ATST146

125 MS/s 14-Bit Thunderbolt 3 Digitizer

- Thunderbolt™ 3 (USB type C) connectivity -- No embedded PC required!
- 2 channels sampled at 14-bit resolution
- 125 MS/s simultaneous real-time sampling rate on each input
- Up to 128 Million samples of on-board acquisition memory per channel
- ±20 mV to ±10 V input range
- Asynchronous DMA device driver
- AlazarDSO® oscilloscope software
- Software Development Kit supports C/C++, C#, Python, MATLAB®, LabVIEW®
- Support for Windows®, Linux® & macOS®

RoHS 3 COMPLIANT 2015/863/EU

Thunderbolt 4 Compatible

Product	Bus	Operating System	Channels	Max. Sample Rate	Bandwidth	Memory Per Channel	Resolution
ATST146	Thunderbolt 3	64-bit Windows 64-bit Linux & macOS	2	125 MS/s on 2 channels	65 MHz (for 50 Ω input)	128 Megasamples	14 bits

Overview

AlazarTech ATS®T146 is a dual-channel, 14-bit, 125 MS/s waveform digitizer card with Thunderbolt 3 connectivity capable of storing up to 128 Million samples per channel of acquired data in its on-board memory or streaming acquired data to PC memory. Thunderbolt 3 connectivity allows data streaming at rates up to 200 MB/s.

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.

From a software perspective, ATST146 looks exactly like the PCI Express based ATS9146. This means that any software developed for ATS9146 will work seemlessly with ATST146, giving customers an easy option to migrate to this Thunderbolt 3 based wave-form digitizer.

ATST146 digitizers are an ideal solution for cost-sensitive OEM applications that require a digitizer to be embedded into the customer's equipment.

ATST146 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 ATST146 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.

Applications

Optical Coherence Tomography (OCT)

Ultrasonic & Eddy Current NDT/NDE

Radar/RF Signal Recording & Analysis

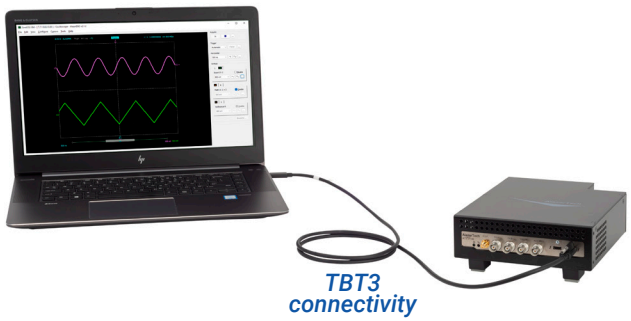
Terabyte Storage Oscilloscope

High-Resolution Oscilloscope

Lidar

Spectroscopy

Multi-Channel Transient Recording



Connect ATST146 directly to your computer using a Thunderbolt 3 cable

Thunderbolt 3 Interface

ATST146 interfaces to the host computer using the Thunderbolt 3 bus that runs at 40 Gbps.

ATST146 is also compatible with the Thunderbolt 4 bus. It is essential that customers use certified Thunderbolt 3 or Thunderbolt 4 cables for optimal performance.

ATST146 is a self-powered device and not bus powered, which means the customer must provide a separate 18~24V DC power to the ATST146 for it to operate.

The AlazarTech® 200 MB/s benchmark was done on an HP® ZBook laptop. Similar results were obtained using the optional Thunderbolt 3 port on an HP Z4 workstation.

Software Portability

The biggest advantage of using Thunderbolt 3 over other serial connections is that any code developed for AlazarTech's PCIe boards can be ported over seamlessly to AlazarTech Thunderbolt 3 devices.

Analog Input

An ATST146 features two analog input channels with extensive functionality. Each channel has 65 MHz of full power analog input bandwidth for 50 Ω input and 10 MHz bandwidth for 1 MΩ input. With software-selectable attenuation, you can achieve an input voltage range of ±20 mV to ±10 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

ATST146 Thunderbolt 3 digitizers use a pair of 125 MS/s, 14-bit ADCs to digitize the input signals. The real-time internal sampling rate ranges from 125 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 ATST146, 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 32 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

ATST146 provides 128 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 an advanced custom DMA engine that can stream data to PC host memory at up to 200 MB/s (exact rate is motherboard dependent).

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

Maximum Sustained Transfer Rate

Data throughput across Thunderbolt 3 connection is highly dependent on the quality of the cable being used. Customers must use a certified Thunderbolt 3 cable to achieve the maximum sustained transfer rate of 200 MB/s.

