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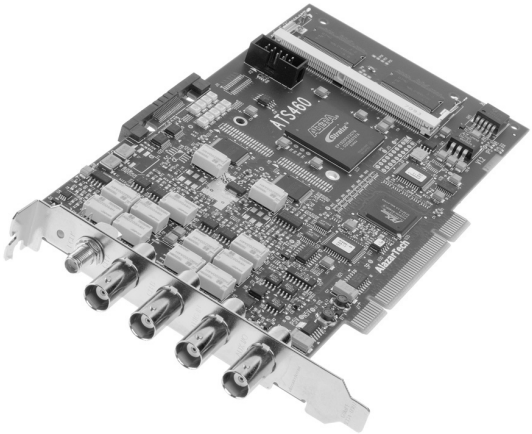
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AlazarTech

ATS460 User Manual

14 Bit, 125 MS/s
Waveform Digitizer for PCI Bus



Written for Hardware Version 1.2
July 2009 Edition
Part Number: 460-USR-4

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AlazarTech Contact Information

AlazarTech, Inc.
6600 Trans-Canada Highway
Suite 310
Pointe-Claire, QC
Canada H9R 4S2

Telephone: (514) 426-4899
Fax: (514) 426-2723

E-mail: info@alazartech.com
Web site: www.alazartech.com

To comment on the documentation for ATS460, send e-mail to support@alazartech.com.

Information required when contacting AlazarTech for technical support:

Owned by: _____

Serial Number: _____

Purchase Date: _____

Purchased From: _____

Software Driver Version: _____

SDK Version: _____

AlazarDSO Version: _____

Operating System: _____

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Compliance

FCC/Canada Radio Frequency Interference 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 communications (DOC), of Industry Canada, 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/DOC 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 a FCC ID code, starting with the letters **EXN**, or the FCC Class B compliance mark.

Consult the FCC web site http://www.fcc.gov for more information.

FCC/DOC 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 the Canadian Department of Communications (DOC).

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

Canadian Department of Communications

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

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 **Declaration of Conformity** at http://www.alazartech.com/support/documents.htm. 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 2002/95/EC of the European Parliament and of the Council of 27 January 2003 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.

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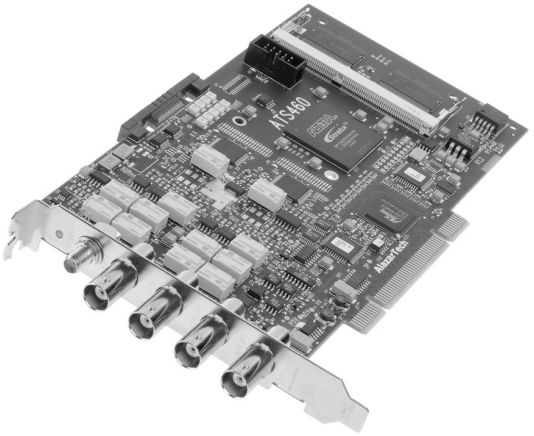
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Chapter 1 - Introduction

This chapter describes the ATS460 and lists additional equipment.



About Your ATS460

Thank you for your purchase of an ATS460. The ATS460 PCI based waveform digitizer has the following features:

- Two 14-bit resolution analog input channels
- Real-time sampling rate of 125 MS/s to 10 KS/s
- 8 Million samples of onboard memory per channel, standard
- Optional 128 Million samples of on-board memory per channel
- 65 MHz analog input bandwidth
- DIP switch selectable Amplifier Bypass Mode for optimum signal integrity
- Optional Dual-Port Memory
- Half length PCI bus card
- Analog trigger channel with software-selectable level and slope
- Software-selectable AC/DC coupling and 1MΩ/50Ω input impedance
- Software-selectable bandwidth limit switch, independent for each channel
- Pre-trigger and Post-Trigger Capture with Multiple Record capability
- NIST traceable calibration

All ATS460 digitizers follow industry-standard Plug and Play specifications on all platforms and offer seamless integration with compliant systems. If your application requires more than two channels for data acquisition, you can synchronize multiple digitizers on all platforms using a Master/Slave SyncBoard 460.

Detailed specifications of the ATS460 digitizers are listed in Appendix A, Specifications.

Acquiring Data with Your ATS460

You can acquire data either programmatically by writing an application for your ATS460 or interactively with the AlazarDSO software.

If you want to integrate the ATS460 in your test and measurement or embedded OEM application, you can program the digitizer using C/C++, Visual BASIC or LabVIEW for Windows or C for Linux operating systems.

- Windows operating systems supported are Windows Vista 32 bit, Windows Vista 64 bit, Windows XP 32 bit and Windows XP 64 bit

- Note that Windows 98SE is not supported.

For programming in C/C++ or Visual BASIC, you must purchase the ATS-SDK software development kit that comes with sample programs and a reference manual describing the API.

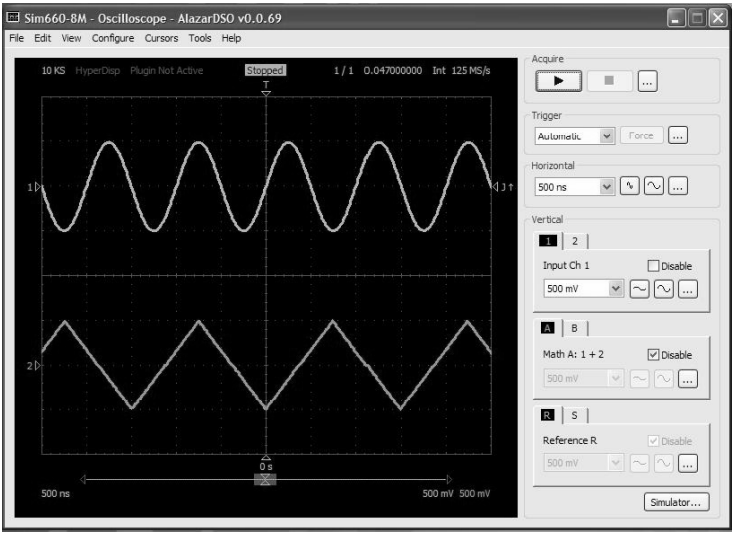
For programming in LabVIEW, you must purchase the ATS-VI virtual instrument library that comes with a high-level, easy-to-use VI that makes integrating the ATS460 into your own system very simple.

With the recent release of Linux drivers for ATS460, it is possible to program your ATS460 under Linux operating system. You will need to sign a Non-Disclosure Agreement with AlazarTech and purchase the ATS-Linux software development kit that comes with source files for the driver (Fedora Core 9 - kernel 2.6) and C source code for a sample program. Also supplied is the AlazarLinuxDSO graphical user interface for the ATS460.

Interactively Controlling your ATS460 with AlazarDSO
The AlazarDSO Soft Front Panel allows you to interactively control your ATS460 as you would a desktop oscilloscope. To launch the Scope Soft Front Panel, select

Start » Programs » AlazarTech » AlazarDSO

The following screen will be displayed. If you connect the input to a signal generator and click on **Start** button, you should see the signal on the screen.

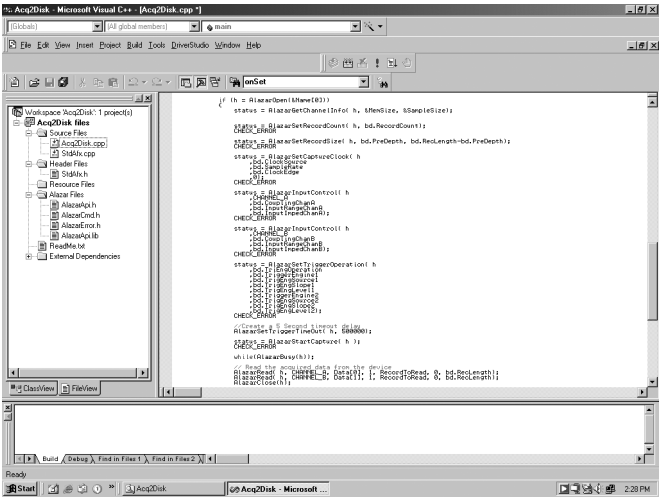


AlazarDSO has been designed to be very intuitive and uses a user interface similar to most of today's digital oscilloscopes.

