ATS9628 User Manual

16-Bit, 2 Channel, 250 MS/s
Waveform Digitizer for PCI Express Gen 2 Bus

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Information required when contacting AlazarTech for technical support:

Owned by:

Serial Number:

Purchase Date:

Purchased From:

Software Driver Version:

SDK Version:

ATS-GPU Version:

AlazarDSO Version:

Operating System:

Important Information

Warranty

The AlazarTech ATS®9628 is warranted against defects in materials and workmanship for a period of one year from the date of shipment, as evidenced by receipts or other documentation. Alazar Technologies Inc. (hereafter "AlazarTech") will, at its option, repair or replace equipment that proves to be defective during the warranty period. This warranty includes parts and labor.

The media on which you receive AlazarTech software are warranted not to fail to execute programming instructions, due to defects in materials and workmanship, for a period of 90 days from date of shipment, as evidenced by receipts or other documentation. AlazarTech will, at its option, repair or replace software media that do not execute programming instructions if AlazarTech receives notice of such defects during the warranty period. AlazarTech does not warrant that the operation of the software shall be uninterrupted or error free.

A Return Material Authorization (RMA) number must be obtained from the factory and clearly marked on the outside of the package before any equipment will be accepted for warranty work. AlazarTech will pay the shipping costs of returning to the owner parts that are covered by warranty.

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Compliance

FCC/Canadian Interference-Causing Equipment Standard (ICES-003) Compliance*

Determining FCC Class

The Federal Communications Commission (FCC) has rules to protect wireless communications from interference. The FCC places digital electronics into two classes. These classes are known as Class A (for use in industrial-commercial locations only) or Class B (for use in residential or commercial locations). Depending on where it is operated, this product could be subject to restrictions in the FCC rules. (In Canada, the department of Innovation, Science and Economic Development (ISED), regulates wireless interference in much the same way.)

Digital electronics emit weak signals during normal operation that can affect radio, television, or other wireless products. By examining the product you purchased, you can determine the FCC Class and therefore which of the two FCC/ISED Warnings apply in the following sections. (Some products may not be labeled at all for FCC; if so, the reader should then assume these are Class A devices).

FCC Class A products only display a simple warning statement of one paragraph in length regarding interference and undesired operation. Most of our products are FCC Class A. The FCC rules have restrictions regarding the locations where FCC Class A products can be operated.

FCC Class B products display either an FCC ID code, starting with the letters **EXN**, or the FCC Class B compliance mark.

Consult the FCC website https://www.fcc.gov/ for more information.

FCC/ISED Warnings

This equipment generates and uses radio frequency energy and, if not installed and used in strict accordance with the instructions in this manual and the CE Mark Declaration of Conformity**, may cause interference to radio and television reception. Classification requirements are the same for the Federal Communications Commission (FCC) and Innovation, Science and Economic Development (ISED) Canada.

Changes or modifications not expressly approved by AlazarTech Inc. could void the user's authority to operate the equipment under the FCC/ISED Rules.

Class A

Federal Communications Commission

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Innovation, Science and Economic Development Canada

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Standard (ICES-003). Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

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Compliance to EU Directives

Readers in the European Union (EU) must refer to the Manufacturer's Declaration of Conformity (DoC) for information** pertaining to the CE Mark compliance scheme. The Manufacturer includes a DoC for most every hardware product except for those bought for OEMs, if also available from an original manufacturer that also markets in the EU, or where compliance is not required as for electrically benign apparatus or cables.

To obtain the DoC for this product, click **Compliance and Conformity** at www.alazartech.com/en/downloads/. This web page lists all DoCs by product family. Select the appropriate product to download or read the DoC.

* Certain exemptions may apply in the USA, see FCC Rules §15.103 **Exempted devices**, and §15.105(c). Also available in sections of CFR 47.

** The CE Mark Declaration of Conformity will contain important supplementary information and instructions for the user or installer.

Environmental Compliance

Alazar Technologies Inc., hereby certifies that this product is 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 has been done using RoHS-compliant components and lead-free soldering.

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.

REACH Compliance

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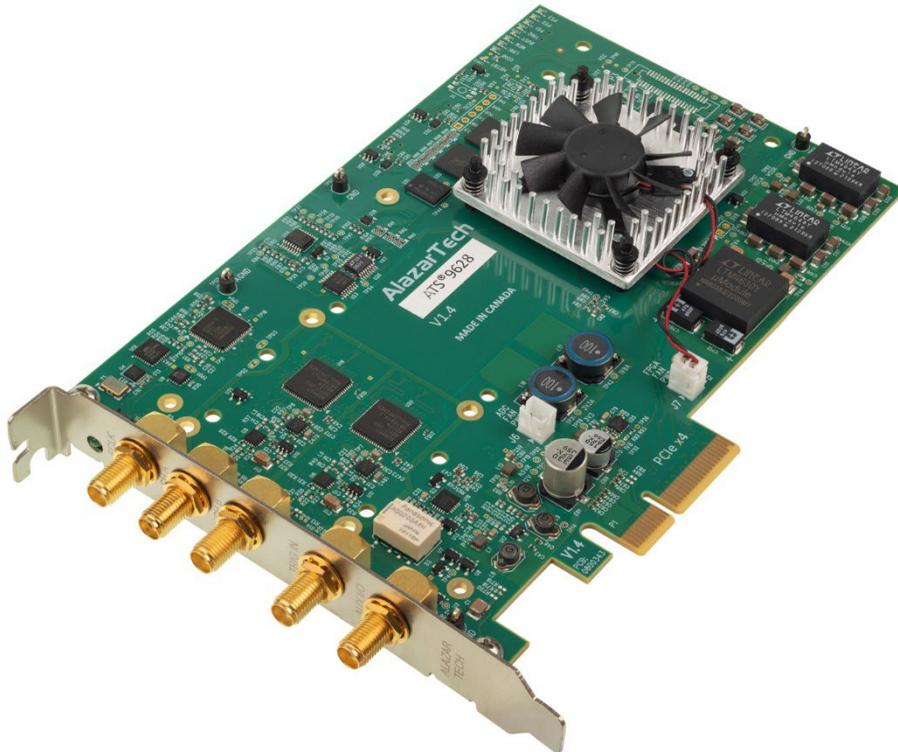
Table of Contents

Change Log

This is the first edition of this manual.

Chapter 1: Introduction

This chapter describes the ATS9628 and lists additional equipment.

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About Your ATS9628

Thank you for your purchase of an ATS9628. This PCI Express (PCIe Gen 2 x4) based waveform digitizer has the following features:

- Two 16-bit resolution analog input channels

- Real-time sampling rate of 250 MS/s to 1 MS/s with internal clock and 250 MS/s to 50 MS/s with external clock

- On-board acquisition memory buffer of 256 Megasamples per channel

- Streaming of acquired data to PC host memory at 1.6 GB/s (exact rate is motherboard dependent)

- DC-120 MHz analog input bandwidth

- Variable frequency external clock (250 MHz to 50 MHz) and 10 MHz Reference Clock included

- Synchronous sampling across multiple ATS9628 boards with optional ATS Sync 4X1G (also coming soon: ATS Sync 8X1G)

- Half-length PCI Express (4-lane) card

- Analog external trigger channel with software-selectable level and slope

- Fixed DC coupling and fixed 50 Ω input impedance

- Pre-trigger and Post-Trigger Capture with Multiple Record capability

- NIST- or CNRC-traceable calibration

- Custom DMA engines for best latency protection against Windows® and Linux® operating systems

- Fully asynchronous software driver for fastest DMA with least CPU overhead

All ATS9628 digitizers follow industry-standard Plug and Play specifications on all platforms and offer seamless integration with compliant systems.

Detailed specifications of the ATS9628 digitizers are listed in *Appendix A - Specifications*.

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ATS9628 Export Control Classification

According to the latest Export and Brokering Controls Handbook, amended in August 2019, ATS9628 is classified by Export Controls Division of Global Affairs Canada as a controlled product under ECL 1-3.A.2.h, which is equivalent to ECCN 3A002.h.

For sales where the ultimate country destination is Canada or U.S., no export permit is required unless the end-use of ATS9628, in part or in its entirety, is related to the development or deployment of weapons of mass destruction.

For shipments to eligible destinations, AlazarTech is allowed to export under a general export permit, unless the end-use of ATS9628, in part or in its entirety, is related to the development or deployment of weapons of mass destruction. For general export permit shipments, users must provide a signed export compliance statement (ECS) that includes a detailed description of the end-use. Shipments cannot be made without a signed ECS on file.

For all other countries, and for all cases where the end-use of ATS9628, in part or in its entirety, is related to the development or deployment of weapons of mass destruction, an export permit is required, which will require extensive details on the end-use and end-users. This process may cause significant delays.

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Acquiring Data with Your ATS9628

You can acquire data either programmatically by writing an application for your ATS9628 or interactively with the AlazarDSO software for Windows or with AlazarFrontPanel for Linux.

Note that AlazarFrontPanel has a limited feature set.

If you want to integrate the ATS9628 in your test and measurement or embedded OEM application, you can program the digitizer using C/C++, Python, MATLAB® or LabVIEW® under Windows, or C/C++ or Python under Linux operating systems.

➢ Windows operating systems supported are 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 for Windows 8.1 and Windows Server 2012 R2 ended in 2018. 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 because 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.

➢ AlazarTech offers ATS9628 Dynamic Kernel Module Support (DKMS) drivers for the following Linux distributions: Ubuntu, Debian, and RHEL®. Only 64-bit Linux operating systems are supported.

Users can download the DKMS driver for their specific distribution by choosing from the available drivers here:
https://www.alazartech.com/en/linux-drivers/ats9628/642/

AlazarTech DKMS drivers may work for Linux distributions other than RHEL, Debian, and Ubuntu, but they have not been tested and technical support may be limited.
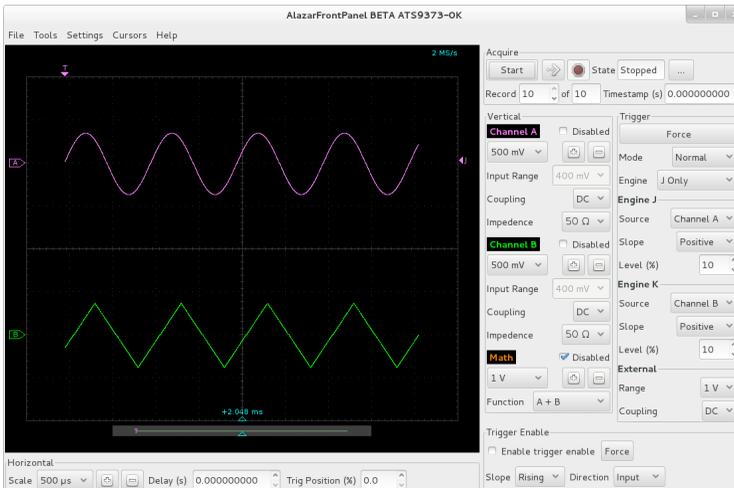
For using a programming language to acquire data from your ATS9628, you must purchase the ATS-SDK package.

Interactively Controlling your ATS9628

The AlazarDSO oscilloscope emulation software for Windows allows you to interactively control your ATS9628 as you would a desktop oscilloscope.
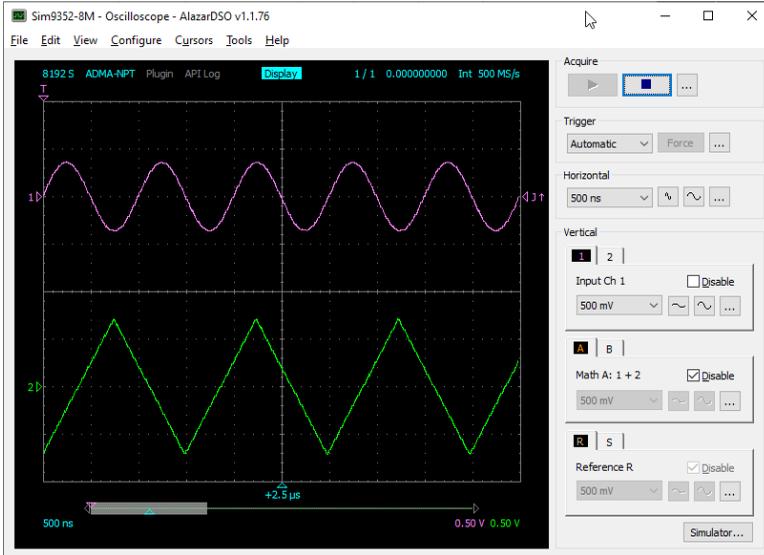
Under Linux, the AlazarFrontPanel application is available.

Note that Alazar Front Panel has a limited feature set.

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ATS-SDK API

The ATS-SDK API is used for programming the ATS9628 in C/C++, C#, LabVIEW, MATLAB and Python. It provides the exact same API that is used for writing AlazarDSO software. To help you get started, ATS-SDK comes with examples that you can use or modify.

The ATS-SDK for Windows 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 header files for C/C++ programming and library wrappers for Python, as well as code samples that demonstrate typical acquisition configurations.

ATS-GPU

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. The ATS-GPU library provides a framework to allow real-time processing of data from AlazarTech PCIe digitizers on a CUDA®-enabled GPU.

To help you get started, **ATS-GPU-BASE** comes with an example of a user application that performs very simple signal processing (data inversion). 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. This signal processing module can lead to a major improvement of signal-to-noise ratio without using CPU resources and without doing FPGA programming.

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

ATS-GPU-NUFFT is an extension of ATS-GPU-OCT that allows non-uniform FFTs to be performed on data acquired uniformly in time domain using a fixed sampling rate. For SS-OCTs where the wavelength does not vary linearly in time, a fixed sampling rate results in data that is non-uniformly distributed in frequency domain. ATS-GPU-NUFFT allows linearized FFTs to be performed on such data. The non-uniform FFT requires a linearization function that describes how the wavelength of the SS-laser evolves during a sweep of the spectrum. Linearization function can either be user defined or measured directly from a k-clock signal.

Optional Upgrades and Accessories

AlazarTech offers the following upgrades and accessories for use with your ATS9628 digitizer:

- ATS9628: One Year Extended Warranty

- ATS9628: ±200mV Input Range Upgrade

- AlazarTech ATS Sync 4X1G (for simultaneous sampling across multiple independent AlazarTech waveform digitizers)

Chapter 2:
Installation and Configuration

This chapter describes how to unpack, install, and configure your ATS9628.

What You Need to Get Started

To set up and use your ATS9628, you will need the following:

- One or more ATS9628 digitizers

- ATS9628 Installation Software downloaded software from
  https://www.alazartech.com/en/product/ats9628/642/

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Unpacking

Your digitizer is shipped in an antistatic clamshell package to prevent electrostatic damage to the digitizer. Electrostatic discharge can damage several components on the digitizer. To avoid such damage in handling the digitizer, take the following precautions:

- Ground yourself via a grounding strap or by holding a grounded object.

- Touch the antistatic package to a metal part of your computer chassis before removing the digitizer from the package.

- Remove the digitizer from the package and inspect the digitizer for loose components or any other sign of damage. Notify AlazarTech if the digitizer appears damaged in any way. Do *not* install a damaged digitizer into your computer.

- *Never* touch the exposed pins of the connectors.

Please note:

Effective January 1, 2025, AlazarTech products no longer ship with USB flash drives.

Refer to the PCN for more information.

Note: You may wish to take note of your product serial number before installation. The serial number is located on a white label on the back of your digitizer. You are also able to obtain your serial number in software.

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Installing the ATS9628 in Windows

Linux users: skip to *Installing the ATS9628 in a Linux System*

There are three main steps involved in the installation on a Windows computer:

1. Physically install the digitizer(s) in your computer.

2. Install ATS9628 software driver, ATSApi Library, and AlazarDSO software that allows you to setup the hardware, acquire signals and view and archive them. There are several ways to do this:

    2 a) Install using Alazar Package Manager and AlazarTech's Storage **(recommended)** or,

    2 b) Install using Alazar Package Manager and a local repository or,

    2 c) Install using downloaded files.

3. Optionally, install:

    3 a) The ATS-SDK software development kit, which enables you to programmatically control the ATS9628

    3 b) The ATS-GPU library, which enables you to perform real-time processing of data from the ATS9628 on a CUDA-compatible GPU

The following paragraphs will guide you through this process in a step-by-step manner.

1. Physically install the digitizer in your computer

Identify an unused PCI Express slot on your motherboard. As per PCI Express specification, the 4-lane ATS9628 card is compatible with any 4-lane, 8-lane or 16-lane connector on the motherboard. Make sure that your computer is powered off before you attempt to insert the ATS9628 digitizer in one of the free PCI Express slots. For best noise performance, leave as much room as possible between your ATS9628 and other hardware. Always screw the digitizer bracket to the chassis in order to create a stable and robust connection to chassis ground. In the absence of such a connection, ATS9628 is not guaranteed to operate within the specifications listed elsewhere in this manual.

⚠ Some motherboards may have a 16-lane connector, but only one or four of the lanes is connected to the motherboard chipset. Motherboard manufacturers refer to this as "Mechanically 16-lane, electrically 1 lane". ATS9628 is fully compatible with such motherboards, but the data throughput across PCI Express bus will be limited by the number of lanes.

⚠ Please note that the PCI Express Revision must be supported by both your motherboard and your CPU model. For example, the ASRock X79Extreme11 motherboard supports PCIe Gen 3, but the Intel i7-3820 CPU only supports PCIe Gen 2. A system made of these two components will only support PCIe Gen 2.

