

- Thunderbolt™ 3 (USB type C) connectivity -- No embedded PC required!
- 2 channels sampled at 12-bit resolution
- 1 GS/s real-time sampling rate
- Variable frequency external clocking
- OCT Ignore Bad Clock technology
- Continuous streaming mode
- ±400 mV fixed input range
- Optional 1 GHz wideband upgrade
- AlazarDSO® oscilloscope software
- Software Development Kit supports C/C++, C#, Python, MATLAB®, LabVIEW®
- Support for Windows® & Linux®



# Thunderbolt 4 Compatible

Product	Bus	Operating System	Channels	Max. Sample Rate	Bandwidth	Memory Per Channel	Resolution
ATST364	Thunderbolt 3	64-bit Windows & 64-bit Linux	2	1 GS/s on 2 channels	500 MHz or Optional 1 GHz	512 Megasamples	12 bits

### Overview

AlazarTech ATS®T364 is a dual-channel, high-speed, 12-bit, 1 GS/s waveform digitizer card with Thunderbolt 3 connectivity, capable of acquiring data into its on-board memory or streaming to PC memory. Thunderbolt 3 connectivity allows data streaming at rates up to 2.6 GB/s.

From a software perspective, ATST364 looks exactly like the PCI Express based ATS9364. This means that any software developed for ATS9364 will work seamlessly with ATST364, giving customers an easy option to migrate to this Thunderbolt 3 based waveform digitizer.

There are two A/D converters on the ATST364 board, each running at 1 GS/s. Unlike other products on the market, ATST364 does not use interleaved sampling. Each input has its own 12-bit, 1 GSPS ADC chip.

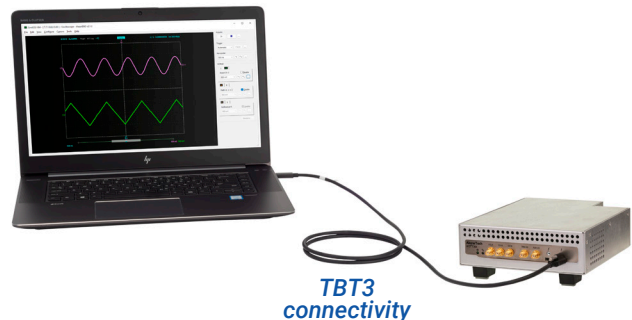
Optional variable frequency external clock allows operation from 1 GHz down to 300 MHz (or 100 MHz for screened ATST364 cards), making ATST364 an ideal waveform digitizer for many applications.

ATST364 is supplied with AlazarDSO software that lets the user start data acquisition immediately, without having to go through a software development process.

Users who need to integrate the ATST364 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.

### Applications

- **Optical Coherence Tomography (OCT)**
- **Ultrasonic & Eddy Current NDT/NDE**
- **RF Signal Recording & Analysis**
- **Terabyte Storage Oscilloscope**
- **High-Resolution Oscilloscope**
- **Spectroscopy**
- **Multi-Channel Transient Recording**



**Connect ATST364 directly to your computer using a Thunderbolt 3 cable**

### Thunderbolt 3 Interface

ATST364 interfaces to the host computer using the Thunderbolt 3 bus that runs at 40 Gbps.

ATST364 is also compatible with the Thunderbolt 4 bus. It is essential that customers use certified Thunderbolt 3 or Thunderbolt 4 cables for optimal performance.

ATST364 is a self-powered device and not bus powered, which means the customer must provide a separate 18~24V DC power to the ATST364 for it to operate.

The AlazarTech® **2.6 GB/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 ATST364 features two analog input channels. Each channel has up to 500 MHz of full power analog input bandwidth. Input voltage range is fixed at  $\pm 400$  mV.

Customers can also order a wideband input upgrade (order number ATST364-009), which increases the bandwidth to 1 GHz.

It must be noted that input impedance of both channels is fixed at 50  $\Omega$ . Input coupling is fixed to DC.

### Optional Wideband Input Upgrade

ATST364 Wideband Input option provides up to 1 GHz analog input on two channels. Input impedance is fixed at 50  $\Omega$ .

### Acquisition System

ATST364 Thunderbolt 3 digitizers use state-of-the-art dual 1 GS/s, 12-bit ADCs to digitize the input signals.

The two channels are guaranteed to be simultaneous, as the two ADCs use a common clock. Note that it is not possible to perform dual edge sampling (DES) on ATST364.

