PCI Digitizers
BY ALAZARTECH

ATS660
125 MS/s 16-Bit PCI Digitizer

- 2 channels sampled at 16-bit resolution
- 125 MS/s simultaneous real-time sampling rate on each input
- ±200mV to ±16V input range
- Up to 128 Million samples of on-board acquisition memory per channel
- Dual Port Memory
- FPGA customization for DDC, FIR, FFT ...
- API Panel software allows quick start-up without any development process
- Software Development Kit supports C/C++, VB and LabVIEW. Also Linux



Product	Bus	Operating System	Channels	Sampling Rate	Bandwidth	Memory Per Channel	Resolution
ATS660	PCI	Windows 2000/XP/ 98SE, Linux 2.6	2	125 MS/s to 10 KS/s	65 MHz	Up to 128 Msamples	16 bits

Overview

ATS660 is a state of the art, dual-channel, high resolution, 16 bit, 125 MS/s waveform digitizer card for PCI bus, capable of storing up to 128 Million samples per channel of acquired data in its on-board memory.

With standard Dual Port Memory, ATS660 allows users to build real-time data acquisition systems even under the Windows operating system, as users are allowed to read acquired data even while the next acquisition is in progress. This includes the ability to stream data to disk at rates up to 10 MS/s on one channel and 5 MS/s on 2 channels.

ATS660 PCI digitizers are an ideal solution for cost sensitive OEM applications that require a digitizer to be embedded into the customer's equipment.

For scientific customers who want to record multiple analog inputs simultaneously, ATS660 offers the best price-performance ratio for multi-channel data acquisition systems of up to 16 channels.

ATS660 is supplied with API Panel software that lets the user get started immediately without having to go through a software development process.

Users who need to integrate the ATS660 in their own program can purchase a Windows based software development kit, ATS-SDK for C/C++ and VB, or ATS-VI for LabVIEW for Windows or a Linux based ATS-Linux.

All of this advanced functionality is packaged in a low power, half-length PCI card available at a very aggressive price point.

Analog Input

An ATS660 features two analog input channels with extensive functionality. Each channel has 65 MHz of full power analog input bandwidth. With software selectable attenuation, you can achieve an input voltage range of ±200mV to ±16V. Attenuating probes (sold separately) can extend the voltage range even higher.

Software selectable AC or DC coupling further increases the signal measurement capability. Software selectable 50Ω input impedance makes it easy to interface to high speed RF signals.

For applications that require the best signal integrity, an Amplifier Bypass Mode is available as a standard feature. This feature increases the SNR to 75 dB, increases input bandwith to 85 MHz while leaving the input range fixed at a nominal value of ±725 mV.

Acquisition System

ATS660 PCI digitizers use a pair of state of the art 125 MS/s, 16-bit ADCs to digitize the input signals. The real-time sampling rate ranges from 125 MS/s down to 1 KS/s. The two channels are guaranteed to be simultaneous, as they share the exact same clock.

An acquisition can consist of multiple records, with each record being captured as a result of one trigger event. A record may contain both pre-trigger and post-trigger data.

Up to 256,000 triggers can be captured into on-board memory. There is no limit on number of triggers if dual port memory is used to acquire data.

In between the multiple triggers being captured, the acquisition system is re-armed by the hardware within 32 sampling clock cycles.

This mode of capture, sometimes referred to as Multiple Record, is very useful for capturing data in applications with a very rapid or unpredictable trigger rate. Examples of such applications include medical imaging, ultrasonic testing, OCT, NMR spectroscopy and lightning test.

On-Board Acquisition Memory

The standard ATS660 PCI digitizer features a total of 32 MBytes (16 Megasamples) of onboard memory, providing up to 8 Million points of acquisition memory for each channel.

Acquisition memory can optionally be upgraded to provide 128 Million samples per channel of signal storage.

Data is acquired into the onboard memory before being transferred to the host PC memory. This transfer is performed using Direct Memory Access (DMA), which uses scatter-gather bus mastering technology.

Dual Port Memory

ATS660 features dual port acquisition memory. This means that data can be transferred to host PC memory even if an acquisition is in progress.

Other digitizers on the market do not provide dual-port memory, thus prolonging the re-arm time of the digitizer. This limits the maximum trigger repeat rate they can handle in applications involving fast triggers, such as medical imaging, ultrasonic testing, NMR spectroscopy and other pulse-echo testing methodologies.