2. Install ATS9628 software driver, ATSApi Library and AlazarDSO software that allows you to set up the hardware, acquire signals and view and archive them.

The following instructions guide you through the process of installing the ATS9628 software driver, ATSApi Library and AlazarDSO software in a computer running Windows 11, Windows 10, Windows Server 2019, or Windows Server 2016 operating systems.

Note that most of the images of the dialog boxes shown below were taken from a Windows 10 computer. Computers running other versions of Windows may have slightly different dialog boxes.

The Alazar Package Manager (APM) software tool provides an easy user-friendly interface that uses AlazarTech's cloud storage to allow the user to quickly install, update or remove different versions of AlazarDSO, ATSAPI and ATS Drivers.

When you first boot up the computer, the plug-n-play Windows operating system will detect the presence of a new PCI card and will attempt to install the device driver if found on the computer.

If the ATS9628 device driver is not found, Windows will display the following dialog box. Click **Close**.
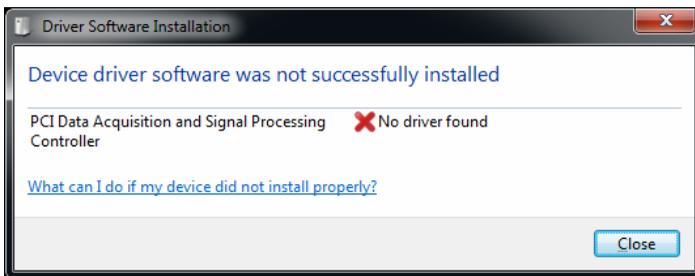

2.a)   Install using Alazar Package Manager and AlazarTech's Storage.

Install Alazar Package Manager for Windows by downloading the installation file from the AlazarTech website:

- Download Alazar Package Manager installation file from www.alazartech.com/apm
- Open the .ZIP archive file downloaded in the previous step.
- Run the *alazarpackagemanagerforwindowsxxx.exe* executable file and follow the on-screen instructions.

I. The Alazar Package Manager Setup screen will appear, click on **Next**.
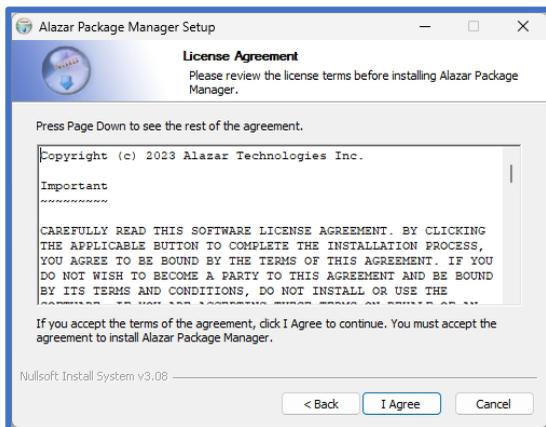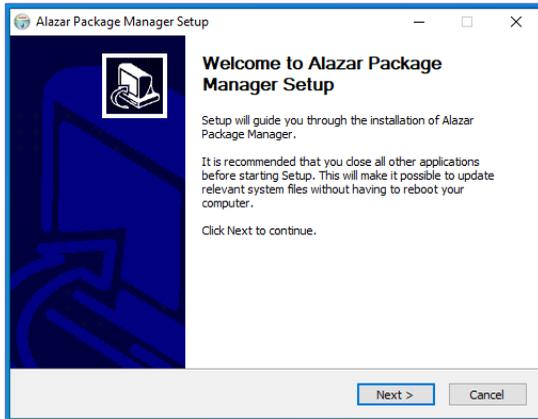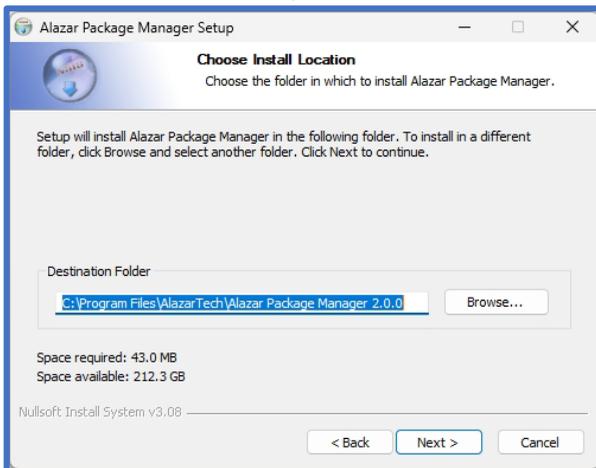

II. Carefully read the software license agreement and click on **I Agree** to proceed.

III. The next screen will be the Install Options screen. The create APM desktop icon option is checked by default. Click on **Next** to proceed.

IV. On this screen select the destination folder in which you wish to install APM then click on **Next** to proceed.

V. If you wish to place APM in a pre-existing start menu folder, you can do so on this screen otherwise, a new Alazar Package Manager folder will be created. Click on **Install** to proceed.
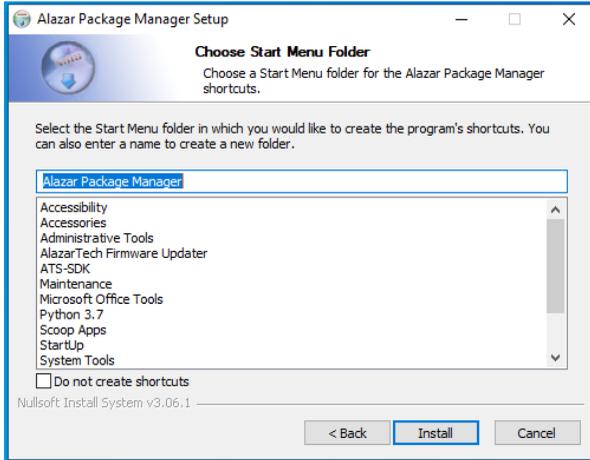
VI. Congratulations, this screen confirms that you have successfully installed Alazar Package Manager (APM). Click on **Finish** to exit the setup prompt.
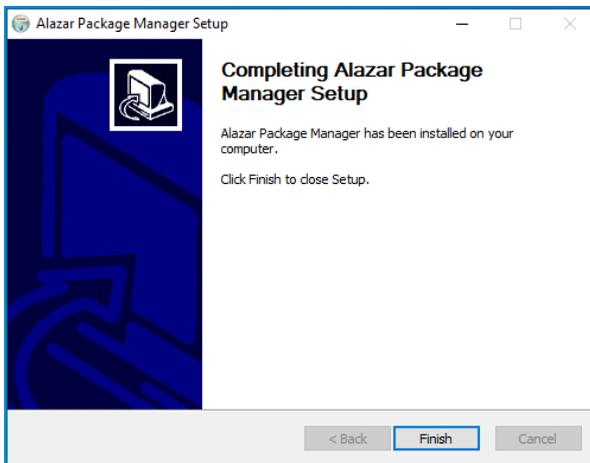
VII. After installing Alazar Package Manager (APM), run the application by clicking on the APM icon on your desktop or by browsing to the installation directory chosen during installation. The following window will be displayed.
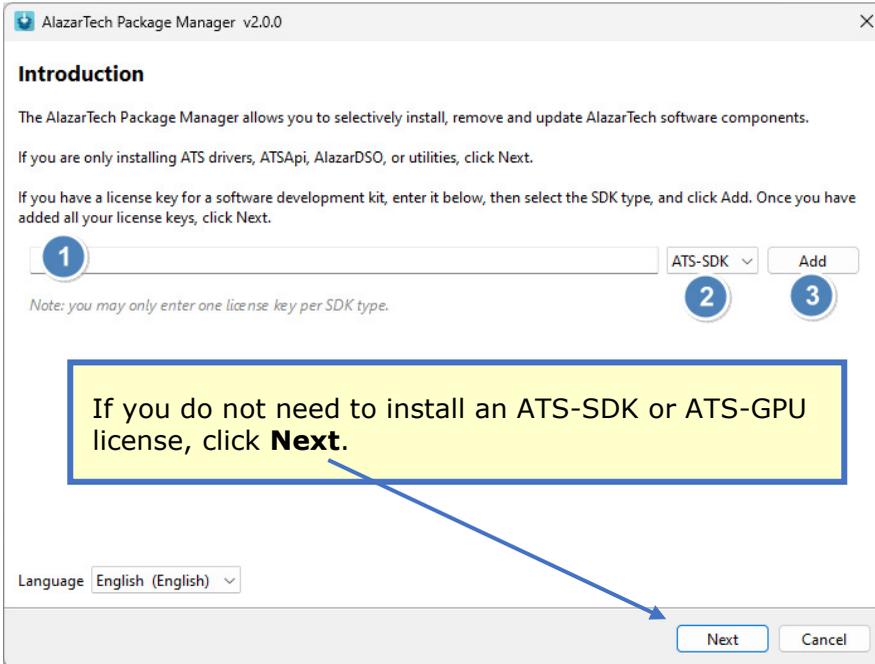
If you have purchased an optional SDK license, make sure to use APM version 2.0 and higher as it is required for SDK installation:

1 Enter your license key[1].

2 Select the SDK type (e.g. ATS-SDK or ATS-GPU) from the pull-down menu.

3 Click Add.

4 Repeat steps 2 and 3 if you have more than one type of SDK to install, then click **Next**.

[1] SDK license keys are provided via an eDelivery email at time of purchase. Starting November 2023, AlazarTech implemented license keys for licensed software. If your SDK is under maintenance and you do not have a license key, please follow the steps shown here https://www.alazartech.com/en/support/faq/?faq=1074 or contact sales@alazartech.com with your invoice or your SDK serial number.

VIII.   At this point, APM will prompt you to select a repository to fetch and install the desired software. There are two possible selections available depending on whether the computer in which you wish to install the software has access to an internet connection. The following instructions will guide you through installing the software if your computer is connected to the internet.

Note: you **must** use *AlazarTech's Storage* if you are installing an SDK.

If you are installing the software by using a local repository, skip to *Install using Alazar Package Manager and Local Repository.*
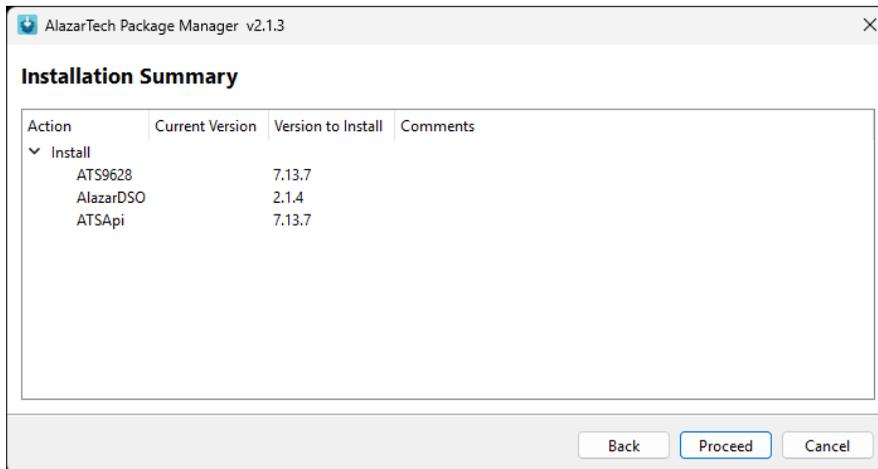
Select the recommended option: **AlazarTech's Storage**.

Click **Next**.

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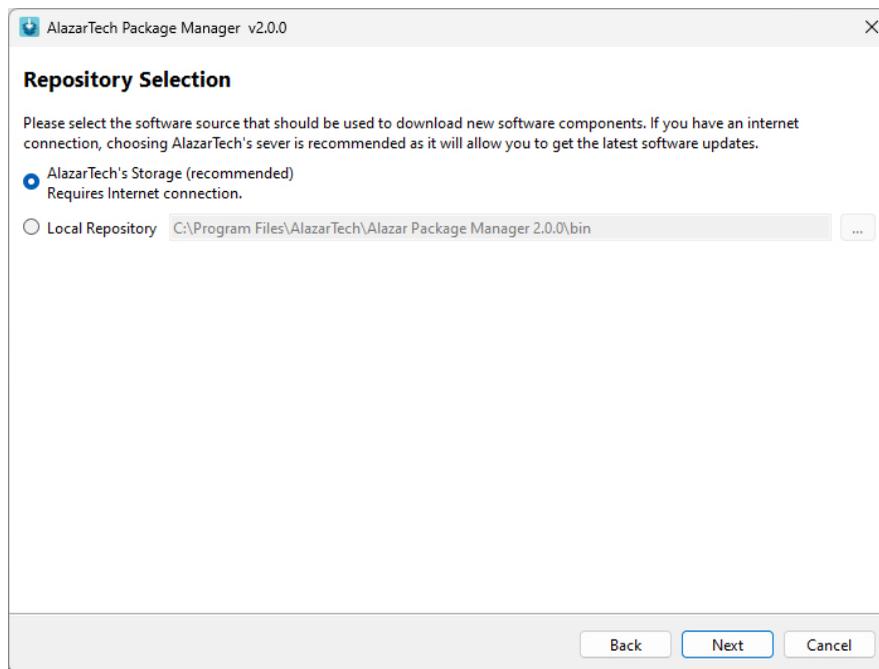
IX. On the **Component Selection** screen, expand the list of **Drivers for installed hardware**, then select the latest available version of AlazarDSO, ATSApi and ATS9628 driver.
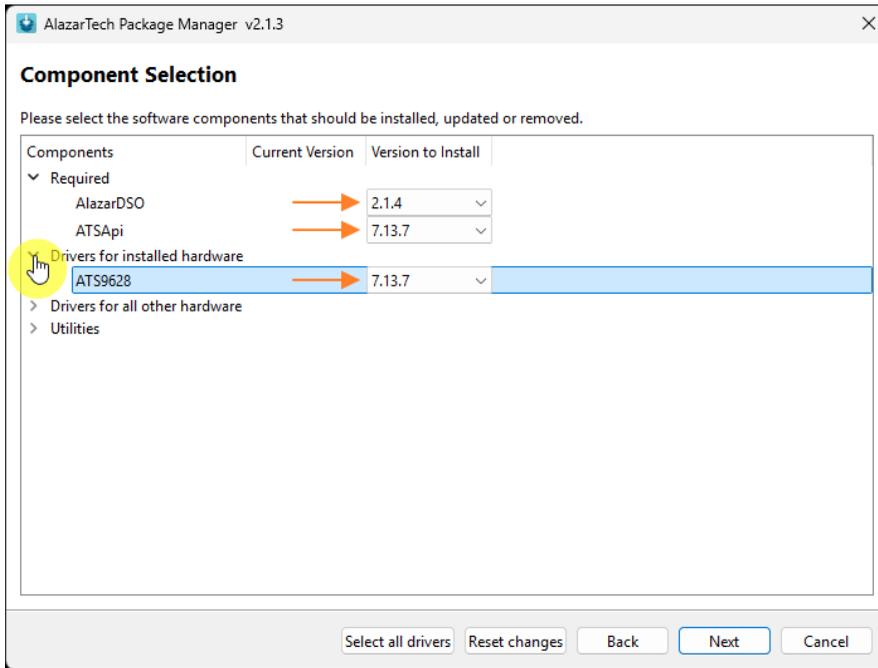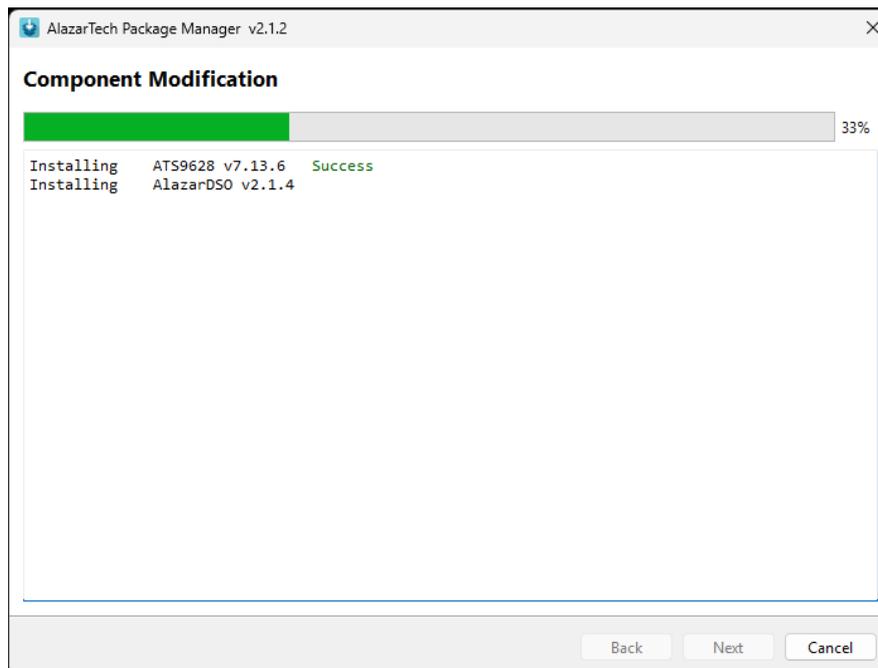

Click **Next.**

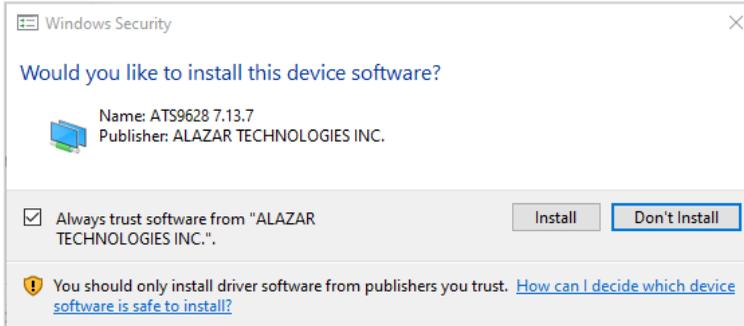X.   An installation summary will be provided.