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. Up to 8176 pre-trigger points can be captured in single channel mode and 4088 in dual-channel mode. ATST364 can capture an infinite number of triggers. In between the multiple triggers being captured, the acquisition system is re-armed by the hardware within 256 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

ATST364 provides 512 Million samples per channel of on-board dual-port memory that can be used for signal storage.

This on-board memory is used as a very deep FIFO to temporarily store acquired ADC data before transferring it to motherboard memory using proprietary DMA engines. This on-board buffer 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 2.6 GB/s.

ATST364 users can quickly determine the maximum sustained transfer rate for their motherboard by connecting their ATST364 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 ATST364-OEM model is also available. It comes without the enclosure so that it can be designed into an OEM's system.



ATST364-OEM (order number ATST364-101) 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.

ATST364-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 10.

### Recommended PCs

We recommend the use of certified Thunderbolt 3 or Thunderbolt 4 laptops or desktop computers with ATST364.

### 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

ATST364 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 ATST364, AlazarTech cannot include a power supply with the digitizer. Though the recommended power supplies have 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.

A new power supply with interchangeable AC blades for international use is now available (order number ATST3PS-002). It includes AC blades for use in North America, Europe, U.K., Australia, and China. Customers may also opt to order the CUI Inc. SMI36-24-V-P5 power supply from their preferred vendor.

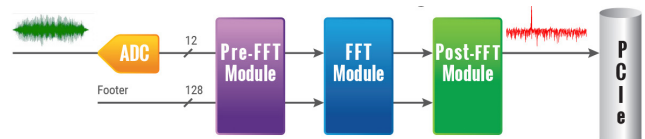
Limited quantities of the NEMA 5-15P power supply (for use in countries with type B outlets) are available at a reduced price (order number ATST3PS-001). Customers may opt to order this Pihong USA PSAC60M-240 power supply and AC30MNA power cord directly from their preferred vendor.

The following Pihong USA NEMA 5-15P power supplies have also been tested by AlazarTech: PPL65U-240 (65W) and PSAC30U-240L6 (30W).

The power supplies specified above have undergone testing at our factory and are the recommended power supplies for AlazarTech Thunderbolt 3 digitizers.

### Optional FPGA-Based FFT Processing

ATST364 On-FPGA FFT option provides the ability to do real-time FFT signal processing using the ATST364 on-board FPGA\*. Note that only one input can be processed.



Up to 4096-point FFT length is supported. A user programmable complex windowing function can be applied to the acquired data before FFT calculation.

The complex FFT output is converted to magnitude in single precision floating-point format. A logarithmic output is also available.

Based on customer feedback, output formats of on-FPGA FFT have been reduced to:

- 10 \* Log of amplitude<sup>2</sup>
- Square Root of amplitude<sup>2</sup>

These outputs provide more than sufficient image resolution in typical OCT applications. If other outputs, such as phase or multiple channel FFT, are required, ATS-GPU-OCT or ATS-GPU-NUFFT can be used.

It is also possible to DMA both frequency and time domain data. This allows users to verify FPGA-based FFT operation during algorithm development.

ATST364 can perform 200,000 4096-point FFTs per second.

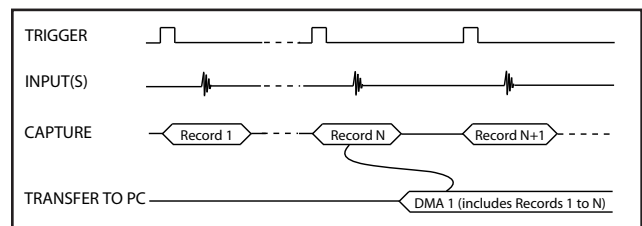
FPGA-based FFT is ideal for customers in the Optical Coherence Tomography (OCT) field.

\*Order part number ATST364-010 for optional FPGA Firmware. Firmware version 6.05 or later, and ATSApi library and driver version 7.9.1 or later are required. If ordered after digitizer delivery, customer will have to perform the firmware update. Furthermore, if the update is for an ATST364 that is no longer under warranty, AlazarTech requires that a series of tests be performed to validate that the digitizer is in working condition.

### 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 + 1) number of records (triggers) have been acquired and written to the on-board memory.

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.

