ATS9120
20 MS/s 12-Bit PCIe Digitizer

- 2 channels sampled at 12-bit resolution
- 20 MS/s simultaneous real-time sampling rate on each input
- Up to 8 Million samples of on-board acquisition memory per channel
- ±40 mV to ±20 V input range
- Asynchronous DMA device driver
- AlazarDSO® Oscilloscope Software
- Software Development Kit supports C/C++, C#, Python, MATLAB®, LabVIEW®
- Support for Windows® & Linux®

RoHS 3 COMPLIANT
2015/863/EU

CE

Product	Bus	Operating System	Channels	Max. Sample Rate	Bandwidth	Memory Per Channel	Resolution
ATS9120	PCIe x1 Gen 1	64-bit Windows & 64-bit Linux	2	20 MS/s	10 MHz	8 Megasamples	12 bits

Overview

AlazarTech ATS®9120 is a dual-channel, 12-bit, 20 MS/s waveform digitizer card capable of storing up to 8 Million samples per channel of acquired data in its on-board memory or streaming acquired data to PC memory. ATS9120 is a single-lane PCI Express (PCIe x1) Gen 1 card, which supports up to 200 MB/s bus throughput.

Users can capture data from one trigger or a burst of triggers. Users can also stream very large datasets continuously to motherboard memory or hard disk.

ATS9120 PCI Express digitizers are an ideal solution for cost sensitive OEM applications that require a digitizer to be embedded into the customer's equipment.

ATS9120 is supplied with AlazarDSO oscilloscope software that lets the user get started immediately without having to write any software.

Users who need to integrate the ATS9120 in their own program can purchase a software development kit, ATS-SDK, for C/C++, C#, Python, MATLAB, and LabVIEW for both Windows and Linux operating system.

All of this advanced functionality is packaged in a low-power, half-length PCI Express card.

Applications

Optical Coherence Tomography (OCT)

Ultrasonic & Eddy Current NDT/NDE

Motor Winding Testing

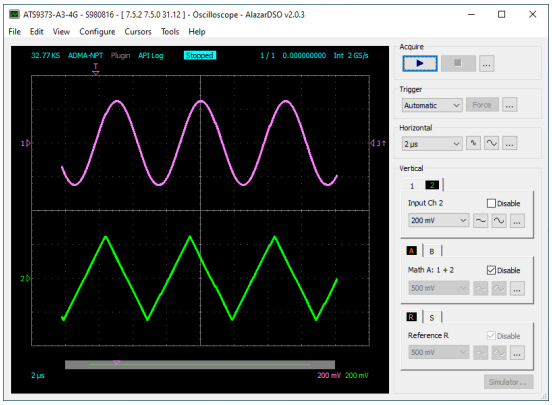
Radar/RF Signal Recording & Analysis

High-Resolution Oscilloscope

Lidar

Spectroscopy

Multi-Channel Transient Recording



PCI Express Bus Interface

ATS9120 interfaces to the host computer using a 1-lane PCI Express bus, operating at 2.5 Gbps.

According to PCIe specification, a 1-lane board can be plugged into any PCIe slot. ATS9120 requires at least one free slot on the motherboard. Electrically, ATS9120 is compatible with slots of all PCIe generations.

The physical and logical PCIe x1 interface is provided by an on-board FPGA, which also integrates acquisition control functions, memory management functions and acquisition datapath. This very high degree of integration maximizes product reliability.

The AlazarTech® 200 MB/s benchmark was done using an ASUS® X299-A motherboard.

The same performance can be expected from virtually all other motherboards.

Analog Input

An ATS9120 features two analog input channels with extensive functionality. Each channel has 10 MHz of full power analog input bandwidth. With software-selectable attenuation, you can achieve an input voltage range of ±40 mV to ±20 V.

Software-selectable AC or DC coupling further increases the signal measurement capability. Software-selectable 50 Ω input impedance makes it easy to interface to high-speed RF signals.

Acquisition System

ATS9120 PCI digitizers use a pair of 20 MS/s, 12-bit ADCs to digitize the input signals. The real-time internal sampling rate ranges from 20 MS/s down to 1 KS/s. The two channels are guaranteed to be simultaneous, as they share the exact same clock.

An acquisition can consist of multiple records, with each record being captured as a result of one trigger event. A record can contain both pre-trigger and post-trigger data.

Infinite number of triggers can be captured by ATS9120, when it is operating using dual-port memory.

In between the multiple triggers being captured, the acquisition system is re-armed by the hardware within 16 sampling clock cycles.

This mode of capture, sometimes referred to as Multiple Record, is very useful for capturing data in applications with a very rapid or unpredictable trigger rate. Examples of such applications include medical imaging, ultrasonic testing, OCT and NMR spectroscopy.

Recommended Motherboards or PCs

Many different types of motherboards and PCs have been benchmarked by AlazarTech. The ones that have produced the best throughput results are listed here: www.alazartech.com/images-media/2246-AlazarTechRecommendedMotherboards.pdf.

On-Board Acquisition Memory

ATS9120 provides 8 Million samples per channel of on-board dual-port memory that can be used for signal storage.

Data is acquired into the on-board memory before being transferred to the host PC memory. This transfer is performed using Direct Memory Access (DMA), which uses scatter-gather bus mastering technology.

This on-board dual-port memory allows loss-less data transfer even if the computer is temporarily interrupted by other tasks.

Driver version 6.03 or higher is required to take advantage of the on-board acquisition memory.

