ATS9870

1 GS/s 8-Bit PCI Express Digitizer

- 1.6 GB/s PCI Express (8-lane) interface
- 2 channels sampled at 8-bit resolution
- 1 GS/s simultaneous real-time sampling rate on each input
- Up to 4 Gigabyte dual-port memory
- ±200 mV to ± 4 V input range
- AlazarDSO® oscilloscope software
- Software Development Kit supports C/C++, C#, Python, MATLAB®,and LabVIEW®
- Support for Windows® & Linux®

RoHS 3 COMPLIANT
2015/863/EU

CE

For new designs, please use ATS9872

Product	Bus	Operating System	Channels	Max. Sample Rate	Bandwidth	Memory Per Channel	Resolution
ATS9870	PCIe x8	64-bit Windows & 64-bit Linux	2	1 GS/s	450 MHz	Up to 4 GB in single channel mode	8 bits

Overview

AlazarTech ATS®9870 is an 8-lane PCI Express (PCIe x8), dual-channel, high-speed, 8-bit, 1 GS/s waveform digitizer card capable of streaming acquired data to PC memory at rates up to 1.6 GB/s or storing it in its deep on-board dual-port acquisition memory buffer of up to 4 Gigabytes.

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

ATS9870 allows users to build real-time data acquisition systems even under the Windows or Linux operating systems, as users are allowed to read acquired data even while the next acquisition is in progress.

ATS9870 PCI Express digitizers are an ideal solution for cost sensitive OEM applications that require a digitizer to be embedded into the customer's equipment.

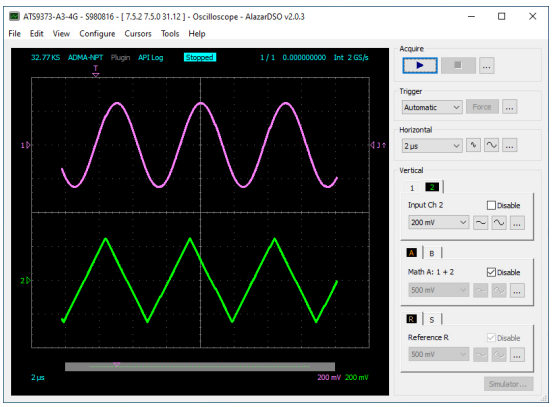
ATS9870 is supplied with AlazarDSO software that lets the user get started immediately without having to go through a software development process.

Users who need to integrate the ATS9870 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 systems.

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

Applications

Ultrasonic & Eddy Current NDT/NDE
Radar/RF Signal Recording
Terabyte Storage Oscilloscope
High-Resolution Oscilloscope
Lidar
Spectroscopy
Multi-Channel Transient Recording



PCI Express Bus Interface

ATS9870 interfaces to the host computer using an 8-lane PCI Express (Gen 1) bus. ATS9870 is also fully compatible with PCIe Gen 2 and Gen 3.

According to PCIe specification, an 8-lane board can be plugged into any 8-lane or 16-lane slot, but not into a 4-lane or 1-lane slot. As such, ATS9870 requires at least one free 8-lane or 16-lane slot on the motherboard.

The physical and logical PCIe x8 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.

PCI Express throughput performance may vary from motherboard to motherboard. The AlazarTech® 1.6 GB/s benchmark was done using ASUS® WS X299 SAGE and P9X79 Pro motherboards.

Other motherboards, such as Intel S5000PSL and various Dell and HP workstations, produced similar results.

Users must always be wary of throughput specifications from manufacturers of waveform digitizers. Some unscrupulous manufacturers tend to specify the raw, burst-mode throughput of the bus.

AlazarTech, on the other hand, specifies the benchmarked sustained throughput. To achieve such high throughput, a great deal of proprietary memory management logic and kernel mode drivers have been designed.

Analog Input

An ATS9870 features two analog input channels with extensive functionality. Each channel has 450 MHz of full power analog input bandwidth.