Confirm the details of the installation and click **Proceed.**

XI.   Alazar Package Manager will install the selected software.

Depending on the settings of your Windows user account, you may see a **Windows Security** screen. Press **install**, after optionally checking *Always trust software from Alazar Technologies Inc.*

XII. After the installation is complete, Alazar Package Manager will report the changes applied.
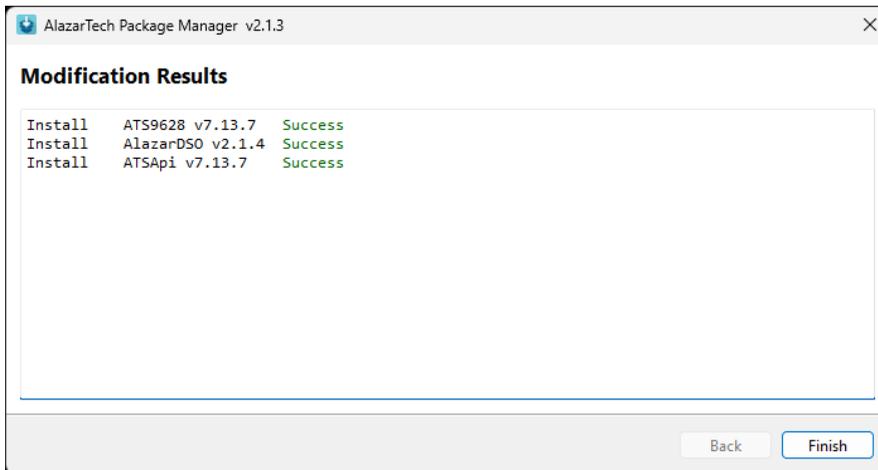
Congratulations! You have now installed your ATS product driver, AlazarDSO, ATSApi library, and SDKs (if purchased) and are now ready to start your acquisition.

AlazarTech

2.b) Install using Alazar Package Manager and Local Repository.

You can create an Alazar Package Manager local repository by saving ATS product driver(s), and AlazarDSO on a USB drive to install them on a computer that does not have internet access.

To create a local repository, you must download ATS product driver(s), and AlazarDSO from the **Software Downloads** section at www.alazartech.com/en/downloads/. You must also download Alazar Package Manager if it is not already installed.

The installation steps will be almost the same as section 2 a), except for VIII, where you would change the Local Repository by clicking on the ellipsis and navigating to your local repository:
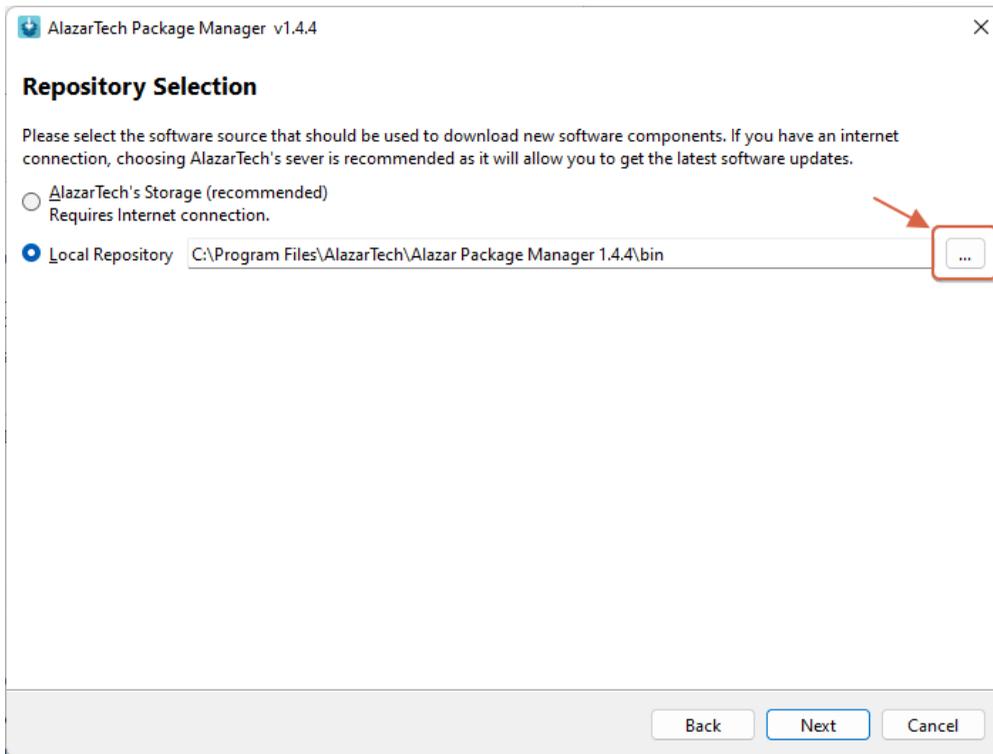
This method is useful if you also wish to install AlazarDSO and/or other AlazarTech Windows drivers because Alazar Package Manager will install everything in one step.

2.c) Install using installation files downloaded from alazartech.com.

The recommended method of installing AlazarTech ATS digitizer Windows drivers and AlazarDSO is **Alazar Package Manager**. It provides a user-friendly interface that uses AlazarTech's cloud storage to allow the user to quickly install, update, or remove different versions of AlazarDSO, ATSApi and AlazarTech ATS Drivers.

If you prefer to install AlazarTech ATS drivers and AlazarDSO downloaded from the AlazarTech website (without using *Alazar Package Manager*):

- Download AlazarTech ATS driver and AlazarDSO installation files from www.alazartech.com/en/downloads/
- Run the downloaded AlazarTech ATS driver .exe file and follow the on-screen prompts.

Double-click on the downloaded AlazarDSO ZIP file, run the AlazarDSO-x.x.x-win64.exe file, and follow the on-screen prompts.

3. Optionally, install the ATS-SDK and ATS-GPU software

If you have purchased an optional SDK license, ATS-SDK and ATS-GPU are delivered electronically. You should have received an email with serial number(s), download link, and the software license key(s)[1] required for installation.

The download link is for the latest version of Alazar Package Manager, which is the new installer for ATS-SDK and ATS-GPU.

I. First, install and launch Alazar Package Manager (<u>Detailed steps shown here</u>). On the **Introduction** screen,
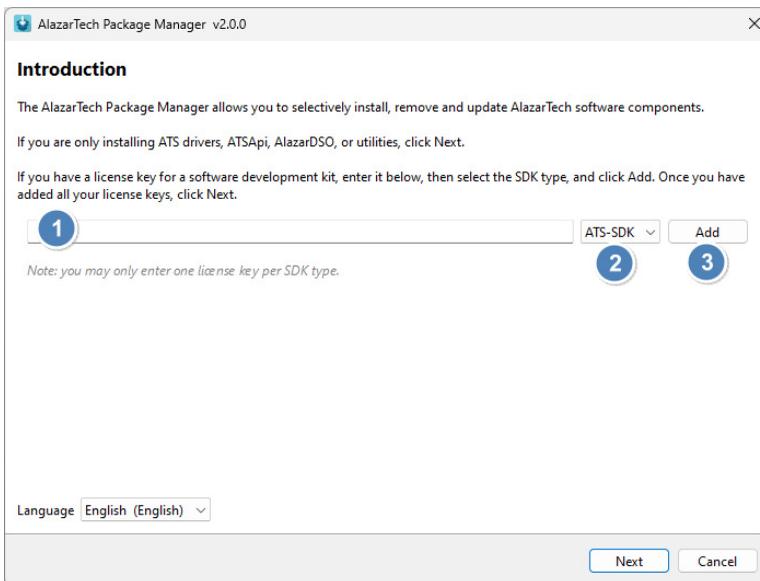
1. Enter your license key[1].

2. Select the SDK type (e.g. ATS-SDK or ATS-GPU) from the pull-down menu.

3. Click **Add**.

4. Repeat steps 2 and 3 if you have more than one type of SDK to install, then click **Next**.

---

[1] Starting November 2023, AlazarTech implemented license keys for licensed software. If your SDK is under maintenance and you do not have a license key, please follow the steps shown here <u>https://www.alazartech.com/en/support/faq/?faq=1074</u> or contact <u>sales@alazartech.com</u> with your invoice or your SDK serial number.

II.   At this point, APM will prompt you to select a repository to fetch and install your SDKs. You **must** use *AlazarTech's Storage* for installing any SDK.

Select the recommended option: **AlazarTech's Storage**.

Click **Next.**

AlazarTech
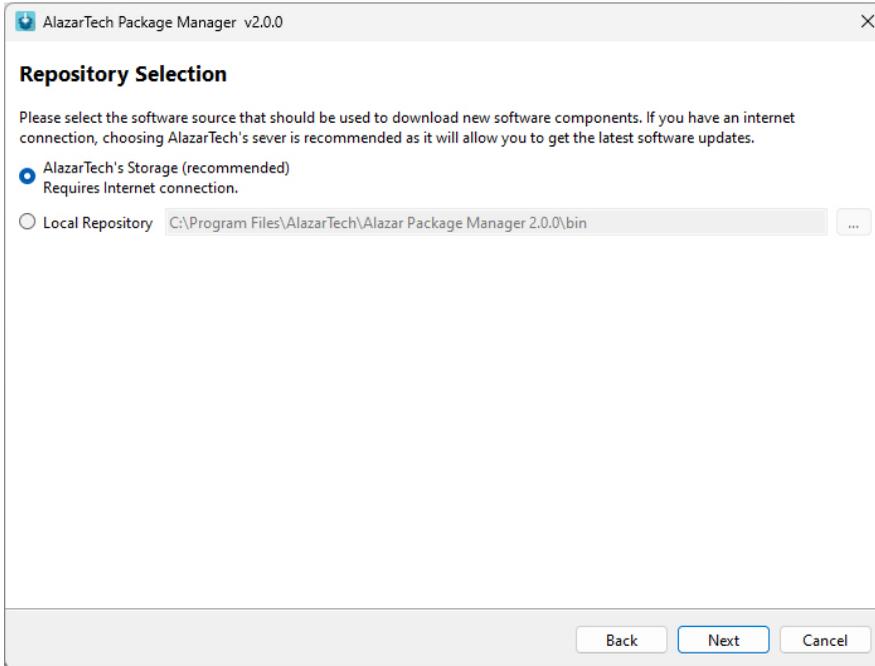
III.   The **Component Selection** screen shows the items that will be installed

Note that you must install the ATS9628 drivers for any of the sample programs included with the ATS-SDK or ATS-GPU to work properly. If you have not already installed the drivers, you may do so here by expanding the list of **Drivers for installed hardware** and selecting the latest ATS9628 driver.

Click **Next.**

AlazarTech
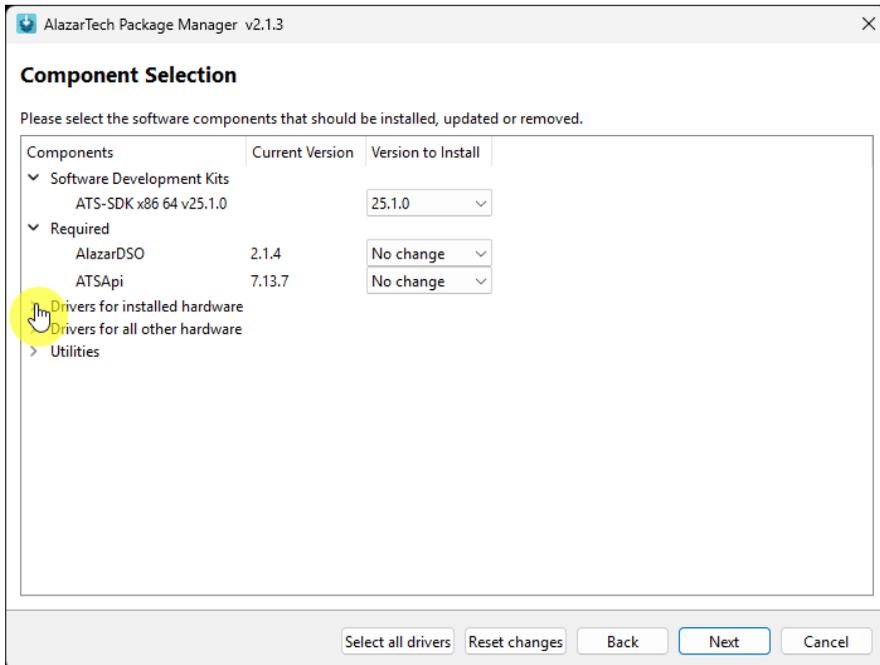
IV. An installation summary will be provided.

Confirm the details of the installation and click **Proceed.**

V. Alazar Package Manager will install the selected software. After the installation is complete, a **Modification Results** screen will report the applied changes.

Congratulations! You have now installed your ATS-GPU and/or ATS-SDK software development kits**.**
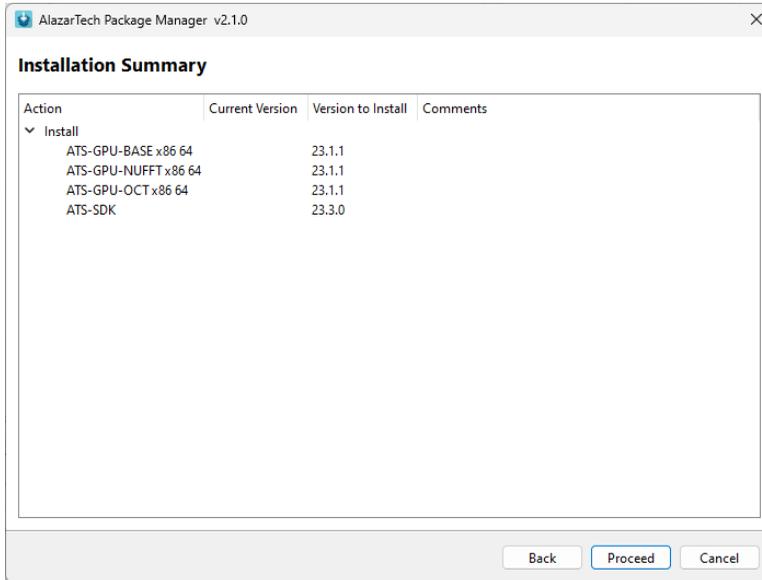
In order to receive the 1 year of maintenance included with your ATS-SDK and ATS-GPU, use the serial number provided with your digital delivery and register your product(s) at: www.alazartech.com/en/my-account/my-products/register/.

Installing the ATS9628 in a Linux System

The first step is to **physically install the digitizer in your computer**.

Identify an unused PCI Express slot on your motherboard. As per PCI Express specification, the 4-lane ATS9628 card is compatible with any 4-lane, 8-lane or 16-lane connector on the motherboard. Make sure that your computer is powered off before you attempt to insert the ATS9628 digitizer in one of the free PCI Express slots. For best noise performance, leave as much room as possible between your ATS9628 and other hardware. Always screw the digitizer bracket to the chassis in order to create a stable and robust connection to chassis ground. In the absence of such a connection, ATS9628 is not guaranteed to operate within the specifications listed elsewhere in this manual.

⚠ Some motherboards may have a 16-lane connector, but only one or four of the lanes is connected to the motherboard chipset. Motherboard manufacturers refer to this as "Mechanically 16-lane, electrically 1 lane". ATS9628 is fully compatible with such motherboards, but the data throughput across PCI Express bus will be limited by the number of lanes.

⚠ Please note that the PCI Express Revision must be supported by both your motherboard and your CPU model. For example, the ASRock X79Extreme11 motherboard supports PCIe Gen 3, but the Intel i7-3820 CPU only supports PCIe Gen 2. A system made of these two components will only support PCIe Gen 2.

You'll now need to install all required AlazarTech Linux packages.

Note: Starting from driver version 7.1.2, Dynamic Kernel Module Support (DKMS) drivers are available 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.

To get the latest version of all AlazarTech Linux Packages, please go to:
https://www.alazartech.com/en/linux-drivers/ats9628/642/

You must select your CPU type from the drop-down menu:

Linux resources for ATS9628 - 16 bit, 250 MS/s DC

Please select your CPU archetype...

Please select your CPU archetype...
arm64 Linux (.deb)
arm64 Linux (.rpm)
x86_64 Linux (.deb)
x86_64 Linux (.rpm)

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The website will display the available Linux resources for your selection:

Linux resources for ATS9628 - 16 bit, 250 MS/s DC

x86_64 Linux (.deb)

Drivers

ATS9628 x86_64 driver for Linux 7.13.7
Release Notes

Getting started with installing Linux Drivers

Utilities

Firmware Update Utility (CLI) 3.5.3
Release Notes

Firmware Update Utility (GUI) 3.5.3
Release Notes

Software

Alazar-Front-Panel 0.5.0
Release Notes

The AlazarTech software components used to communicate with digitizer boards and make acquisitions are divided into several packages that must be installed separately. Descriptions of each component are in the next section.