ATS-SDK API

The ATS-SDK API is used for programming the ATS460 in C/C++ or Visual BASIC. It provides the exact same API that is used for writing AlazarDSO software. To help you get started, ATS-SDK comes with examples you can use or modify.

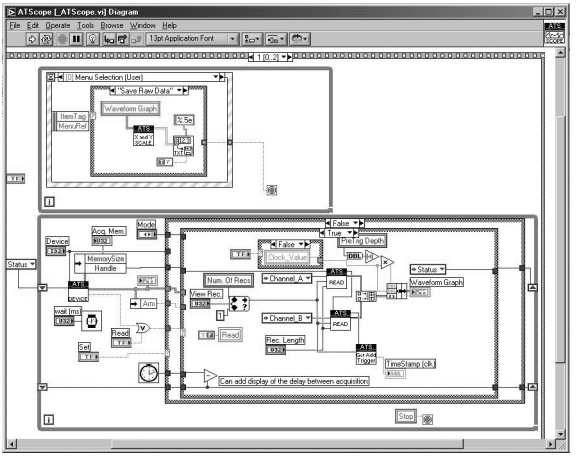
Note that only the Asynchronous API functions should be used when programming the ATS460. Traditional API and AutoDMA API is not supported.



ATS-VI LabVIEW VI

ATS-VI allows you to integrate the ATS460 into your own LabVIEW program. A high level VI is supplied that requires very few controls to get started.

Note that only the AsyncDMA.vi virtual instrument (vi) should be used when programming the ATS460. Traditional vi's and synchronous AutoDMA vi's are not supported.



ATS-Linux for ATS460

The ATS-Linux for ATS460 can be used for programming the ATS460 under Linux operating system. A source code driver is supplied that has been compiled for Fedora Core 9 (Kernel 2.6) running on an i386 platform. Sample program is supplied in C. The API is identical to the Windows API.

Note that you will need to sign a Non-Disclosure Agreement with AlazarTech in order for the source code of the drivers to be shared with you.

Optional Upgrades

AlazarTech offers the following upgrades and accessories for use with your ATS460 digitizer:

- ATS460: Dual Port Memory Upgrade
- ATS460: External Clock Upgrade
- ATS460: Trigger Enable Input Upgrade
- ATS460: Trigger Output Upgrade
- ATS460: Master/Slave SyncBoard 2 position
- ATS460: Master/Slave SyncBoard 4 position
- ATS460: Master/Slave SyncBoard 8 position
- ATS460: 8M to 128M Memory Upgrade
- AlazarDSO – Stream To Disk Module
- AlazarDSO – Plug-In Development Kit

Chapter 2 - Installation and Configuration

This chapter describes how to unpack, install, and configure your ATS460.

What You Need to Get Started

To set up and use your ATS460, you will need the following:

- One or more ATS460 digitizers

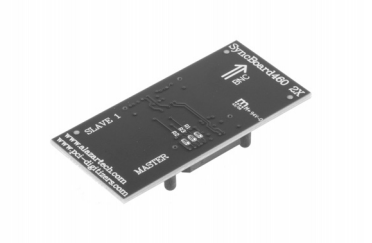


- ATS460 Install Disk

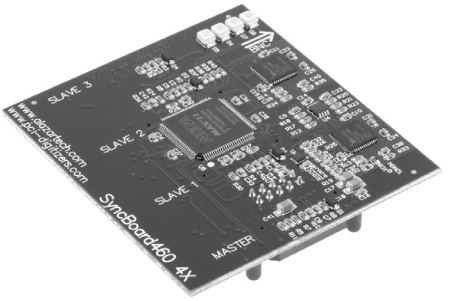


- For Master/Slave operation only:
  SyncBoard of appropriate width

SyncBoard 2X for up to 2 digitizers



SyncBoard 4X for up to 4 digitizers



Unpacking

Your digitizer is shipped in an antistatic 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.

Installing the ATS460

There are four main steps involved in installation:

1. Physically install the digitizer(s) and SyncBoard, if any, in your computer.
2. Install ATS460 software driver
3. Install AlazarDSO software that allows you to setup the hardware, acquire signals and view and archive them
4. Optionally, install the ATS-SDK software development kit or ATS-VI LabVIEW VI, which enables you to programmatically control the ATS460

Thanks to the flexible nature of AlazarTech's driver installation software, you can either install the hardware first or install the software driver first.

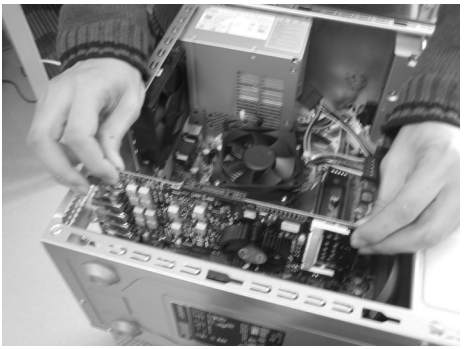
The following paragraphs will guide you through this process in a step-by-step manner.

1. **Physically install the digitizer in your computer**

   Identify an unused PCI slot on your motherboard.

   Make sure that your computer is powered off before you attempt to insert the ATS460 digitizer in one of the free PCI slots.

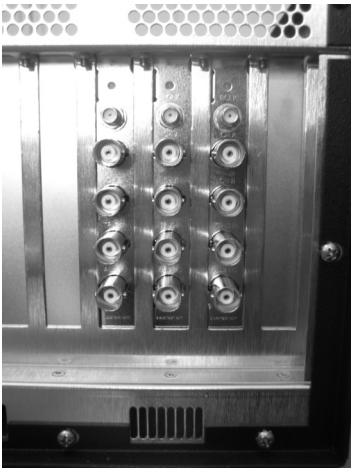
   For best noise performance, leave as much room as possible between your ATS460 and other hardware.



   Always screw the digitizer bracket to the chassis in order to create a stable and robust connection to chassis ground.

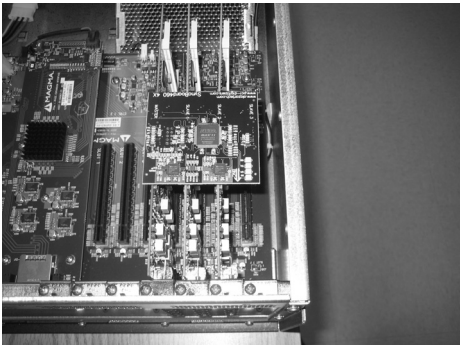
   In the absence of such a connection, ATS460 is not guaranteed to operate within the specifications listed elsewhere in this manual.

2. **For Master/Slave Installation**
   If you are installing multiple ATS460 digitizers that will be configured as a Master/Slave system, make sure that you insert all cards in adjacent slots.



The connector on the SyncBoard that is labeled as “MASTER”, must be inserted into the Master/Slave connector of the left-most digitizer, if you are facing the BNC connectors of the ATS460 digitizers.

If you are installing fewer than the maximum number of digitizers supported by your SyncBoard, the unused SyncBoard connectors must be on the right-hand side of the digitizers, if you are facing the BNC connectors of the ATS460 digitizers.



Once you have completed this step, you should power the computer on.

3. **Install ATS460 software driver**

The following instructions guide you through the process of installing the ATS460 in a computer running Windows Vista, Windows XP or Windows 2000 operating systems.

Note that the images of the dialog boxes shown below were taken from a Windows XP computer. Computers running Vista may have slightly different dialog boxes.

Installation of Multiple ATS460 Digitizers
If you are installing multiple ATS460 digitizers, the operating system will detect one card at a time and you will have to go through the driver installation setup as many times as you have cards.

Installing ATS460 Hardware First

If you decided to install the ATS460 hardware before installing the ATS460 software driver, then when you first boot up the computer, the plug-n-play Windows operating system will detect the presence of a new PCI card and ask you to provide the device driver.

a) When you power on for the first time, Windows will display the **Welcome to the Found New Hardware Wizard**



Click **Cancel**.

b) Insert the installation CD. If it does not auto-run, manually run the Setup.exe program on the ATS460 Driver Disk.