ATS660, equipped with Dual Port Memory option, does not suffer from such drawbacks and provides the best solution for these applications.

Dual Port Memory also allows streaming of acquired data over PCI bus. Streaming to disk has been tested at rates of 10 MS/s on one channel and 5 MS/s on 2 channels. Even faster rates have been achieved using RAID systems.

FPGA Customization

A number of OEM applications require real-time signal processing of the digitized data. ATS660 contains a large FPGA with ample resources, including hardware multipliers, to implement FIR filters, demodulation, IQ detection, DDC, FFT etc.

All customization work has to be done at AlazarTech factory. Contact the factory to discuss your specific needs.

Software Selectable Bandwidth Limit

A majority of applications for PCI digitizers require oversampling of input signal, i.e. the frequency of the analog signal being digitized is a factor of 5 or 6 lower than the sample rate or even the Nyquist rate.

ATS660 features a software-controlled bandwidth limit switch, which reduces high frequency noise and improves signal to noise ratio. This switch is independently selectable for each input channel.

When selected, bandwidth limit switch can reduce the input bandwidth of a particular input to be approximately 20 MHz.

Natural Input Range

A waveform digitizer provides the best dynamic performance when it is operated within its Natural Input Range (NIR). The NIR of a digitizer is defined as the input range for which the input signal has the minimum amount of gain or attenuation.

Minimum gain ensures that there is a minimum amount of noise that is injected into the signal due to amplification. Minimum attenuation ensures that the ratio between the signal amplitude and the ground noise is the highest.

NIR for the ATS660 is the ±800 Volt input range.

Amplifier Bypass Mode

To obtain optimum dynamic performance, choose the Amplifier Bypass Mode. This mode comes standard with the ATS660.

Each channel can be independently bypassed using on-board DIP-switches.

Once the amplifier has been bypassed, the input for that channel has 50Ω impedance, DC coupling and a 575 mV full scale input range. Diode protection is still included, but users should avoid saturation of the input beyond 120% of full scale

Display of Very Large Data Sets

Capturing a very large amount of data is only part of the solution the ATS660 offers. ATS660 also provides very fast rendering of this data on the computer screen.

Most products on the market that provide large amount of storage memory use standard Windows display routines to plot data on the screen. This is extremely slow and can take many minutes to update the screen. Many software packages, such as LabVIEW, explicitly warn against using large data arrays.

ATS660 uses custom HyperDisP display management technology to render these very large datasets on the computer screen in a fraction of a second.

Zooming in and out of the signal is also supported by the custom HyperDisP display management technology.

Triggering

The ATS660 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, ATS660 offers two trigger engines (called Engines X and Y). This allows the user to combine the two engines using a logical OR, AND or XOR operand.

The user can specify the number of records to capture in an acquisition, the length of each record and the amount of pre-trigger data.

A programmable trigger delay can also be set by the user. This is very useful for capturing the signal of interest in a pulse-echo application, such as ultrasound, radar, lidar etc.

Trigger Time Stamp

A 40-bit time stamp counter comes standard with the ATS660. By default, this counter is initialized to a zero value when an acquisition session is started and increments once for every two samples captured, thus providing a 2-clock timing accuracy. At 125 MS/s sample rate, this counter will not roll over for well over 2 hours.

The value of this counter is latched into trigger memory for each trigger, i.e. once per record, for up to specified number of records.

This allows the user to find out the timing of each trigger in a multiple record acquisition relative to the start of the acquisition.

It is also possible to configure the timestamp counter to reset for the first subsequent acquisition only and never again, until a software reset is issued. This feature enables users to obtain precise timing information about multiple acquisitions.

Multiple-Digitizer Synchronization

ATS660 features a Master/Slave connector that allows synchronization of multiple digitizers to allow truly synchronous sampling across as many as 16 channels.

A SyncBoard 460 (sold separately) is required to connect the Master/Slave connectors on multiple digitizers in the system together. Such a system is called a Master/Slave system.

SyncBoard 460 is a board-level product that features controlled impedance, equal length traces to deliver Positive Emitter Coupled Logic (PECL) level clock, trigger and initialization signals to each ATS660 in the system.