If you want to programmatically control your AlazarTech digitizer, you will need the following components:

- driver package for your AlazarTech digitizer
- libats
- ats-devel

If you want to simply use a GUI to immediately start acquiring data, you will need the following components:

- driver package for your AlazarTech digitizer
- libats
- Alazar-front-panel

If you want to use a GPU for signal processing of data acquired from your AlazarTech digitizer, you will need the following components:

- driver package for your AlazarTech digitizer
- libats
- ats-devel
- ats-gpu-base
- ats-gpu-oct
- (optional) ats-gpu-nufft

Description of AlazarTech Linux Packages:

- **libats**: The shared library that allows user programs to communicate with the board drivers.

- **ats-devel**: Contains header files, documentation, and code samples required to build software that links against the AlazarTech library. The required password and download link are delivered electronically when you purchase ATS-SDK.

- **Alazar-front-panel**: A GTK-based virtual oscilloscope application that allows users to get started using the boards without developing their own software.

- **driver packages**: These packages each contain the driver for one of AlazarTech's products.

- **ats-gpu-base**: Contains the header files, documentation, and code samples required to write an application in C/C++ to transfer data from AlazarTech PCIe digitizers to a CUDA-enabled GPU. Requires expert programming knowledge of CUDA development. Support is limited to the published user manual; no other technical support will be provided. Currently only available in .deb for x86_64.

- **ats-gpu-oct**: Contains the header files, documentation, and code samples required to write an application to perform high-speed floating-point FFT on k-clocked data from AlazarTech PCIe digitizers. Requires ats-gpu-base and ats-devel (ATS-SDK). Currently only available in .deb for x86_64.

- **ats-gpu-nufft**: Contains the header files, documentation, and code samples required to write an application to perform high-speed floating-point FFT on data that is uniformly sampled in time from AlazarTech PCIe digitizers. Requires ats-gpu-base, ats-gpu-oct, and ats-devel (ATS-SDK). Currently only available in .deb for x86_64.

Note: Beginning with driver version 7.1.2, AlazarTech Linux drivers use DKMS to not be dependent on the exact kernel version that the host machine is running.

Installation Instructions

AlazarTech packages can be installed using the standard tools of Linux distributions, e.g. yum/dnf on RHEL/CentOS, and apt-get/apt on Debian/Ubuntu. For more information, refer to the documentation of your Linux distribution.

Note: The **ats-devel** package is not architecture specific.

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On development machines, AlazarTech recommends installing all the packages provided with the boards. On the other hand, in a production environment, the **ats-devel** and **Alazar-front-panel** packages are optional. It is enough to install the **libats** package in addition to user-developed applications and the drivers corresponding to the boards used to get a working system.

To install packages for ATS9628 on your Linux system, follow these steps:

1. Once you have connected one or several ATS9628 in your computer, power it on.
2. Install the corresponding software packages for your ATS9628.
3. If you purchased the optional ATS-GPU library, you should have received an email with serial number, link to download, and password to install. Download and install ATS-GPU. Contact support@alazartech.com if you have not received the appropriate software package.

Note: If you have previously installed different AlazarTech products in your computer, only the driver package will be new. Be sure to use the latest version of all packages though, as older libraries, for example, may not be compatible with all the features of recent drivers.

Installation Troubleshooting

If you are experiencing difficulties using AlazarTech digitizers on your Linux system, please ensure that the following packages are all installed:

- Alazar-front-panel
- libats
- driver package for your board (with the corresponding distribution)

If these packages are installed, but the AlazarFrontPanel application does not detect your board, please run the following command at a prompt:

```
$ lsmod | grep -i ATS
```

If this command shows no output, the driver for your board did not start. To know more, run the following command:

```
$ /usr/local/AlazarTech/bin/ats9628.rc start
```

If there is a "Required key not available" message in the output, it indicates that the driver will not load because of a signature issue. On kernels where the EFI_SECURE_BOOT_SIG_ENFORCE config is enabled, third-party drivers cannot load if UEFI Secure Boot is active. The simplest solution is to disable secure boot in the UEFI BIOS settings.

Updating ATS9628 Driver in Windows

From time to time, AlazarTech updates the device drivers for its products. These updates may be required for product enhancements or for bug fixes.

This section of the manual takes you through the steps required to update the device driver for the ATS9628 PCI Express waveform digitizer.

In other words, this section shows you how to install a newer version of the driver, when you already have a previous version of the driver installed on your machine.

Instructions using Alazar Package Manager (recommended):

1. Run Alazar Package Manager.

    On the *Introduction* screen, click on **Next**.

2. From the *Repository Selection* screen, select the recommended option: *AlazarTech's Storage (recommended)* and click **Next**.

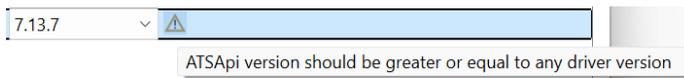3. The next screen will be the **Component Selection** screen.

By default, APM will detect the digitizer(s) in your system and install the latest versions of the software components needed to use them. In this case, the latest available version of AlazarDSO, ATSApi and ATS9628 driver will be automatically selected for installation.

You will see the currently installed version in the column *Current Version*. In the column *Version to Install*, you will see a different version number if there is a newer version (or *No change* if there is no update).
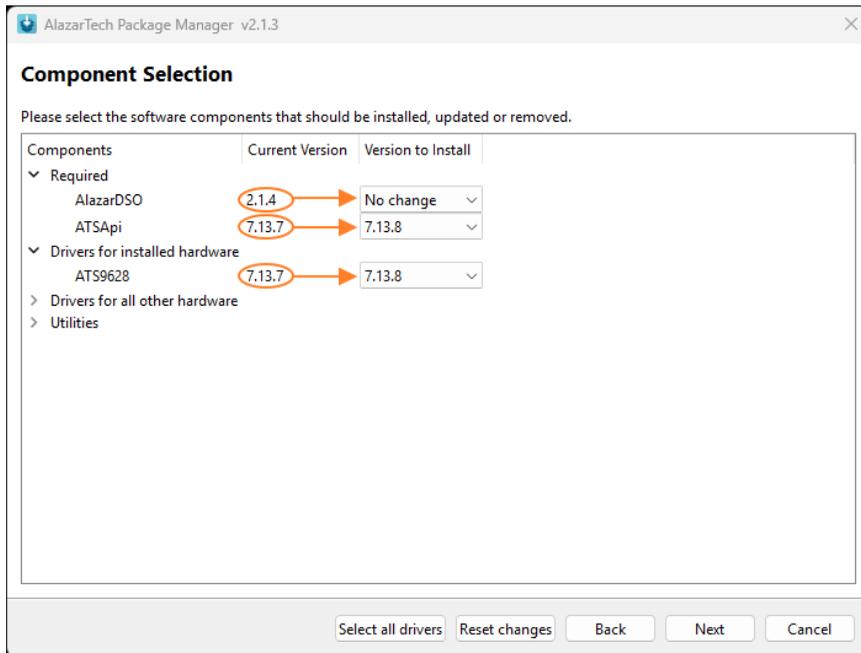

Note 1: To see the driver(s) that will be installed, you may need to expand the *Drivers for installed hardware* list by clicking on the ❯ in the Components column.

Note 2: Your ATSApi library version should be greater than or equal to the driver version. A warning will appear if you have incorrectly selected a version to install:

Click on **Next** to proceed.

4. The next screen will be the ***Installation Summary*** screen.
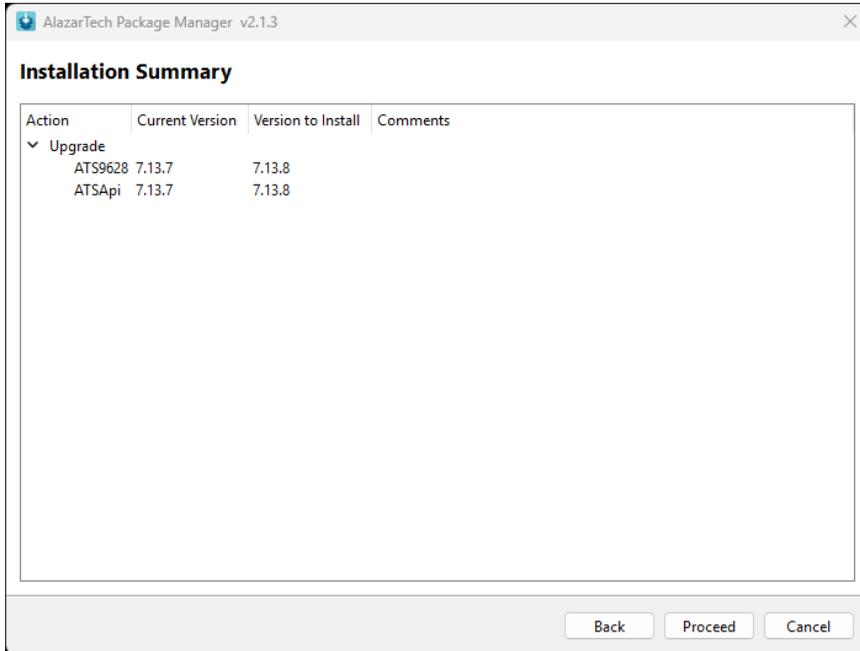
Confirm the details of the installation and click **Proceed**.

If you wish to make any changes, click the **Back** button.

5. The next screen will be the ***Component Modification*** screen where you will see APM's progress. It will uninstall the previous ATSApi library and driver version and install the selected (latest) version.

6. After the installation is complete, Alazar Package Manager will present the ***Modification Results*** screen to show the applied changes.

Click **Finish**.

Instructions using downloaded files :

1. Download the latest driver from AlazarTech's website: www.alazartech.com/en/downloads/

2. Run the installation file (*.exe extension). For example, the installation file for driver version 7.9.0 is called **ATS9628_Driver_V7.9.0.exe**, and follow the instructions.

Please note:

AlazarTech recommends that you register your ATS9628 to receive notifications of new driver releases. Take note of your serial number and go to www.alazartech.com/en/my-account/my-products/register/.

You must be logged into your *My AlazarTech* account to register a product. If you do not have an account, sign-up for one here: www.alazartech.com/en/register/.

AlazarTech

Updating ATS9628 Driver in Linux

Download and install the latest driver for your Linux distribution (RHEL, Debian or Ubuntu) from: https://www.alazartech.com/en/linux-drivers/ats9628/642/

You must first select your CPU type from the drop-down menu:

Linux resources for ATS9628 – 16 bit, 250 MS/s DC

Please select your CPU archetype...

Please select your CPU archetype...
arm64 Linux (.deb)
arm64 Linux (.rpm)
x86_64 Linux (.deb)
x86_64 Linux (.rpm)

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The website will display the available Linux resources for your selection:

Linux resources for ATS9628 – 16 bit, 250 MS/s DC

x86_64 Linux (.deb)

Drivers

ATS9628 x86_64 driver for Linux 7.13.7
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Firmware Update Utility (CLI) 3.5.3
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Firmware Update Utility (GUI) 3.5.3
Release Notes

Software

Alazar-Front-Panel 0.5.0
Release Notes

AlazarTech packages can be installed using the standard tools of Linux distributions, e.g. yum/dnf on RHEL/CentOS, and apt-get/apt on Debian/Ubuntu. For more information, refer to the documentation of your Linux distribution.

AlazarTech

Please note:

AlazarTech recommends that you register your ATS9628 to receive notifications of new driver releases. Take note of your serial number and go to www.alazartech.com/en/my-account/my-products/register/.

You must be logged into your *My AlazarTech* account to register a product. If you do not have an account, sign-up for one here: www.alazartech.com/en/register/.

Updating ATS9628 Firmware in Windows

Linux users: skip to *Updating ATS9628 Firmware in a Linux System*

- Go to the AlazarTech website and choose your board from the **PRODUCTS** drop-down menu

- Down on the product's page, from the **Software** section:

  1. Download the **Firmware Update Utility**

  2. Download the **Firmware** file – *E.g.: ATS9628 Firmware*

- Unarchive both files. Make sure that the **Windows Driver** is installed on this computer. Also make sure that all other applications using this driver or **ATSAPI.dll** are closed (E.g.: AlazarDSO).

- Run the executable file **fwupdater-x.x.x.exe** (where x.x.x is the firmware updater version number) to install AlazarTech Firmware Updater.
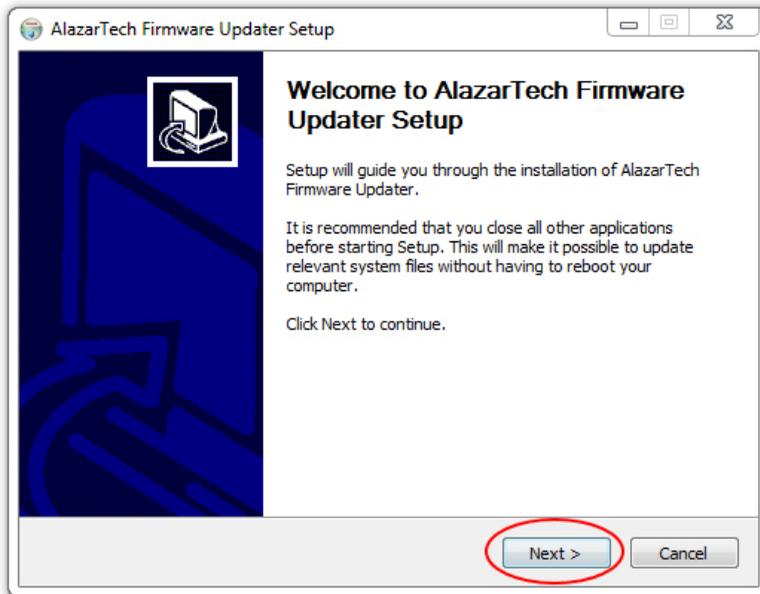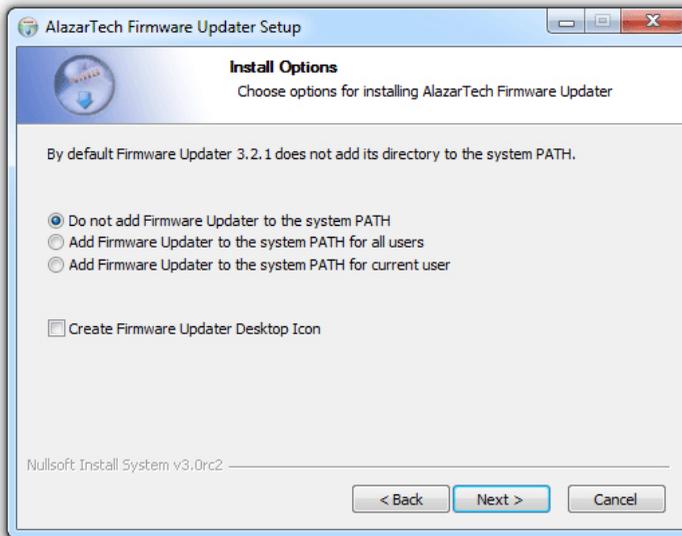

Click **NEXT**

- You must **Agree** to the License Agreement in order to proceed
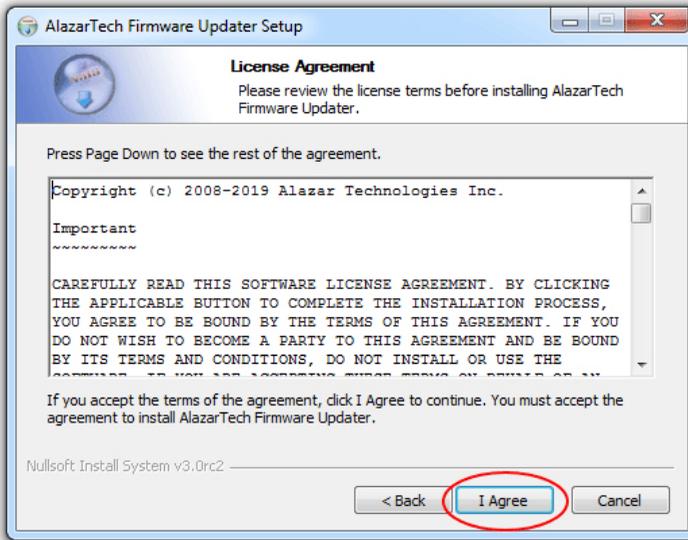
- Select your Install Options and click **NEXT**