With software-selectable attenuation, you can achieve an input voltage range of ±200 mV to ± 4V.

It must be noted that input impedance of both channels is fixed at 50 Ω. Software-selectable AC or DC coupling further increases the signal measurement capability.

Acquisition System

ATS9870 PCI Express digitizers use a state of the art dual 1 GSPS, 8-bit ADC to digitize the input signals. The real-time sampling rate ranges from 1 GS/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 ATS9870, 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 64 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.

On-Board Acquisition Memory

ATS9870 supports on-board memory buffers of 256 Megabytes, 2 Gigabytes and 4 Gigabytes.

Acquisition memory can either be divided equally between the two input channels or devoted entirely to one of the channels.

There are two distinct advantages of having on-board memory:

First, a snapshot of the ADC data can be stored into this acquisition memory at full acquisition speed of 2 Gigabytes per second.

Second, and more importantly, on-board memory can also act as a very deep FIFO between the Analog-to-Digital converters and PCI Express bus, allowing very fast sustained data transfers across the bus, even if the operating system or another motherboard resource temporarily interrupts DMA transfers.

Maximum Sustained Transfer Rate

PCI Express support on different motherboards is not always the same, resulting in significantly different sustained data transfer rates. The reasons behind these differences are complex and varied and will not be discussed here.

ATS9870 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.

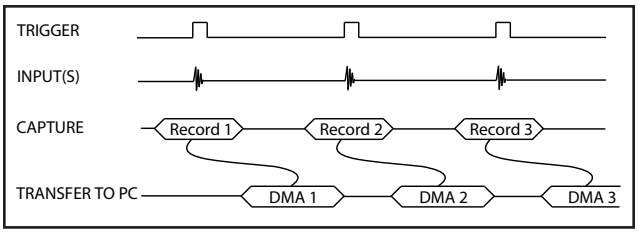
ATS9870, which is equipped with dual-port on-board memory, will be able to achieve this maximum sustained transfer rate.

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 (as high as 1.7 GB/s for PCIe Gen 1) are listed here: www.alazartech.com/images-media/2246-AlazarTechRecommendedMotherboards.pdf.

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 8192 records (triggers). This number is called RecordsPerBuffer.

Users can also specify that each record should come with its own header that contains a 40-bit trigger timestamp.

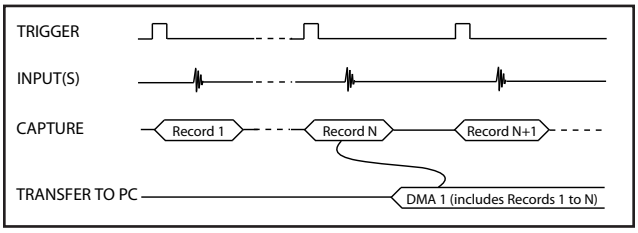
A BUFFER_OVERFLOW flag is asserted if more than 512 buffers have been acquired by the acquisition system, but not transferred to host PC memory by the AutoDMA engine.

While Traditional AutoDMA can acquire data to PC host memory at the maximum sustained transfer rate of the motherboard, 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.

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, the memory bandwidth is optimized and the entire on-board memory acts like a very deep FIFO.



Note that a DMA is not started until RecordsPerBuffer number of records (triggers) have been acquired.

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.

More importantly, a BUFFER_OVERFLOW flag is asserted only if the entire on-board memory is used up. This provides a very substantial improvement over Traditional AutoDMA.

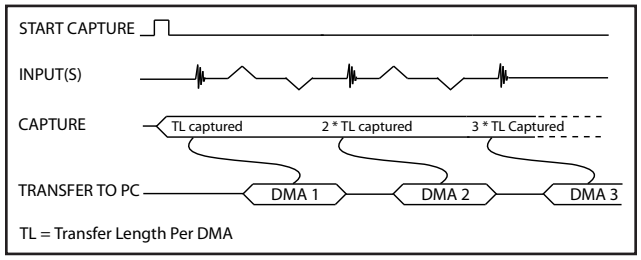
NPT AutoDMA can easily acquire data to PC host memory at the maximum sustained transfer rate of the motherboard without causing an overflow.