Click **Next**.

c) The following dialog box will be displayed showing the progress of installation of ATS460 driver files in the operating system driver store.



a) The following final screen will confirm that the driver has been installed.



Now your ATS460 is fully installed and is ready to use.

Installing ATS460 Driver First

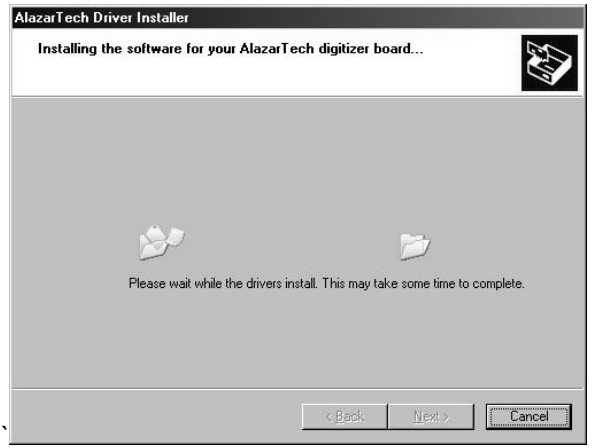
If you decided to install the ATS460 software driver before installing the ATS460 hardware, then you must follow the following sequence to make sure your operating system recognizes ATS460 as an installed device.

b) Insert the installation CD. If it does not auto-run, manually run the Setup.exe program on the ATS460 Driver Disk.



Click **Next**.

c) The following dialog box will be displayed showing the progress of installation of ATS460 driver files in the operating system driver store.



d) The following final screen will confirm that the driver has been installed.



e) Click **Finish** and power down your computer

f) Physically install your ATS460 card(s).

If you are installing a Master/Slave system, also install the SyncBoard.

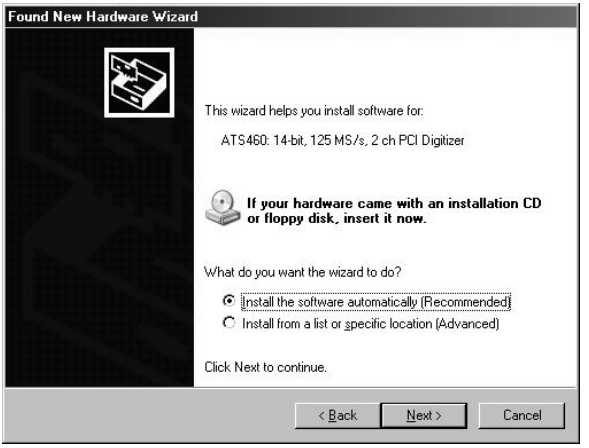
g) Power on your computer

h) Windows will display the **Welcome to the Found New Hardware Wizard**



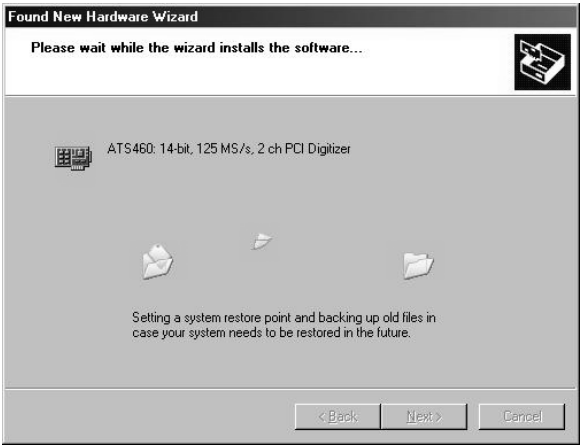
Click **Next**

i) The following dialog box will be displayed:



j) Choose to install the software automatically. Click **Next**

Operating system will copy the appropriate files to its system folders. The following dialog box will be displayed:



k) Operating system will display the **Completing the Found New Hardware Wizard** message.



Click **Finish**. Now your ATS460 is fully installed and is ready to use.

3. **Install AlazarDSO software that allows you to setup the hardware, acquire signals and view and archive them**

   If you are installing from the CD shipped with the ATS460 digitizer:

   - Insert the ATS460 Install disk
   - Use Windows Explorer to navigate to the AlazarDSO folder on the ATS460 Install Disk. Run Setup.exe program
   - Follow the instructions on the screen.

   If you are installing AlazarDSO after having downloaded the installation file from AlazarTech web site:

   - Download AlazarDSO installation file from www.alazartech.com/support/downloads.htm
   - Unzip the file downloaded in the previous step.
   - Browse to the folder that contains the unzipped file, Setup.exe
   - Run this executable file and follow the instructions on the screen.

4. **Optionally, install the ATS-SDK software development kit or ATS-VI LabVIEW VI, which enables you to programmatically control the ATS460**

   Insert the ATS-SDK or ATS-VI CD. Software installation will start automatically.

   If, for any reason, installation does not start automatically, run the SETUP.EXE program.

   Follow the instructions on the screen.

   Note that you must have already installed the ATS460 drivers for any of the sample programs included with the ATS-SDK or ATS-VI to work properly.

Installing the ATS460 in a Linux System

ATS460 is fully compatible with the popular Linux operating system.

AlazarTech supplies source code Linux drivers that have been tested under Fedora Core 9 (kernel 2.6).

- Note that a Non-Disclosure Agreement must be signed between Alazartech and your company before any source code can be released to you.

AlazarTech does not provide software support for compiling drivers for other versions of Linux, i.e. customers will be fully responsible for compiling drivers for their own Linux operating system.

To install Linux drivers in a Fedora Core 9 system, follow the instructions listed below:

1. Copy the supplied RPM file to the target machine
2. Double-click on the RPM icon. This will install the driver as well as associated applications.
3. Reboot the PC.
   Note that if you do not reboot the PC, the driver will not be loaded.

The RPM file will also install an application called AlazarFrontPasnel. This is a Graphical User Interface (GUI) using which you can setup and acquire data from the ATS460.

Note that AlazarFrontPasnel has been compiled using GTK+2 libraries. If you intend to use an operating system other than Fedora Core 9, make sure that the GTK+2 libraries have been installed on your machine.

Compiling the ATS460 Linux Driver

If you need to compile the ATS460 driver for a version of Linux other than Fedora Core 9, follow the following steps:

1. Install the Linux kernel header files.
2. Extract the driver sources using the command "tar xvfz PlxLinux-ATS460-x.x.x.tgz". This will create a folder names "PlxLinux" with the driver files inside.
3. Set the shell environment variable PLX_SDK_DIR to the root location where the "PlxLinux" directory was created. For example, if using bash and the PlxLinux directory is in your home directory, then add the following line to the ~/.bashrc :

   declare -x PLX_SDK_DIR=$HOME/PlxLinux
4. To build the ATS460 driver, type

   ```
   cd PlxLinux/linux/driver
   ./make
   ```

   This will create the file ATS460.ko, the loadable driver file. You can change build defines in PlxLinux/linux/makefiles/Gcc.def. Copy the driver to /usr/local/AlazarTech/bin.
5. Load the driver by rebooting the computer or typing:

   ```
   cd /usr/local/AlazarTech/bin
   ATS460.rc start
   ```

   The customer should be able to run the AlazarLinuxDSO application or Acq2Disk sample in /usr/local/AlazarTech/samples/ATS460.
6. If it is necessary to rebuild the library, type

   ```
   cd PlxLinux/linux/api
   make
   ```

This will create SharedLibrary/libPlxApi.so.0.0. Copy the file to /usr/local/AlazarTech/lib and then run ldconf

Updating ATS460 Driver

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 ATS460 PCI 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.

1. Download the latest driver from AlazarTech's web site:
   www.alazartech.com/support/downloads.htm
2. Unzip the downloaded file to a local folder
3. Run the resulting installation file (*.exe extension). For example, the installation file for driver version 5.6.9 is called **ATS460_Driver_V5.6.9.exe**.

   The following welcome screen will be displayed:



   Click **Next**.