ATST146 users can quickly determine the maximum sustained transfer rate for their motherboard by connecting their ATST146 to the Thunderbolt 3 or Thunderbolt 4 port of their laptop or desktop computer and running the bus benchmarking tool provided in AlazarDSO for Windows or AlazarFrontPanel for Linux.

OEM model

An ATST146-OEM model is also available. It comes without the enclosure so that it can be designed into an OEM's system.

ATST146-OEM (order number ATST146-101) includes one 0.7-meter passive cable with single screw lock on one end. It does not include a power supply or software & documentation on USB flash drive.

ATST146-OEM features two power connectors: a DC-jack that is used with an external AC-DC power supply; and a 2 pin locking Molex MiniFit 39-29-9029 connector that can be used in applications that require a more robust connection in OEM applications.

If OEMs wish to use the Molex MiniFit connector, the design of the power supply and related cabling is their responsibility. The power supply must comply with the requirements as specified in the Power Requirements section on page 8.

Recommended PCs

We recommend the use of certified Thunderbolt 3 or Thunderbolt 4 laptops or desktop computers with ATST146.

Recommended Thunderbolt 3 Cables

While Thunderbolt 3 uses the same USB C connector as USB 3.x, the unique electrical requirements of Thunderbolt 3 require the use of special cables that have been certified by an accredited laboratory.

According to Thunderbolt 3 specification, the maximum cable length for passive cables is 0.8 meters. Longer lengths require active cables.

AlazarTech supplies one 0.7 meter passive cable with the digitizer. We have also tested the Corning® 25 meter optical cable model# COR-AOC-CCU6JPN025M20.

Recommended AC-DC Power Supply

ATST146 is a self-powered Thunderbolt 3 device. Users must supply the necessary power to the digitizer for it to operate.

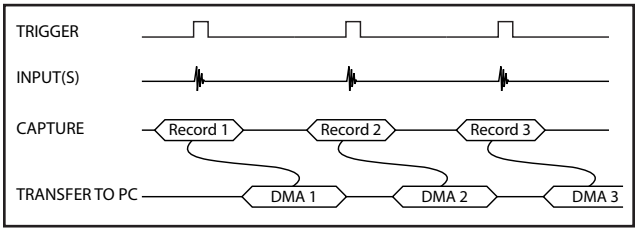
In order to obtain safety certification for the ATST146, AlazarTech cannot include a power supply with the digitizer. Though the recommended power supply has all the necessary compliance marks, our Safety test lab insisted on reviewing the power supply schematics and bill of materials, which were not shared by the power supply manufacturer.

The power supply must, therefore, be ordered separately (order number ATST3PS-001). Customers may opt to order the Phihong USA PSAC60M-240 power supply and AC30MNA power cord directly from Digi-Key (part numbers 993-1136-ND and 993-1037-ND respectively).

The power supply specified above has undergone testing at our factory and is the recommended power supply for AlazarTech Thunderbolt 3 digitizers.

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.

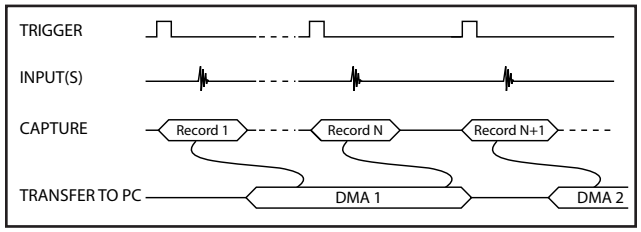
In other words, a BUFFER_OVERFLOW can occur if more than 512 triggers occur in very rapid succession, even if all the on-board memory has not been used up.

ATST146 features a high-performance memory management firmware that allows much faster data throughput in Traditional mode than previous generation digitizers. Traditional AutoDMA is the fastest way to move data into user buffers. It is the recommended method.

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.



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

More importantly, a BUFFER_OVERFLOW flag is asserted if the on-board memory overflows, i.e. the amount of memory that has been written into but not read out to Thunderbolt 3 bus exceeds the on-board memory size.

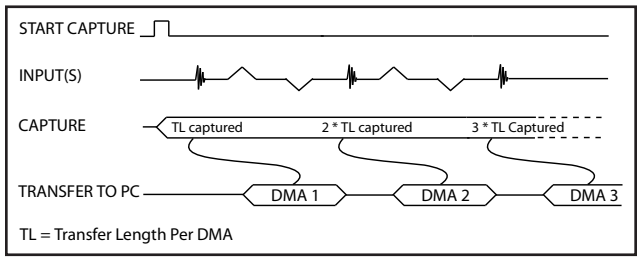
NPT AutoDMA can easily acquire data to PC host memory at the maximum sustained transfer rate of the motherboard without causing an overflow.

