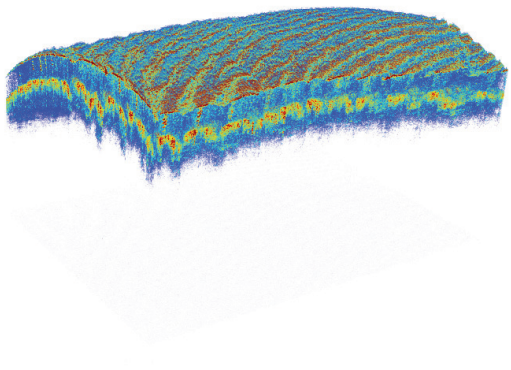
ATS-GMA-OCT
OCT Signal Processing Library

- Very High-Speed Floating Point FFT
- Dispersion Compensation and Windowing Functions
- Requires ATS-GMA-BASE
- Stream data to GPU with latency as low as 100 µs
- Up to 6.9 GB/s transfer rate for PCIe Gen 3 digitizer boards
- Supports AMD Radeon™ Pro GPUs and AMD SDK version 2.9 and higher, which support OpenCL™
- Designed to work with AlazarTech PCI Express waveform digitizers
- Compatible with Windows® 7 and Windows 10



Product	GPU Compatibility	Operating System	Throughput to GPU	FFT Length	Max. FFTs Per Second
ATS-GMA-OCT	AMD Radeon Pro	Windows 7 & Windows 10 (64-bit versions only)	Up to 6.9 GB/s	Up to 2 M Points	1,900,000 (2048 pt FFTs, see benchmark table below for more details)

Overview

ATS-GMA-OCT is an OCT Signal Processing Library developed by AlazarTech that provides very high-speed floating point FFT capability for data acquired by AlazarTech's PCI Express waveform digitizers or for user-supplied data. ATS-GMA-OCT must be used with ATS-GMA-BASE.

ATS-GMA-BASE allows users to DMA data from AlazarTech PCI Express waveform digitizers to AMD Radeon Pro Graphical Processing Units (GPUs) at rates up to 6.9 GB/s with a latency as low as 100 µs. ATS-GMA-BASE does not use any host memory buffers for temporary storage.

With this very low latency and high speed data transfer, it is now possible to acquire signals at 4 GS/s sample rate and 12 bit resolution and DMA the gapless stream to a GPU for complex signal processing.

ATS-GMA-OCT provides out-of-the-box OCT imaging. It contains floating point FFT routines that have been optimized to provide the maximum number of FFTs per second. Kernel code running on the GPU can do zero-padding, apply a windowing function, do a floating point FFT, calculate the amplitude and convert the result to a log scale. It is also possible to output phase information.

Modular API

ATS-GMA-OCT has a unique, modular API that allows users to easily customize their signal processing algorithms. The modularity provides many hooks into the GPU data path, where customers can add their own signal processing code.

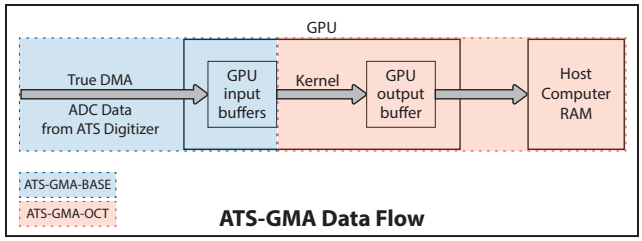
Benchmarks

The following performance benchmarks were measured using an ATS9373 in an Asus® X99-DELUXE system with an Intel Core i7 @3.5 GHz, 64 GB DDR4 RAM, and acquired in NPT mode.

The same benchmarks on an Asus X299-A with an Intel Core i9 @3.31 GHz, 32 GB DDR4 RAM showed a ~20% decrease in performance for 1 MB and 4 MB buffer sizes for the WX 9100. The reason for this decrease in performance is unknown at this time.

GMA Buffer Size (MB)	FFT Length	FFTs per second	
		Radeon Pro WX 7100	Radeon Pro WX 9100
1	2048	1,700,000	1,300,000
	4096	850,000	700,000
	8192	325,000	325,000
	65536	30,000	35,000
4	2048	1,900,000	1,800,000
	4096	950,000	875,000
	8192	350,000	400,000
	65536	35,000	45,000
	1048576	1,400	2,200
16	2048	1,900,000	1,900,000
	4096	950,000	950,000
	8192	350,000	485,000
	65536	35,000	60,000
	1048576	1,400	2,500

ATS-GMA Data Flow



ATS-GMA Data Flow

ATS-GMA-BASE is supplied with an example user application in source code. The application includes GPU kernels that use ATS-GMA-BASE to receive data, do very simple signal processing (data inversion), and copy the processed (inverted) data back to a user buffer. All this is done at the highest possible data transfer rate.