- Select your Installation Location and click **NEXT**
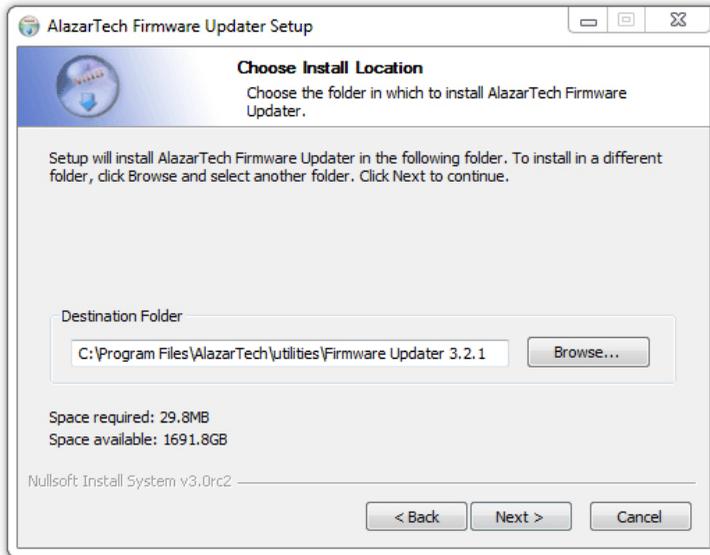
- Select your Start Menu Folder and click **NEXT**
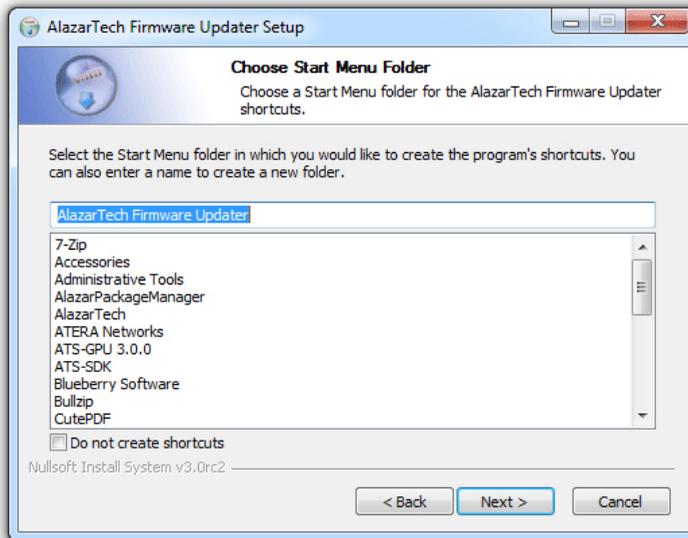
- Select your Components and click **NEXT**. AlazarTech Firmware Updater 3.0+ comes in two forms: a graphical user interface (GUI), which is recommended for most users, and a command line interface (CLI) that is more appropriate for OEMs and advanced users.
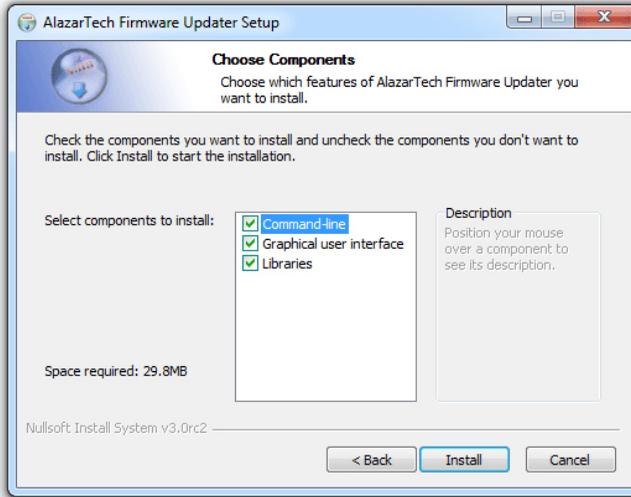
- Click **FINISH** to complete the installation. Once the firmware updater is installed, you can start it from the **AlazarTech Firmware Updater** start menu item, or by pressing the start button and typing **Firmware Updater**.
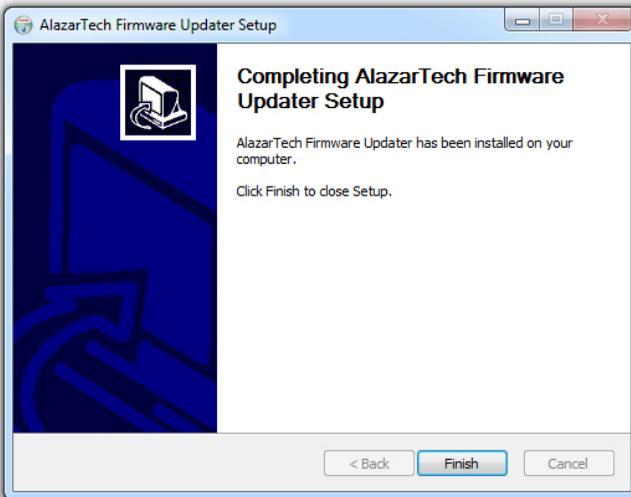
- When you start **AlazarTech Firmware Updater**, you will see the following:
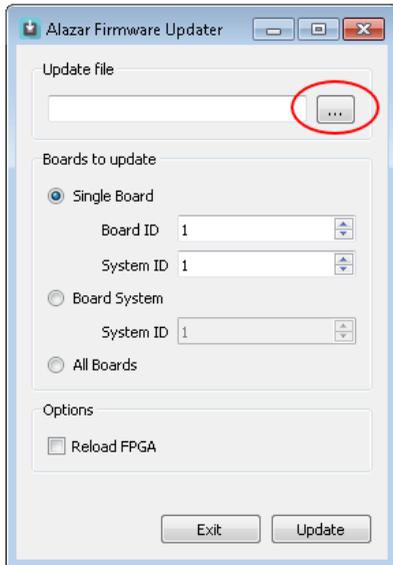
In **Update file**, click on the ellipsis to choose the corresponding firmware (.rpd file) you previously downloaded.

- Select the board(s) that you wish to update. If you have only one board installed in the computer, you can leave the **Boards to update** section unmodified. The options available are:

  - **Single Board Only**: Updates one digitizer in the system. The digitizer to update is selected with the **Board ID** and **System ID** fields.

  - **Boards System**: Updates all the boards in a system. The boards system is selected with the **System ID** field.

  - **All Boards**: Updates all the boards in the computer

- Once all the parameters are set properly, click **UPDATE** to start the FPGA update. A window will appear to indicate the progress of this process.

- After the update is complete, you should power cycle the computer (**Note:** Simply restarting your computer will not be enough to reload the FPGA). You can then confirm that the update worked:

    o   Run AlazarDSO software

    o   Press **F4** key. It will display the Board Properties page. One of the lines is **FPGA version**. Make sure the version number displayed corresponds to the version of the FPGA you downloaded (.exe file name).

AlazarTech
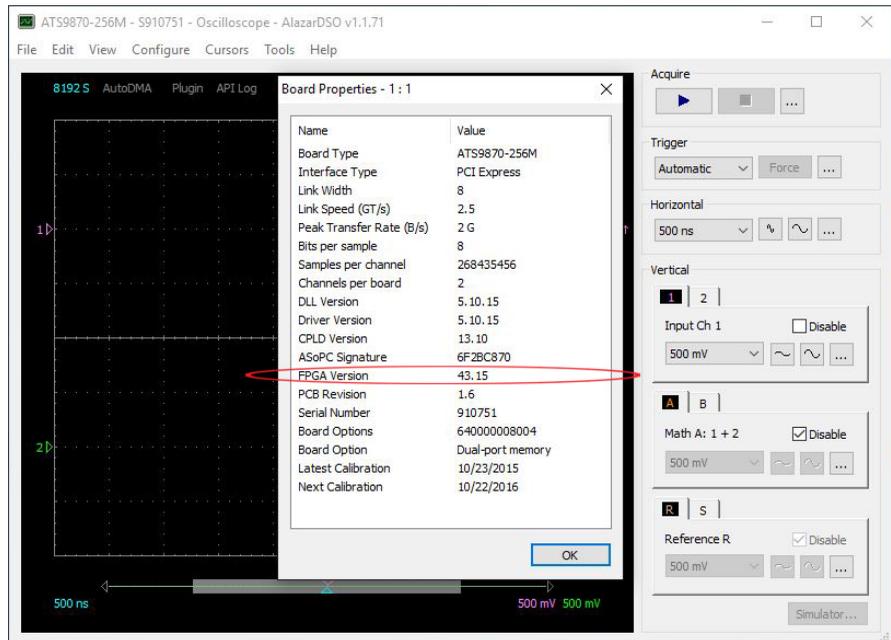
Updating ATS9628 Firmware in a Linux System

Note: The following instructions have been created using CentOS. Users with other Linux distributions may have different on-screen instructions to follow, as well as a different interface.

- Go to the [AlazarTech website](#) and choose your board from the PRODUCTS drop-down menu

- Down on the product's page:

    1. Click on **ATS9628 Firmware** to download the firmware file

       Software

       AlazarDSO
       Version: 2.1.4
       Release Notes

       Drivers

       Alazar Package Manager for Windows
       Version: 2.1.2
       Release Notes

       ATS9628 x86_64 driver for Windows
       Version: 7.13.7
       Release Notes

       Linux Resources
       Linux ReadMe

       Firmware

       ATS9628 Firmware
       Version: 3.07
       Release Notes

2. From the **Drivers** section, click on **Linux Resources** and you'll be brought to www.alazartech.com/en/linux-drivers/ats9628/642/. From here, select your CPU type from the drop-down menu:
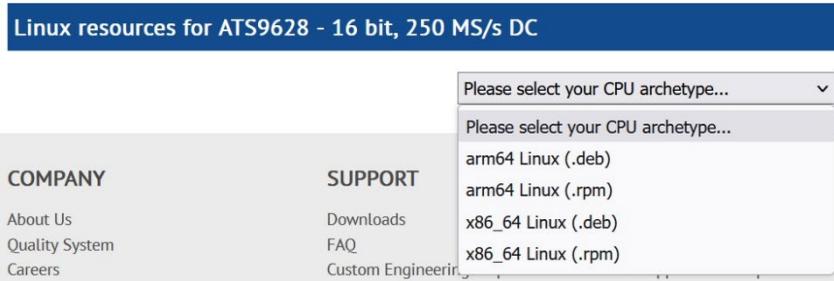
3. You will then see the available Linux resources for your selection:
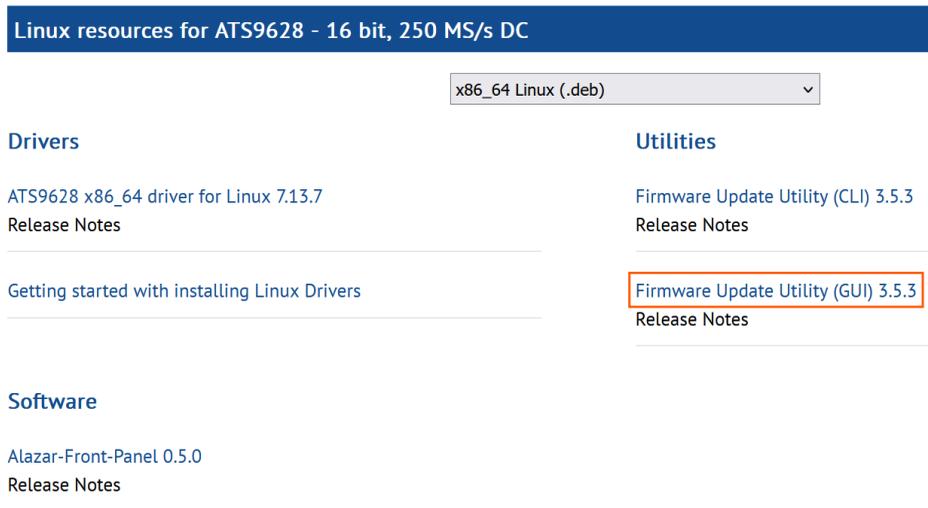
Download **Firmware Update Utility (GUI) x.x.x** (currently only available for x86 architecture).

Note: The following instructions have been created for the graphical user interface (GUI) variation of the firmware updater as it is recommended for most users. To install the command-line interface (CLI) variation, download **fwupdater-x.x.x-CLI.exe** instead.

- Unarchive both files. Make sure that the Linux Driver is installed on this computer. Also make sure that all other applications using this driver or the ATSApi Library are closed (E.g.: AlazarFrontPanel).

- Run the executable file **fwupdater-x.x.x-GUI.exe** (where x.x.x is the firmware updater version number) to install AlazarTech Firmware Updater.

- Click the blue **Install** button to begin the process.
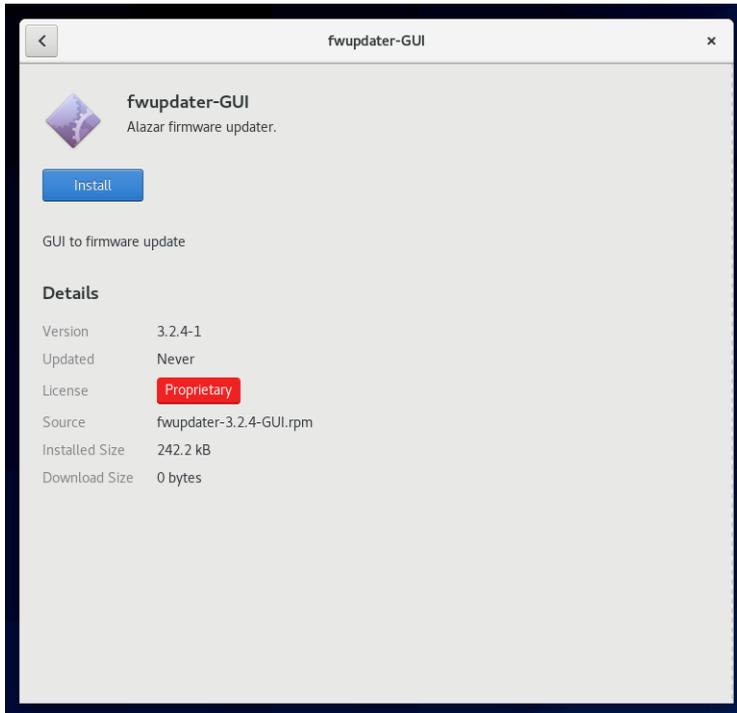
- Once the firmware updater is installed, you can start it from the Alazar Firmware Updater start menu item, or by pressing the start button and typing Firmware Updater.

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- When you start AlazarTech Firmware Updater, you will see the following:
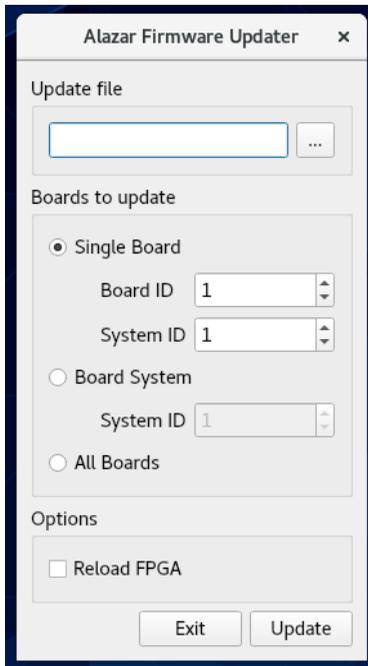
- In Update file, click on the ellipsis to choose the corresponding firmware (.pof or .rpd file) you previously downloaded.

- Select the board(s) that you wish to update. If you have only one board installed in the computer, you can leave the Boards to update section unmodified. The options available are:

  - **Single Board Only:** Updates one digitizer in the system. The digitizer to update is selected with the Board ID and System ID fields.

  - **Boards System:** Updates all the boards in a system. The boards system is selected with the System ID field.

  - **All Boards:** Updates all the boards in the computer

- Once all the parameters are set properly, click UPDATE to start the FPGA update. A window will appear to indicate the progress of this process.
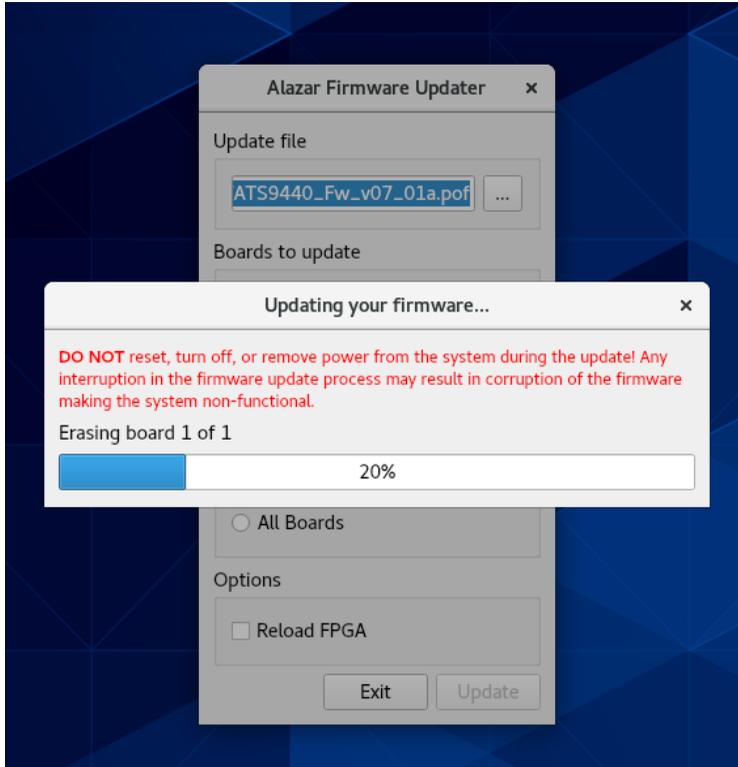
- After the update is complete, you will see a window indicating that the update was successful. You should shut down, then turn on the computer. (**Note:** Simply restarting your computer will not be enough to reload the FPGA)
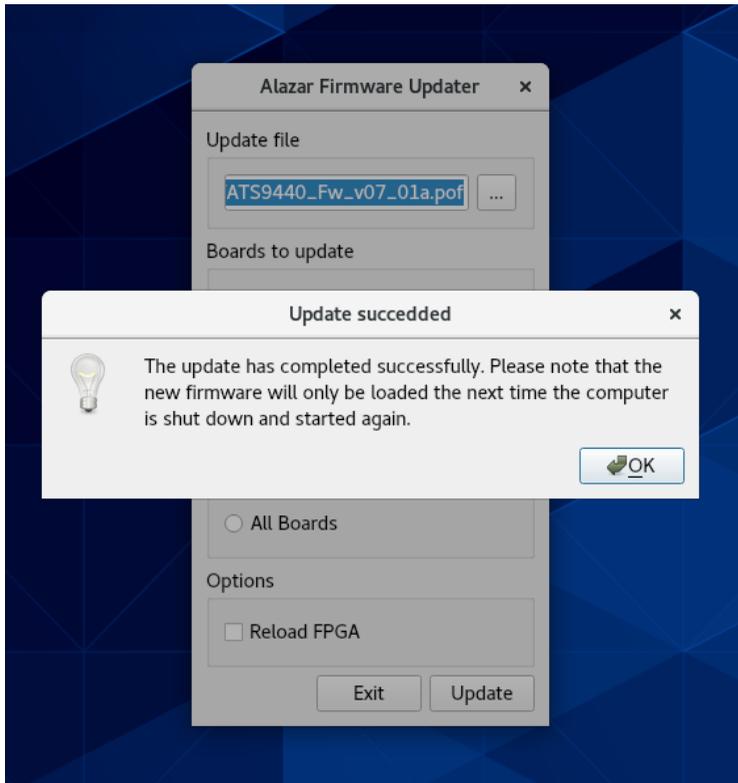
- You can then confirm that the update worked:

    o   Run AlazarFrontPanel software

    o   Next, click Help and then select About from the drop-down menu
        that follows.
        This will display an About AlazarFrontPanel pop-up.

