

Acquitek XM Series

Multifunction Analog I/O Boards for PXI

User Manual
July 2004

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Acquitek XM Series

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1

Introduction

The Acquitek XM Series of multifunction analog I/O boards was designed to provide high speed and 16 Bit precision at a low price to meet challenging PC-based instrumentation applications. All XM Series boards utilize an onboard processor, large local memory buffers, and PCI bus mastering to provide glitch-free capture and output of analog waveforms with nearly unlimited lengths. This performance is provided even under non-realtime PC operating systems when running complex user applications, which are supported by a comprehensive Software Development Kit and sample code.

With up to 32 inputs sampled at up to 1 MHz and flexible triggering, the XM Series is ideal for high-speed automation and control applications. The onboard DSP coprocessor can offload critical real-time tasks, such as event-driven channel sequence changes or sensor input linearization (through look up tables or computation), to free the host program for higher-level algorithms and applications. The outputs are waveform quality with both waveform playback capability and function generation, or they can be slaved to the input channel sequence. The board is PCI Plug-and-Play and autocalibrating, so there are no jumpers or potentiometers to manually adjust.

Features:

- 16/32 Single Ended Inputs (8/16 in Differential Mode)
- Up to 1 MS/s Maximum Sampling Rate
- 16 Bit A/D Resolution
- Up to 16 MB (8 MSample) Local Acquisition Memory
- 64K Channel-Gain List
- Flexible Triggering Modes
- Up to 2 Output Channels (Waveform Quality)
- Up to 1 MS/s D/A Converter per Channel
- 16 Bit D/A Resolution
- Up to 16 MB (8 MSample) Local Waveform Memory
- 1 Hz Sample Clock Resolution from onboard DDS
- 16/32 Digital I/O's (synchronous with analog I/O)
- Up to 3 Counter/Timers
- PCI Bus-Mastering Transfers
- Onboard 143 MHz, 32 Bit DSP for Real-Time Processing and Control
- Windows 98/Me/2000/XP

XM Series Product Line:

XM Series - 250 kHz (1x, 2x, 4x, 8x Gain)

XM-2320	16 analog in, 16 digital I/O, 2 analog outputs, 250 kHz
XM-2310	16 analog in, 16 digital I/O, 0 analog outputs, 250 kHz
XM-2350	32 analog in, 32 digital I/O, 2 analog outputs, 250 kHz
XM-2340	32 analog in, 32 digital I/O, 0 analog outputs, 250 kHz

XM Series - 250 kHz (High Gain: 1x,10x,100x,1000x Gain)

XM-2321	16 analog in, 16 digital I/O, 2 analog outputs, 250 kHz
XM-2311	16 analog in, 16 digital I/O, 0 analog outputs, 250 kHz
XM-2351	32 analog in, 32 digital I/O, 2 analog outputs, 250 kHz
XM-2341	32 analog in, 32 digital I/O, 0 analog outputs, 250 kHz

XM Series - 1 MHz (1x, 2x, 4x, 8x Gain)

XM-2420	16 analog in, 16 digital I/O, 2 analog outputs, 1 MHz
XM-2410	16 analog in, 16 digital I/O, 0 analog outputs, 1 MHz
XM-2450	32 analog in, 32 digital I/O, 2 analog outputs, 1 MHz
XM-2440	32 analog in, 32 digital I/O, 0 analog outputs, 1 MHz

XM Series - 1 MHz (High Gain: 1x,10x,100x,1000x Gain)

XM-2421	16 analog in, 16 digital I/O, 2 analog outputs, 1 MHz
XM-2411	16 analog in, 16 digital I/O, 0 analog outputs, 1 MHz
XM-2451	32 analog in, 32 digital I/O, 2 analog outputs, 1 MHz
XM-2441	32 analog in, 32 digital I/O, 0 analog outputs, 1 MHz

2

Installation

XM Series Installation

To install the XM Series hardware and software, complete the following steps:

Install the Acquitek Data Acquisition Hardware

- Turn off your computer and disconnect the power cord.
- Locate a free PXI expansion slot.
- Carefully remove the card from its packaging.
- Insert the card into the PXI expansion slot and activate the latch
- Reconnect the power cord.