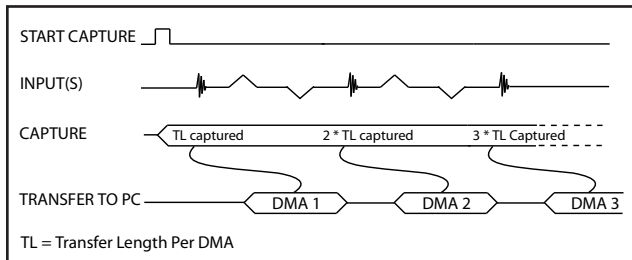
This is the recommended mode of operation for most ultrasonic scanning, OCT and medical imaging applications.

It should be noted that even though this mode is called “No Pre Trigger”, it is possible to do limited pre-trigger data captures, i.e. up to 8176 points in single channel mode and 4088 points in dual channel mode.

### 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 ATST364 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.

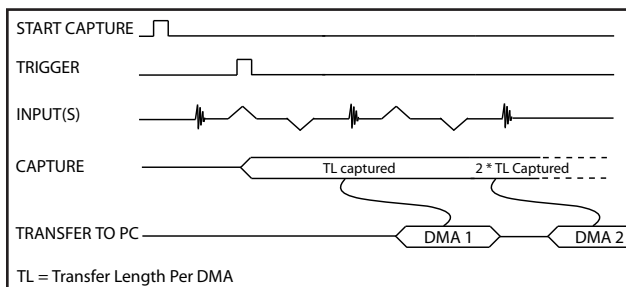


The amount of data to be captured is controlled by counting the number of buffers acquired. Acquisition is stopped by an AbortCapture command.

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.

### Multi-board Systems using ATS 4X1G

ATST364: Sync 4X1G is a device that allows simultaneous sampling across multiple independent ATST364 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, ATST364 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, ATST364 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  $(2^{n-1})$ .

### Data Packing Mode

By default, ATST364 stores 12-bit data acquired by its on-board A/D converters as a 16-bit integer. Users can also choose to pack the data as 12-bit integers or even 8-bit integers. Being able to reduce the total amount of data being transferred can be very useful in data recording applications.

Firmware version 7.x+ and driver version 7.x.x+ are required to take advantage of 8-bit data packing.

Note that it is the user application's responsibility to unpack the data. Also note that NPT Footers are not available in Data Packing Mode.

### Triggering

ATST364 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, ATST364 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

ATST364 external trigger input (TRIG IN) is a 3.3 V TTL input. External Trigger must be a 3.3 V TTL digital signal. Minimum pulse height requirement is 2.0 Volts. Input impedance of this input is 6.6 k $\Omega$ .

Analog signals and smaller amplitude digital signals will not be detected as trigger events.

User can select between rising edge and falling edge of this signal as the trigger event.

Note: If full 12-bit resolution is required, users should select CH A or CH B as the trigger source. When the External Trigger Input is used as the trigger source, the least significant bit (LSB) of each 12-bit sample is replaced by the state of the external trigger signal source.

### Timebase

ATST364 timebase can be controlled either by on-board low-jitter VCO or by optional External Clock.

On-board low-jitter VCO uses a 10 MHz TCXO as a reference clock.

### Optional External Clock

While the ATST364 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.

ATST364 External Clock option provides an SMA input for an external clock signal, which should have a high slew rate. Signal levels, specified in detail on page 10, must be respected.

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

There are two types of External Clock supported by ATST364:

#### Fast External Clock

A new sample is taken by the on-board ADCs for each rising 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 300 MHz and lower than 1 GHz.

For customers whose external clocks may go lower than 300 MHz during the acquisition, it is possible to have AlazarTech screen the ATST364 boards for external clock operation down to 100 MHz (Order number ATST364-006)

This is the ideal clocking scheme for OCT applications.

#### 10 MHz Reference Clock

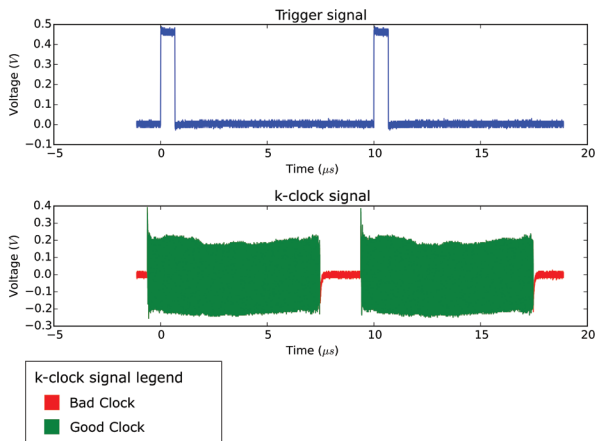
With the optional external clock upgrade, it is possible to generate the sampling clock based on an external 10 MHz reference input. This is useful for RF systems that use a common 10 MHz reference clock.

