBuffer()`.

### Public Members

bool **unpack**

Flag to activate unpacking;

bool **deinterleave**

Flag to activate deinterleaving.

U32 **transferLength**

Number of samples per record per channel.

U32 **recordsPerBuffer**

Number of records per buffer per channel.

U32 **channelCount**

channelCount Number of active channels

[ALAZAR\\_PACKING](#) **input\_pack\_mode**

A member of `ALAZAR_PACKING` indicating the data packing mode of input buffer

[ALAZAR\\_PACKING](#) **output\_pack\_mode**

A member of `ALAZAR_PACKING` indicating the desired output data packing. Ignored if `unpack` is set to 0.

`ALAZAR_INTERLEAVING` **input\_interleave**

A member of `ALAZAR_INTERLEAVE` indication the data interleaving of the input buffer

bool **hasNPTFooters**

Flag to indicate if NPT footers are present.

void \***ATS\_CUDA\_AllocCPUBuffer**(U32 bytesPerBuffer)

Allocates page-locked memory on the host computer.

This function is used to allocate host memory and is accessible to the device. Memory can be accessed directly by the device and can be written or read at high bandwidth.

**Parameters**

**bytesPerBuffer** – Total number of bytes to allocate per buffer

**Returns**

This function returns a CPU buffer pointer.

void \***ATS\_CUDA\_AllocGPUBuffer**(U32 bytesPerBuffer)

Allocates memory on the device.

This function is used to allocate memory on the device.

**Parameters**

**bytesPerBuffer** – Total number of bytes to allocate per buffer

**Returns**

This function returns a GPU buffer pointer.

RETURN\_CODE **ATS\_CUDA\_AverageRecords**(void \*GPUBufferIn, void \*GPUBufferOut, cudaStream\_t stream, U32 samplesPerRecordPerChannel, U32 recordsPerBufferIn, U32 recordsPerBufferOut, U32 channelCount, [ATS\\_CUDA\\_Input\\_DataType](#) inputDataType)

Launches on the GPU a kernel to average records in a buffer.

#### Parameters

- **GPUBufferIn** – Pointer to the GPU buffer to be averaged.
- **GPUBufferOut** – Pointer to the averaged output GPU buffer.
- **stream** – Stream identifier on which processing is to take place.
- **samplesPerRecordPerChannel** – Samples per record per channel.
- **recordsPerBufferIn** – Number of records in the input GPU buffer
- **recordsPerBufferOut** – Desired number of records in the averaged GPU buffer
- **channelCount** – Number of input channels.
- **inputDataType.** – Data type of the input data. This parameter must receive one element of [ATS\\_CUDA\\_Input\\_DataType](#).

RETURN\_CODE ATS\_CUDA\_BaseProcessBuffer(void \*GPUBufferIn, void \*GPUBufferOut,  
cudaStream\_t stream,  
[UNPACK\\_DEINTERLEAVE\\_OPTIONS](#) opt)

Launches on the GPU a kernel to unpack and/or deinterleave a buffer acquired with an AlazarTech digitizer.

#### Parameters

- **GPUBufferIn** – Pointer to a GPU buffer to on which to apply unpacking/deinterleaving.
- **GPUBufferOut** – Pointer to a GPU buffer where data is to be outputted.
- **stream** – Stream identifier on which processing is to take place
- **opt** – Structure that defines how the unpacking and deinterleaving kernel is to be configured. See [UNPACK\\_DEINTERLEAVE\\_OPTIONS](#).

RETURN\_CODE **ATS\_CUDA\_ConvertToVolts**(void \*GPUBufferIn, void \*GPUBufferOut, U32 samplesPerRecord, U32 recordsPerBuffer, U32 channelCount, InputRange \*Ranges, [ATS\\_CUDA\\_Input\\_DataType](#) inputDataType, cudaStream\_t stream)

Launches on the GPU a kernel to convert raw data in float32, and optionally convert the data to volts.

#### Parameters

- **GPUBufferIn** – Pointer to the GPU buffer of records to be converted.
- **GPUBufferOut** – Pointer to the GPU buffer of records in float32.
- **samplesPerRecord** – Samples per record.
- **recordsPerBuffer** – Records per buffer.
- **channelCount** – Number of input channels.
- **Ranges** – Pointer to the structure with maximum and minimum input range values in volts for each input channel. See InputRange. If nullptr is passed, just convert data to float.
- **inputDataType** – Data type of the input data. This parameter must receive one element of [ATS\\_CUDA\\_Input\\_DataType](#).
- **stream** – Stream identifier on which processing is to take place.