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

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 ATS9870 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.

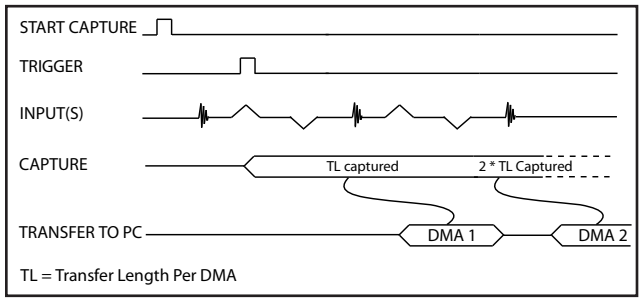
A BUFFER_OVERFLOW flag is asserted only if the entire on-board memory is used up.

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 only if the entire on-board memory is used up.

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.

This is the recommended mode for RF signal recording that has to be started at a specific time, e.g. based on a GPS pulse.

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, ATS9870 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.

To the best of our knowledge, no other supplier of waveform digitizers provides asynchronous software drivers. Their synchronous drivers force the CPU to manage data acquisition, thereby slowing down the overall data acquisition process.

Output Data Format

By default, ATS9870 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 ATS9870 is equipped with sophisticated 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, ATS9870 offers two trigger engines (called Engines J and K).

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

The external trigger input on the ATS9870 is labeled TRIG IN on the face plate.

By default, the input impedance of this input is 50 Ω and the full scale input range is +/- 5 Volts. The trigger signal is treated as an analog signal in this situation and a high-speed comparator receives the signal.

Timebase

Timebase on the ATS9870 can be controlled either by on-board low-jitter VCO or by optional External Clock. On-board low-jitter VCO uses an on-board 10 MHz TCXO as a reference clock.

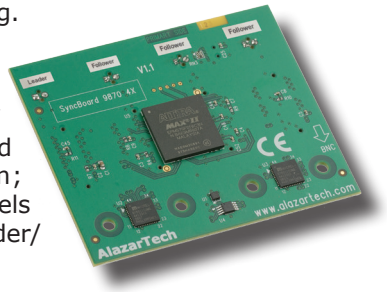
Leader/Follower Systems

Users can create a multi-board Leader/Follower system by synchronizing up to four ATS9870 boards using an appropriate SyncBoard-9870. Note that ATS9870 board must be hardware version 1.3 or higher.

SyncBoard-9870 is a mezzanine board that connects to the Leader/Follower connector along the top edge of the ATS9870 and sits parallel to the motherboard. For additional robustness, users can secure the SyncBoard-9870 to a bracket mounted on each of the ATS9870 boards.

SyncBoard-9870 is available in different widths: 2x, 4x, 2x-W, 3x-W or 4x-W.

SyncBoards with the -W suffix provide 2-slot spacing between ATS9870 cards to support some of the newer motherboards that space out the on-board x8 or x16 slots by two slots. The -W SyncBoards are also a better solution from thermal point of view, as there is better air flow with 2-slot spacing.



The 2x and 2x-W models allow a 2-board Leader/Follower system; the 3x-W model allows a 2 or 3-board Leader/Follower system; and the 4x and 4x-W models allow 2, 3 or 4 board Leader/Follower systems.

The Leader board's clock and trigger signals are copied by the SyncBoard-9870 and supplied to all the Follower boards. This guarantees complete synchronization between the Leader board and all Follower boards.

It should be noted that SyncBoard-9870 does not use a PLL-based clock buffer, allowing the use of variable frequency clocks in Leader/Follower configuration. A Leader/Follower system samples all inputs simultaneously and also triggers simultaneously on the same clock edge.