4. The following dialog box will be displayed showing the progress of installation of ATS460 driver files.



5. The following final screen will confirm that the driver has been installed.

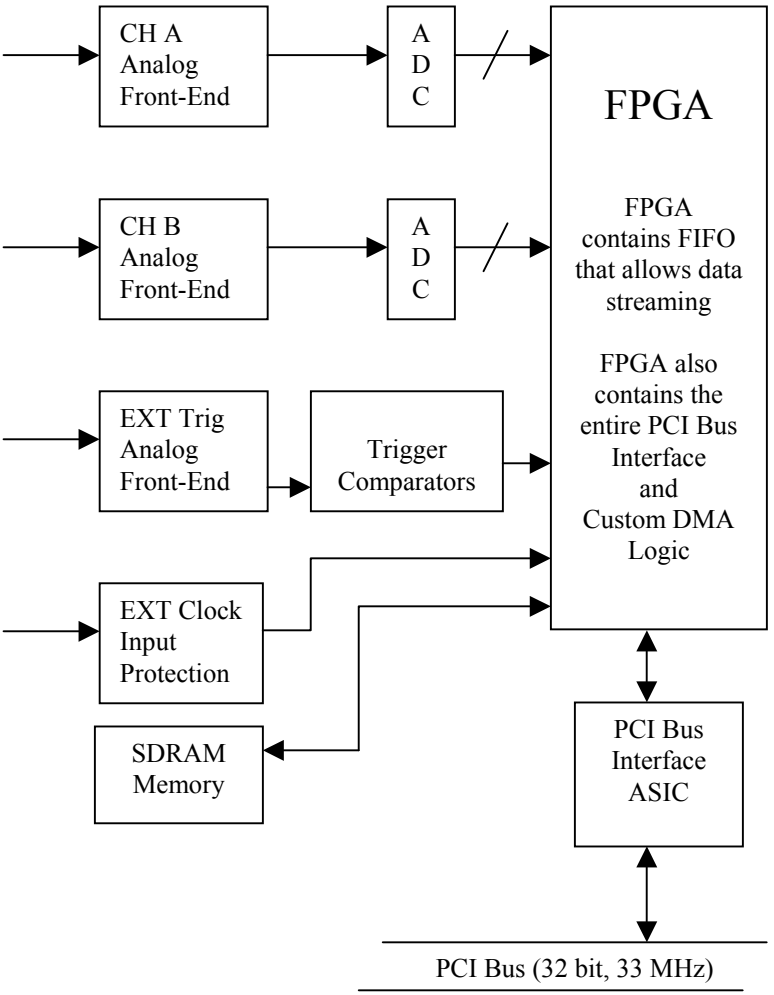


a. Click **Finish**.

ATS460 driver has now been updated

Chapter 3 - Hardware Overview

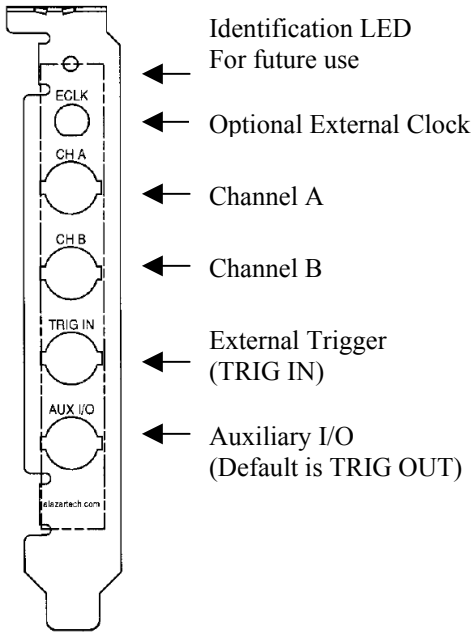
This chapter includes an overview of the ATS460, explains the operation of each functional unit making up your ATS460, and describes the signal connections. Following is a high-level block diagram of ATS460.



Input Connectors

ATS460 digitizers have one SMA connector for ECLK (External Clock) Input, two standard BNC female connectors for CH A and CH B analog input connections, one standard BNC female connector for the TRIG IN (External Trigger) input and one standard BNC female connector for AUX I/O (Auxiliary Input or Output).

The following pictorial shows the various connectors available on the digitizer bracket.



Signal Connections

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

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

If External Clock Upgrade is installed on your ATS460, use the ECLK input for clocking the ATS460 in applications that require an external clock. Consult the chapter Optional External Clock for details on various types of clocking schemes available.

AUX I/O connector can be used for outputting TRIG OUT signal, a 5 V TTL signal synchronous with the on-board trigger signal and the sampling clock.

- Note that the Trigger Output connector can also be configured as a Trigger Enable Input if a hardware modification is done to the board. Contact factory for details.

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 ATS460 by attaching the probe's ground clip to the signal ground.

The EXTernal Trigger input (labeled TRIG IN) has a programmable input range of ±5 V or ±1 V.

The CH A, CH B, and EXT inputs have a software-programmable coupling selection between AC and DC. Use AC coupling when your AC signal contains a large DC component. Without AC coupling, it is difficult to view details of the AC component with a large DC offset and a small AC component, such as switching noise on a DC supply. If you enable AC coupling, you remove the large DC offset for the input amplifier and amplify only the AC component. This technique makes effective use of dynamic range to digitize the signal of interest.

The *low-frequency corner* in an AC-coupled circuit is the frequency below which signals are attenuated by at least 3 dB. The low-frequency corner is approximately 10 Hz with 1 MΩ input impedance and 100 KHz with 50Ω input impedance.

Pipelined ADC
Each of the two ADCs on the ATS460 is a pipelined flash converter with a maximum conversion rate of 125 MS/s.

If you use an Fast External Clock or Medium 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.

Note that burst clocking is allowed only when you are using Slow external Clock.

Pre-Trigger Multiple Record Acquisition
The ATS460 allows the capture of multiple records into the on-board memory. This allows you to capture rapidly occurring triggers in lightning test, ultrasound or radar applications.

Unlike other digitizers on the market, users are allowed to acquire both pre- and post-trigger data when acquiring more than one record in an acquisition session. This feature can be very useful in lightning test, power line monitoring and other applications that feature rapidly occurring transient signals.

Specifying Record Length
Record Length is specified in number of sample points. It must be a minimum of 128 points and can be specified with a 16-sample resolution up to a maximum of the per-channel on-board memory.

Record Length thus specified determines the maximum number of records you can capture in one acquisition session. The relationship is given by:

Max. Records = Channel Memory / (Record Length + 16)

Note that, unlike other products in its class, ATS460 allows you to capture multiple records into the on-board memory without requiring software-assisted re-arming of the digitizer.

Specifying Pretrigger Depth
ATS460 acquires a certain number of samples, called the pretrigger depth, *before* it allows the trigger circuitry to operate, thereby guaranteeing that the required number of sample points will be captured before trigger occurs.

User is allowed to set pretrigger depth for an acquisition session. Same values are used for all records captured in that session.

Pretrigger depth can be a minimum of 0 points and can be specified with a 16 sample resolution up to a maximum of (Record Length – 64).

Specifying Record Count
User can specify the number of records that must be captured in one acquisition session. The minimum value must be 1 and the maximum value is given by:

Max. Records = (Per-Channel Memory) / (Record Length + 16)

Amplifier Bypass Option

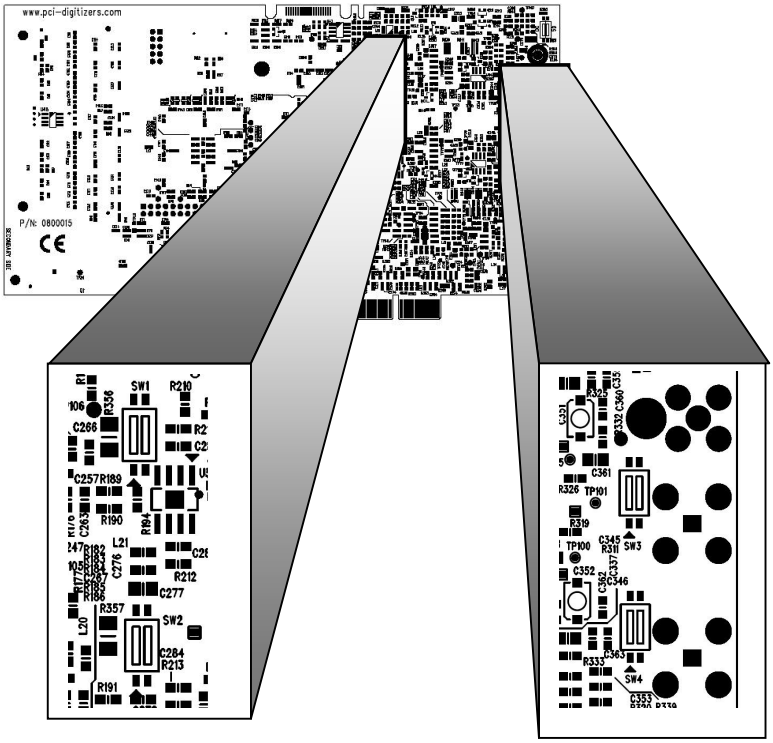
ATS460 V1.2 hardware includes the capability to bypass the input amplifier in order to maximize dynamic performance.