RETURN\_CODE **ATS\_CUDA\_Copy**(void \*destination, void \*source, U32 bytesPerBuffer,  
cudaMemcpyKind kind, cudaStream\_t stream)

Copies data from host/device to device/host.

**Parameters**

- **destination** – Pointer to the destination memory address
- **source** – Pointer to the source memory address
- **bytesPerBuffer** – Size in bytes of the buffer to copy
- **kind** – Type of transfer
- **stream** – Stream identifier on which the copy takes place

RETURN\_CODE **ATS\_CUDA\_CopyDeviceToHost**(void \*GPUBuffer, void \*CPUBuffer, U32 bytesPerBuffer, cudaStream\_t stream)

Copies data between host and device.

**Parameters**

- **GPUBuffer** – Pointer to the GPU source memory address
- **CPUBuffer** – Pointer to the CPU destination memory address
- **bytesPerBuffer** – Size in bytes of the buffer to copy
- **stream** – Stream identifier on which the copy takes place

RETURN\_CODE **ATS\_CUDA\_CopyHostToDevice**(void \*GPUBuffer, void \*CPUBuffer, U32 bytesPerBuffer, cudaStream\_t stream)

Copies data between host and device.

**Parameters**

- **GPUBuffer** – Pointer to the GPU destination memory address
- **CPUBuffer** – Pointer to the CPU source memory address
- **bytesPerBuffer** – Size in bytes of the buffer to copy
- **stream** – Stream identifier on which the copy takes place

`cudaStream_t ATS_CUDA_CreateStream()`

Create a synchronous stream.

This function returns a pointer to the new stream identifier.

RETURN\_CODE ATS\_CUDA\_DestroyStream(cudaStream\_t stream)

Destroys and cleans up an asynchronous stream.

**Parameters**

**stream** – Stream identifier.

RETURN\_CODE **ATS\_CUDA\_FreeCPUBuffer**(void \*CPUBuffer)

Frees page-locked memory.

This function is used to free host memory allocated by `ATS_CUDA_AllocCPUBuffer()`.

**Parameters**

**CPUBuffer** – Pointer to the memory to free

RETURN\_CODE **ATS\_CUDA\_FreeGPUBuffer**(void \*GPUBuffer)

Frees memory on the device.

This function is used to free GPU memory allocated by `ATS_CUDA_AllocGPUBuffer()`.

**Parameters**

**GPUBuffer** – Pointer to the device memory to free

RETURN\_CODE ATS\_CUDA\_GetVersion(U8 \*major, U8 \*minor, U8 \*revision)

Get ATS-CUDA version number.

**Parameters**

- **major** – ATS-CUDA major version number.
- **minor** – ATS-CUDA minor version number.
- **revision** – ATS-CUDA revision number.

RETURN\_CODE **ATS\_CUDA\_GetComputeCapability**(U32 deviceIndex, int \*major, int \*minor)

Function to get the compute capability of specified GPU.

**Parameters**

- **deviceIndex** – 0-based index to the device.
- **major** – Major compute capability version number.
- **minor** – Minor compute capability version number.

**Returns**

ApiSuccess if it succeeded.

**Returns**

ApiFailed if it failed. See %TEMP%/ATS\_GPU.log (/tmp/ATS\_GPU.log under Linux) for more information.

RETURN\_CODE ATS\_CUDA\_MultiplyRecords(void \*GPUBufferIn, void \*multiplierRecord, void \*GPUBufferOut, U32 samplesPerRecord, U32 recordsPerBuffer, *ATS\_CUDA\_Input\_DataType* inputDataType, cudaStream\_t stream)

Launches on the GPU a kernel to multiply the records by a reference record.

#### Parameters

- **GPUBufferIn** – Pointer to the GPU buffer of records to be multiplied.
- **multiplierRecord** – Pointer to the reference record multiplying the records.
- **GPUBufferOut** – Pointer to the multiplication result GPU buffer.
- **samplesPerRecord** – Samples per record.
- **recordsPerBuffer** – Records per buffer.
- **inputDataType** – Data type of the input data. This parameter must receive one element of *ATS\_CUDA\_Input\_DataType*.
- **stream** – Stream identifier on which processing is to take place.