ATST364 uses an on-board low-jitter VCO to generate the 1 GHz, 500 MHz, or 400 MHz high-frequency clock used by the ADC. This 1 GHz, 500 MHz, or 400 MHz sampling rate can then be decimated by a factor of 1, 2, 4, 8 or any other integer value that is divisible by 8.

### OCT Ignore Bad Clock

The ADCs used on the ATST364 require the external clock frequency to be above 300 MHz and lower than 1 GHz. In OCT applications, these limits cannot always be respected due to the nature of the optical source.

AlazarTech's *OCT Ignore Bad Clock* technology allows safe operation with these out-of-specification clocks without requiring the use of a dummy clock in the source.



Users must set the trigger source to be External Trigger input (TRIG IN) when using OCT Ignore Bad Clock. The External Trigger must be set in TTL input range. If these two conditions are not met, the OCT Ignore Bad Clock circuitry will not function.

See [www.alazartech.com/en/technology/oct-ignore-bad-clock/](http://www.alazartech.com/en/technology/oct-ignore-bad-clock/) for more information on this technology.

### AUX Connector

ATST364 provides an AUX (Auxiliary) SMA connector that is configured as a Trigger Output connector by default.

When configured as a Trigger Output, AUX SMA connector outputs a 5 Volt TTL signal synchronous to the ATST364 Trigger signal, allowing users to synchronize their test systems to the ATST364 Trigger.

When combined with the Trigger Delay feature of the ATST364, this option is ideal for ultrasonic and other pulse-echo imaging applications.

AUX connector can also be used as a Trigger Enable Input for Frame Capture (B-scan) applications. In fact, this is the most popular use of AUX connector in OCT applications.

### Calibration

Every ATST364 digitizer is factory calibrated to NIST- or CNRC-traceable standards. To recalibrate an ATST364, 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*. If ordered after board shipment, use order number: *TestReport-AO*.

### On-Board Monitoring

Adding to the reliability offered by ATST364 are the on-board diagnostic circuits that constantly monitor over 20 different voltages, currents and temperatures. LED alarms are activated if any of the values surpass the limits.

### AlazarDSO Software

ATST364 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 ATST364 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 ATST364 and acquire data in user buffers.

The purchase of an ATS-SDK license includes a subscription that provides the following benefits for a period of 12 months from the date of purchase:

- Download ATS-SDK updates from the AlazarTech website;
- Receive technical support on ATS-SDK.

Customers who want to receive technical support and download new releases beyond this 12 month period should purchase extended support and 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 ATST364 to a GPU card at rates up to 2.6 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 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.

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 970,000 FFTs per second when capturing data in single-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 wave-length 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 ATST364 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/atst364/682/](http://www.alazartech.com/en/linux-drivers/atst364/682/)

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 ATST364-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.



# ATST364

## 1 GS/s 12-Bit Thunderbolt 3 Digitizer

### Accessories for Out-of-Warranty Products

Accessories, such as the DC power supply, 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 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 repair charge.

### Extended Warranty

The purchase of an ATST364 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 ATST364-061). This must 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/](http://www.alazartech.com/en/my-account/my-products/).

### Export Control Classification

According to the *Export Controls Division of the Government of Canada*, ATST364 is currently not controlled for export from Canada. Its export control classification is N8, which is equivalent to ECCN EAR99. ATST364 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 ATST364, 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

ATST364 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

ATST364 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.

Electromagnetic Immunity:  
EN 55035:2017/A11:2020:  
Multimedia Equipment (MME) Immunity characteristics. Limits and methods of measurement:  
EN 61000-4-2:2009, EN 61000-4-4:2012, EN 61000-4-5:2006, EN 61000-4-6:2009, EN 61000-4-11:2004.