A Master/Slave system is guaranteed to sample simultaneously across all channels in that system. Triggering is also guaranteed to be simultaneous across all digitizers in the system.

ATS660 based master/slave systems provide the best price-performance for high channel count systems.

Optional External Clock

While the ATS660 features low jitter, high reliability 125 MHz and 100 MHz crystal oscillators as the source of the timebase system, there may be occasions when digitizing has to be synchronized to an external clock source.

ATS660 External Clock option provides an SMA input for an external clock signal, which can be a sine wave or LVTTL signal.

User can set the input impedance and coupling for the external clock input by setting the appropriate DIP switches located in the top-left corner of the ATS660 printed circuit board.

In order to operate the ADC under optimal conditions, the user must set the appropriate frequency range for the external clock being supplied. The following ranges are supported:

Fast External Clock: $1\ \text{MHz} < f_{EXT} < 125\ \text{MHz}$

Slow External Clock: $f_{EXT} < 1\ \text{MHz}$

The active edge of the external clock is software selectable between the rising or falling edge.

AUX Connector

ATS660 provides an AUX (Auxiliary) BNC onnector that is configured as a Trigger Output connector upon by default.

When configured as a Trigger Output, AUX BNC connector outputs a 5 Volt TTL signal synchronous to the ATS660 Trigger signal, allowing users to synchronize their test systems to the ATS660 Trigger.

When combined with the Trigger Delay feature of the ATS660, this option is ideal for ultrasonic and other pulse-echo imaging applications.

Other uses of AUX connector include its use as a Trigger Enable Input and Clock Output.

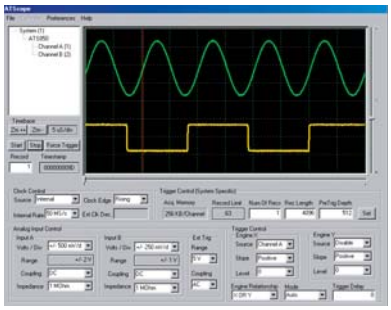
Calibration

Every ATS660 digitizer is factory calibrated to NIST-traceable standards. To recalibrate an ATS660, the digitizer must either be shipped back to the factory or a qualified metrology lab.

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Software



ATS660 is supplied with the API Panel software that allows the user to setup the acquisition hardware and capture, display and archive the signals.

A Windows compatible software development kit, ATS-SDK is also offered. It allows programs written in C/C++ and VisualBASIC to fully control the ATS660.

A set of high performance VIs for LabVIEW 6.1 and higher, called ATS-VI, can also be purchased.

A Linux based software development kit, ATS-Linux, is also available. Linux kernel versions up to v2.6 are supported.

DUAL PORT MEMORY

ATS660 offers dual-port memory that improves high speed data acquisition in many applications.

The simplest example of such an application is the ability to stream data over PCI bus into a disk drive.

The on-board acquisition memory of the ATS660 acts as a very deep FIFO, thus providing a buffer against system latencies introduced by the operating system (Windows or Linux).

Thanks to ATS660's dual-port memory, data throughput is usually limited by the speed of the disk drives and not the speed of acquisition.

A more complex example is burst trigger captures found in pulse-echo testing such as ultrasonics, radar, lidar, OCT, medical imaging etc.

In these applications, a trigger is received at a high repeat rate and a short record has to be captured for each trigger on one or two (or more) channels. Sometimes, this record also has to have pre-trigger data. In many of these applications, it is also important not to miss any triggers.

AlazarTech designed its proprietary AutoDMA circuitry to manage dual-port memory for such applications.

Firstly, users are allowed to segment the on-board memory into many short circular buffers. Each buffer is used to acquire pre- and post-trigger data from one trigger event.

Once the record for this trigger has been recorded into on-board memory, a DMA transfer is launched to transfer this data to PC memory, without any CPU involvement. All this time, the next record is being recorded in the next circular buffer.

Once a trigger record has been transferred to PC memory, that circular buffer can be re-used for another trigger.

This sequence can go on infinitely, producing Gigabytes of data even with a card with only 8 Meg memory per channel.

A high-level API allows most Windows (or Linux) programs to take advantage of dual port memory.

Tests have shown dual-port AutoDMA based burst transfers to yeild trigger repeat rates almost 10 times faster than the traditional arm-acquire-transfer sequence used by other single-ported digitizers on the market.