ATS-GMA-OCT is supplied with example programs in C/C++, that allow users to set-up the waveform digitizer parameters, set-up FFT parameters in the GPU, do the acquisition, and receive the FFT result buffer.

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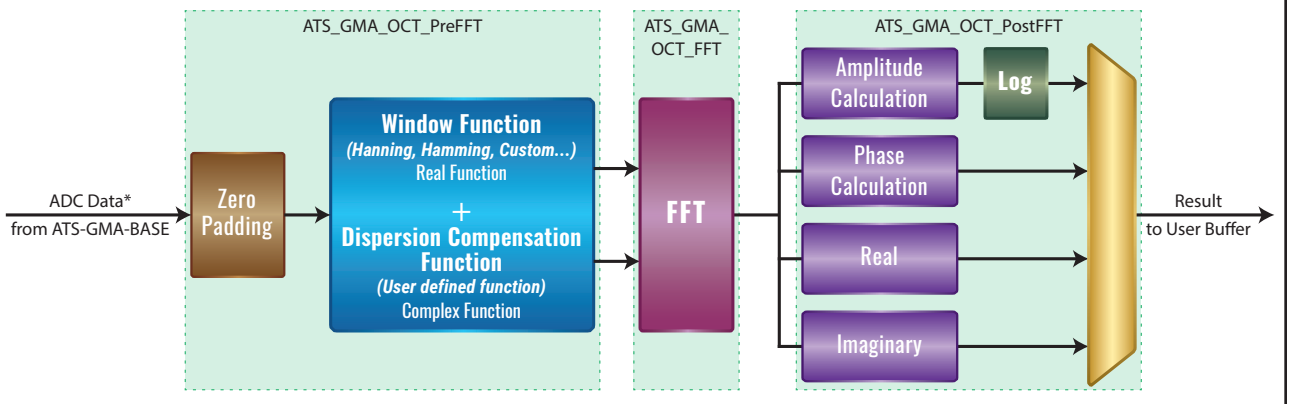

OCT Signal Processing Block Diagram

*Data can come from multiple channels

Programming with ATS-GMA-OCT

Users can use example programs in C/C++ to set-up the waveform digitizer parameters, set-up FFT parameters in the GPU, do the acquisition, and receive the FFT result buffer.

C/C++ example programs are provided with Visual Studio projects and CMake build files.

Waveform digitizer data is transferred to the GPU in a buffer that will contain many records. This number, RecordsPerBuffer, is specified by the user. Users should make sure that they choose this number such that the buffer size is in the order of 1 MByte or larger. Smaller buffers can reduce overall data throughput. It is recommended to use larger buffers for optimal performance (4-16 MB).

For software validation purposes, ATS-GMA-OCT allows the GPU to operate on user-supplied data. It should be noted that the overall throughput may be significantly reduced.

If the number of samples per record is not a power of 2, a zero-padding is required to an accepted length. ATS-GMA-OCT FFT will then apply a complex windowing function, do a single-precision floating point FFT, calculate the amplitude and phase, and convert the amplitude to logarithmic values.

Very Long FFTs

For some applications, it is necessary to perform very long FFTs (e.g. one million points).

Even if a waveform digitizer has an on-board FPGA, such very long FFTs do not fit inside an FPGA due to resource limitations of the FPGA.

With the ATS-GMA-OCT Signal Processing Library, ATS-GMA is fully capable of calculating such very long FFTs. Our benchmarks using Intel i7 5930K CPU and Radeon Pro WX 9100 GPU have shown that ATS-GMA is capable of doing 2500 one million point FFTs per second in single channel mode (keep up with sample rate of up to 2.5 GS/s). Even longer FFTs are possible. We have not tested the limits of FFT length with ATS-GMA.

Zero Padding

The user sets the length of the Fourier transform to be done on the GPU. This value must be a power of 2 and also must be equal to or larger than the record length (number of samples per record). If record length is not a power of 2, ATS-GMA-OCT will perform zero-padding before doing further signal processing.