    o   One of the lines is FPGA version. Make sure the version number
        displayed corresponds to the version of the FPGA you downloaded
        (.exe file name).
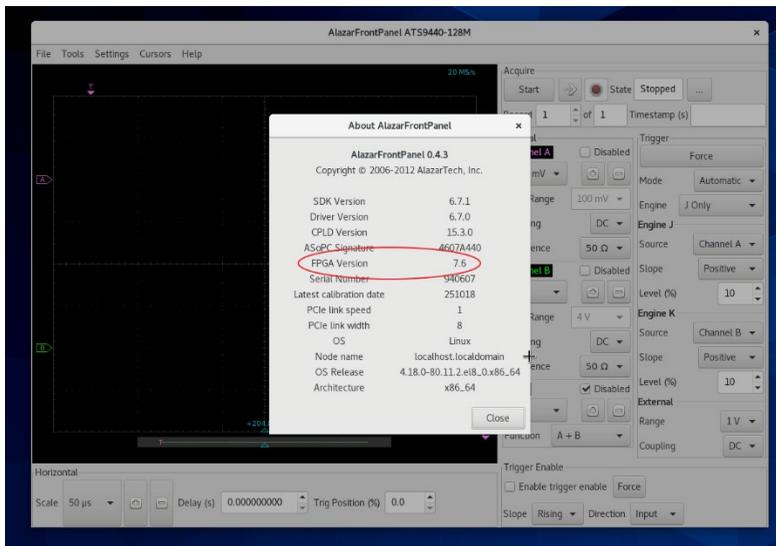
Chapter 3: Hardware Overview

This chapter includes an overview of the ATS9628, explains the operation of each functional unit making up your ATS9628, and describes the signal connections.

Following is a high-level block diagram of ATS9628.

AlazarTech

ATS9628 BLOCK DIAGRAM
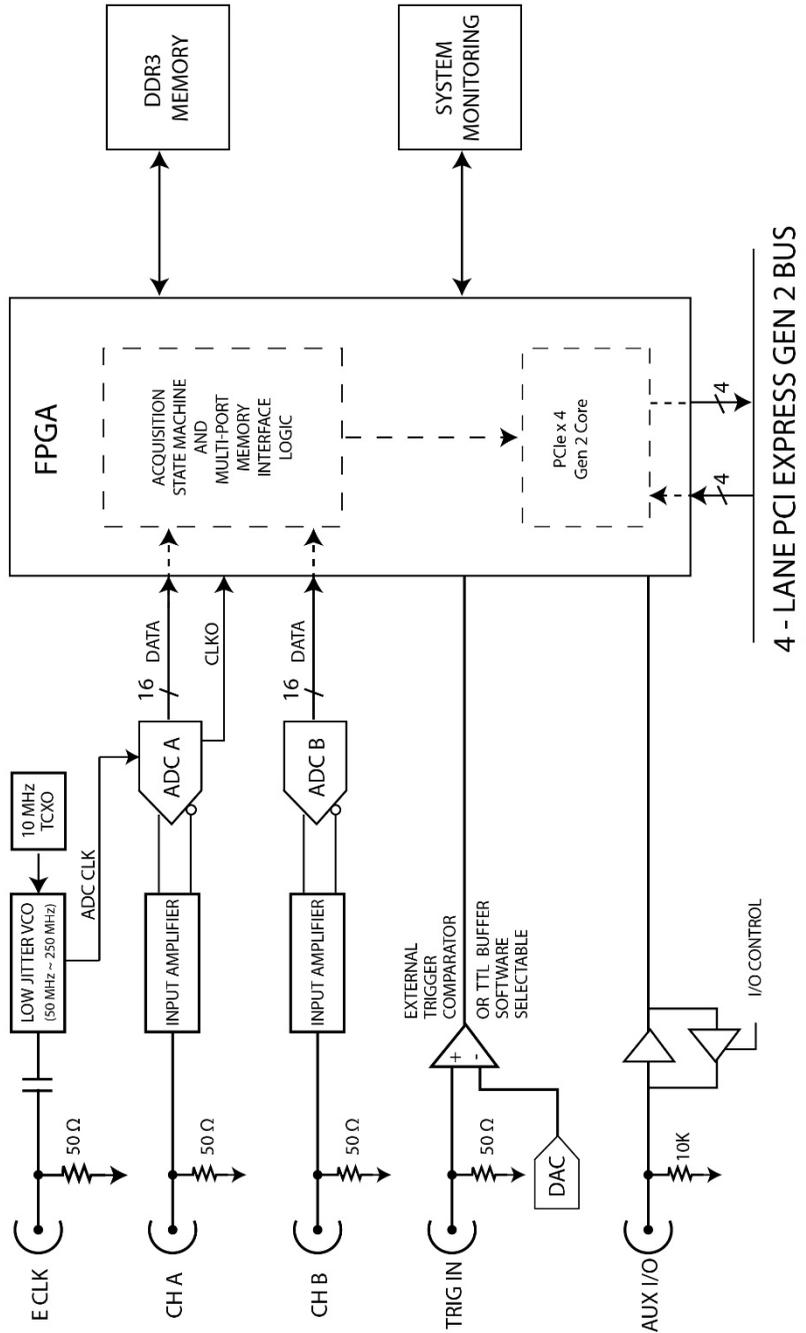
Physical Overview
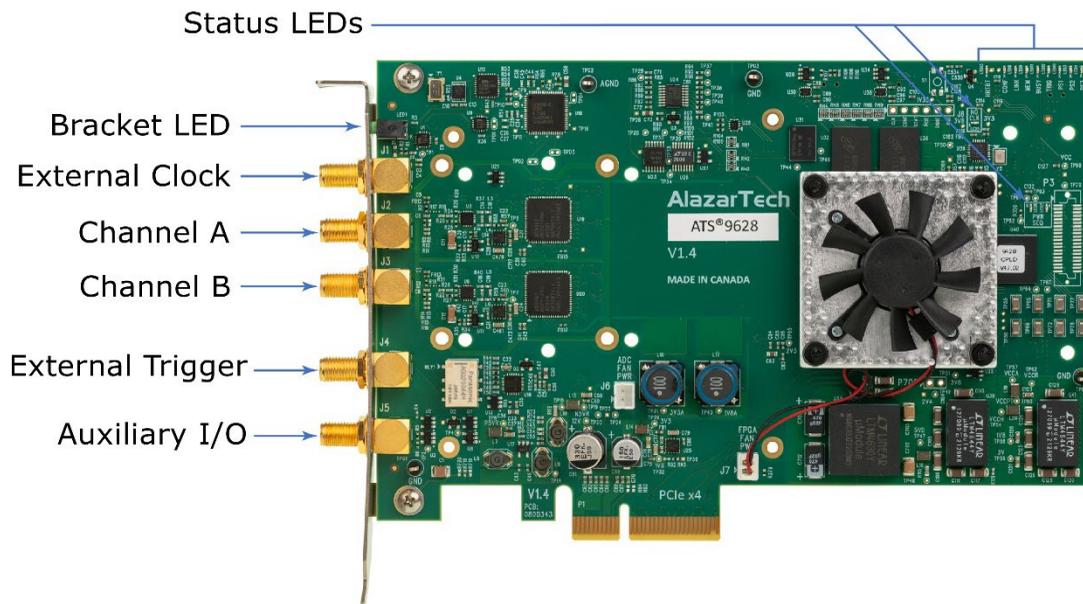
Figure 1 - ATS9628 Overview

ATS9628 has 5 SMA connectors:

- ECLK: The external clock input
- CH A: The channel A input
- CH B: The channel B input
- TRIG IN: The external trigger input
- AUX I/O: The auxiliary input/output connector

It also has a bracket LED that can be software controlled and is used for identification.

Lastly, ATS9628 has various *Status LEDs* on the top edge of the PCB that can be used for debugging.
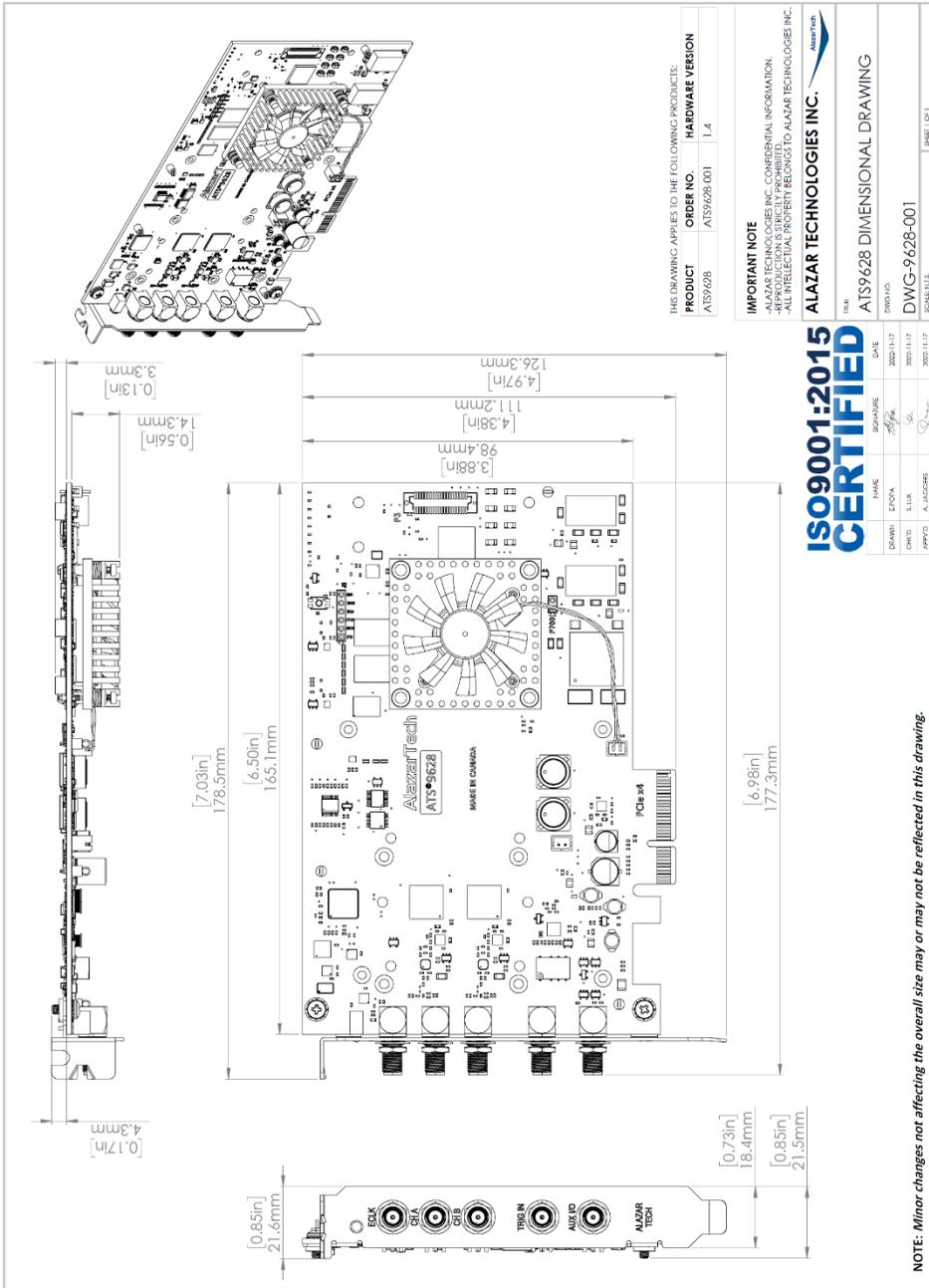
Figure 2 - ATS9628 Mechanical Drawing

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Status LEDs

ATS9628 has 11 Status LEDs. Descriptions are provided below in the order in which they appear, from left to right, top to bottom:
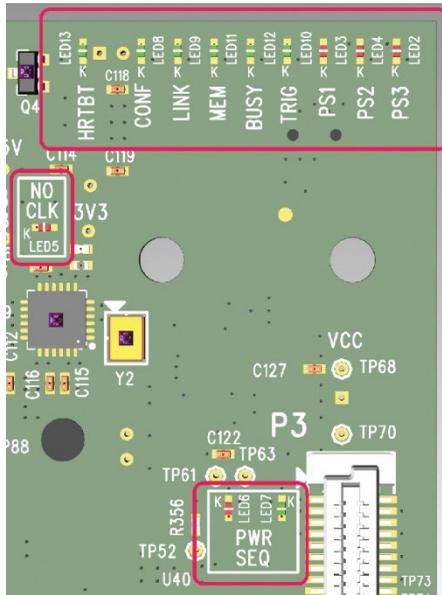
Figure 3 - ATS9628 Status LEDs

- **HRTBT (LED13)**: This LED should blink constantly. It indicates that one of the base clocks is running at the required frequency.

- **CONF (LED8)**: This LED being on indicates that the FPGA has been loaded with firmware. If the LED is off, it means that the FPGA has not been configured.

- **LINK (LED9)**: This LED being ON indicates that a PCIe link has been negotiated between the board and the motherboard. The exact time at which this LED turns on is dependent on the motherboard and its BIOS. Typically, this LED will turn on a few seconds after the FPGA is configured. If the FPGA LED is on but LINK LED does not turn on, it indicates either: the motherboard slot is not enabled by the CPU or the BIOS; or there is a problem in the transceiver power supplies; or one or more of the transceiver coupling capacitors along the gold-fingers on the secondary side have been damaged.

- **MEM (LED11)**: This LED indicates that on-board memory is detected by the board. When the software driver is loaded at the start of an application, it forces a full memory test. If the test is completed successfully, this LED is turned on, otherwise it remains off. If this LED is off, there is a hardware problem with the ATS9628.

- **BUSY (LED12)**: This LED being on indicates that the board has been armed for capture. If board is being armed repeatedly, this LED will blink or, if the re-arm rate is very high, may even appear as a dimly lit LED.

- **TRIG (LED10)**: This LED being on indicates that the board has received a trigger and is capturing post-trigger data. If board is being triggered repeatedly, this LED will blink or, if the trigger rate is very high, may even appear as a dimly lit LED

- **PS1 (LED3)**: Power Monitor error output from the board. This LED being red indicates that there is an overheating or power supply issue. Refer to *Figure 4 – Flowchart for Power Monitor Status LEDs* for steps to follow if this LED is red.

- **PS2 (LED4)**: Power Monitor error output from the board. This LED being red indicates that there is an overheating or power supply issue. Refer to *Figure 4 – Flowchart for Power Monitor Status LEDs* for steps to follow if this LED is red.

- **PS3 (LED2)**: Power Monitor error output from the board. This LED being red indicates that there is an overheating or power supply issue. *Figure 4 – Flowchart for Power Monitor Status LEDs* for steps to follow if this LED is red.

- **NO CLK (LED5)**: This LED being on indicates a loss of signal; that the crystal oscillator used to generate base clocks is not working. This LED should always be off. If this LED is on, this means that the clock chip is not working normally.

- **PWR SEQ (LED6)**: This LED being ON means there is a fault in the power supply sequencing.