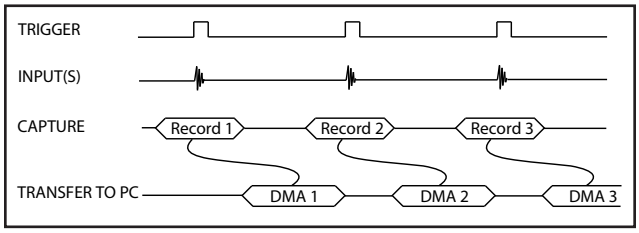
Maximum Sustained Transfer Rate

Virtually all modern motherboards support the specified 200 MB/s throughput.

ATS9120 users can quickly determine the maximum sustained transfer rate for their motherboard by inserting their card in a PCIe slot and running the bus benchmarking tool provided in AlazarDSO for Windows or AlazarFrontPanel for Linux.

Traditional AutoDMA

In order to acquire both pre-trigger and post-trigger data in a dual-ported memory environment, users can use Traditional AutoDMA.



Data is returned to the user in buffers, where each buffer can contain from 1 to 8191 records (triggers). This number is called RecordsPerBuffer.

A BUFFER_OVERFLOW flag is asserted if more than 512 buffers have been acquired by the acquisition system, but not transferred to host PC memory by the AutoDMA engine.

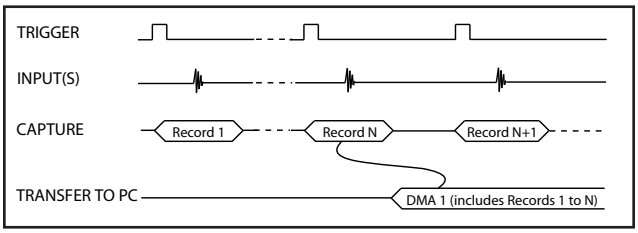
In other words, a BUFFER_OVERFLOW can occur if more than 512 triggers occur in very rapid succession, even if all the on-board memory has not been used up.

Traditional AutoDMA mode is only available with driver version 6.03 or higher.

No Pre-Trigger (NPT) AutoDMA

Many ultrasonic scanning and medical imaging applications do not need any pre-trigger data: only post-trigger data is sufficient.

NPT AutoDMA is designed specifically for these applications. By only storing post-trigger data and using an FPGA FIFO as temporary storage, data throughput is optimized.



NPT AutoDMA buffers do not include headers. However, users can specify that each record should come with its own footer that contains a 40-bit trigger timestamp. The footer is called NPT Footer.

NPT Footer requires driver version 7.5.2 or higher and firmware version 6.05 or higher.

It should be noted that a BUFFER_OVERFLOW flag is asserted if the FPGA FIFO overflows.

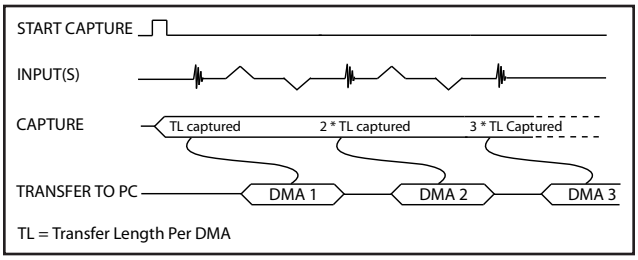
This is the recommended mode of operation for most ultrasonic scanning, OCT and medical imaging applications.

It is possible to acquire up to 4096 points of pre-trigger data even in NPT mode.

Continuous AutoDMA

Continuous AutoDMA is also known as the data streaming mode.

In this mode, data starts streaming across the PCIe bus as soon as the ATS9120 is armed for acquisition. It is important to note that triggering is disabled in this mode.



Continuous AutoDMA buffers do not include headers, so it is not possible to get trigger time-stamps.

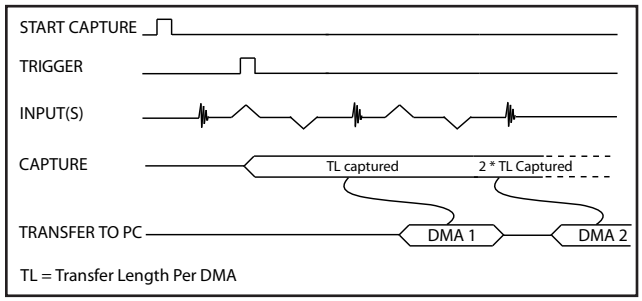
A BUFFER_OVERFLOW flag is asserted if the FPGA FIFO overflows.

The amount of data to be captured is controlled by counting the number of buffers acquired. Acquisition is stopped by an AbortCapture command.

Continuous AutoDMA can easily acquire data to PC host memory at the maximum sustained transfer rate of the motherboard without causing an overflow. This is the recommended mode for very long signal recording.

Triggered Streaming AutoDMA

Triggered Streaming AutoDMA is virtually the same as Continuous mode, except the data transfer across the bus is held off until a trigger event has been detected.



Triggered Streaming AutoDMA buffers do not include headers, so it is not possible to get trigger time-stamps.

A BUFFER_OVERFLOW flag is asserted if the FPGA FIFO overflows.

As in Continuous mode, the amount of data to be captured is controlled by counting the number of buffers acquired. Acquisition is stopped by an AbortCapture command.

Triggered Streaming AutoDMA can easily acquire data to PC host memory at the maximum sustained transfer rate of the motherboard without causing an overflow.