Multi-board Systems using ATS 4X1G

ATS9870: Sync 4X1G is a device that allows simultaneous sampling across multiple independent ATS9870 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.

Optional External Clock

While the ATS9870 features low-jitter VCO and 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.

ATS9870 External Clock option provides an SMA input for an external clock signal, which should be a high slew rate signal.

Input impedance for the External Clock input is fixed at 50 Ω. External clock input is always AC-coupled.

There are two types of External Clock supported by ATS9870. 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 200 MHz and lower than 1 GHz.

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.

ATS9870 uses an on-board low-jitter VCO to generate the 1 GHz high-frequency clock used by the ADC.

AUX Connector

ATS9870 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 ATS9870 Trigger signal, allowing users to synchronize their test systems to the ATS9870 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 ATS9870, this option is ideal for ultrasonic and other pulse-echo imaging applications.

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

Real-Time Signal Processing

One of the unique features of AlazarTech's waveform digitizer product line is that acquired data is available for real-time signal processing by the host CPU.

What makes this very powerful is the fact that most modern CPUs have multiple cores, which can be used to do real-time signal processing using parallel processing principles.

If your algorithm can be written to take advantage of parallel processing, this may be a very cost-effective solution for signal processing applications.

AlazarTech has been able to demonstrate that a 2.4 GHz, quad-core CPU can do real-time averaging of acquired data at 1.5 GB/s while using up only 25% of CPU cycles. A faster CPU or a CPU with more cores can do signal processing even faster.

Another very popular application is to monitor a pulse train for particle detection applications. AlazarTech has created a parallel processing algorithm that allows real-time pulse detection and characterization at rates in excess of 1 GB/s.

Calibration

Every ATS9870 digitizer is factory calibrated to NIST- or CNRC-traceable standards. To recalibrate an ATS9870, the digitizer must be shipped back to the factory.

AlazarDSO Software

ATS9870 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 ATS9870 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 ATS9870 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 ATS9870 to a GPU card at rates up to 1.6 GB/s.

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.

FFTs can be done on triggered data or on continuous gapless stream of data. It is also possible to do spectral averaging. Our benchmarks showed that it was possible to do 520,000 FFTs per second when capturing data in dual-channel mode and using a NVIDIA® Quadro® P5000 GPU.

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 ATS9870 includes Windows 11, Windows 10, Windows Server® 2019, and Windows Server 2016. As Windows Server 2019 and 2016 are seldom used by our customers, they are expected to work but are not regularly tested with each software release. If there are issues related to Windows Server 2016 or 2019, tech support may not be as rapid as for other operating systems.

Only 64-bit Windows operating systems are supported. The last 32-bit Windows driver is version 5.10.24, which supports Windows 7.

Microsoft mainstream support ended in 2018 for Windows 8.1 and Windows Server 2012 R2. As such, AlazarTech has ceased development on these operating systems. Current software and driver releases may work with these operating systems but they are not officially supported.

Due to lack of demand and due to the fact that Microsoft no longer supports these operating systems, AlazarTech no longer supports Windows 8, Windows 7, Windows XP, Windows Vista, Windows Server 2012, Windows Server 2008 R2, and Windows Server 2008.

Linux Support

AlazarTech offers ATS9870 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/ats9870/5/

Only 64-bit Linux operating systems are supported.

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 license (order number ATS9870-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.

Accessories for Out-of-Warranty Products

Accessories, such as SyncBoards, purchased for use with in-warranty digitizer cards will be covered by a 1-year warranty.

Accessories purchased for use with out-of-warranty digitizers will not be warranted against defects in materials and workmanship. As AlazarTech cannot verify with certainty that the cause of any malfunction is not due to the non-warranted digitizer, accessories purchased for out-of-warranty digitizers will require a warranty waiver.

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 *Extended Warranty* section below).

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 ATS9870 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 the appropriate Extended Warranty:

ATS9870-061 for ATS9870-256M
ATS9870-062 for ATS9870-2G
ATS9870-063 for ATS9870-4G

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/.