In previous hardware versions, Amplifier Bypass Option had to be a hardware upgrade. Once done, this upgrade could not be undone in the field.

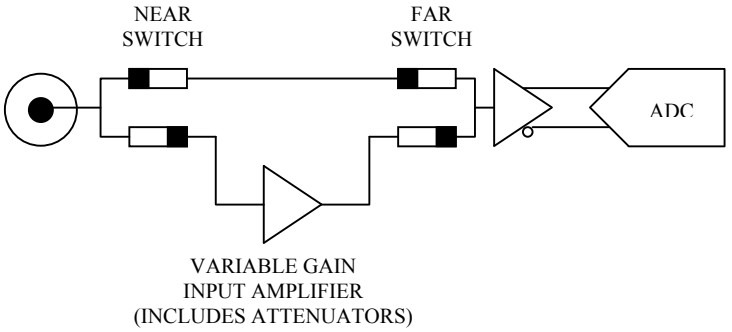
ATS460 V1.2 allows the user to set and reset the Amplifier Bypass Option using on-board DIP switches.

The user can bypass the amplifier on any one, or both, channels of ATS460 V1.2.

The following picture of the secondary side of ATS460 V1.2 board shows the location of four DIP switches used for this purpose (2 DIP switches per channel):



The concept behind Amplifier Bypass Option is very simple, as shown below:



There are two DIP switches per channel: the one closest to the input BNC connectors is called the “Near Switch” and the one closest to the ADC IC is called the “Far Switch”.

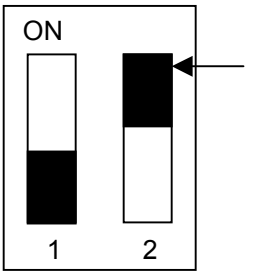
Each DIP switch, in turn, has two individual switches, called Switch 1 and Switch 2.

Under normal operating conditions, Switch 1 is always OFF (disconnected) and Switch 2 is always ON (connected). Thus, the input signal travels through the input amplifier and attenuator circuitry before being digitized by the ADC IC.

To select “Amplifier Bypass Mode”, the switch settings must be changed such that Switch 1 is always ON (connected) and Switch 2 is always OFF (disconnected). This would bypass all input amplifier circuitry and inject the signal directly into the driving amplifier of the ADC.

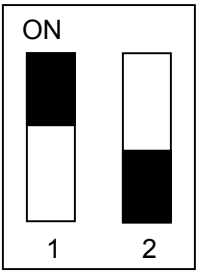
It is very important that the user set both the “Near Switch” and “Far Switch” with the same settings. Failure to do so can cause measurement errors.

The default setting of all four of the DIP switches is shown below:

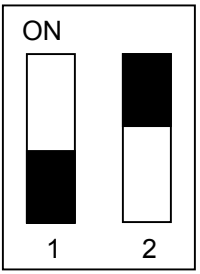


The black square represents the plastic tab for the switch. Note that the actual tab may not be black. It may, in fact, be white.

To set Amplifier Bypass Option for a channel, change the DIP Switch setting of the Near and Far switches for that particular channel to be as shown below:



To re-insert the input amplifier in the signal path, i.e. to remove Amplifier Bypass Option, change the DIP Switch setting of the Near and Far switches for that particular channel to be the same as the factory-set default:



NOTE THAT ANY SETTINGS OTHER THAN THE ONES SHOWN ABOVE ARE ILLEGAL, AND MAY CAUSE DAMAGE TO THE ATS460 ANALOG CIRCUITRY

Calibration

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

All ATS460 digitizers come factory calibrated to the levels indicated in Appendix A, Specifications. Note that AlazarTech calibration is fully NIST 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 ATS460 digitizer.

Externally recalibrate the ATS460 when this calibration interval has expired.

This requires three very simple steps:

1. Verify whether or not ATS460 is still within its specifications. If it is, then your calibration can be extended by another one-year period
2. If not, perform calibration, i.e. make adjustments to the circuit until it is within specifications again
3. If any adjustments have been made, verify if the ATS460 is within specifications

Verification and Calibration procedures are available to all registered users of ATS460 upon request.

Master/Slave Operation

You can use two or more ATS460 digitizers in one system to increase the number of channels for your application by synchronizing digitizers using the appropriate SyncBoard.

Currently, up to 16 channel (8 board) systems are supported for ATS460. For higher channel counts, contact the factory for special system configuration.

Unlike other products on the market, ATS460 does not suffer from clock jitter between master and slave digitizers.

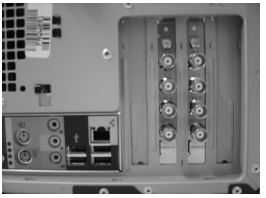
The unique design of the ATS460 clock circuit provides a buffered copy of the Master digitizer's clock to itself and all the slave digitizers, thereby maintaining a very low skew between Master and Slave digitizer clocks.

Note that an ATS460 Master/Slave system is capable of triggering from any one of its input channels. This is valuable in multi-channel detector applications that cannot predict the input channel that is going to receive the first pulse.

With fully synchronous A/D conversion, arming and triggering, an ATS460 based Master/Slave system is an ideal multi-channel transient analyzer.

Restrictions
To ensure proper master/slave operation of your ATS460 digitizers, you must observe the following restrictions:

- All Master/Slave digitizers must be installed in adjacent slots, i.e. there should be no gap between the digitizers that are to be configured as a Master/Slave system



Good Installation



Bad Installation

- You must connect the appropriate SyncBoard to all of the ATS460 digitizers in your system. Note that all SyncBoards are polarized, so you cannot make a mistake in inserting them

- If you are using fewer than the maximum number of digitizers allowed by the SyncBoard, make sure that the connector labeled “M” (Master) on the SyncBoard is connected to one of the ATS460 digitizers. Any over-hang of the SyncBoard should be beyond the last slave board in your system

The presence of a SyncBoard is detected by the ATS460 driver when the ATSApi DLL is loaded. This DLL gets loaded when you run any application program written for ATS460. Examples of such application programs are AlazarDSO, one of the sample programs supplied with ATS-SDK or ATS-VI or any custom software written using ATS-SDK or ATS-VI.

If you run AlazarDSO or your own software that loads the ATSApi DLL, after having installed a SyncBoard, the ATS460 driver will automatically recognize that the digitizers are now configured as Master/Slave.

As such, there is no need to have your hardware upgraded or modified in any way to go from a set of independent boards to Master/Slave and vice-versa.

HyperDisP® Display Technology

ATS460 uses proprietary HyperDisP® technology to allow the user to display datasets as long as 8 Million points in a fraction of a second. This provides the user with instantaneous feedback on the screen, compared to many tens of seconds or even minutes it may take with other product on the market.

Displaying large datasets under Windows is difficult, to say the least. The first problem is that Windows does not like to allocate large data buffers. This implies that a large data buffer will inevitably thrash to disk, slowing down display processing.

Secondly, standard Windows draw routines are not optimized for large datasets and slow down the display even if the data does not thrash to disk.

HyperDisP® is a proprietary hardware technology contained in the ATS460 that reduces large datasets to a more manageable size, without losing any of the information contained in the signal.

In other words, HyperDisP® enables fast screen updates not by simply “skipping” data points, but by doing data processing on every captured point and mapping it to one of the screen pixels

Optional External Clock

ATS460 PCI Digitizer optionally allows you to supply the ADC clock. This option 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.