Multi-board Systems using ATS 4X1G

ATS9120: Sync 4X1G is a device that allows simultaneous sampling across multiple independent ATS9120 waveform digitizers. This is achieved by providing common clock and trigger signals to each digitizer.

Sync 4X1G supports Trigger Enable and Trigger Disable so that users can delay triggering until all digitizers are armed; this is a distinct advantage over passive signal splitters.

ATS Sync 4X1G comes with a software library that allows user software to control it.

Sync 4X1G interfaces to AlazarTech digitizer cards using a proprietary high-frequency cable. The provided cable terminates in a ganged micro-miniature RF connector, which is used to connect to the Sync 4X1G.

The other end of the cable terminates in male SMA and BNC connectors, which are used to connect to the digitizer External Clock and External Trigger respectively.

Sync 4X1G connects to the host computer using a provided USB cable. Please refer to the ATS Sync 4X1G datasheet for full specifications.

Asynchronous DMA Driver

The various AutoDMA schemes discussed above provide hardware support for optimal data transfer. However, a corresponding high-performance software mechanism is also required to make sure sustained data transfer can be achieved.

This proprietary software mechanism is called Async DMA (short for Asynchronous DMA).

A number of data buffers are posted by the application software. Once a data buffer is filled, i.e. a DMA has been completed, ATS9120 hardware generates an interrupt, causing an event message to be sent to the application so it can start consuming data. Once the data has been consumed, the application can post the data buffer back on the queue. This can go on indefinitely.

One of the great advantages of Async DMA is that almost 95% of CPU cycles are available for data processing, as all DMA arming is done on an event-driven basis.

Output Data Format

By default, ATS9120 data comes out as unsigned binary, where code 0 represents the negative full scale, code (2^n-1) represents the positive full scale with zero being 2^{n-1}.

It is possible to change the data format to signed binary using an API call. In signed binary format, zero is represented by code 0, positive full scale is represented by (2^{n-1}-1) and negative full scale is represented by (2^{n-1}).

Triggering

The ATS9120 is equipped with sophisticated analog and digital triggering options, such as programmable trigger thresholds and slope on any of the input channels or the External Trigger input.

While most oscilloscopes offer only one trigger engine, ATS9120 offers two trigger engines (called Engines J and K). This allows the user to combine the two engines using a logical OR operand.

The user can specify the number of records to capture in an acquisition, the length of each record and the amount of pre-trigger data.

A programmable trigger delay can also be set by the user. This is very useful for capturing the signal of interest in a pulse-echo application, such as ultrasound, radar, lidar etc.

External Trigger Input

ATS9120 external trigger input (TRIG IN) can be set as an analog input with ±2.5 V full scale input range and 50 Ω input impedance, or a 3.3 V TTL input.

When TTL input is selected, the input impedance increases to approximately 6 kΩ, making it easier to drive the TRIG IN input from high-output impedance sources.

Trigger Time Stamp

A 40-bit time stamp counter comes standard with the ATS9120. By default, this counter is initialized to a zero value when an acquisition session is started and increments once for every sample captured, thus providing a 1-clock timing accuracy. At 20 MS/s sample rate, this counter will not roll over for well over 15 hours.

This allows the user to find out the timing of each trigger in a multiple record acquisition relative to the start of the acquisition.

It is also possible to configure the timestamp counter to reset for the first acquisition only and never again, until a software reset is issued. This feature enables users to obtain precise timing information about multiple acquisitions.

Optional External Clock

While the ATS9120 features a 10 MHz TCXO as the source of the timebase system, there may be occasions when digitizing has to be synchronized to an external clock source.

ATS9120 External Clock upgrade (order number ATS9120-005) provides an SMA input for an external clock signal with a frequency between 20 MHz and 1 MHz.

Users can also set a decimation factor for the external clock. For example, if the user wants to digitize the input signal on every tenth clock edge, this factor can be set to 10. Minimum decimation value is 1 and maximum is 100,000.

There are two types of External Clock supported by ATS9120. These are described below.

Fast External Clock

A new sample is taken by the on-board ADCs for each rising (or falling) edge of this External Clock signal.

In order to satisfy the clocking requirements of the ADC chips being used, Fast External Clock frequency must always be higher than 1 MHz and lower than 20 MHz.

10 MHz Reference Clock

It is possible to generate the sampling clock based on an external 10 MHz reference input. This is useful for RF systems that use a common 10 MHz reference clock.

ATS9120 uses an on-FPGA low-jitter PLL to generate the 20 MHz clock used by the ADC.

AUX Connector

ATS9120 provides an AUX (Auxiliary) BNC connector that is configured as a Trigger Output connector by default.

When configured as a Trigger Output, AUX BNC connector outputs a 5 Volt TTL signal synchronous to the ATS9120 Trigger signal, allowing users to synchronize their test systems to the ATS9120 Trigger. Note that the Trigger output is synchronized to a divide-by-8 clock (dual channel mode) or divide-by-16 clock (single channel mode).

When combined with the Trigger Delay feature of the ATS9120, this option is ideal for ultrasonic and other pulse-echo imaging applications.

AUX connector can also be used as a Trigger Enable Input and programmable Clock Output.

Calibration

Every ATS9120 digitizer is factory calibrated for gain and offset accuracy to NIST- or CNRC-traceable standards, using an oscilloscope calibrator. To recalibrate an ATS9120, the digitizer must be shipped back to the factory.

Test Reports

AlazarTech thoroughly tests every digitizer that leaves the factory; each board must pass hundreds of tests before it is shipped to a customer.