Connect the Cables

- Connect the IO cables to your external devices or breakout board.

Install the Windows Device Drivers

- Turn on the computer.
- When Microsoft Windows boots, it should discover the new device and launch the New Hardware Wizard.
- Insert the Acquitek Data Acquisition Setup CD into your CD-ROM drive.
- Direct the New Hardware Wizard to search the CD-ROM drive for the device drivers.
- Windows may warn that the drivers are not authenticated. Proceed with installation.
- After the drivers are installed, remove the CD and reboot your computer.

Install the Application Software and Third Party Drivers

- Insert the Acquitek Data Acquisition Setup CD into your CD-ROM drive.
- Run Setup.exe from the root directory of the CD
- Follow the onscreen instructions to install the application and driver software. It is recommended that you leave installation options unchanged to perform a full installation of all software components.
- After the installation completes, remove the CD and reboot your computer.

Configure the Data Acquisition Hardware

- Run Acquitek Control Center from the Acquitek program group on the Windows Start menu.
- The new data acquisition device should appear as a node in the Local System | Hardware | Acquitek | PCI/PXI branch of the System tree. Click on the node.
- The serial number and logical device number will display in the Configuration pane. The logical device number is the tag that all application software uses to specify which hardware device will be used.
- To change the assigned device number, click on the configuration tab and select a new number using the device number edit control. Click the save button to make the change permanent.

Test the Data Acquisition Hardware

- If Acquitek Control Center is not still running, re-run the application from the Acquitek program group on the Windows Start menu and select the System tree node for the data acquisition device.
- Select the Test tab in the Configuration pane.
- The displayed test panels can be used to test all analog input channels and analog output channels as well as the digital IO lines. Connecting an analog output to an analog input, then turning on both panels can be used as a quick check to verify basic operation.

Run Application Software

- Installation and configuration of the Acquitek data acquisition hardware and software is now complete.
- You can run the included Acquitek Bench application software to use the device in a wide range of test and measurement tasks.
- Remember that all application software will refer to the data acquisition hardware using the logical number assigned by Acquitek Control Center.

3

Hardware Overview

Hardware Overview

The Acquiretek XM Series of multifunction analog I/O boards was designed to provide high speed and 16-bit precision at a low price to meet challenging PC-based instrumentation applications. All XM Series boards utilize an onboard processor, large local memory buffers, and PCI bus mastering to provide glitch-free capture and output of analog waveforms with nearly unlimited lengths. This performance is provided even under non-realtime PC operating systems when running complex user applications, which are supported by a comprehensive Software Development Kit and sample code. With up to 32 inputs sampled at up to 1 MHz and flexible triggering, the XM Series is ideal for high-speed automation and control applications. The onboard DSP coprocessor can offload critical real-time tasks, such as event-driven channel sequence changes or sensor input linearization (through look up tables or computation), to free the host program for higher-level algorithms and applications. The outputs are waveform quality with both waveform playback capability and function generation, or they can be slaved to the input channel sequence. The board is PCI Plug-and-Play and autocalibrating, so there are no jumpers or potentiometers to manually adjust.

The XM architecture is shown below in figure 3-1.