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 Thunderbolt 3 bus as soon as the ATST146 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.

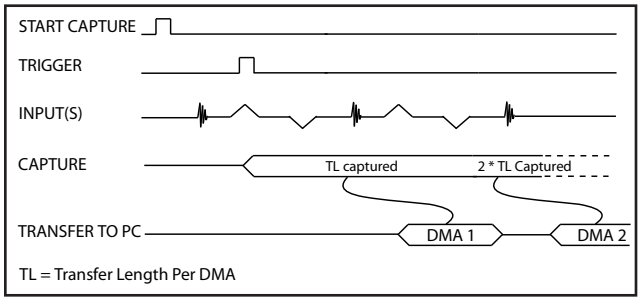
A BUFFER_OVERFLOW flag is asserted only if the entire on-board memory is used up.

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.

Asynchronous DMA Driver

AlazarTech's dual-port memory and 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, ATST146 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, ATST146 data comes out as unsigned binary, where code 0 represents the negative full scale, code (2^{n-1}-1) represents the positive full scale with zero being 2^{n-2}.

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-2}-1) and negative full scale is represented by (2^{n-2}).

Triggering

The ATST146 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, ATST146 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

ATST146 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 ATST146. 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 2-clock timing accuracy. At 125 MS/s sample rate, this counter will not roll over for well over 30 minutes.

The value of this counter is latched each time a trigger is detected and the latched value is included in Traditional AutoDMA Header.

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. This feature is not supported by the standard API, but can be configured using special register reads and writes.

Optional External Clock

While the ATST146 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.

ATST146 External Clock option (order number ATST146-005) provides an SMA input for an external clock signal with a frequency between 125 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 three types of External Clock supported by ATST146. 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 125 MHz.

Slow External Clock

This type of clock should be used when the clock frequency is either too slow or is a burst-type clock. Both these types of clock do not satisfy the minimum clock requirements listed above for Fast External Clock.

In this mode, the ATST146 ADCs are run at a preset internal clock frequency. The user-supplied Slow External Clock signal is then monitored for low-to-high transitions. Each time there is such a transition, a new sample is stored into the on-board memory.

It should be noted that there can be a 0 to +8 ns sampling jitter when Slow External Clock is being used, as the internal ADC clock is not synchronized to the user-supplied clock.

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.

In this mode, ATST146 uses an advanced clock generator circuit consisting of a VCO and PLL to generate the sampling clock.

AUX Connector

ATST146 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 ATST146 Trigger signal, allowing users to synchronize their test systems to the ATST146 Trigger. Note that the Trigger output is synchronized to a divide-by-2 clock.

When combined with the Trigger Delay feature of the ATST146, 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 ATST146 digitizer is factory calibrated for gain and offset accuracy to NIST- or CNRC-traceable standards, using an oscilloscope calibrator. To recalibrate an ATST146, the digitizer must be shipped back to the factory.

RoHS Compliance

ATST146 units are 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.

On-Board Monitoring

Adding to the reliability offered by ATST146 are the on-board diagnostic circuits that constantly monitor over 15 different voltages, currents and temperatures. LED alarms are activated if any of the values surpass the limits.

AlazarDSO Software

ATST146 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 ATST146 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 ATST146 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 ATST146 to a CUDA®-enabled 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 Thunderbolt 3 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.

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 ATST146 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.

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 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/atst146/635/

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 ATST146-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.

MacOS Support

As per Thunderbolt 3 licensing agreement, we do provide drivers for MacOS. A console application can be made available to users interested in use of ATST146 under MacOS.

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 ATST146 includes a standard one (1) year parts and labor warranty. Customers may extend their warranty by ordering an Extended Warranty (order number ATST146-061).

This must be purchased before expiration of the standard warranty (or before expiration of an Extended Warranty). Extended Warranties can only be purchased while there is a valid warranty in place.

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 Government of Canada, ATST146 is currently not controlled for export from Canada. Its export control classification is N8, which is equivalent to ECCN EAR99. ATST146 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 ATST146, 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.

System Requirements

Personal computer with at least one free Thunderbolt 3 or Thunderbolt 4 port, (must be a certified Thunderbolt 3 or Thunderbolt 4 port to achieve full data throughput), 128 GB RAM, 100 MB of free hard disk space.