In addition to an 8-hour burn-in, each digitizer undergoes a full Performance Verification Test (PVT) where functionality such as external trigger, internal & external clock are tested, and characteristics such as frequency response and bandwidth are measured to ensure that they are within specification.

Customers can obtain test reports for their AlazarTech digitizer (for a fee) by adding the following order number to their digitizer order: *TestReport*. When ordering test reports after the digitizer order, use: *TestReport-AO*.

AlazarDSO Software

ATS9120 is supplied with the powerful AlazarDSO software that allows the user to setup the acquisition hardware and capture, display and archive the signals.

The Stream-To-Memory command in AlazarDSO allows users to stream a large dataset to motherboard memory.

AlazarDSO software also includes powerful tools for benchmarking the computer bus and disk drive.

Software Development Kits

AlazarTech provides easy-to-use software development kits for customers who want to integrate the ATS9120 into their own software.

A Windows-compatible software development kit, called ATS-SDK, includes headers, libraries and source code sample programs written in C/C++, C#, Python, MATLAB, and LabVIEW.

A Linux-compatible software development kit, called ATS-devel, includes headers, libraries and source code sample programs written in C++ and Python.

These programs can fully control the ATS9120 and acquire data in user buffers.

The purchase of an ATS-SDK license includes a subscription that allows users to download ATS-SDK updates from the AlazarTech website for period of 12 months from the date of purchase.

Customers who want to download new releases beyond this 12 month period should purchase extended maintenance (order number ATS-SDK-1YR).

ATS-GPU

ATS-GPU is a software library developed by AlazarTech to allow users to do real-time data transfer from ATS9120 to a GPU card at full bus speed.

Interfacing waveform digitizers to GPUs involves creating a software mechanism to move data from one to the other and back to user buffers. The standard techniques used most often can get the job done, but feature very low data throughput due to software overheads.

AlazarTech designed ATS-GPU to eliminate this software bottleneck so that data can be moved from AlazarTech digitizers to GPUs and from GPUs to user buffers at full PCIe bus speeds. Once the data is available in GPU memory, many types of digital signal processing (DSP) can be done on this data at near-hardware speeds.

ATS-GPU-BASE is supplied with an example user application in source code. The application includes GPU kernels that use ATS-GPU 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.

Programmers can replace the data inversion code with application-specific signal processing kernels to develop custom applications.

Version 23.1.0 and higher of ATS-GPU-BASE includes a Boxcar Averaging example kernel that provides the ability to perform real-time boxcar averaging on signals acquired by AlazarTech waveform digitizers. It uses optimized GPU routines that allow raw data acquisition rates up to 6.9 GB/s. This signal processing module can lead to a major improvement of signal-to-noise ratio without using CPU resources and without doing FPGA programming.

ATS-GPU-OCT is the optional OCT Signal Processing library for ATS-GPU. It contains floating-point FFT routines that have also 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.

ATS-GPU-NUFFT is an extension of ATS-GPU-OCT that allows non-uniform FFTs to be performed on data acquired uniformly in time domain using a fixed sampling rate. For SS-OCTs where the wavelength does not vary linearly in time, a fixed sampling rate results in data that is non-uniformly distributed in frequency domain. ATS-GPU-NUFFT allows linearized FFTs to be performed on such data.

ATS-GPU supports 64-bit Windows and 64-bit Linux for CUDA®-based development.

Support for Windows

Windows support for ATS9350 includes Windows 11, Windows 10, Windows 8.x, Windows 7 SP1 with security update KB3033929 (SHA-2 Code Signing Support), Windows Server 2012, Windows Server 2010, and Windows Server 2008 R2.

Only 64-bit Windows operating systems are supported.

Microsoft support for Windows 7 and Windows Server 2008 R2 ended on January 14, 2020. As such, AlazarTech ceased development on Windows 7 and Windows Server 2008 R2 as of this date. We will continue to support customers using Windows 7 and Windows Server 2008 R2 until December 31, 2020. After this date, no support will be provided.

Due due to lack of demand and due to the fact that Microsoft no longer supports these operating systems, AlazarTech no longer supports Windows XP, Windows Vista, and Windows Server 2008.

Linux Support

AlazarTech offers Dynamic Kernel Module Support (DKMS) drivers for the following Linux distributions: Ubuntu, Debian, and RHEL®.

AlazarTech DKMS drivers may work for other Linux distributions but they have not been tested and technical support may be limited.

Users can download the DKMS driver and associated library for their specific distribution here:
www.alazartech.com/en/linux-drivers/ats9120/19/

A GUI application called AlazarFrontPanel that allows simple data acquisition and display is also provided.

ATS-SDK includes source code example programs for Linux, which demonstrate how to acquire data programmatically using a C compiler. Note that example programs are only provided for Python and C++.

Based on a minimum annual business commitment, the Linux driver source code licence (order number ATS9120-LINUX) may be granted to qualified OEM customers for a fee. For release of driver source code, a Non-Disclosure Agreement must be executed between the customer's organization and AlazarTech.

All such source code disclosures are made on an as-is basis with limited support from the factory.

Upgrading Your Digitizer in The Field

It is always recommended to get upgrades installed at the factory with the initial digitizer purchase.

If the digitizer is still under warranty, it may be possible to add certain upgrades in the field, but there is a small chance that the upgrade will not work, in which case the digitizer would need to be returned to the factory to complete the upgrade.