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.

There are three types of External Clock supported by ATS460:

- Fast External Clock
- Medium External Clock
- Slow External Clock

The following paragraphs describe the three 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 80 MHz to 125 MHz. This setting turns on a Digital Locked Loop (DLL) that stabilizes the duty cycle seen by the ADC to be close to 50%, even if the external clock does not have an exact 50% duty cycle.

Even though a DLL exists on the ATS460, it is recommended that the external clock signal have a duty cycle of be 50% +/- 5%.

The frequency range for guaranteed operation of the DLL is from 125 MHz down to 80 MHz. Note that the DLL seems to behave well down to 40 MHz at room temperature, but we cannot guarantee this operation.

If the External Clock supplied is lower than the operational range of the DLL, measurement quality will be compromised. Measurement errors may include gain errors, signal discontinuities and general signal distortion.

If you want to clock slower than the lower limit of the DLL, the DLL must be turned off. This is done in the Medium External Clock range.

Medium External Clock
This setting must be used when the external clock frequency is in the range of 10 MHz to 80 MHz.

Medium External Clock setting turns off the DLL for duty-cycle stabilization. This allows guaranteed data conversion to take place down to 10 MHz. Note that ATS460 ADCs seem to behave well down to 2 MHz clock frequency at room temperature, but we cannot guarantee this operation.

If the External Clock supplied is lower than the operational range of Medium External Clock, measurement quality will be compromised. Measurement errors may include gain errors, signal discontinuities and general signal distortion.

If you want to clock slower than the lower limit of Medium External Clock, you must use the Slow External Clock range.

Slow External Clock
This setting must be used when the external clock frequency is slower than the lower limit of Medium External Clock.

In this range, the input clock is tracked by the 125 MHz internal clock and a sample is taken on every rising or falling clock edge. As such, there will be a timing error of 0 to 8 nanoseconds. For low bandwidth signals, this error can be considered to be negligible.

Note that if you use Slow External Clock and your clock frequency is higher than 10 MHz, you may see significant signal distortion.

Selecting External Clock Impedance and Coupling
For Hardware version 1.1

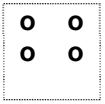
The input impedance and coupling of the External Clock input is jumper-selectable on the ATS460.

A 4-pin header, located in the top-left corner of the board, allow you to select between AC and DC coupling and 50Ω and approximately 10 KΩ input impedance.

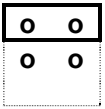
Placing a shunt across the top row of the 4-pin header will select DC coupling. Absence of the shunt means your External clock is AC-coupled.

Placing a shunt across the bottom row of the 4-pin header will select 50Ω impedance. If the shunt is not placed, the input impedance is approximately 10 KΩ.

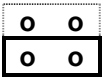
Here are the possible jumper selections for this 4-pin header.



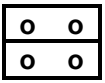
AC Coupling (Shunt is not placed)
Approx. 10KΩ Impedance (Shunt is not placed)



DC Coupling (Top row is shunted)
Approx. 10KΩ Impedance (Shunt is not placed)



AC Coupling (Shunt is not placed)
50Ω Impedance (Shunt is placed)



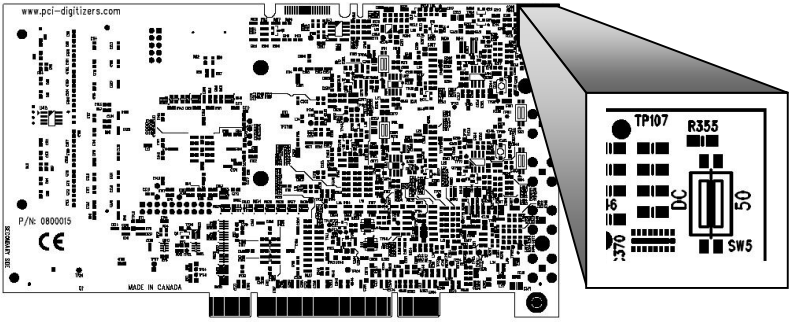
DC Coupling (Top row is shunted)
50Ω Impedance (Shunt is placed)

Here are the recommended jumper settings for this header:

Fast External Clock	Shunt bottom row, i.e. use 50Ω impedance. In general it is advisable to use AC coupling for such fast clock signals, i.e. top-row of the header is not shunted. However, the choice of using AC or DC coupling depends on the type of input signal being used for external clocking. If the input is a zero-centered sine wave, you can use DC coupling, but if it is a PECL or CMOS signal, it is advisable to use AC coupling.
Medium External Clock	Shunt bottom row, i.e. use 50Ω impedance. In general it is advisable to use AC coupling for such fast clock signals, i.e. top-row of the header is not shunted. However, the choice of using AC or DC coupling depends on the type of input signal being used for external clocking. If the input is a zero-centered sine wave, you can use DC coupling, but if it is a PECL or CMOS signal, it is advisable to use AC coupling.
Slow External Clock	Shunt the top row of the 4-pin header, i.e. use DC coupling. In general, it is advisable to use 10 KΩ input impedance for Slow External Clock, as the input in this mode is a TTL gate. If you have a strong enough TTL driver in the output stage of the clock generator, you can choose 50Ω impedance

Selecting External Clock Impedance and Coupling
For Hardware version 1.2

The input impedance and coupling of the External Clock input is DIP Switch selectable on the ATS460 V1.2.

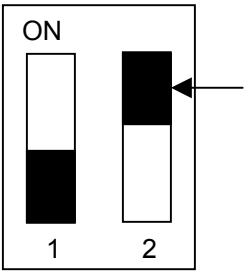


A 4-pin (2 position) DIP switch, located on the secondary side in the top-right corner of the board, allows you to select between AC and DC coupling and 50Ω and approximately 10 KΩ input impedance.

The left hand switch, Switch 1, controls External Clock input coupling.

The right hand switch, Switch 2, control External Clock input impedance.

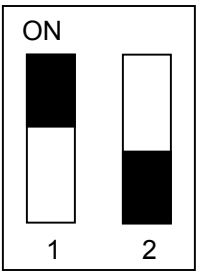
The two switches can be set by flipping the tab for that switch to the ON (top) position.



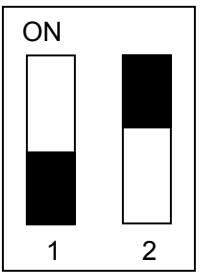
The black square represents the plastic tab for the switch. Note that the actual tab may not be black. It may, in fact, be white.

If Switch 1 is set, External Clock input coupling is DC. Otherwise, it is AC.

Switch 1 is set. Therefore, input coupling is DC

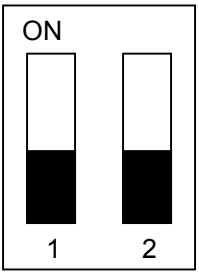


If Switch 2 is set, External Clock input impedance is 50 Ω. Otherwise, it is approximately 10 KΩ.

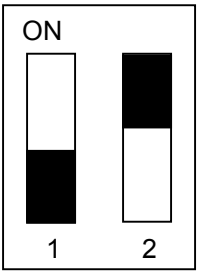


Switch 2 is set. Therefore, input impedance is 50 Ω

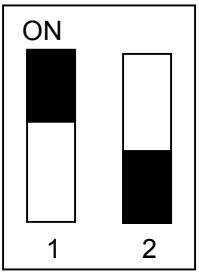
Here are the possible settings for this DIP switch:



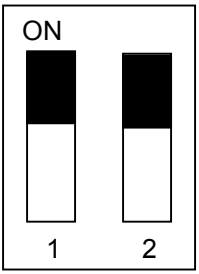
AC Coupling
10KΩ impedance



AC Coupling
50Ω impedance



DC Coupling
10KΩ impedance



DC Coupling
50Ω impedance

Here are the recommended switch settings for various types of external clock signals:

Fast External Clock	Use 50Ω impedance. In general it is advisable to use AC coupling for such fast clock signals. However, the choice of using AC or DC coupling depends on the type of input signal being used for external clocking. If the input is a zero-centered sine wave, you can use DC coupling, but if it is a PECL or CMOS signal, it is advisable to use AC coupling.
Medium External Clock	Use 50Ω impedance. In general it is advisable to use AC coupling for such fast clock signals However, the choice of using AC or DC coupling depends on the type of input signal being used for external clocking. If the input is a zero-centered sine wave, you can use DC coupling, but if it is a PECL or CMOS signal, it is advisable to use AC coupling.
Slow External Clock	Use DC coupling. In general, it is advisable to use 10 KΩ input impedance for Slow External Clock, as the input in this mode is a TTL gate. If you have a strong enough TTL driver in the output stage of the clock generator, you can choose 50Ω impedance

Optional Dual-Port Memory

One of the most unique features of the ATS460 is its optional Dual-Port memory and the associated DMA engine. 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 Linux are not real-time operating systems, i.e. the operating system cannot guarantee a deterministic response time to an event, such as an interrupt 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.