# ATST364

## 1 GS/s 12-Bit Thunderbolt 3 Digitizer

### Safety:

IEC 62368-1:2018 / EN 62368-1:2020+A11:2020:  
Audio/video, information and communication technology equipment - Part 1: Safety requirements.

ATST364 also follows the provisions of the following directives: 2014/35/EU (Low Voltage Equipment); 2014/30/EU (Electromagnetic Compatibility).

### FCC & ICES-003 Compliance

ATST364 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

ATST364 (with enclosure)	ATST364-001
ATST364-OEM (without enclosure)	ATST364-101
ATST364: External Clock Upgrade	ATST364-005
ATST364: Screened External Clock Upg.	ATST364-006
ATST364: Wideband Input Upgrade	ATST364-009
ATST364: On-FPGA FFT	ATST364-010
ATST364: One Year Extended Warranty	ATST364-061
ATSTxxx: Power Supply & Cable (NEMA 5-15P)	ATST3PS-001
ATSTxxx: AC-DC Power Supply (International)	ATST3PS-002
Test reports ordered with board	TestReport
Test reports ordered after board shipment	TestReport-AO
ATST364: Sync 4X1G	ATST364-025
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

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# ATST364 1 GS/s 12-Bit Thunderbolt 3 Digitizer

## 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), 16 GB RAM; if using AlazarDSO, 16 GB of free hard disk space is also required.

## Power Requirements

Input voltage: +20 V to +24 V  
Voltage ripple: 240 mV<sub>p-p</sub>, max  
Current consumption: 1.2 A at 24 Vdc 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: 687 g  
OEM version: 252 g

## I/O Connectors

ECLK, CH A, CH B,  
TRIG IN, AUX I/O 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  
Bandwidth (-3 dB)  
DC-coupled, 50 Ω Standard DC - 500 MHz  
With wideband option, the bandwidth increases to DC - 1GHz  
Number of channels 2, simultaneously sampled  
Maximum Sample Rate 1 GS/s single shot  
Minimum Sample Rate 1 MS/s single shot for internal clocking  
Full Scale Input ranges  
50 Ω input impedance: ±400 mV  
DC accuracy ±2% of full scale in all ranges  
Input coupling DC  
Input impedance 50 Ω ±1%  
Absolute maximum input  
50 Ω ±4 V (DC + peak AC for CH A, CH B and TRIG IN only without external attenuation)

## Acquisition Memory System

Acquisition Memory/ch 512 Million samples per channel  
Record Length Software-selectable with 128-point resolution. Record length must be a minimum of 512 points. There is no upper limit on the maximum record length.  
Number of Records Software selectable from a minimum of 1 to a maximum of infinite number of records  
Pre-trigger depth From 0 to 8176 for single channel  
From 0 to 4088 for dual channel  
Post-trigger depth Record Length - Pre-Trigger Depth

## Timebase System

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

## Dynamic Parameters

Typical values measured on the 400 mV range of CH A of a randomly selected ATST364. Input signal was provided by an SRS SG384 signal generator, followed by a 9-pole bandpass filter. Output amplitude was set to approximately 95% of the full scale input.

	50MHz at -0.5 dBFS <sup>1</sup>	100MHz at -0.5 dBFS <sup>2</sup>	200MHz at -0.5 dBFS <sup>3</sup>
<b>SNR</b>	57.25 dB	59.50 dB	56.62 dB
<b>SFDR</b>	59.65 dBc	59.03 dBc	57.40 dBc
<b>SINAD</b>	57.01 dB	57.25 dB	56.35 dB

<sup>1</sup>Bandpass filter Q36T-50M-5M-50-720BMF; 49.9 MHz frequency

<sup>2</sup>Bandpass filter Q36T-100M-10M-50-720BMF; 99.9 MHz frequency

<sup>3</sup>Bandpass filter Q36T-200M-20M-50-720BMF; 199.9 MHz frequency

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 500 mV<sub>p-p</sub> to 2 V<sub>p-p</sub>  
Input impedance 50 Ω  
Input coupling AC  
Maximum frequency for Fast External Clock 1 GHz  
Minimum frequency for Fast External Clock 300 MHz  
100 MHz for Screened ECLK boards  
Sampling Edge Rising only

## Optional 10 MHz Reference PLL Input

Signal Level 500 mV<sub>p-p</sub> to 2 V<sub>p-p</sub>  
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. 1 GHz, 500 MHz, or 400 MHz