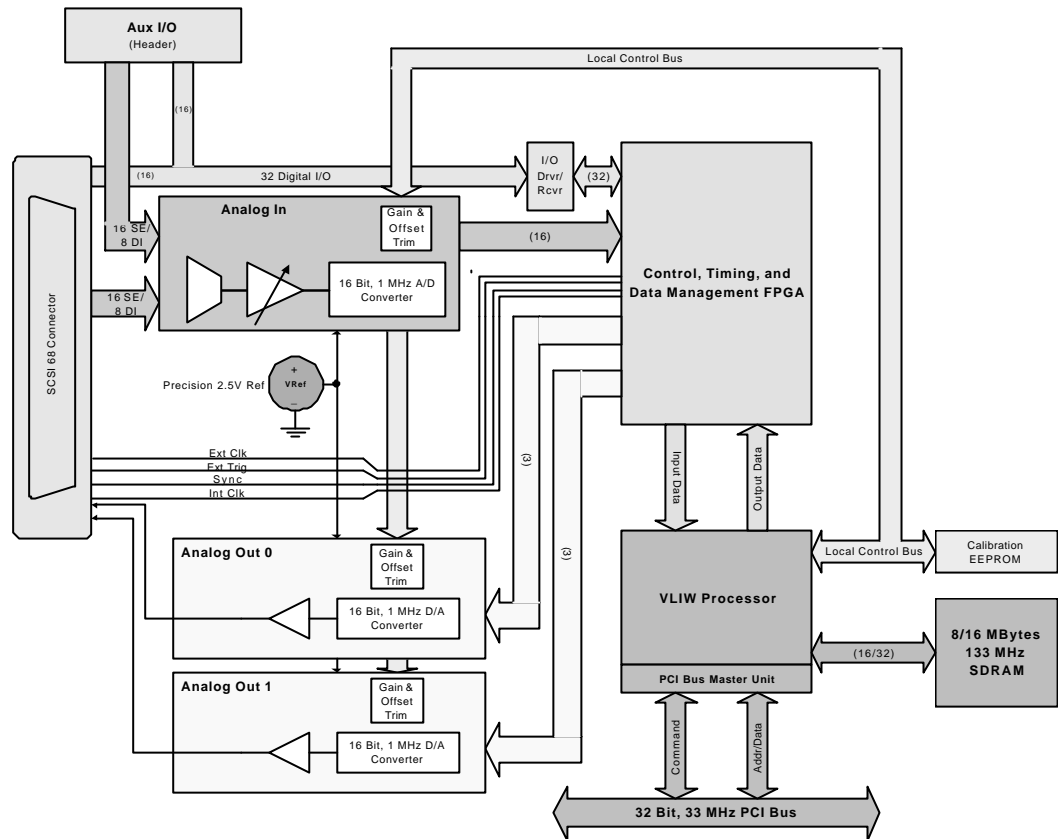


Figure 3-1 – XM Board Block Diagram

The mechanical layout of the XM Series board is depicted in Figure 3-2 below. All members of the XM family share the same board footprint. Family members without analog outputs will have unpopulated components in the analog output section.

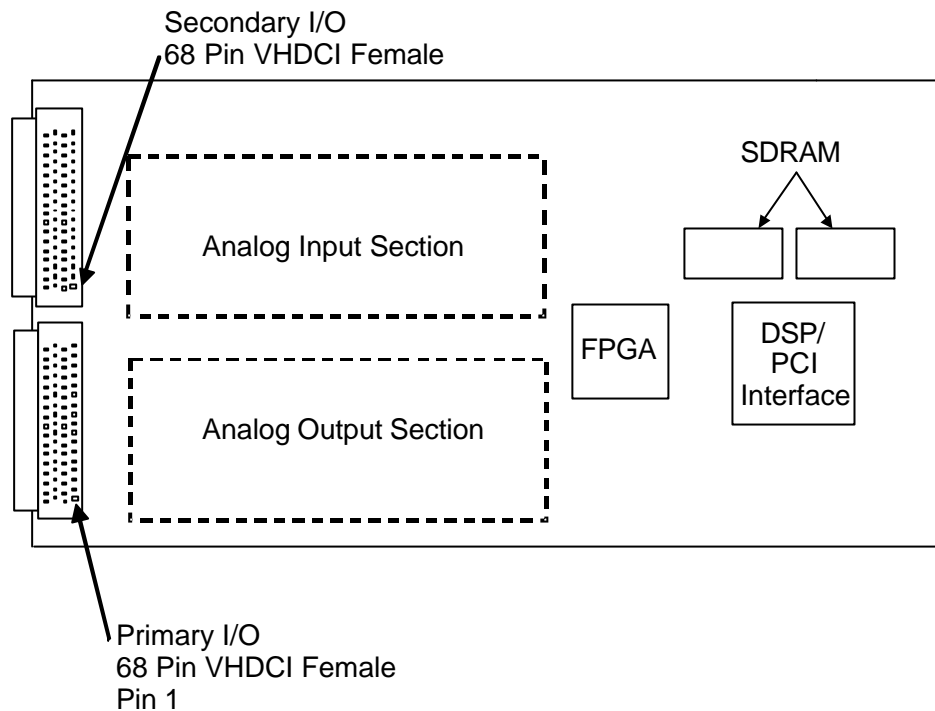


Figure 3-2 – XM Board Layout

Connectors

The XM board has one 68 pin female VHDCI connector on which 16 analog inputs, 16 digital I/O's, two analog outputs (if applicable) and a variety of timing and reference signals are brought out. The pinout of this connector is shown in Figure 3-3a below. An Acquitek B-1150/1155 with an L-485x connecting cable is recommended for use with this connector.