Export Control Classification

According to the *Export Controls Division of the Government of Canada*, ATS9870 is currently not controlled for export from Canada. Its export control classification is N8, which is equivalent to ECCN EAR99. ATS9870 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 ATS9870, 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.

RoHS Compliance

ATS9870 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.

EC Conformity

ATS9870 conforms to the following standards:

Electromagnetic Emissions:
CISPR 22:2006/EN 55022:2006 (Class A):
Information Technology Equipment (ITE). Radio disturbance characteristics. Limits and method of measurement.

Electromagnetic Immunity:
CISPR 24:1997/EN 55024:1998 (+A1 +A2):
Information Technology Equipment Immunity characteristics — Limits and methods of measurement.

Safety:
IEC 60950-1:2005: Information technology equipment — Safety — Part 1: General requirements.

IEC 60950-1:2006: Information technology equipment — Safety — Part 1: General requirements.

ATS9870 also follows the provisions of the following directives: 2014/35/EU (Low Voltage Equipment); 2014/30/EU (Electromagnetic Compatibility).

FCC & ICES-003 Compliance

ATS9870 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-003:2006.

ORDERING INFORMATION

ATS9870-256M	ATS9870-002
ATS9870-2G	ATS9870-003
ATS9870-4G	ATS9870-004
ATS9870: External Clock Upgrade	ATS9870-005
ATS9870: SyncBoard 2x	ATS9870-006
ATS9870: SyncBoard 4x	ATS9870-007
ATS9870-256M to 2G Upgrade	ATS9870-010
ATS9870-256M to 4G Upgrade	ATS9870-011
ATS9870-2G to 4G Upgrade	ATS9870-012
ATS9870: SyncBoard 2x-W	ATS9870-020
ATS9870: SyncBoard 3x-W	ATS9870-021
ATS9870: SyncBoard 4x-W	ATS9870-022
ATS9870-256M: One Year Extended Warranty	ATS9870-061
ATS9870-2G: One Year Extended Warranty	ATS9870-062
ATS9870-4G: One Year Extended Warranty	ATS9870-063
ATS9870: Sync 4X1G	ATS9870-025
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 x8 or x16 PCI Express (v1.0a, v1.1 or v2.0) slot, 2 GB RAM, 100 MB of free hard disk space, SVGA display adaptor and monitor with at least a 1024 x 768 resolution.

Power Requirements

+12 V	1.2 A, typical
+3.3 V	1.1 A, typical

Physical

Size	Single slot, half-length PCI Express card (4.377 inches x 6.5 inches excluding the connectors protruding from the front panel)
Weight	250 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	8 bits
Bandwidth (-3 dB)	
DC-coupled, 50 Ω	±40 mV range: DC - 200 MHz All other ranges: DC - 450 MHz
AC-coupled, 50 Ω	±40 mV range: 100 kHz - 200 MHz All other ranges: 100 kHz - 450 MHz
Number of channels	2, simultaneously sampled
Maximum sample rate	1 GS/s
Minimum sample rate	1 KS/s (internal clock) 200 MS/s (external clock)
Full scale input ranges	
50 Ω input impedance:	±40 mV, ±100 mV, ±200 mV, ±400 mV, ±1 V, ±2 V, and ±4 V, software-selectable
DC accuracy	±2% of full scale in all ranges
Input coupling	AC or DC, software-selectable
Input impedance	50 Ω ±1%
Absolute maximum input	
50 Ω	±4 V (DC + peak AC for CH A and CH B only without external attenuation)

Acquisition Memory System

Memory size	256 MB, 2 GB or 4 GB
Record length	Software-selectable with 64-point resolution. Record length must be a minimum of 256 points and maximum of the on-board memory size for single-port memory operation. There is no upper limit on the maximum record length in data streaming mode.
Number of records	Software-selectable from a minimum of 1 to a maximum of infinite number of records
Pre-trigger depth	From 0 to (Record Length –128) in NPT mode
Post-trigger depth	Record Length – Pre-Trigger Depth