- **PWR SEQ (LED 7)**: Reserved
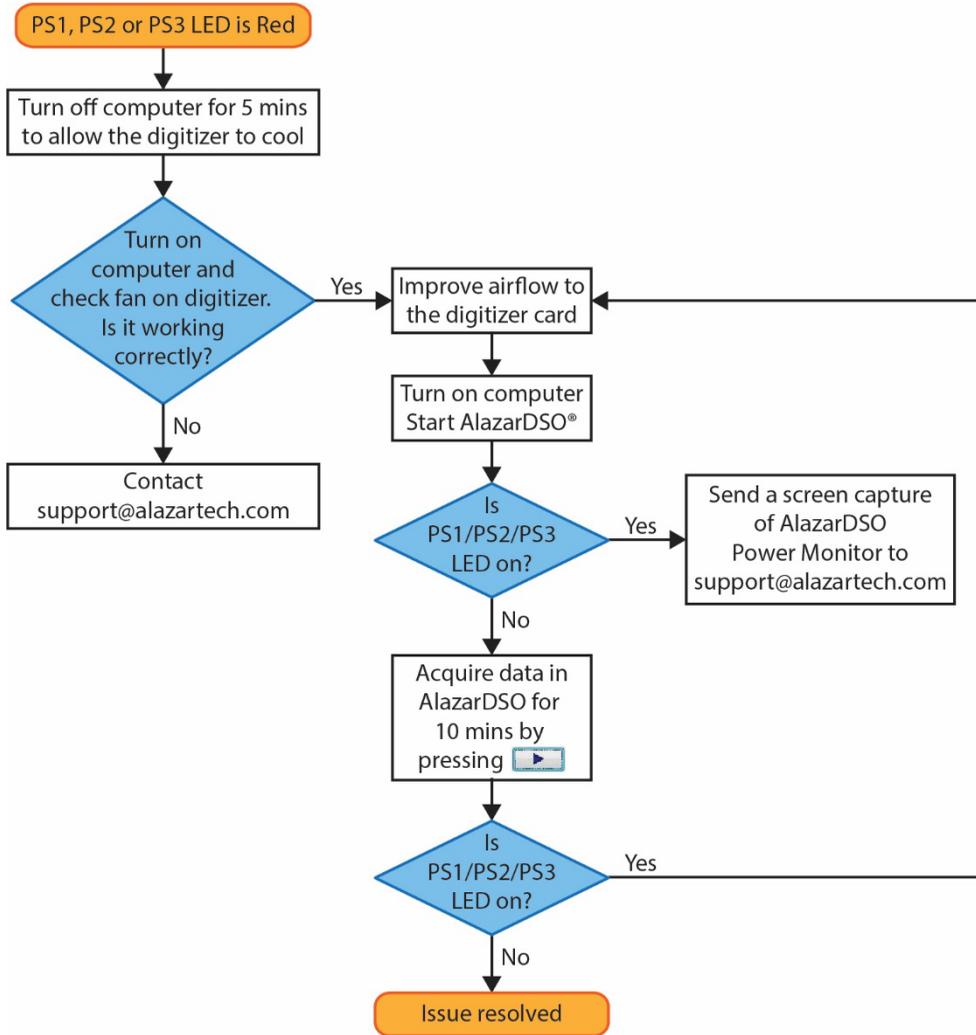
Figure 4 – Flowchart for Power Monitor Status LEDs

Consult this FAQ for instructions on accessing Power Monitor in AlazarDSO:
www.alazartech.com/en/support/faq/?faq=[1045]

Note: for Power Monitor error outputs, the Status LED remains on even after the issue is resolved. To turn off the Status LED, you must press the "Clear Int." button in the AlazarDSO Power Monitor plug-in or restart the computer.

Signal Connections

You can use CH A and CH B to digitize data as well as to trigger an acquisition.

Use the TRIG IN input for an external trigger only; data on the TRIG channel cannot be digitized.

Use the ECLK input for clocking the ATS9628 in applications that require an external clock. Signal levels are specified in detail in *Appendix A - Specifications*. Consult the chapter *External Clock* for details on various types of clocking schemes available.

AUX I/O connector can be used as the following I/Os:

Outputs:

- Trigger Output
- Pacer (programmable clock) Output
- Software-controlled Digital Output

Inputs:

- Trigger Enable Input
- Software-readable Digital Input

Analog Input

The two analog input channels are referenced to common ground in bipolar mode. These settings are fixed; therefore, neither the reference nor the polarity of input channels can be changed. You cannot use CH A or CH B to make differential measurements or measure floating signals unless you subtract the digital waveforms in software.

For accurate measurements, make sure the signal being measured is referenced to the same ground as your ATS9628 by attaching the cable's ground shield to the signal ground.

The External Trigger input (labeled TRIG IN) either has a fixed input range of ±3 V with 50 Ω input impedance or can be configured as a TTL input with 6.3 kΩ ±10% input impedance.

The CH A and CH B inputs are DC-coupled. If you need to measure AC-coupled signals, you must use external capacitors to block the DC bias.

The input range of the CH A and CH B inputs are fixed at ±1.25 V. For applications that require capture of small signals, customers can purchase the ATS9628-014 upgrade that allows the input range to be permanently changed to ±200 mV. It should be noted that the analog input bandwidth is limited to 100 MHz with this upgrade. Furthermore, this option cannot be implemented in the field and must be ordered at the time of placing the ATS9628 order.

Differences between ATS9628 and ATS9626

The ATS9628 and ATS9626 function very similarly. The main differences between the ATS9628 and ATS9626 are:

- PCIe interface: ATS9628 has a 1.6 GB/s 4-lane PCI Express Gen 2 interface whereas the ATS9626 has a 1.6 GB/s 8-lane PCI Express Gen 1 interface.

- Minimum sample rate for internal clock on ATS9628 is 1 MS/s while the minimum sample rate for internal clock on ATS9626 is 1 KS/s.

- Absolute maximum input on ATS9628 is ±2 V versus ±4 V on ATS9626.

- On-board acquisition memory on ATS9628 is 256 Million samples per channel whereas ATS9626 has 2 Gigasamples of memory that can either be divided equally between two channels or devoted entirely to one channel.

- External clock: ATS9628 does not have Dummy Clock Switchover.

- Auxiliary I/O connectors: The ATS9628 has one Aux I/O connector whereas the ATS9626 has two Aux I/O connectors.

- ATS9628 multi-board Leader/Follower systems require the Accessory: *ATS Sync 4X1G for multi-board configurations* whereas ATS9626 requires a SyncBoard-9626.

Pipelined Analog-to-Digital Converters

The ATS9628 uses pipelined flash ADCs with a maximum conversion rate of 250 MS/s.

If you use an external clock, you must provide a free-running clock to ensure reliable operation. You also must follow all the timing specifications on the external clock as described in *Appendix A - Specifications*.

Using a pipelined architecture also introduces a lower limit on the sampling rate. The minimum sample rate when using external clock with the ATS9628 is 50 MS/s.

Multiple Record Acquisition

The ATS9628 allows the capture of multiple records into the on-board memory. This allows you to capture rapidly occurring triggers in OCT, ultrasound or spectroscopy applications.

Note that ATS9628 allows you to acquire pre-trigger data.

Specifying Record Length

Record Length is specified in number of sample points. It must be a minimum of 256 points and can be specified with a 32-point resolution.

Specifying Pre-trigger Depth

You can acquire pre-trigger data in Traditional AutoDMA mode with a resolution of 32 points. The maximum pre-trigger amount is given by:
(Record Length – 64)

Specifying Record Count

User can specify the number of records that must be captured into host PC memory. The minimum value must be 1.

There is no upper limit on how many records you can capture in one acquisition.

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Calibration

Calibration is the process of minimizing measurement errors by making small circuit adjustments.

All ATS9628 digitizers come factory calibrated to the levels indicated in *Appendix A - Specifications*. Note that AlazarTech calibration is fully NIST- or CNRC-traceable.

However, your digitizer needs to be periodically recalibrated in order to maintain its specified accuracy. This calibration due date is listed on the CALIBRATION sticker affixed to your ATS9628 digitizer.

For verification and recalibration your AT9628 must be shipped back to the AlazarTech factory.

External Clock

The ATS9628 PCI Express Digitizer allows you to bypass the on-board clock oscillator and supply your ADC clock. This feature is extremely important in many RF applications in which phase measurements must be made between the inputs themselves or between the inputs and an external event.

Another application that requires external clock is Optical Coherence Tomography (OCT) that sometimes requires analog sampling to take place relative to an MZI clock, sometimes also known as k-clock.

Driving high performance ADCs must be done carefully, as any injection of phase jitter through ADC clocks will result in reduction in data conversion quality.

Aside from phase noise, the clock signal for a pipelined ADC must also have a duty cycle close to 50%. This maximizes the dynamic performance of the ADC. See Fast External Clock section below for more details.

External clock input impedance is fixed at 50 Ω.

External clock input is always AC-coupled.

There are two types of External Clock supported by ATS9628:

- Fast External Clock
- 10 MHz Clock Reference

The following paragraphs describe the two types of External Clock input and outline the restrictions on each of them.

Fast External Clock

This setting must be used when the external clock frequency is in the range of 50 MHz to 250 MHz.

It is highly recommended that the Fast External Clock signal have a duty cycle of 50% ±5%. However, duty cycle specification can be substantially relaxed at lower frequencies.

If the External Clock supplied is lower than 50 MHz, measurement quality may be compromised. Measurement errors may include gain errors, signal discontinuities and general signal distortion.

External Clock provides an SMA input for an external clock signal, which should have a high slew rate. Signal levels, specified in detail in *Appendix A - Specifications*, must be respected.

The receiver circuit for Fast External Clock acts as a high-speed analog comparator that translates the input signal into a PECL (Positive ECL) clock signal that features very fast rise times.

Since Fast External Clock is always ac-coupled and self-biased, there is no real need for the user to set the external clock level.

10 MHz Reference Clock

ATS9628 allows the user to synchronize the sampling clock to an external 10 MHz reference signal. This is useful in many RF applications.

Reference clock frequency must be 10 MHz ± 0.1 MHz and should have a high slew rate. Signal levels, specified in detail in *Appendix A - Specifications*, must be respected.

It should be noted that the 10 MHz reference produces a 250 MHz clock. Users can set lower sampling frequency by specifying a decimation value. The sampled data can be decimated by a factor of 1, 2, 5, 10 or any other integer value that is divisible by 5.

OCT Ignore Bad Clock

AlazarTech has developed **OCT Ignore Bad Clock**, a technology that can effectively ignore the k-clock signal for a user-specified amount of time. This is useful in OCT applications if the k-clock falls out of specification during the return.
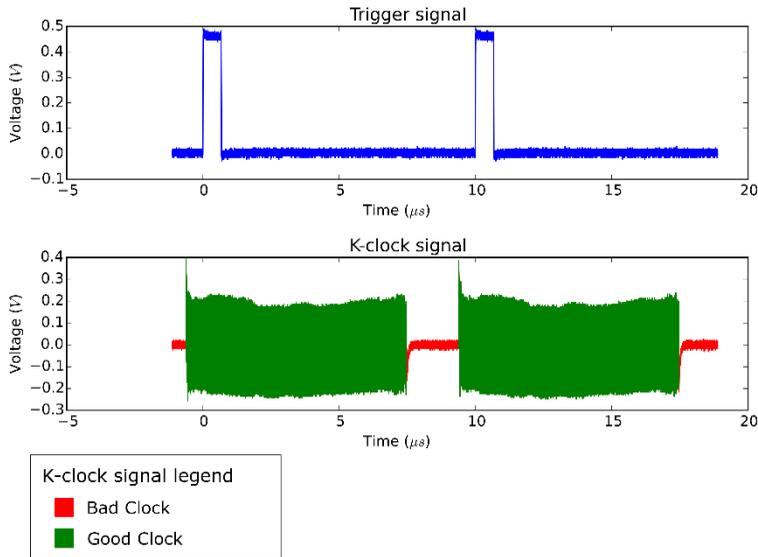
Figure 5 - OCT Ignore Bad Clock

Users must call an API function that takes *Good Clock Duration* and *Bad Clock Duration* as input parameters. The user must determine the correct values for these parameters. Some laser manufacturers may be able to provide these parameters.

AlazarTech has created a software utility called **IgnoreBadClock** that lets the user confirm their *Duration* values using an oscilloscope.

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/ for more information on this technology.

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Optional ±200mV Input Range Upgrade

ATS9628 has two DC-coupled analog input channels. Each channel has analog input bandwidth from DC to 120 MHz. The full-scale input range is fixed at ±1.25 V.

For applications that require capture of small signals, customers can purchase the *ATS9628: ±200mV Input Range Upgrade* (order number ATS9628-014) that allows the input range to be permanently changed to ±200 mV.

It should be noted that the analog input bandwidth is limited to 100 MHz with this upgrade. Furthermore, this upgrade must be done at the factory and must be ordered at the time of placing the ATS9628 order.

Accessory: ATS Sync 4X1G for multi-board configurations

The AlazarTech ATS® Sync 4X1G is a device that allows simultaneous sampling across up to 4 independent AlazarTech waveform digitizers. This is achieved by providing common clock and trigger signals to each digitizer.

While it is possible to supply copies of clock and trigger signals using passive signal splitters, that scheme does not prevent the triggering of some digitizers while the rest of the digitizers are still being armed. Sync 4X1G solves this problem by allowing users to disable triggering during the digitizer arming process and enable it only after all digitizers are armed. This can be done programmatically using the C++ example program supplied with ATS Sync 4X1G.
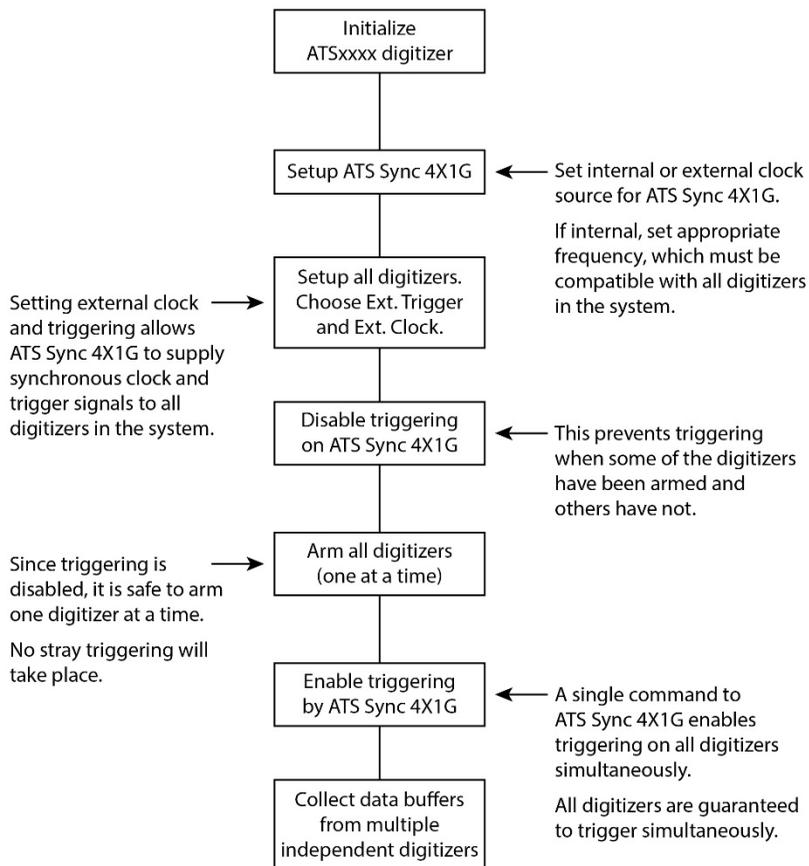
Figure 6 – ATS Sync 4X1G Workflow
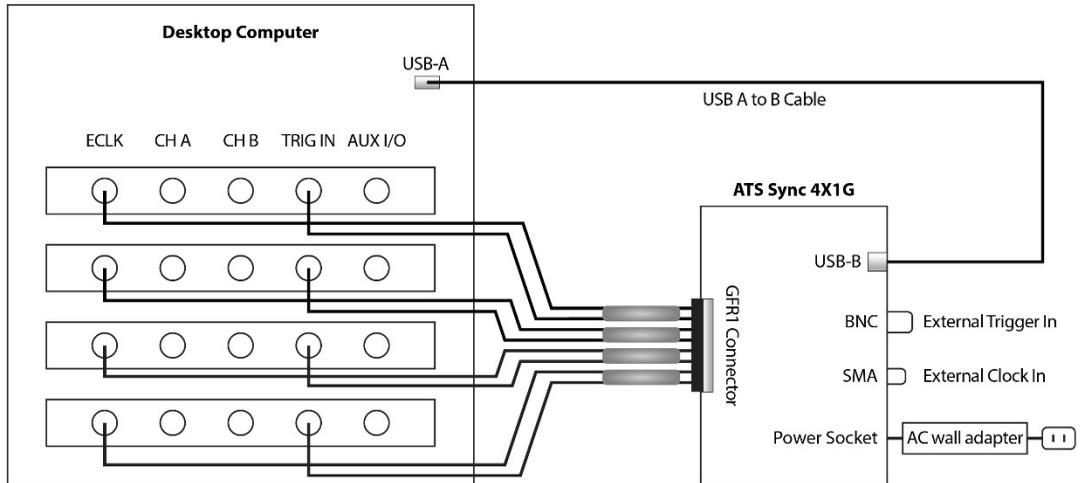
Figure 7 – ATS Sync 4X1G Connection Diagram

Up to 4 ATS9628 digitizers can be connected to provide an acquisition system with up to 8 channels.

Use with digitizers operating at different sample rates

It is also possible to use ATS Sync 4X1G with AlazarTech waveform digitizers operating at different sampling rates. These may be multiple digitizers of the same type, each setup with a different sample rate, or multiple digitizers of different types, e.g. ATS9628 and ATS9371.

In this case, Clock outputs of Sync 4X1G will not be connected to the digitizers. Each digitizer's clock source and sampling speed must be set as if it is an independent board. Trigger outputs of Sync 4X1G will be connected to the various digitizers to ensure that none of them accept a trigger before all of them are armed.

Note that only the trigger will be synchronized between digitizers. Sampling clocks will not be coherent.

More information on ATS Sync 4X1G:
https://www.alazartech.com/en/product/ats-sync-4x1g/749/

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Optional Extended Warranty

The ATS9628, like all AlazarTech digitizers, includes a standard one (1) year parts and labor warranty. However, customers might want to extend this warranty to further protect their product(s).

> If a waveform digitizer is out of warranty, the user will not be eligible for free technical support on AlazarTech hardware or software products, and they will need to purchase technical support hours (order number SUPPORT-HR5) to obtain assistance.
>
> In addition, any necessary repairs to out-of-warranty hardware products will carry a minimum bench charge.

Customers may extend their warranty by ordering an Extended Warranty (order number ATS9628-061).