In addition, on an Acquitek 32 input XM board (i.e XM-2450), analog inputs 16-31 and digital I/O 16-31 are brought out on a second 68 pin female VHDCI connector. The pinout of this connector, which is very similar to the main connector, is shown in Figure 3-3b below. An additional Acquitek B-1150/1155 and L-485x cable is recommended for use with this connector. The B-1150/1155 and the L-485x cables are described below in the Accessories section.

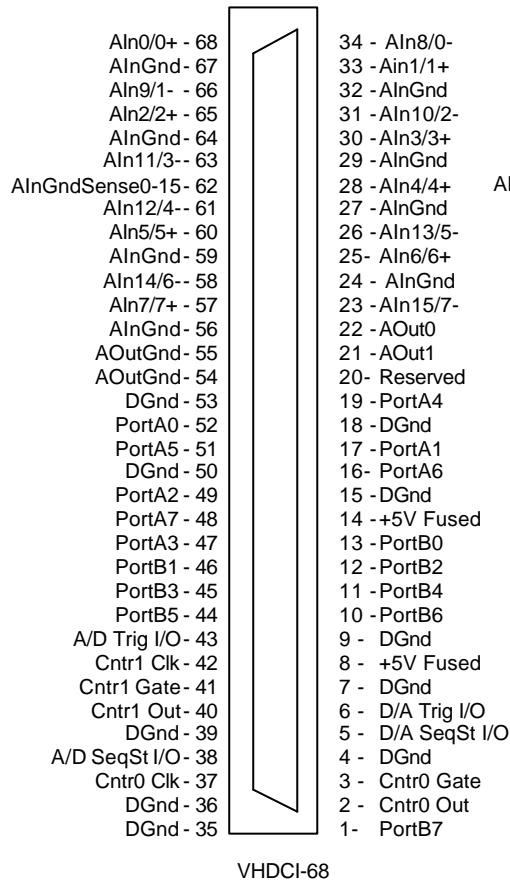


Figure 3-3a – XM VHDCI-68 Pinout

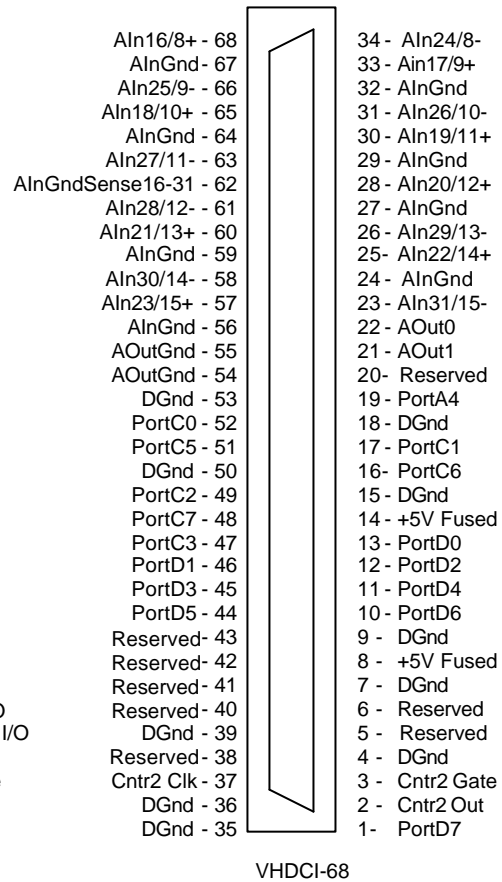


Figure 3-3b – XM Secondary VHDCI Pinout

Analog Inputs

The Acquiretek XM board has up to 32 analog inputs which are multiplexed into a programmable gain instrumentation amplifier and then converted into digital data by a 16 bit successive approximation A/D. The analog inputs are high impedance to prevent undesired loading of the system to be measured. High impedance inputs are prone to noise pickup. While crosstalk between channels of the XM board is small, best performance can be obtained by grounding unused inputs or capacitively coupling them to ground or to the reference in differential mode. This will minimize any chance for crosstalk. Additionally, it is possible for noise on an unused, unconnected input to saturate the instrumentation amplifier, particularly in high gain applications. The recovery time of the instrumentation amplifier from saturation is longer than normal switching time.