If the digitizer is no longer under warranty, the upgrade must be done at the factory and there will be a minimum service charge in addition to the cost of the upgrade. This is so that AlazarTech can verify that the digitizer meets basic performance levels prior to any upgrade.

Technical Support

AlazarTech is known for its world-class technical support. Customers receive free technical support on hardware products that are under warranty.

AlazarTech digitizers come with a standard one (1) year parts and labor warranty. This warranty can be extended for a fee (more information can be found in the next section: *Extended Warranty*).

If your waveform digitizer is out of warranty, you will not be eligible for free technical support on AlazarTech hardware or software products and you will need to purchase technical support hours (order number SUPPORT-HR5) to obtain assistance.

In addition, any necessary repairs to your out-of-warranty hardware products will carry a minimum bench charge.

Extended Warranty

The purchase of an ATS9120 includes a standard one (1) year parts and labor warranty. AlazarTech hardware parts and labor warranty should be maintained to ensure uninterrupted access to technical support and warranty repair services.

Customers may extend their warranty by ordering an Extended Warranty (order number ATS9120-061).

This should be purchased before expiration of the standard warranty (or before expiration of an Extended Warranty).

If the warranty lapses, renewal at a later date will be subject to a reinstatement fee, to cover the administrative costs of warranty reinstatement, and a 6-month waiting period for repair claims. Furthermore, warranty must be extended at least 6 months past the current date.

Users can purchase up to 4 (four) additional years of warranty extensions for a maximum total of 5 years of warranty.

Get your warranty end date by registering your product at: www.alazartech.com/en/my-account/my-products/.

RoHS Compliance

ATS9120 is fully RoHS compliant, as defined by Directive 2015/863/EU (RoHS 3) of the European Parliament and of the Council of 31 March 2015 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

All manufacturing is done using RoHS-compliant components and lead-free soldering.

REACH Compliance

AlazarTech verifies its supply chain against the latest REACH requirements. A compliance statement is usually available within 6 months of release of the European Chemicals Agency (ECHA) updated substance of very high concern (SVHC), Authorizations, and Restrictions lists.

Export Control Classification

According to the Export Controls Division of Government of Canada, ATS9120 is currently not controlled for export from Canada. Its export control classification is N8, which is equivalent to ECCN EAR99. ATS9120 can be shipped freely outside of Canada, with the exception of countries listed on the *Area Control List* and *Sanctions List*. Furthermore, if the end-use of ATS9120, in part or in its entirety, is related to the development or deployment of weapons of mass destruction, AlazarTech is obliged to apply for an export permit.

EC Conformity

ATS9120 conforms to the following standards:

Electromagnetic Emissions:
CISPR 32:2015/AMD1:2019 /
EN 55032:2015/A11:2020 (Class A):
Multimedia Equipment (MME) Radio disturbance characteristics. Limits and method of measurement:
EN 61000-3-2:2014, EN 61000-3-3:2013.

EN 55035:2017/A11:2020:
Multimedia Equipment (MME) Immunity characteristics — Limits and methods of measurement.

Safety:
IEC 62368-1:2014 / EN 62368-1:2014+A11:2017:
Audio/video, information and communication technology equipment - Part 1: Safety requirements.

ATS9120 also follows the provisions of the following directives: 2014/35/EU (Low Voltage Equipment); 2014/30/EU (Electromagnetic Compatibility).

FCC & ICES-003 Compliance

ATS9120 has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15, subpart B of the FCC Rules, and the Canadian Interference-Causing Equipment Standard ICES-003 issue 7 October 2020.

ORDERING INFORMATION

ATS9120	ATS9120-001
ATS9120: External Clock Upgrade	ATS9120-005
ATS9120: One Year Extended Warranty	ATS9120-061
Test reports ordered with board	TestReport
Test reports ordered after board order	TestReport-AO
ATS9120: Sync 4X1G	ATS9120-025
ATS Sync xX1G: AC Wall Adapter	SYNC-X1G-PWR
ATS Sync 4X1G: GRF1-SMA/BNC cable	SYNC-4X1-CBL
SYNC-4X1G: One Year Extended Warranty	SYNC-4X1-061
ATS-SDK purchased with a digitizer board or ATS-GPU: License + 1 Year Subscription (Supports C/C++, Python, MATLAB, and LabVIEW)	ATS-SDK
ATS-SDK purchased separately: License + 1 Year Subscription + 5 hours of technical support (Supports C/C++, Python, MATLAB, and LabVIEW)	ATS-SDK-WOD
ATS-GPU-BASE: GPU Streaming Library License + 1 Year Subscription	ATSGPU-001
ATS-GPU-OCT: Signal Processing Library License + 1 Year Subscription (requires ATSGPU-001)	ATSGPU-101
ATS-GPU-NUFFT: ATS-GPU-OCT Extension for fixed-frequency sampled data License + 1 Year Subscription (requires ATSGPU-001 & ATSGPU-101)	ATSGPU-201
5 Hours of technical support	SUPPORT-HR5

System Requirements

Personal computer with at least one free PCI Express slot with 16 GB RAM; if using AlazarDSO, 16 GB of free hard disk space is also required.