Timebase System

Timebase options	Internal Clock or External Clock (Optional)
Internal sample rates	1 GS/s, 500 MS/s, 250 MS/s, 100 MS/s, 50 MS/s, 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	±2 ppm

Dynamic Parameters

Typical values measured on CH A of a randomly selected ATS9870. Input signal was provided by a Marconi 2018A signal generator, followed by a 9-pole, 20 MHz band-pass filter (TTE Q36T-20M-2M-50-720BMF). Input frequency was set at 20 MHz and output amplitude was 708 mV rms, which was approximately 95% of the full scale input. Input was not averaged and bandwidth limiting filter was disabled.

SNR	40.55 dB
SINAD	40.09 dB
THD	-54.8 dB
SFDR	-52.05 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

Input impedance	50 Ω
Input coupling	AC
Fast External Clock	
Signal level	500 mV_{P-P} to 2 V_{P-P}
Maximum frequency	1 GHz with 50% ±5% duty cycle
Minimum frequency	200 MHz with 50% ±5% duty cycle
Sampling edge	Rising or Falling, software-selectable
Slow External Clock	
Signal Level	3.3 V LVTTL
Maximum frequency	60 MHz
Minimum frequency	DC

Optional 10 MHz Reference PLL Input

Signal level	500 mV_{P-P}
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.	1 GHz

Triggering System

Mode	Edge triggering with hysteresis
Comparator type	Digital comparators for internal (CH A, CH B) triggering and analog comparators for TRIG IN (External) triggering
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	450 MHz
Trigger delay	Software-selectable from 0 to 9,999,999 sampling clock cycles
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
Input impedance	50 Ω
Bandwidth (-3 dB)	
DC-coupled	DC - 450 MHz
Input range	±5 V
DC accuracy	±10% of full scale input
Absolute maximum input	±8 V (DC + peak AC without external attenuation)
Coupling	DC

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-8 clock (dual channel mode) or divide-by-16 clock (single channel mode)
Input	
Amplitude:	3.3 Volt TTL (5 Volt-compliant)
Input coupling:	DC

Materials Supplied

ATS9870 PCI Express Card

ATS9870 Installation Disk (on USB Flash Drive)

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

Manufactured By:

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DATASHEET REVISION HISTORY

Changes from version 1.6M (Dec 2023) to version 1.6N	Section, Page
Added section on ATS9870: Sync 4X1G	Multi-board Systems using ATS 4X1G, pg. 4
Modified warranty reinstatement fee information	Extended Warranty, pg. 7
Added Sync 4X1G, its accessories and extended warranty: ATS9870-025, SYNC-X1G-PWR, SYNC-4X1-CBL, SYNC-4X1-061	Ordering Information, pg. 8
Specified that Operating temperature is ambient	Environmental, pg. 9

Changes from version 1.6L (Nov 2022) to version 1.6M	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. 6
Modified to include new warranty reinstatement policy	Extended Warranty, pg. 7
Added section for REACH Compliance	REACH Compliance, pg. 7
Trigger Engine Source: Corrected label for External Trigger from EXT to TRIG IN	Triggering System, pg. 8
Added REACH Compliance to list of Certification and Compliances	Certification and Compliances, pg. 9

Changes from version 1.6K (July 2022) to version 1.6L	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 and that the last driver version that supports 32-bit Windows is 5.10.24.	Support for Windows, pg. 6
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 accessory policy	Accessories for Out-of-Warranty Products, pg. 6
Added new section to detail AlazarTech's upgrade policy	Upgrading Your Digitizer in The Field, pg. 6