RETURN\_CODE **ATS\_CUDA\_QueryDeviceCount**(U32 \*pDeviceCount)

Function to get the number of available CUDA devices.

**Parameters**

**pDeviceCount** – Outputs the number of devices detected on the system.

**Returns**

ApiSuccess if it succeeded.

**Returns**

ApiFailed if the CUDA driver returned an error.

RETURN\_CODE ATS\_CUDA\_QueryDeviceName(U32 deviceIndex, char \*deviceName, int maxChars)

Function to get the name of a specific CUDA device.

**Parameters**

- **deviceIndex** – 0-based index to the device.
- **deviceName** – Char array to output the name of the device.
- **maxChars** – Size of the char array.

**Returns**

ApiSuccess if it succeeded.

**Returns**

ApiFailed if the CUDA driver returned an error.

**Returns**

ApiInvalidIndex if the index provided is greater than the number of platforms or devices available.

RETURN\_CODE **ATS\_CUDA\_QueryDeviceSerialNumber**(U32 deviceIndex, char  
\*deviceSerialNumber, int maxChars)

Function to get the serial number of a specific CUDA device.

**Parameters**

- **deviceIndex** – 0-based index to the device.
- **deviceName** – Char array to output the serial number of the device.
- **maxChars** – Size of the char array.

**Returns**

ApiSuccess if it succeeded.

**Returns**

ApiFailed if the CUDA driver returned an error.

**Returns**

ApiInvalidIndex if the index provided is greater than the number of platforms or devices available.

RETURN\_CODE **ATS\_CUDA\_SetComputeDevice**(U32 deviceIndex)

Allows you to specify which GPU should be used to process sample data from a digitizer, if more than one GPU is available.

**Parameters**

**deviceIndex** – 0-based index to the device.

**Returns**

ApiSuccess if it succeeded.

**Returns**

ApiFailed if it failed. See %TEMP%/ATS\_GPU.log (/tmp/ATS\_GPU.log under Linux) for more information.

RETURN\_CODE ATS\_CUDA\_StreamSynchronize(cudaStream\_t stream)

Waits for a stream to complete.

This function blocks the host thread until stream has completed all operations.

**Parameters**

**stream** – Stream identifier.

bool **ATS\_CUDA\_StreamQuery**(cudaStream\_t stream)

Queries a synchronous stream for completion status.

This function blocks the host thread until stream has completed all operations.

**Parameters**

**stream** – Stream identifier.

**Returns**

This function returns 1 if all operations in stream have completed.

**Returns**

This function returns 0 if not.

```
RETURN_CODE ATS_CUDA_SeparateDataFromNPTFooters(void *GPUBufferIn, void *GPUDataOut,  
                                                U32 numberOfRecords, U32  
                                                bytesPerFooterBlock, U32  
                                                footerBlockStrideBytes, cudaStream_t  
                                                stream)
```

Launches on the GPU a kernel to extract the digitized data from buffers containing NPT footers.

#### Parameters

- **GPUBufferIn** – Pointer to a GPU buffer of raw data acquired with an ATS board containing NPT footers.
- **GPUDataOut** – Pointer to a GPU buffer where the raw data is to be extracted.
- **numberOfRecords** – Number of records in GPUBufferIn.
- **bytesPerFooterBlock** – Number of bytes per NPT footer block.
- **footerBlockStrideBytes** – Distance in bytes between two consecutive NPT footer blocks.
- **stream** – Stream identifier on which processing is to take place.

RETURN\_CODE ATS\_CUDA\_ExtractNPTFooters(void \*GPUBufferIn, void \*GPUFooters, U32  
numberOfRecords, U32 bytesPerFooterBlock, U32  
footerBlockStrideBytes, cudaStream\_t stream)

Launches on the GPU a kernel to extract NPT footers from buffers containing NPT footers.

**Parameters**

- **GPUBufferIn** – Pointer to a GPU buffer of raw data acquired with an ATS board containing NPT footers.
- **GPUFooters** – Pointer to a GPU buffer where the NPT footers are to be extracted.
- **numberOfRecords** – Number of records in GPUBufferIn.
- **bytesPerFooterBlock** – Number of bytes per NPT footer block.
- **footerBlockStrideBytes** – Distance in bytes between two consecutive NPT footer blocks.
- **stream** – Stream identifier on which processing is to take place.



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