Power Requirements

+12 V	1 A, typical
+3.3 V	0.25 A, typical

Physical

Size	Single slot, half length PCI Express card (4.38 inches x 6.5 inches excluding the connectors protruding from the front panel)
Weight	142 g

I/O Connectors

CH A, CH B, TRIG IN, AUX I/O	BNC female connectors
ECLK	SMA female connector

Environmental

Operating temperature	0 to 55 degrees Celsius, ambient
Storage temperature	-20 to 70 degrees Celsius
Relative humidity	5 to 95%, non-condensing

Acquisition System

Resolution	12 bits Data is returned as MSB-justified 16-bit unsigned integers
Bandwidth (-3 dB)	
DC-coupled, 1 MΩ	DC - 10 MHz
DC-coupled, 50 Ω	DC - 10 MHz
AC-coupled, 1 MΩ	10 Hz - 10 MHz
AC-coupled, 50 Ω	100 kHz - 10 MHz
Bandwidth flatness:	± 3 dB
Number of channels	2, simultaneously sampled
Maximum Sample Rate	20 MS/s single shot
Minimum Sample Rate	1 KS/s single shot for internal clocking
Full Scale Input ranges	
1 MΩ input impedance:	±40 mV, ±50 mV, ±80 mV, ±100 mV, ±200 mV, ±400 mV, ±500 mV, ±800 mV, ±1 V, ±2 V, ±4 V, ±5 V, ±8 V, ±10 V, and ±20 V, software-selectable
50 Ω input impedance:	±40 mV, ±50 mV, ±80 mV, ±100 mV, ±200 mV, ±400 mV, ±500 mV, ±800 mV, ±1 V, ±2 V, and ±4 V, software-selectable
DC accuracy	±2% of full scale in all input ranges
Input coupling	AC or DC, software-selectable
Input impedance	50 Ω or 1 MΩ ±1% in parallel with 55 pF ±5 pF, software-selectable For input ranges ≥2 V: 53 pF ±2 pF For input ranges ≤1 V: 56 pF ±2 pF
Absolute maximum input	
1 MΩ	±28 V (DC + peak AC for CH A, CH B and TRIG IN only without external attenuation)
50 Ω	±4 V (DC + peak AC for CH A, CH B and TRIG IN only without external attenuation)

On-Board Acquisition Memory System

On-board acq memory	8 M
Acquisition Memory/ch	Up to 8 Million samples per channel
Record Length	Software-selectable with 32-point resolution, specified in number of sample points. Must be a minimum of 256 points and must be a multiple of 16.
Number of Records	Software-selectable from a minimum of 1 to a maximum of infinite number of records
Pre-trigger depth	
Single-channel	0 to 4080 (software-selectable) with 16-point resolution in NPT mode
Dual-channel	0 to 2040 (software-selectable) with 16-point resolution in NPT mode
Post-trigger depth	Record Length - Pre-trigger depth

Timebase System

Timebase options	Internal Clock or External Clock (Optional)
Internal Sample Rates	20 MS/s, 10 MS/s, 5 MS/s, 2 MS/s, 1 MS/s, 500 KS/s, 200 KS/s, 100 KS/s, 50 KS/s, 20 KS/s, 10 KS/s, 5 KS/s, 2 KS/s, 1 KS/s
Internal Clock accuracy	±25 ppm

Dynamic Parameters

Typical values measured using a randomly selected ATS9120 in ±1 V input range, DC coupling and 50 Ω impedance. Input was provided by an HP8656A signal generator, followed by a 9-pole, 1 MHz band-pass filter. Input frequency was set at 1 MHz and amplitude was 650 mV rms (92% of full scale input).

SNR	60 dB
SINAD	58 dB
THD	-61 dB
SFDR	-62 dB

Note that these dynamic parameters may vary from one unit to another, with input frequency and with the full scale input range selected.

Optional ECLK (External Clock) Input

Signal Level	200 mV_{P-P} to 2 V_{P-P} with a high slew rate, or 3.3 V LVTTL
Input impedance	50 Ω for AC signals 10 kΩ for DC
Input coupling	AC
Maximum frequency	20 MHz for Fast External Clock
Minimum frequency	1 MHz for Fast External Clock
Sampling Edge	Rising

Optional 10 MHz Reference Input

Signal Level	200 mV_{P-P} to 2 V_{P-P} with a high slew rate
Input impedance	50 Ω
Input Coupling	AC
Input frequency	10 MHz ± 0.1 MHz
Maximum frequency	10.1 MHz
Minimum frequency	9.9 MHz
Sampling Clock Freq.	20 MHz fixed. Lower sample rates available using decimation

Triggering System

Mode	Edge triggering with hysteresis
Comparator Type	Analog comparators
Number of Trigger Engines	2
Trigger Engine Combination	Engine J, engine K, J OR K, software-selectable
Trigger Engine Source	CH A, CH B, TRIG IN, Software or None, independently software-selectable for each of the two Trigger Engines
Hysteresis	±5% of full scale input, typical
Trigger sensitivity	±10% of full scale input range. This implies that the trigger system may not trigger reliably if the input has an amplitude less than ±10% of full scale input range selected
Trigger level accuracy	±5%, typical, of full scale input range of the selected trigger source
Bandwidth	10 MHz
Trigger Delay	Software-selectable from 0 to 9,999,999 sampling clock cycles. Has to meet alignment requirements (see ATS-SDK User Manual for more information).
Trigger Timeout	Software-selectable with a 10 µs resolution. Maximum settable value is 3,600 seconds. Can also be disabled to wait indefinitely for a trigger event

TRIG IN (External Trigger) Input

Input type	Analog or 3.3 V TTL, software-selectable
Input coupling	DC only
Analog input impedance	1 MΩ
Analog bandwidth (-3 dB)	DC - 10 MHz
Analog input range	±2.5 V
Analog DC accuracy	±10% of full scale input
Analog absolute max. input	±8 V (DC + peak AC without external attenuation)
TTL input impedance	10 kΩ ±10%
TTL min. pulse width	32 ADC sampling clocks
TTL min. pulse amplitude	2 Volts
TTL absolute max. input	-0.7 V to +5.5 V