Changes from version 1.6J (Nov 2021) to version 1.6K	Section, Page
Changes to maintenance subscription inclusions: removed technical support	Software Development Kits, pg. 5
Added Windows 11	Support for Windows, pg. 6
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. 8
Updated specification name from *Input protection* to *Absolute maximum input* Actual value did not change.	TRIG IN (External Trigger) Input, pg. 9
Updated name for product *Software Development Kit* Now called: *ATS-SDK purchased with a digitizer board or ATS-GPU*	Ordering Information, pg. 9
Added products ATS-SDK-WOD and SUPPORT-HR5	Ordering Information, pg. 9

Changes from version 1.6I (Sept 2021) to version 1.6J	Section, Page
Changed term for multi-board system to *Leader/Follower*	Leader/Follower Systems, pg. 4
Specified number of extended warranties that users may purchase	Extended Warranty, pg. 6

Changes from version 1.6H (June 2021) to version 1.6I	Section, Page
Updated support status for Windows 8.x and Windows Server versions 2012 R2, 2016, 2019	Support for Windows, pg. 6

Changes from version 1.6G (Jan 2020) to version 1.6H	Section, Page
Added note to advise that ATS9870 is not recommended for new designs Suggested replacement is ATS9872	pg. 1
Updated motherboard used for benchmarking	PCI Express Bus Interface, pg. 2

DATASHEET REVISION HISTORY

Changes from version 1.6G (Jan 2020) to version 1.6H (continued)	Section, Page
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. 6
Updated product registration URL	Extended Warranty, pg. 6
Updated Low Voltage Equipment and Electromagnetic Compatibility directives	EC Conformity, pg. 7
Updated year of ICES-003 standard	FCC & ICES-003 Compliance, pg. 7
Added Auxiliary I/O input coupling (DC)	Auxiliary I/O (AUX I/O), pg. 9
Added order number for ATS-GPU-NUFFT	Ordering Information, pg. 9

Changes from version 1.6F (May 2019) to version 1.6G	Section, Page
Changed *Sampling Rate* column to *Max. Sample Rate*	Feature Table, pg. 1
Added AlazarFrontPanel (for Linux) as benchmarking tool	Maximum Sustained Transfer Rate, pg. 2
Replaced signal sine wave requirement with high slew rate for external clock signal	Optional External Clock, pg. 5
Removed qualified metrology lab as option for recalibrating ATS9870	Calibration, pg. 5
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. 6
Specified Linux distributions: CentOS, Debian, and Ubuntu	Linux Support, pg. 6
Clarified specifications by separating Fast and Slow External Clock changed fast external clock signal level from "±200 mV" to "500 mV_{P-P} to 2 V_{P-P}"	Optional ECLK (External Clock) Input, pg. 8
Changed signal level from ±200 mV to 500 mV_{P-P}, removed sine wave requirement	Optional 10 MHz Reference PLL Input, pg. 8
Corrected Output types (removed Busy Output and added Pacer Output)	Auxiliary I/O (AUX I/O), pg. 9

Changes from version 1.6E (Jan 2019) to version 1.6F	Section, Page
Updated ATS-GPU benchmarks (FFTs per second, number of channels, and GPU)	ATS-GPU, pg. 6
Removed *ATS-GMA* section as this product is being discontinued	ATS-GMA, pg. 6
Added section *Extended Warranty*	Extended Warranty, pg. 6
Updated Trademark information	pg. 7
Specified that listed Pre-trigger depth applies to NPT mode	Acquisition Memory System, pg. 8
Removed ATS-GMA order numbers (ATSGMA-001, ATSGMA-101)	Ordering Information, pg. 9

Changes from version 1.6D (Sept 2018) to version 1.6E	Section, Page
Updated *Sanctions List* URL	Export Control Classification, pg. 6
Updated Trademark information	pg. 7