Taking precautions not to leave unused inputs floating will minimize the chance that such an input could be selected inadvertently leading to unexpected saturation and issues with switching.

Signal Input Modes

Three input modes are available to suit a variety of applications. A knowledge of the analog input signal modes and operation will help in achieving the maximum performance in any application.

Single Ended – In single ended mode, the input voltage is measured with respect to system ground at the computer. As shown in Figure 3-4, this can work well on a floating source.

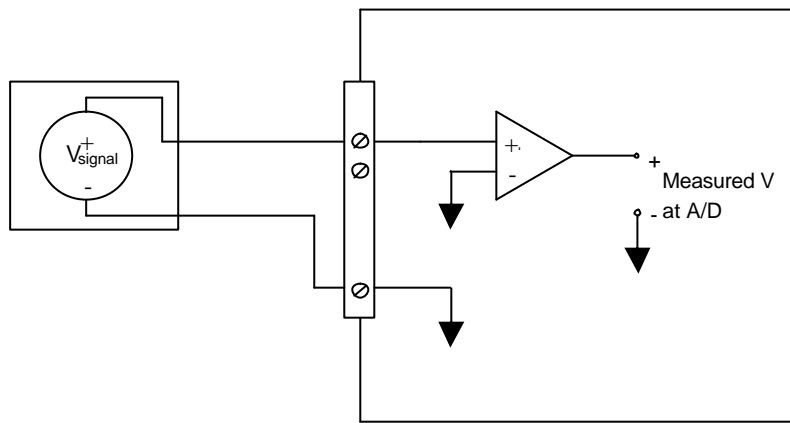


Figure 3-4 – Single Ended, Floating Source

However, as shown in Figure 3-5, in the situation where the source is referenced, problems may arise. It is common for the source being measured to have a different reference potential than the measurement computer, for example if they are powered from different circuits of the electrical distribution system. In this case, the resulting voltage measured by the A/D converter is $V_{\text{signal}} + V_{\text{cm}}$, where V_{cm} is the potential difference between the source ground and measurement computer ground. This can easily be on the order of volts in a typical commercial setting, and fluctuate as loads are connected or removed from the electrical distribution system.

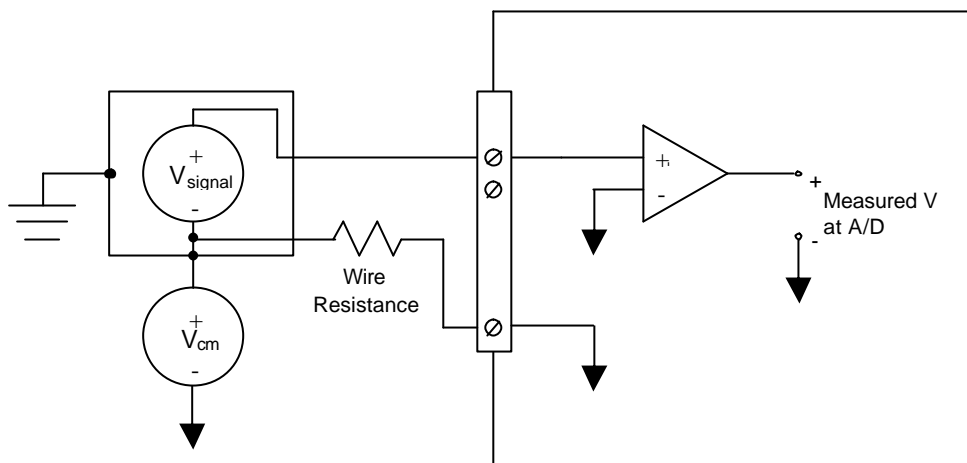


Figure 3-5 – Single Ended, Referenced

Finally, as shown in Figure 3-6, even the simple floating source scenario shown in Figure 3-4 can result in measurement errors due to noise pickup. This is because the signal line terminates in a high impedance PGIA input, while the reference line terminates in low impedance ground. The noise pickup will be far more severe on the high impedance signal line, resulting in the measurement of $V_{\text{signal}} + V_{\text{noisepickup}}$ at the A/D converter. The noise pickup will be most severe in long cable runs and with high impedance sources.