For example, it is very common for PCI digitizers that boast very fast throughput to slow down considerably when capturing pulsed radar or ultrasonic signals at Pulse Repeat

Frequency (PRF) of 1 KHz or so, even though each capture is only 2048 bytes (a paltry 2 MB/s throughput).

In other words, digitizers that specify raw data throughput of 100 MB/s can hardly handle 2MB/s effective throughput due to operating system related delays in issuing re-arm commands.

Real-Time Operating Systems
Some vendors claim that switching to a real-time operating system (RTOS) can solve the problems involved in PRF data capture.

Before switching to an expensive RTOS (such as VxWorks, QNX or PharLap ETS), ask the vendor of the operating system, the supplier of your PC system and manufacturer of the digitizer board if they are all guaranteed to be 100% compatible and interoperable with each other with deterministic interrupt latencies and if you will get your money back if the system does not work at your PRF rates with your software.

Here is an excerpt from a FAQ section of one such supplier of RTOS:

> Question: How do system configuration and CPU selection impact the interrupt latency?
>
> Answer: Hardware platforms and the configuration of the associated drivers that use the hardware do impact response times. Some of the common issues include:
>
> Video cards - some of the higher-end cards lock-out (or busy-wait) the bus for extended periods of time to improve their performance.
>
> DMA devices - devices which burst DMA for lengthy period.
>
> Power management which cycles off the CPU during IDLE CPU periods.
>
> Memory speeds, processor speeds, etc.

A PCI digitizer being used in a PRF or streaming application is, by definition, doing “burst DMA for lengthy period”, and is a type of product that can negatively impact response times of the RTOS.

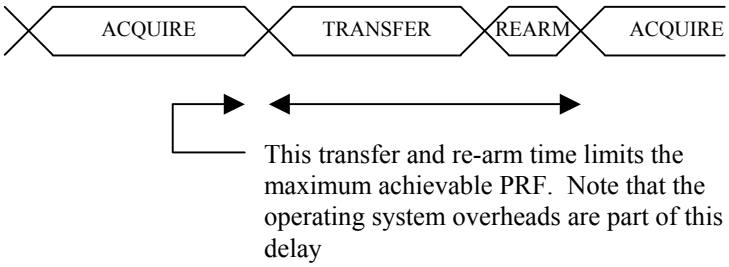
As such, the claim that an RTOS can remove all timing uncertainties in PRF application is suspect, to say the least.

Furthermore, you may not be able to get software drivers for the selected RTOS for all the hardware components you need for your system.

In summary, moving to a real-time operating system will not guarantee data throughput, but will surely increase the overall system cost, increase the cost of software development and maintenance and limit the number of suppliers for other hardware components.

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.

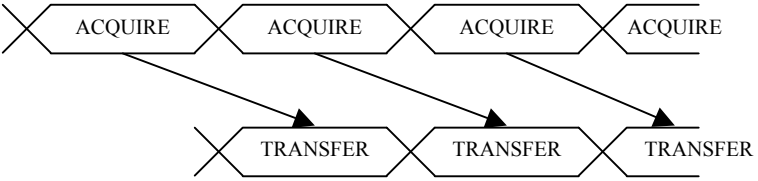


ATS460 solves this problem by providing optional Dual-Port memory that can act as a deep FIFO and an advanced DMA engine that can stream data to PC host memory at up to 100 MB/s.

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

Asynchronous DMA
Just having dual-ported memory or a FIFO, on its own, does not solve the problem of PRF captures 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.

ATS460'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.



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

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 AlazarAsyncRead API function is used, CPU usage is almost 0% even when 100 MB/s DMA is going on.

No Pre-Trigger (NPT) AsyncDMA

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

NPT AutoDMA is designed specifically for these applications. By only storing post-trigger data, the memory bandwidth is optimized.

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

A BUFFER_OVERFLOW flag is asserted if the Data FIFO overflows.

Continuous AsyncDMA

Continuous AutoDMA is also known as the data streaming mode.

In this mode, data starts streaming across the PCI bus as soon as the ATS460 is armed for acquisition. It is important to note that triggering is disabled in this mode.

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

A BUFFER_OVERFLOW flag is asserted if the Data FIFO overflows.

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

Continuous AutoDMA can easily acquire data to PC host memory at sustained rates up to 100 MB/s without causing an overflow. This is the recommended mode for very long signal recording.

Triggered Streaming AsyncDMA

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

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

A BUFFER_OVERFLOW flag is asserted if the Data FIFO overflows.

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

Triggered Streaming AutoDMA can easily acquire data to PC host memory at sustained rates up to 100 MB/s 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.

Stream To Disk
Any one of the AutoDMA modes can be combined with a fast disk drive to create a very efficient and low cost data streaming system.

AlazarDSO Stream To Disk module (sold separately) allows out-of-the-box disk streaming. No programming is required. Note, however, that the speed with which data can be stored to memory will be limited by the lower of:

1. ATS460 Bus Throughput (100 MB/s)
2. PCI throughput supported by the motherboard
3. Sustained Throughput of the disk drive system

AlazarDSO version 1.0.19 and higher include a Disk Throughput Benchmarking tool, using which you can quickly and easily see how fast your disk drives are.

Files are saved as ATB format binary files, and can automatically be converted to text files or MATLAB compatible files.

For more information on complete disk streaming systems, please contact the factory or your local distributor.

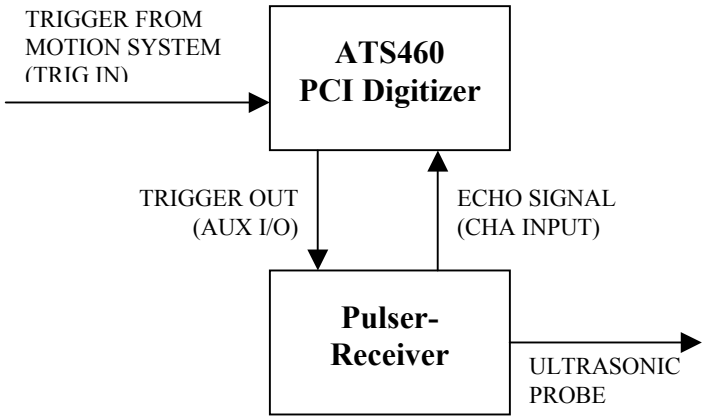
Trigger Out Signal

Many ultrasound applications require the digitizer to generate a Trigger Output signal synchronous with its internal sampling clock.

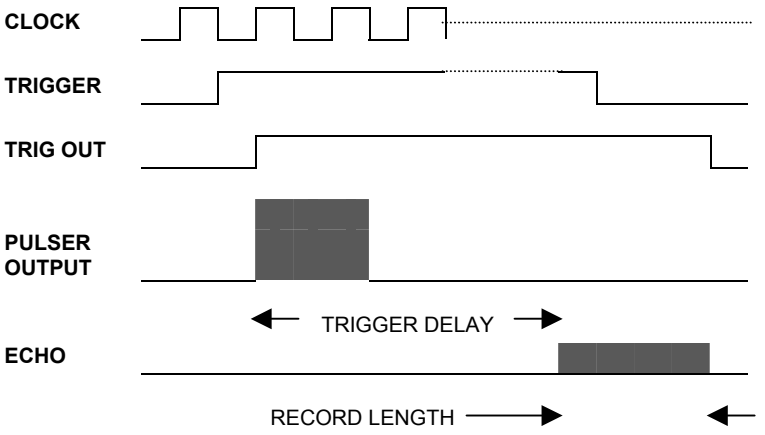
Such synchronization is almost essential if multiple acquisitions have to be averaged.