Changes from version 1.6C (Jan 2018) to version 1.6D	Section, Page
Updated RoHS Compliance to RoHS 3	Global change
Clarified Operating System Support	Features & Feature Table, pg. 1
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. 4
Added information on ATS-SDK license	Software Development Kits, pg. 5
Specified 64-bit version for Windows and Linux support	ATS-GPU, pg. 6
Added *ATS-GMA* section	ATS-GMA, pg. 6
Added list of supported Microsoft Windows versions	Support for Windows, pg. 6
Added Trademark information	pg. 7
Removed Bandwidth Flatness	Acquisition System, pg. 8
Added *Acquisition Memory System* section	Acquisition Memory System, pg. 8
Removed *Amplifier Bypass Mode* section	Amplifier Bypass Mode, pg. 8
Added Duty Cycle for fast external clock min. & max. frequencies; Corrected Sampling Edge; Added Maximum Amplitude: 2 V_{P-P}	Optional ECLK (External Clock) Input, pg. 8

DATASHEET REVISION HISTORY

Changes from version 1.6C (Jan 2018) to version 1.6D (continued)	Section, Page
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
Corrected Trigger Engine Combination	Triggering System, pg. 9
Removed AC-coupled bandwidth and AC coupling. Coupling is DC only.	TRIG IN (External Trigger) Input, pg. 9
Replaced TRIG OUT Output section with Auxiliary I/O (AUX I/O)	Auxiliary I/O (AUX I/O), pg. 9
Added subscription length for ATS-SDK, ATSGPU-001, ATSGPU-101, and added products ATSGMA-001, ATSGMA-101	Ordering Information, pg. 9

Changes from version 1.6B (Oct 2017) to version 1.6C	Section, Page
Added note about NPT Footers	No Pre-Trigger (NPT) AutoDMA, pg. 3
Added section on External Trigger Input	External Trigger Input, pg. 4
Added CNRC as calibration standard	Calibration, pg. 5
Added -BASE and -OCT to ATS-GPU description for clarity	ATS-GPU, pg. 5
Corrected size of card	Physical, pg. 7
Updated email address	Manufactured By, pg. 8

Changes from version 1.6A (Sept 2017) to version 1.6B	Section, Page
Updated description for product ATSGPU-001 & ATSGPU-101	Ordering Information System, pg. 8

Changes from version 1.5A (Jan 2013) to version 1.6A	Section, Page
Added Python to list of supported languages for Software Development Kit	Features, pg. 1
Added Python & LabVIEW to list of supported languages for ATS-SDK, removed ATS-VI	Overview, pg. 1
Added 2-slot-spacing SyncBoards (-W models)	Master/Slave Systems, pg. 4
Removed Hardware Averaging Firmware (order number ATS9870-014)	Hardware Averaging Firmware, pg. 5
Modified AlazarDSO description	AlazarDSO Software, pg. 5
Modified Software Development Kit description: added Python support, removed ATS-VI	Software Development Kit, pg. 5
Replaced section *GPU Based Signal Processing* with new *ATS-GPU* section	ATS-GPU, pg. 6
Changed section title from *ATS-Linux* to *Linux Support*, and modified description	Linux Support, pg. 6
Added Export Control Classification information	Export Control Classification, pg. 6
Added section on RoHS compliance	RoHS Compliance, pg. 6
Added section on EC Conformity	EC Conformity, pg. 6
Added section on FCC & ICES-003 Compliance	FCC & ICES-003 Compliance, pg. 6
Updated External Trigger Input Impedance to 50 Ω	TRIG IN (External Trigger) Input, pg. 8
Updated list of Certification and Compliances	Certification and Compliances, pg. 8
Corrected product names for ATS9870-007, ATS9360-011, ATS9360-012, ATS-SDK	Ordering Information, pg. 8
Removed products ATS9870-008, ATS9870-009, ATS9870-013, ATS9870-014, ATS9870-LIN, ATS-VI, ATS-GPU.	Ordering Information, pg. 8
Added products ATS9870-020, ATS9870-021, ATS9870-022, ATS9870-061, ATS9870-062, ATS9870-063, ATSGPU-001, ATSGPU-101	Ordering Information, pg. 8