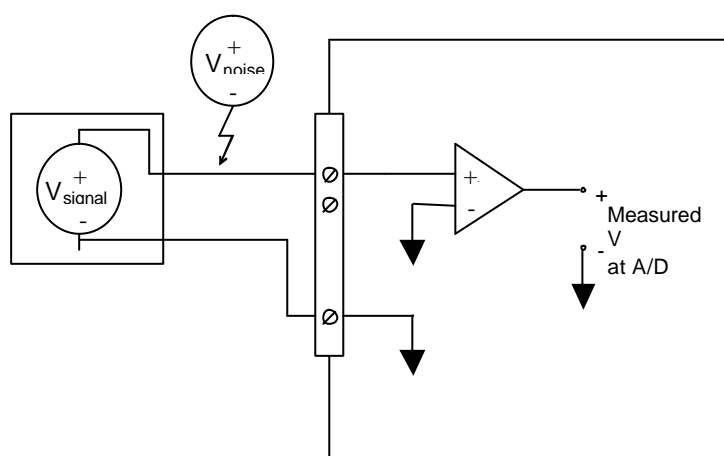


Figure 3-6 – Single Ended, Floating Source+Noise

For the given considerations, it is recommended that single ended mode only be used under the following conditions:

- cable runs of less than 3 meters, and
- signal levels of 1V or greater, and
- common power ground between input source and measurement computer.

Differential – Differential mode eliminates many of the problems associated with single ended input mode. As shown in Figure 3-7, a referenced source with a different reference potential than the measurement computer results in no measurement error when using differential mode.

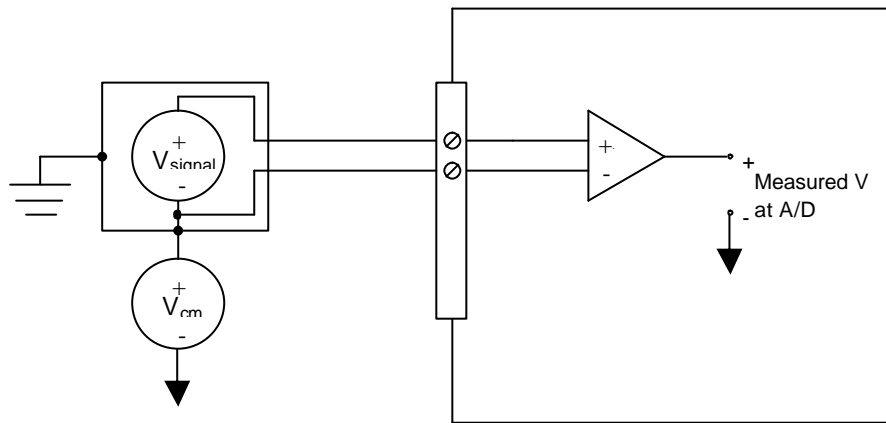


Figure 3-7 – Differential, Referenced Source

Also with differential mode, measurement error due to noise pickup is also reduced as compared to the single ended case. This is because both lines in the differential pair are terminated by a high impedance PGIA input. As long as both lines pass through essentially the same electromagnetic fields, which is the case when using twisted pair wires or wires in close proximity to each other, the noise induced on each line will be the same. The PGIA will reject the noise which is common to both lines of the differential pair.

When using differential mode with floating sources, care must be taken to keep the floating source within the common mode range of the XM board and outside the range which will trigger the input protection circuitry on the input multiplexer.

Please see the following sections regarding common mode range and input protection for details.