> ATS460 uses a high quality crystal-controlled clock oscillator as its timebase.
>
> It should be noted that crystal oscillators are one of the most reliable and repeatable types of clock source available.
>
> Crystal oscillators also provide far superior long-term jitter performance compared to PLL based clocking schemes.
>
> The same qualities that make crystal oscillators such an ideal clock source also make it impossible to synchronize them to an external signal, such as an external trigger input or a 10 MHz reference clock.

As such, the best way to fully synchronize the acquisition system to a signal source, such as a pulser-receiver, is to trigger the pulser-receiver with a trigger signal that has already been synchronized to the ADC sampling clock. Hence the Trigger Out Signal.



When connected as shown in the diagram above, the system works as follows:



Appendix A - Specifications

This appendix lists the specifications of the ATS460. These specifications are typical at 25 °C unless otherwise stated. The operating temperature range is 0 to 50 °C.

System Requirements

Computer with at least one free PCI slot, 128 MB RAM, 20 MB of free hard disk space.

Power Requirements

+5V	2.2 A, typical for ATS460-8M
	1.6 A, typical for ATS460-128M
	+5V voltage level must remain between the range of 4.75V to 5.20V at all times after power-on

Physical

Size	Single slot, half-length PCI card (4.2 inches x 7.2 inches)
Weight	500 g

I/O Connectors

ECLK	SMA female connector
CH A, CH B, TRIG IN, TRIG OUT	BNC female connectors

Environmental

Operating temperature	0 to 55 °C
Storage temperature	-20 to 70 °C
Relative humidity	5 to 95%, non-condensing

Acquisition System

Resolution	14 bits Data is returned as MSB-justified 16-bit unsigned integers

Bandwidth (-3dB)	
DC-coupled, 1MΩ	DC - 65 MHz
DC-coupled, 50Ω	DC - 65 MHz
AC-coupled, 1MΩ	10 Hz - 65 MHz
AC-coupled, 50Ω	100KHz - 65 MHz
Bandwidth flatness:	± 1dB, from DC to 10 MHz with DC coupling ± 1dB, from 50Hz to 10 MHz with AC, 1 MΩ ± 1dB, from 200 KHz to 10 MHz with AC, 50Ω
Bandwidth Limit	20 MHz, typical. Software selectable for each input channel independently
Number of channels	2 simultaneously sampled
Maximum Sample Rate	125 MS/s single shot
Minimum Sample Rate	10 KS/s single shot (internal clock)
Full Scale Input ranges	
1 MΩ:	±20mV, ±40mV, ±50mV, ±80mV, ±100mV, ±200mV, ±400mV, ±500mV, ±800mV, ±1V, ±2V, ±4V, ±5V, ±8V and ±10V, software selectable
50 Ω:	±20mV, ±40mV, ±50mV, ±80mV, ±100mV, ±200mV, ±400mV, ±500mV, ±800mV, ±1V, ±2V and ±4V, software selectable
DC accuracy	±2% of full scale in all input ranges
Input coupling	AC or DC, software selectable
Input impedance	50Ω or 1MΩ ±1% in parallel with 30 pF ±10pF, software selectable
Input protection	
1MΩ	±28V (DC + peak AC for CH A, CH B and EXT only without external attenuation)
50Ω	±5V (DC + peak AC for CH A, CH B and EXT only without external attenuation)

Amplifier Bypass Mode

DIP Switch Selectable	Yes, independently for each channel
Input Range	Approximately 525 mV rms (+7.5 dBm)
Input Coupling	DC, irrespective of input coupling setting for the channel
Input Impedance	50 Ω, irrespective of input impedance setting for the channel
Input Bandwidth (-3dB)	85 MHz

Acquisition Memory System

Acquisition Memory/channel	For ATS460-8M: Up to 8,000,000 samples per channel standard For ATS460-128M: Up to 128,000,000 samples per channel standard
Record Length	Software selectable with 16-point resolution. Record length must be a minimum of 128 points. Maximum record length is limited by the acquisition memory per channel.
Number of Records	Software selectable from a minimum of 1 to a maximum of 256,000 or (Acquisition Memory Per Channel / (Record Length+16)), whichever is lower
Pre-trigger depth	0 to (Record Length-64), software selectable with 16 point resolution
Post-trigger depth	Record Length - Pre-trigger depth

Timebase System

Timebase options	Internal Clock or External Clock (Optional)
Internal Sample Rates	125 MS/s, 100 MS/s, 50 MS/s, 20 MS/s, 10 MS/s, 5 MS/s, 2 MS/s, 1 MS/s, 500 KS/s, 200 KS/s, 100KS/s, 50 KS/s, 20KS/s, 10KS/s
Internal Clock accuracy	±25 ppm

Dynamic Parameters

Typical values measured using a randomly selected ATS460 with Amplifier Bypass Mode. Input was provided by a HP8656A signal generator, followed by a 9-pole, 1 MHz band-pass filter (TTE Q36T-1M-100K-50-720B). Input frequency was set at 1 MHz and output amplitude was 500 mV rms, which is approximately 95% of the 525 mVrms full scale input in Amplifier Bypass Mode.

SNR	70.8 dB
SINAD	67.99 dB
THD	-71.13 dB
SFDR	-71.56 dB

Note that these measurements were made using raw data: no signal averaging was used to artificially improve the results.

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

Optional ECLK (External Clock) Input

Signal Level	LVTTL levels or 500 mV sine wave
Input impedance	50Ω, 1 KΩ, DIP switch selectable
Input Coupling	AC or DC, DIP switch selectable
Maximum frequency	
Fast External Clock:	125 MHz with 50% ±5% duty cycle
Medium External Clock:	80 MHz with 50% ±5% duty cycle
Slow External Clock:	10 MHz with minimum positive or negative pulse width of 8 ns
Minimum frequency	
Fast External Clock:	80 MHz with 50% ±5% duty cycle
Medium External Clock:	10 MHz with 50% ±5% duty cycle
Slow External Clock:	DC
Decimation factor	Software selectable from 1 to 100,000 Fixed to 1 for Slow External Clock
Sampling Edge	Rising or Falling, software selectable

Triggering System

Mode	Edge triggering with fixed hysteresis
Number of Trigger Engines	2
Trigger Engine Combination	OR, AND, XOR, software selectable
Trigger Engine Source	CH A, CH B, EXT, Software or None, independently software selectable for each of the two Trigger Engines
Hysteresis	±5% of full-scale input, typical
Trigger sensitivity	±10% of full scale input range. This implies that the trigger system may not trigger reliably if the input has an amplitude less than ±10% of full-scale input range selected
Trigger level accuracy	±10%, typical, of full-scale input range of the selected trigger source
Bandwidth	65 MHz
Trigger Delay	Software selectable from 0 to 9,999,999 sampling clock cycles
Trigger Timeout	Software selectable with a 10 us resolution. Maximum settable value is 3,600 seconds. Can also be disabled to wait indefinitely for a trigger event

Optional TRIG OUT Output

Output Signal	5 Volt TTL
Synchronization	Synchronized to rising edge of sampling clock

EXT (External Trigger) Input

Input impedance	1 MΩ in parallel with 30pF ±10pF
Bandwidth (-3dB)	
DC-coupled	DC - 25 MHz
AC-coupled	10 Hz - 25 MHz
Input range	±5V or ±1V, software selectable
DC accuracy	±10% of full-scale input
Input protection	±28V (DC + peak AC without external attenuation)
Coupling	AC or DC, software selectable

Certification and Compliances

CE Mark Compliance

Materials Supplied

One ATS460 Digitizer

One ATS460 Install Disk (CD)

One ATS460 User Manual

All specifications are subject to change without notice



ALAZAR TECHNOLOGIES INC.
6600 Trans-Canada Highway, Suite 310
Pointe-Claire, QC
CANADA H9R 4S2

Tel: (514) 426-4899
Fax: (514) 426-2723

E-mail: info@alazartech.com
Web: www.alazartech.com

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