Power Requirements

Input voltage:	+22 V to +26 V
Voltage ripple:	240 mV_{P-P}, max
Current consumption:	1 A at 24 V input

Power Connectors

Connector types:	
DC (Barrel Plug)	2.1mm I.D. x 5.5mm O.D. x 9.5mm
Molex (for OEM use)	MiniFit 39-29-9029

Physical

Size
(excluding the connectors protruding from the front panel)

In enclosure:	6.5 inches x 8.16 x 2.7 inches
OEM version:	6.57 inches x 5.5 inches

Weight

In enclosure:	655 g
OEM version:	220 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
Storage temperature	-20 to 70 degrees Celsius
Relative humidity	5 to 95%, non-condensing

Acquisition System

Resolution	14 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 - 65 MHz
AC-coupled, 1 MΩ	10 Hz - 10 MHz
AC-coupled, 50 Ω	100 kHz - 65 MHz
Number of channels	2, simultaneously sampled
Maximum sample rate	125 MS/s single shot
Minimum sample rate	1 KS/s single shot for internal clocking
Full scale input ranges	
1 MΩ input impedance:	±20 mV, ±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, and ±10 V, software-selectable
50 Ω input impedance:	±20 mV, ±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 EXT only without external attenuation)
50 Ω	±4 V (DC + peak AC for CH A, CH B and EXT only without external attenuation)

On-Board Acquisition Memory System

On-board acq. memory	512 Megabytes
Acquisition memory/ch	Up to 128 Million samples per channel
Record length	Software-selectable with 32-point resolution, specified in number of sample points. Must be a minimum of 128 points and must be a multiple of 32.
Number of records	Software-selectable from a minimum of 1 to a maximum of infinite number of records
Pre-trigger depth	16 to (Record Length - 64) points, software-selectable, with 16-point resolution in traditional mode
Post-trigger depth	Record Length - Pre-Trigger Depth

Timebase System

Timebase options	Internal Clock or External Clock (Optional)
Internal sample rates	125 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	±25 ppm

Optional ECLK (External Clock) Input

Input impedance	50 Ω for AC signals 10 kΩ for DC
Input coupling	AC
Fast External Clock	
Signal level	500 mV_{P-P} to 2 V_{P-P}
Maximum frequency	125 MHz with 50% ±5% duty cycle
Minimum frequency	1 MHz with 50% ±5% duty cycle
Sampling edge	Rising
Decimation factor	Software-selectable from 1 to 100,000
Slow External Clock	
Signal level	3.3 V LVTTL
Maximum frequency	10 MHz with minimum positive or negative pulse width of 8 ns
Minimum frequency	DC

Optional 10 MHz Reference Input

Signal level	500 mV_{P-P} to 2 V_{P-P}
Input impedance	50 Ω
Input coupling	AC coupled
Input frequency	10 MHz ± 0.1 MHz
Maximum frequency	10.1 MHz
Minimum frequency	9.9 MHz
Sampling clock freq.	125 MHz, 100 MHz, 50 MHz, 20 MHz, 10 MHz, 5 MHz, 2 MHz, 1 MHz, 500 kHz, 200 kHz, 100 kHz, 50 kHz, 20 kHz, 10 kHz, 5 kHz, 2 kHz, 1 kHz, software-selectable

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, EXT, 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	65 MHz
Trigger delay	Software-selectable from 0 to 9,999,999 sampling clock cycles. Must 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 - 25 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	6 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.
Input	
Amplitude:	3.3 Volt TTL (5 Volt compliant)
Input coupling:	DC

Materials Supplied

For ATST146 (ATST146-001):
- ATST146 Thunderbolt 3 Digitizer card in enclosure
- ATSTxxx 0.7m Thunderbolt 3 passive 1x screw lock cable
- ATST146 Install Disk on USB flash drive

For ATST146-OEM (ATST146-101):
- ATST146 Thunderbolt 3 Digitizer card
- ATSTxxx 0.7m Thunderbolt 3 passive 1x screw lock cable
- ATST146 Drivers & user manual as downloadable content

All specifications are subject to change without notice

ORDERING INFORMATION

ATST146 (with enclosure)	ATST146-001
ATST146-OEM (without enclosure)	ATST146-101
ATST146: External Clock Upgrade	ATST146-005
ATST146: One Year Extended Warranty	ATST146-061
ATSTXXX: DC Power Supply	ATST3PS-001
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

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