If these effects are problematic, a simple solution is to connect a large value resistor from one of the source terminals to system ground as shown in Figure 3-8 below. Assuming the differential voltage is within the XM range, this will keep the common mode voltage from causing trouble as well. 100kOhm is a good starting point. For faster sampling applications, reduce the value as low as possible given the differential source constraints. For slower sampling, values up to 10 MOhm will be sufficient to keep the common mode voltage within range and provide very little source loading.

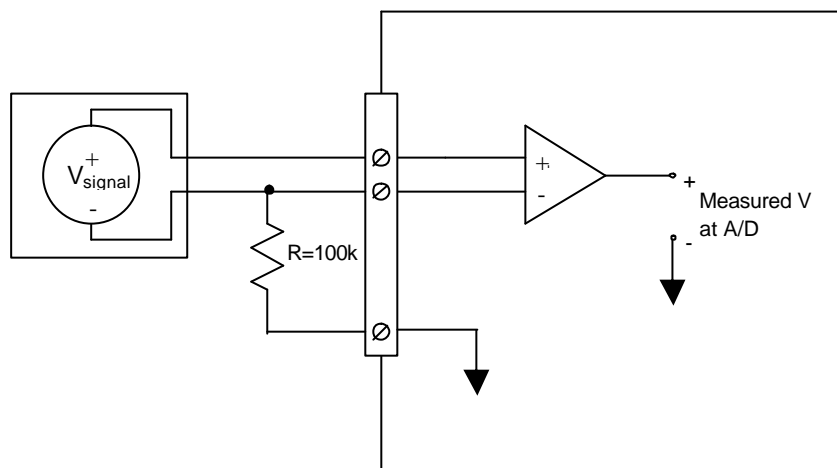


Figure 3-8 – Differential, large common mode source

Differential mode is the recommended input operating mode in nearly all cases.

Pseudo-Differential – While differential mode eliminates many of the problems associated with single ended input mode, it does so at the cost of reducing the number of available inputs by half. Pseudo-differential mode provides many of the same benefits of differential mode without reducing the number of available inputs.

In pseudo-differential mode, inputs are referenced to the pseudo-differential reference input, which is a high impedance input. As can be seen from Figure 9, this mode can be effective in eliminating measurement errors due to ground potential differences in a similar manner to differential mode. However, there is a

single pseudo-differential reference input which is shared among all analog inputs from 0-15. On 32 input boards, there is a second pseudo-differential reference input which is shared among analog inputs 16-31. Again referring to Figure 3-9, pseudo-differential mode will eliminate measurement errors due to ground potential difference only if all pseudo-differential inputs sharing a common pseudo-differential reference input also share the same voltage reference (which need not be the same as the measurement computer ground reference).

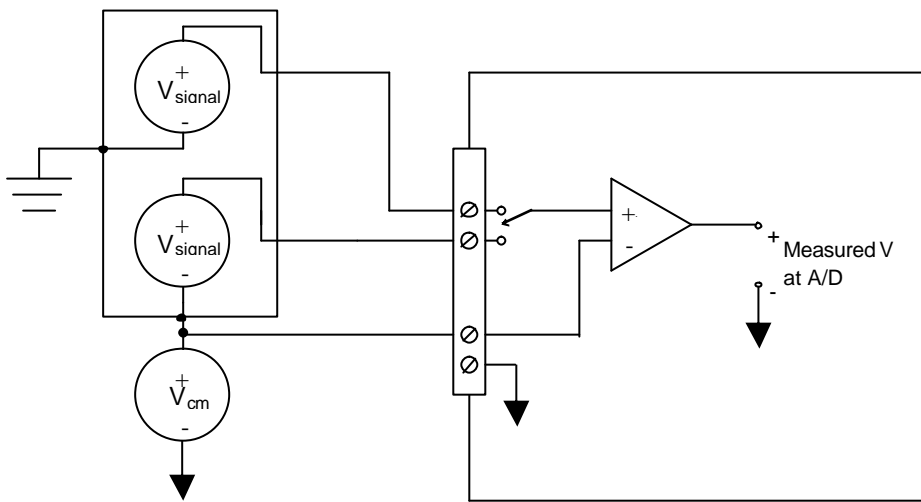


Figure 3-9 – Pseudo-Differential inputs

Common Mode Range

As shown in Figure 3-9 above, the instrumentation amplifier will not measure any signal between its inputs and ground, and only measure the difference between the voltages at its inputs. Both input signals must be in the range $A_{\text{inGnd}} - 10\text{V}$ to $A_{\text{inGnd}} + 10\text{V}$ in order for the instrumentation amplifier to function correctly.