This should be purchased before expiration of the standard warranty (or before expiration of a previously purchased extended warranty).

If the warranty lapses[1], 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.

Users can find their warranty end date by registering their product at:www.alazartech.com/en/my-account/my-products/.

AlazarTech reserves the right to limit the number of warranty extensions for any product.

Note:
[1] If the warranty lapses, the customer will have to prove that the digitizer is working before they can reinstate their warranty. Steps for this are detailed in the following FAQ: https://www.alazartech.com/en/support/faq/?faq=1078.

Chapter 4:
Specific Features

This section contains information about features specific to AlazarTech digitizers and ATS9628 in particular.

Streaming Data Across the Bus

One of the most unique features of the ATS9628 is its on-board, dual-port acquisition memory, with custom Direct Memory Access (DMA), that can be used for signal storage.

Data is acquired into the on-board memory before being transferred to the host PCT memory. This transfer is performed using custom DMA, which uses scatter-gather bus mastering technology. This on-board dual-port memory allows loss-less data transfer even if the computer is temporarily interrupted by other tasks. This combined by the advanced, fully asynchronous software driver allows data transfer to host PC memory without any appreciable "in-process" software involvement.

These features are particularly useful for applications that require:

a) Continuous, gapless data capture. Also known as "Data Streaming" to PC host memory or hard disk

or

b) Data capture from rapidly occurring triggers, also known as Pulse Repeat Frequency Captures or PRF Captures.

In order to understand these sophisticated features, let us first review some of the issues involved in transferring data under Windows or Linux operating systems.

The Effects of the Operating System

Windows and most Linux distributions are not real-time operating systems, i.e. the operating system cannot guarantee a deterministic response time to an event, such as an interruption or a software-generated event.

This means that if software has to play any appreciable part in data transfer, then the data throughput cannot be guaranteed, as the operating system will have the last say as to when the data collection application will get the CPU cycles to execute the necessary commands.

Note that the above is true even if the digitizer claims to use Direct Memory Access (DMA) to do the actual transfer but uses software commands to re-arm the digitizer. It is the re-arm command that will determine the overall data throughput.

Dual Port Memory

The basic throughput problem faced by digitizers is that almost all of them use single-port memory, i.e. if you are reading data from the acquisition memory, you cannot capture into it and vice-versa.

This requires a software handshake which is heavily dependent on the operating system response time.

TRIGGERED DATA ACQUISITION USING SINGLE-PORT MEMORY
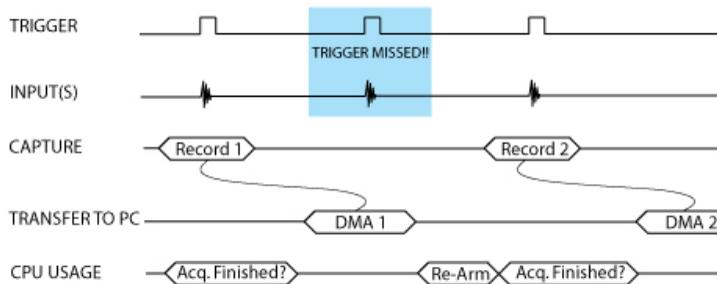
NOTE 1: Some Trigger events may be missed while data is being off-loaded from on-board memory
NOTE 2: Virtually all CPU cycles are used up in managing data acquisition. Very little left for for data processing

ATS9628 solves this problem by providing on-board memory that can act as a very deep FIFO and an advanced custom DMA engine that can stream data to PC host memory at up to 1.6 GB/s (exact rate is motherboard dependent).

TRIGGERED DATA ACQUISITION USING DUAL-PORT MEMORY
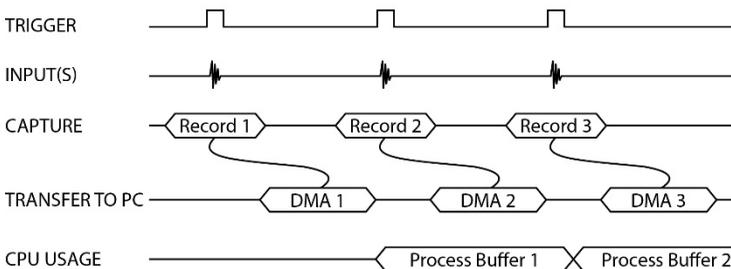
NOTE 1: No Trigger Events Are Missed - Guaranteed
NOTE 2: Over 95% of CPU cycles are available for data processing

The bottom line is that software does not have to wait until the end of data capture to read the acquired data.

AutoDMA

Just having dual-ported memory or a FIFO, on its own, does not solve the problem of capturing rapidly occurring triggers or streaming applications. Software still has to get involved in re-arming the hardware after every capture and again for reading the data from on-board acquisition memory.

ATS9628's proprietary AutoDMA circuitry allows the acquisition system to be re-armed by a hardware command and data transfer to be initiated by the hardware itself, thus removing virtually all "in-process" software involvement.
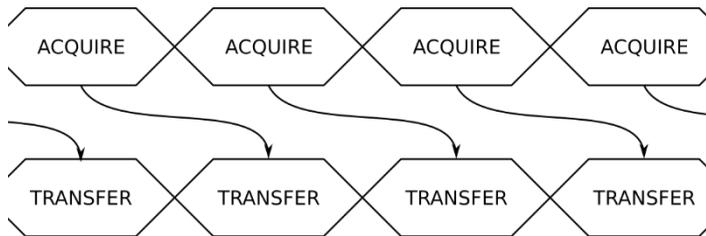
Figure 8 - AutoDMA acquisition and transfer cycle

Of course, software still must set up the DMA when one of the buffers fills up, but, thanks to the custom DMA engine and fully asynchronous driver that uses overlapped IO, these tasks can be paralleled.

In other words, when software is re-arming DMA channel 0, DMA channel 1 is already transferring data to host memory.

Note that if data throughput is too high, a DMA_OVERFLOW flag gets set and is available to the programmer.

Consumption of the captured data is, of course, under the control of user-created software, and it is this that will determine the maximum PRF instead of the bus throughput.

The important thing to note is that if asynchronous DMA is used, CPU usage is no more than 5%, even if a 1.6 GB/s DMA is going on.

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Traditional AutoDMA

In order to acquire both pre-trigger and post-trigger data in a dual-ported memory environment, users can use Traditional AutoDMA.
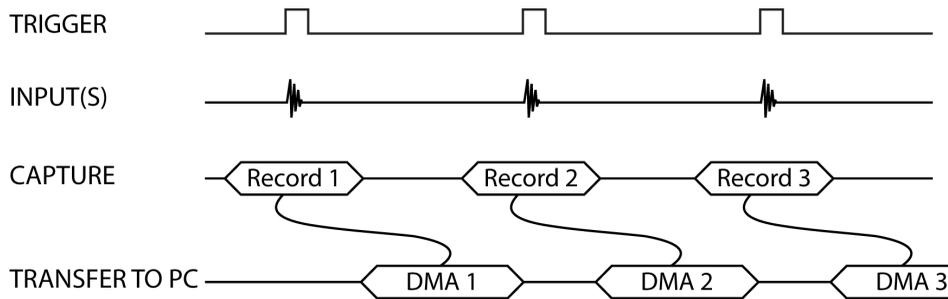
Figure 9 - Traditional AutoDMA Transfers

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.

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.

ATS9628 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 for new designs such as the ATS9628.

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.
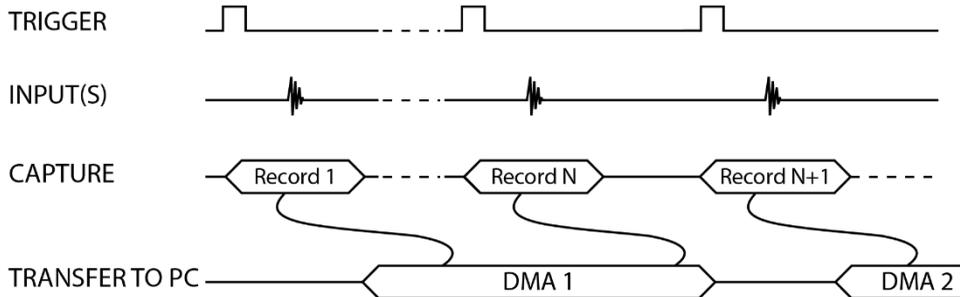
Figure 10 - AutoDMA NPT Transfers

NPT AutoDMA buffers do not include headers or footers, 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 PCIe 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 PCI bus as soon as the ATS9628 is armed for acquisition. It is important to note that triggering is disabled in this mode.
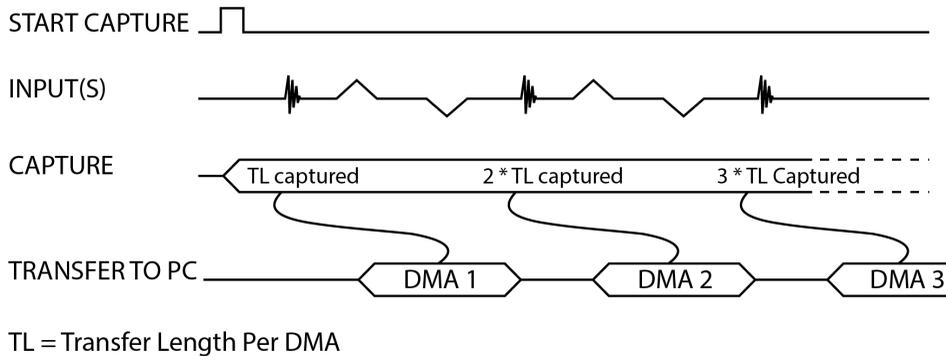
Figure 11 - Continuous AutoDMA Transfers

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.

TL = Transfer Length Per DMA
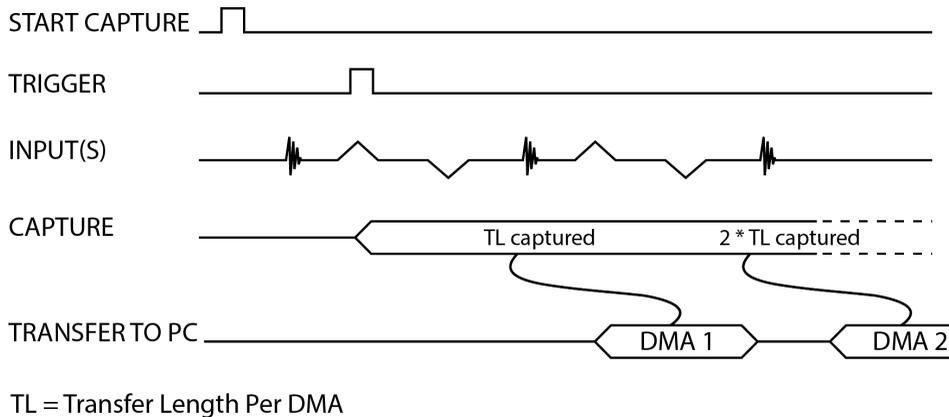
Figure 12 - Triggered Streaming AutoDMA Transfers

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.

Output Data Format

By default, ATS9628 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}).

Stream To Memory

AlazarDSO features a free 'Stream To Memory' module which allows it's users to acquire data to computer RAM and to analyze it or save it to disk later. This is very useful in cases where the acquisition data rate is higher than the disk writing speed, but the total acquisition size is less than the free RAM of the computer.

This module is accessed by clicking on **Tools** >> **Stream To Memory**...

Triggering

ATS9628 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, ATS9628 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.

Appendix A - Specifications

This appendix lists the specifications of the ATS9628. These specifications are typical at 25 °C unless otherwise stated. The operating temperature range is 0 to 55 °C (ambient).

Minimum Requirements

OS	Windows 11, Windows 10, Windows Server 2019, and Windows Server 2016 (64-bit only), or one of the *Supported Linux Distributions* (64-bit only)
RAM	16 GB
HDD	16 GB of free hard disk space if using AlazarDSO.
PCIe slot	One free PCIe slot that is mechanically x4, x8 or x16.

Recommended Motherboard Specifications

PCIe revision	2 or higher
PCIe transceiver speed	5 Gbps
PCIe port lanes	4
Compatibility	
Mechanical	x4, x8, x16 and open-ended slots
Electrical	x1, x4, x8 and x16 slots

Power Requirements

+12 V	1.5 A, typical
+3.3 V	1.0 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

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I/O Connectors

ECLK	SMA female
CH A	SMA female
CH B	SMA female
TRIG IN	SMA female
AUX I/O	SMA female

Environmental

Operating temperature	0 to 55 ^{o}C, ambient
Storage temperature	-20 to 70 ^{o}C
Relative humidity	5 to 95%, non-condensing

Acquisition System

Resolution	16 bits
Bandwidth (-3 dB)	
DC-coupled, 50 Ω	DC - 120 MHz for boards without ±200mV Input Range Upgrade
	DC - 100 MHz for boards with ±200mV Input Range Upgrade
Number of channels	2, simultaneously sampled
Max. sample rate	250 MS/s single shot
Min. sample rate	1 MS/s single shot for internal clocking
Full scale input range	±1.25 V standard. Can be permanently changed to ±200mV with ATS9628-014 upgrade.
Input coupling	DC only
Input impedance	50 Ω ±1%
Absolute maximum input	±2 V (DC + peak AC for CH A, CH B, and TRIG IN only without external attenuation)

Acquisition Memory System

Memory size	256 Million samples per channel
Record length	Software-selectable with 32-point resolution. Record length must be a minimum of 256 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 4080 for single channel in NPT mode
	From 0 to 2040 for dual channel in NPT mode
Post-trigger depth	Record Length – Pre-Trigger Depth

Timebase System

Timebase options	Internal Clock or External Clock
Internal sample rates	250 MS/s, 200 MS/s, 125 MS/s, 100 MS/s, 50 MS/s, 20 MS/s, 10 MS/s, 5 MS/s, 2 MS/s, 1 MS/s
Internal clock accuracy	±2 ppm

Dynamic Parameters

Typical values measured on the 400 mV range of CH A of a randomly selected ATS9628. Input signal was provided by a Rohde & Schwarz SMB100A signal generator, followed by a 9-pole, 10 MHz band-pass filter (TTE Q36T-50M-5M-50-720BMF). Input frequency was set at 49.9 MHz at -0.5 dBFS, which was approximately 95% of the full scale input.

SNR	69.2 dB
SINAD	57.3 dB
SFDR	59.6 dBc

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

ECLK (External Clock) Input

Signal level	500 mV$_{p-p}$ to 3.3 V$_{P-P}$
Input impedance	50 Ω
Input coupling	AC
Maximum frequency	250 MHz for Fast External Clock
Minimum frequency	50 MHz for Fast External Clock
Sampling edge	Rising
Maximum amplitude	2 V$_{P-P}$

AlazarTech

10 MHz Reference PLL Input

Signal level	500 mV$_{\text{p-p}}$ to 3.3 V$_{\text{P-P}}$
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.	250 MHz

Triggering System

Mode	Edge triggering with hysteresis
Comparator type	Digital comparators for internal (CH A, CH B) triggering and software-selectable analog comparators or TTL gate 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	50 MHz
Trigger delay	Software-selectable from 0 to 9,999,999 sampling clock cycles. Must meet alignment requirements (see ATS-SDK Guide 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 range	Analog or 3.3 V TTL, software-selectable
Input coupling	DC only
Analog input impedance	50 Ω
Analog bandwidth (-3 dB)	DC - 250 MHz
Analog input range	±3 V
Analog DC accuracy	±10% of full scale input
Analog absolute max. input	±8 V (DC + peak AC without external attenuation)
TTL input impedance	6.3 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. 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

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

Materials Supplied

One ATS9628 PCI Express Card

One ATS9628 Software Installer downloadable from product page

Supported Linux Distributions

AlazarTech offers ATS9628 DKMS drivers for the following Linux distributions: RHEL, Debian, and Ubuntu. 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 for their specific distribution by choosing from the available drivers here:

https://www.alazartech.com/en/linux-drivers/ats9628/642/

All specifications are subject to change without notice.

Appendix B - Benchmarks

This appendix lists the data throughput measured by our technicians on various computers and motherboards under different operating systems.

Given the constantly changing nature of computers, these benchmarks are provided as a reference only and AlazarTech assumes no liability in case the computer you purchase behaves differently than what was observed in AlazarTech's laboratory.

Model	CPU	Throughput
ASUS TRX40-Pro	AMD Ryzen Threadripper 3960X 24-Core @ 3.79GHz	1.79 GB/s
ASROCK AMD X399	AMD Ryzen 2920X 12-Core 3.50 GHz	1.88 GB/s
GIGABYTE MZ31-AR0	AMD EPYC™ 7001	1.7 GB/s
GIGABYTE Z390 DESIGNARE	i5-8400	1.78 GB/s
ASUS ROG STRIX X570-E	AMD Ryzen 7 3700X	1.88 GB/s
ASROCK AMD X399	AMD Ryzen 2920X	1.88 GB/s
ASUS WS X299 SAGE	Intel® Core™ i9-9820X	1.79 GB/s

Table 1 - Windows Bus Throughput Benchmark

Model	CPU	Distro	Throughput
ASUS PRIME X299	i7-7740X	CentOS 7	1.6 GB/s
GIGABYTE MZ31-AR0	AMD EPYC™ 7001	CentOS 7	1.6 GB/s

Table 2 - Linux Bus Throughput Benchmark

Note: To ensure optimum performance, you should always make sure to use the latest BIOS. Most motherboard-related issues we see are fixed with a BIOS update.

List of AlazarTech Recommended Motherboards & PCs

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