Auxiliary I/O (AUX I/O)

Signal direction	Input or Output, software-selectable. Trigger Output by default
Output types:	Trigger Output, Pacer (programmable clock) Output, Software-controlled Digital Output
Input types:	Trigger Enable Software-readable Digital Input
Output	
Amplitude:	5 Volt TTL
Synchronization:	Synchronized to a clock derived from the ADC sampling clock. Divide-by-4 clock (dual channel mode) or divide-by-8 clock (single channel mode)
Input	
Amplitude:	5 Volt TTL or 3.3 Volt TTL
Input coupling:	DC

Materials Supplied

ATS9120 PCIe Card

ATS9120 Software Installer (downloadable from product page)

Certification and Compliances

RoHS 3 (Directive 2015/863/EU) Compliance

REACH Compliance

CE Marking — EC Conformity

FCC Part 15 Class A / ICES-003 Class A Compliance

All specifications are subject to change without notice

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DATASHEET REVISION HISTORY

Changes from version 1.3D (Feb 2024) to version 1.3E	Section, Page
Modified PCIe slot compatibility to include all PCIe generations	PCI Express Bus Interface, pg. 2
Added section	Test Reports, pg. 5
Added test report order numbers	Ordering Information, pg. 7
Updated system requirements	System Requirements, pg. 8
Replaced install disk on USB flash drive with downloadable content	Materials Supplied, pg. 9

Changes from version 1.3C (Dec 2023) to version 1.3D	Section, Page
Added section on ATS9120: Sync 4X1G	Multi-board Systems using ATS 4X1G, pg. 3
Modified warranty reinstatement fee information	Extended Warranty, pg. 7
Specified that Operating temperature is ambient	Environmental, pg. 8
Added Sync 4X1G, its accessories and extended warranty: ATS93120-025, SYNC-X1G-PWR, SYNC-4X1-CBL, SYNC-4X1-061	Ordering Information, pg. 9

Changes from version 1.3B (Nov 2022) to version 1.3C	Section, Page
Corrected unsigned binary positive full scale to 2^{n}-1 (was incorrectly stated as 2^{n-1}-1), corrected signed binary positive full scale to 2^{n-1}-1 (was incorrectly stated as 2^{n-2}-1) and negative full scale 2^{n-1} (was incorrectly stated as 2^{n-2}).	Output Data Format, pg. 4
Added paragraph on Boxcar Averaging for *ATS-GPU-BASE*	ATS-GPU, pg. 5
Modified to include new warranty reinstatement policy	Extended Warranty, pg. 6
Added section for REACH Compliance	REACH Compliance, pg. 6
Absolute maximum input: Corrected label for External Trigger from EXT to TRIG IN	Acquisition System, pg. 8
Trigger Engine Source: Corrected label for External Trigger from EXT to TRIG IN	Triggering System, pg. 9
Added REACH Compliance to list of Certification and Compliances	Certification and Compliances, pg. 9

Changes from version 1.3A (July 2022) to version 1.3B	Section, Page
Removed 32-bit Windows	Feature Table, pg. 1
Added new section to specify default output data format is unsigned binary and that it can be changed to signed binary via an API call.	Output Data Format, pg. 4
Separate description for Linux SDK to detail supported programming languages	Software Development Kits, pg. 5
Noted that only 64-bit Windows is supported	Support for Windows, pg. 5
Updated download link for the Linux driver and associated library, and added note: ATS-SDK example programs are only provided for Python and C++	Linux Support, pg. 6
Added new section to detail AlazarTech's upgrade policy	Upgrading Your Digitizer in The Field, pg. 6

Changes from version 1.3 (Nov 2021) to version 1.3A	Section, Page
Changes to maintenance subscription inclusions: removed technical support	Software Development Kits, pg. 5
Added Windows 11	Support for Windows, pg. 5
Added new section to specify how AlazarTech handles technical support: Customers receive free technical support on hardware products that are under warranty. Out-of-warranty support requires the purchase of support hours.	Technical Support, pg. 6
Updated specification name from *Input protection* to *Absolute maximum input* Actual value did not change.	Acquisition System, pg. 7
Updated specification names (actual values did not change): *Analog input protection* to *Analog absolute max. input* *TTL input protection* to *TTL absolute max. input*.	TRIG IN (External Trigger) Input, pg. 8
Updated name for product *Software Development Kit* Now called: *ATS-SDK purchased with a digitizer board or ATS-GPU*	Ordering Information, pg. 8
Added products ATS-SDK-WOD and SUPPORT-HR5	Ordering Information, pg. 8

Changes from version 1.2G (July 2021) to version 1.3	Section, Page
Specified number of extended warranties that users may purchase	Extended Warranty, pg. 6
Updated terminology to match the standard: changed *Information Technology Equipment (ITE)* to *Multimedia Equipment (MME)*	EC Conformity, pg. 6