It's true: Two are better than one!

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System Requirements

Pentium based computer with at least one free PCI slot, 512 MB RAM, 100 MB of free hard disk space, SVGA display adaptor and monitor with at least a 800 x 600 resolution. API Panel software requires Internet Explorer 5.0 or higher.

Power Requirements

+5V	2.5 A, typical for ATS660-8M 3.0 A, typical for ATS660-128M +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

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

Environmental

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

Acquisition System

Resolution	16 bits Data is returned as 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
Number of channels	2, simultaneously sampled
Maximum Sample Rate	125 MS/s single shot
Minimum Sample Rate	1 KS/s single shot for internal clocking
Full Scale Input ranges	
1 MΩ input impedance:	±200mV, ±400mV, ±800mV, ±2V, ±4V, ±8V, and ±16V, software selectable
50 Ω input impedance:	±200mV, ±400mV, ±800mV, ±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 50 pF ±10pF, software selectable
Input protection	
1MΩ	±28V (DC + peak AC for CH A, CH B and EXT only without external attenuation)
50Ω	±4V (DC + peak AC for CH A, CH B and EXT only without external attenuation)

Amplifier Bypass Mode

Standard Feature	Yes
DIP Switch selectable	Yes, independently for each channel
Input Range	Approx. 725 mV rms
Input Coupling	DC, irrespective of the input coupling setting for the channel
Input Impedance	50 Ω, irrespective of the input impedance setting for the channel
Input bandwidth (-3dB)	85 MHz

On-Board Acquisition Memory System

Onboard acq memory	32 MB for ATS660-8M 512 MB for ATS660-128M
Acquisition Memory/ch	Up to 8 Million samples per channel for ATS660-8M Up to 128 Million samples per channel for ATS660-128M
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, 20 KS/s, 10 KS/s, 5 KS/s, 2 KS/s, 1 KS/s
Internal Clock accuracy	±25 ppm

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Dynamic Parameters

Typical values measured using a randomly selected ATS660 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	72.9 dB
SINAD	72.3 dB
THD	-83 dB
SFDR	-82 dB

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

Optional ECLK (External Clock) Input

Signal Level	±500mV Sine wave or 3.3V LVTTL
Input impedance	50Ω or 1KΩ, selectable
Maximum frequency	125 MHz for Fast External Clock 10 MHz for Slow External Clock
Minimum frequency	1 MHz for Fast External Clock DC for Slow External Clock
Decimation factor	Software selectable from 1 to 100,000
Sampling Edge	Rising or Falling, software selectable

Triggering System

Mode	Edge triggering with hysteresis
Comparator Type	Digital comparators for internal (CH A, CHB) triggering and analog comparators for TRIG IN (External) triggering
Number of Trigger Engines	2
Trigger Engine Combination	OR, AND, XOR, selectable
Trigger Engine Source	CH A, CH B, EXT, Software or None, independently software selectable for each of the two Trigger Engines
Hysteresis	±5% of full scale input, typical
Trigger sensitivity	±10% of full scale input range. This implies that the trigger system may not trigger reliably if the input has an amplitude less than ±10% of full scale input range selected
Trigger level accuracy	±5%, typical, of full scale input range of the selected trigger source
Bandwidth	65 MHz
Trigger Delay	Software selectable from 0 to 9,999,999 sampling clock cycles
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

ORDERING INFORMATION

ATS660-8M	ATS660-001
ATS660-128M	ATS660-010
ATS660: 8 Meg to 128 Meg Upgrade	ATS660-011
ATS660: External Clock Upgrade	ATS660-004
SyncBoard 460 2X	ATS660-006
SyncBoard 460 4X	ATS660-007
SyncBoard 460 8X	ATS660-008
C/C++, VB SDK for ATS660	ATS660-SDK
LabVIEW VI for ATS660	ATS660-VI
Linux Driver for ATS660	ATS660-Linux

TRIG IN (External Trigger) Input

Input impedance	1 MΩ in parallel with 50pF ±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

TRIG OUT Output

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

Materials Supplied

- ATS660 PCI Card
- ATS660 Hardware Manual
- ATS660 Install Disk

Certification and Compliances

CE Mark Compliance

All specifications are subject to change without notice

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