# ATST364 1 GS/s 12-Bit Thunderbolt 3 Digitizer

## 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	250 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	3.3 V TTL
Input coupling	DC only
TTL input impedance	6.6 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. Divide-by-4 clock (dual channel mode) or divide-by-8 clock (single channel mode)
Input	
Amplitude:	3.3 Volt TTL (5 Volt-compliant)
Input coupling	DC only

## Materials Supplied

For ATST364 (ATST364-001):  
 ATST364 Thunderbolt 3 Digitizer card in enclosure  
 ATSTxxx 0.7m Thunderbolt 3 passive 1x screw lock cable  
 ATST364 Install Disk on USB flash drive

For ATST364-OEM (ATST364-101):  
 ATST364 Thunderbolt 3 Digitizer card  
 ATSTxxx 0.7m Thunderbolt 3 passive 1x screw lock cable  
 ATST364 Drivers & user manual as downloadable content

## 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:**  
**Alazar Technologies, Inc.**  
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### DATASHEET REVISION HISTORY

#### Changes from version 1.1D (Feb 2024) to version 1.1E Section, Page

Added new Optional Wideband Input Upgrade	Global change
Corrected typo on bandwidth and added details on Wideband Input Upgrade	Analog Input, pg. 2
Added section	Optional Wideband Input Upgrade, pg. 2
Added new power supply with international blades	Recommended AC-DC Power Supply, pg. 3
Added section	Test Reports, pg. 6
Added order numbers: ATS9364-009, ATST3PS-002, TestReport, TestReport-AO	Ordering Information, pg. 9
Updated system requirements	System Requirements, pg. 10

#### Changes from version 1.1C (Dec 2023) to version 1.1D Section, Page

Added section on ATST364: Sync 4X1G	Multi-board Systems using ATS 4X1G, pg. 4
Modified warranty reinstatement fee information	Extended Warranty, pg. 8
Specified that Operating temperature is ambient	Environmental, pg. 9
Added Sync 4X1G, its accessories and extended warranty: ATST364-025, SYNC-X1G-PWR, SYNC-4X1-CBL, SYNC-4X1-061	Ordering Information, pg. 10

#### Changes from version 1.1B (Aug 2023) to version 1.1C Section, Page

Updated ATST364 product photo	Global change
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 note about firmware and driver version required for 8-bit data packing	Data Packing Mode, pg. 4
sAdded note about trigger source	OCT Ignore Bad Clock, pg. 5
Modified to include new warranty reinstatement policy	Extended Warranty, pg. 7
Removed 800 MS/s from Internal Sample Rates	Timebase System, pg. 9
Trigger Engine Source: Corrected label for External Trigger from EXT to TRIG IN	Triggering System, pg. 10

#### Changes from version 1.1A (Nov 2022) to version 1.1B Section, Page

Added two additional models of tested power supplies Corrected power supply order number Added note about the power supply's type B (NEMA 5-15P) plug	Recommended AC-DC Power Supply, pg. 3
Added section for new upgrade: On-FPGA FFT	Optional FPGA-Based FFT Processing, pg. 3
Added new Boxcar averaging example kernel available with ATS-GPU-BASE 23.1.0+	ATS-GPU, pg. 6
Added section for REACH Compliance	REACH Compliance, pg. 8
Added section for EC Conformity	EC Conformity, pg. 8
Added section for FCC & ICES-003 Compliance	FCC & ICES-003 Compliance, pg. 8
Corrected input voltage and current consumption	Power Requirements, pg. 9
Corrected minimum record length from 256 to 512 points	Acquisition Memory System, pg. 9
Added Certification and Compliances section	Certification and Compliances, pg. 10
Added order information for new upgrade: On-FPGA FFT	Ordering Information, pg. 10

#### Changes from version 1.1 (Nov 2022) to version 1.1A Section, Page

Corrected cable length and added details for 25m optical cable	Recommended Thunderbolt 3 Cables, pg. 2
Added paragraph on the need to exclude the AC-DC power supply	Recommended AC-DC Power Supply, pg. 3
Added download link for Linux drivers	Linux Support, pg. 6
Included dimensions and weight of both the enclosed version and OEM version	Physical, pg. 8
Corrected typo in model number for installation disk	Materials Supplied, pg. 9
Corrected power supply order number to: ATST3PS-001	Ordering Information, pg. 9
Updated Trademarks list	pg. 9