DATASHEET REVISION HISTORY

Changes from version 1.1F (Jan 2020) to version 1.1G	Section, Page
Added NPT Footer support as well as the minimum required driver and firmware; Removed note about DMA not being started until RecordsPerBuffer number of records (triggers) have been acquired. This is not the case for ATS9120.	No Pre-Trigger (NPT) AutoDMA, pg. 3
Removed *5 V-compliant* from 3.3 V TTL input	External Trigger Input, pg. 4
Updated section *ATS-GPU* and added paragraph on ATS-GPU-NUFFT	ATS-GPU, pg. 5
Updated Linux Support (RHEL) and added new DKMS drivers	Linux Support, pg. 5
Updated product registration URL	Extended Warranty, pg. 6
Updated standards and directives	EC Conformity, pg. 6
Updated year of ICES-003 standard	FCC & ICES-003 Compliance, pg. 6
Present Analog input specs and TTL input specs separately for clarity	TRIG IN (External Trigger) Input, pg. 8
Added Auxiliary I/O input coupling (DC)	Auxiliary I/O (AUX I/O), pg. 8
Updated software descriptions and added order number for ATS-GPU-NUFFT	Ordering Information, pg. 8

Changes from version 1.1E (May 2019) to version 1.1F	Section, Page
Changed *Sampling Rate* column to *Max. Sample Rate*	Feature Table, pg. 1
Removed qualified metrology lab as option for recalibrating ATS9120	Calibration, pg. 4
Specified Windows 7 version support, re-ordered list of operating systems, and added end-of-support notice for Windows 7 and Windows Server 2008 R2	Support for Windows, pg. 5
Specified Linux distributions: CentOS, Debian, and Ubuntu	Linux Support, pg. 5
Changed signal level from "±200 mV sine wave or 3.3 V TTL" to "200 mV_{p-p} to 2 V_{p-p} with a high slew rate, or 3.3 V TTL" Removed maximum amplitude, information included in signal level	Optional ECLK (External Clock) Input, pg. 7
Changed signal level from "±200 mV sine wave or square wave" to "200 mV_{p-p} to 2 V_{p-p} with a high slew rate"	Optional 10 MHz Reference Input, pg. 8
Corrected Output types (removed Busy Output and added Pacer Output)	Auxiliary I/O (AUX I/O), pg. 8

Changes from version 1.1D (Mar 2019) to version 1.1E	Section, Page
Removed *ATS-GMA* section as this product is being discontinued	ATS-GMA, pg. 5
Added section *Extended Warranty*	Extended Warranty, pg. 5
Updated Trademark information	pg. 6
Removed ATS-GMA order numbers (ATSGMA-001, ATSGMA-101)	Ordering Information, pg. 8

Changes from version 1.1C (Jan 2019) to version 1.1D	Section, Page
Updated Multiple Record description and pre-trigger data information	Acquisition System, pg. 2
Added section on recommended motherboards	Recommended Motherboards or PCs, pg. 2
Added dual-port memory information and required driver version	On-Board Acquisition Memory, pg. 2
Removed section *Pre-Trigger Acquisition* (information now included in *Acquisition System*)	Pre-Trigger Acquisition, pg. 2
Specified that listed *Pre-trigger depth* applies to NPT mode	On-Board Acquisition Memory System, pg. 7

Changes from version 1.1B (Sept 2018) to version 1.1C	Section, Page
Updated Memory Per Channel to 8 Megasamples	Feature Table, pg. 1
Updated on-board memory to 8 Megasamples	Overview, pg. 1
Updated on-board memory to 8 million samples per channel	On-Board Acquisition Memory, pg. 2
Added Traditional AutoDMA section	Traditional AutoDMA, pg. 2
Updated *Sanctions List* URL	Export Control Classification, pg. 6
Updated on-board memory to 8 M	On-Board Acquisition Memory System, pg. 8

Changes from version 1.1A (June 2018) to version 1.1B	Section, Page
Updated RoHS Compliance to RoHS 3	Global change
Added *Recommended Motherboards or PCs*	Recommended Motherboards or PCs, pg. 2
Correction of trigger engines: changed to J and K (instead of X and Y)	Triggering, pg. 3

DATASHEET REVISION HISTORY

Changes from version 1.1A (June 2018) to version 1.1B (continued)	Section, Page
Specified that External Trigger Input 3.3 V TTL input is 5 V-compliant	External Trigger Input, pg. 3
Added information on ATS-SDK license	Software Development Kits, pg. 5
Specified 64-bit version for Windows and Linux support	ATS-GPU, pg. 5
Added list of supported Microsoft Windows versions	Support for Windows, pg. 5
Moved trademark information and added AlazarTech trademarks	pg. 6
Added "PLL" to section name for clarity, corrected Input Frequency tolerance, and added Max. and Min. Frequencies	Optional 10 MHz Reference PLL Input, pg. 8
Clarified specs by providing separate specifications for Analog and TTL input, Added TTL min. pulse width, TTL min. pulse amplitude, and TTL input protection	TRIG IN (External Trigger) Input, pg. 8
Added *Auxiliary I/O (AUX I/O)* section	Auxiliary I/O (AUX I/O), pg. 8
Added subscription length: ATS-SDK, ATSGPU-001, ATSGPU-101, ATSGMA-001, ATSGMA-101	Ordering Information, pg. 8

Changes from version 1.1 (March 2018) to version 1.1a	Section, Page
Added trademark and registered trademark information	Global change
Corrected real-time sampling rate range to *20 MS/s down to 1 KS/s*	Acquisition System, pg. 2
Added section on ATS-GMA	ATS-GMA, pg. 5
Added missing Full Scale Input range for 1 MΩ input impedance: ±20 V	Acquisition System, pg. 6
Added ATS-GMA order information	Ordering Information, pg. 7