Dispersion Compensation Function

Dispersion compensation is an essential part of any OCT signal processing system. ATS-GMA-OCT Signal Processing Library allows users to multiply the zero-padded data with a user-specified Dispersion Compensation Function (DCF). The DCF is a complex function.

Windowing Function

The windowing function in the ATS-GMA-OCT Signal Processing Library is used to ensure that there are no discontinuities in the FFT. Note that the length of the window function should be the same as the length of the A-Scan, e.g. if the A-scan is 1536 points long, the window function should also be 1536 points long, even though the FFT length could be longer with padding.

Amplitude and Phase Output

The FFT algorithm implemented in the OCT Signal Processing Library is capable of calculating both amplitude and phase outputs. All outputs are provided as single-precision floating point data (32 bits per data point).

Data Throughput to GPU

The data transfer rate to GPU is dependent on the generation of PCI Express digitizer board used:

PCIe Link Speed	Transfer Rate
Gen 3: ATS9373, ATS9371	Up to 6.9 GB/s
Gen 2: ATS9360, ATS9416	Up to 3.5 GB/s
Gen 1: ATS9870, ATS9350, ATS9351, ATS9120*, ATS9625, ATS9626, ATS9440, ATS9462**	Up to 1.6 GB/s (Exact rate is limited by digitizer sample rate)

Compatible Waveform Digitizers

All AlazarTech PCI Express waveform digitizers are compatible with ATS-GMA. Only single-board configurations are supported at this time.

AlazarTech's PCI bus waveform digitizers are not supported, as the host CPU is more than capable of handling data rates generated by PCI bus boards.

ATS-GMA cannot directly be interfaced with non-AlazarTech

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waveform digitizers. However, users can always capture data from non-AlazarTech digitizers and pass it to the GPU using the software validation data path.

Note that this will probably not provide optimal throughput. Also note that AlazarTech will not support this type of software development.

Software Licensing Policy

Users are allowed to freely distribute the ATS-GMA-OCT libraries as long as they have purchased one ATS-GMA-OCT license and there is an AlazarTech PCI Express waveform digitizer present in the same computer. If an AlazarTech PCI Express waveform digitizer is not present in the computer, users must purchase a separate license for each computer on which ATS-GMA-OCT is installed.

In no case is the user allowed to distribute or share the source code of ATS-GMA-OCT with other users.

Annual Subscriptions

The purchase of an ATS-GMA-OCT license includes a subscription that provides customers with the following benefits for a period of 1 year on ATS-GMA-OCT:

- Download ATS-GMA-OCT updates from the AlazarTech website;
- Receive new example programs as they become available;
- Receive technical support on ATS-GMA-OCT.

Note that support is provided for product bugs, and not for writing custom GPU kernels or for learning GPU programming.

ORDERING INFORMATION

ATS-GMA-BASE: GPU Streaming Library 1 Year Subscription	ATSGMA-001
ATS-GMA-BASE-1YR: 1 year extended support & maintenance for ATS-GMA-BASE	ATSGMA-002
ATS-GMA-OCT: Signal Processing Library 1 Year Subscription (requires ATSMA-001)	ATSGMA-101
ATS-GMA-OCT-1YR: 1 year extended support & maintenance for ATS-GMA-OCT	ATSGMA-102

ATS-GMA-OCT main API functions

```
ATS_GMA_OCT_AbortCapture
ATS_GMA_OCT_AllocBuffer
ATS_GMA_OCT_FFT
ATS_GMA_OCT_FreeBuffer
ATS_GMA_OCT_GenerateWindowFunction
ATS_GMA_OCT_GetBuffer
ATS_GMA_OCT_PostBuffer
ATS_GMA_OCT_PostFFT
ATS_GMA_OCT_PreFFT
ATS_GMA_OCT_ReadOutputBuffer
ATS_GMA_OCT_Setup
ATS_GMA_OCT_SetWindowFunction
ATS_GMA_OCT_StartCapture
```


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DATASHEET REVISION HISTORY

Changes from version 4.0 (May 2018) to version 4.0a	Section, Page
Corrected benchmarking system specifications	Benchmarks, pg. 1
Added note about results for Radeon Pro WX 9100 benchmarks with Asus X299-A	Benchmarks, pg. 1
Corrected conditions of Zero Padding	Programming with ATS-GMA-OCT, pg. 2
Clarified conditions for distributing ATS-GMA-OCT	Software Licensing Policy, pg. 3