Input Protection

As shown in the XM block diagram (Fig 3-1), the input multiplexer is the first component through which the analog inputs pass following the connector. The input multiplexer is fault protected to protect it and the downstream components from damage if the input is inadvertently connected to a source

voltage outside the analog input range. The overvoltage protection range is listed in the board specifications section. When the overvoltage protection is operating, the mux goes into a high impedance state and negligible current will flow into or from the board.

It is possible that a floating source will have enough static charge that its common mode voltage is in the range where the overvoltage protection is operable. In this event, since the mux is high impedance, no current will flow from the floating source to dissipate its common mode potential. It is therefore advisable to connect a high value resistor to reference a floating source to the XM board ground (10 MOhm is sufficient to drain static charge, but 10 kOhm may be preferable in a fast switching application).

Input Bias Current

The PGIA on the XM Series boards, like all instrumentation amplifiers, requires a return path for the bias currents at its inputs. In the case of the XM Series, the bias currents are extremely small, typically less than 10 pA. On the XM Series boards, there are onboard bias resistors of 10 MOhm on both the positive and negative PGIA inputs. These provide a path for the PGIA input bias current and introduce less than 100uV of measurement error. On a typical low impedance, referenced source, most of the bias current will flow through the source resistance and the measurement error will be much smaller. Having the bias resistors on board simplifies connection to a floating source, subject to the limitations discussed above in the Input Protection section. Without these onboard resistors, one or both terminals of a floating source would always require a resistive connection to ground to provide input bias current.

Multi-Channel Scanning

The XM series of multifunction boards can scan multiple inputs at the maximum sampling rate of the board. However, settling times of the analog input system must be accounted for in order to achieve accurate measurement results. Settling time is the amount of time required for a system to respond to a transient input event, such as an input switch in a multiplexed data system. If all of the inputs to be sampled are of similar magnitude and on the same input range, settling time may not be a factor. However, if different gains are used between input channels, *it will be very important to consider how settling time may affect measurement accuracy.* Settling times for the XM input and outputs are provided in the specifications section.

Settling time during multi-channel scanning is also adversely affected by a multiplexer property called charge injection. The analog input multiplexer injects a small amount of charge (given in the specifications section) into the selected input upon switching. This introduces a voltage error on the input equal to the charge injected divided by the input capacitance. The voltage error will decay according to the RC time constant of the input resistance and capacitance. High impedance inputs will cause the voltage error to take longer to decay, and thus the settling time could increase.

Note that if an input signal saturates the PGIA, there is a significantly longer overload recovery time than the normal PGIA settling time when switching inputs in a non-saturated case. Therefore it is strongly advised to select input ranges which will not cause the PGIA to become saturated. For the same reason, it is also suggested that unused inputs be grounded (in single ended mode) or tied to the reference signal (differential mode) to prevent noise pickup from saturating the PGIA if an unused input is inadvertently selected in the multichannel scan.

As discussed above, there are several potential pitfalls with multi-channel scanning. The user should consider alternatives to simple multi-channel scanning if in doubt about any of the above settling time limitations to avoid any channel to channel dependencies. One such alternative is to acquire multiple points consecutively from each channel before switching to the next channel. These points can be averaged to reduce the effects of system noise or noise pickup on cables. If multi-channels scanning is used, always use low impedance input sources.

Analog Outputs

Only applicable to boards equipped with analog outputs (XM-2320/2321, XM-2350/2351, XM-2420/2421, XM-2450/2451).

Many members of the XM Series are equipped with two analog outputs. These outputs have software selectable output ranges of 0 to 10V and -10 to +10V. In the unipolar mode, the data format is straight binary. In bipolar mode, the data format is two's complement.

The analog outputs can operate in quasi-static or clocked mode. The output circuitry has been designed with both high accuracy and fast settling time to permit output of high quality waveforms. The onboard DSP, deep onboard FIFO, and PCI bus mastering ensure reliable output of waveforms or other sequences at the full sample rate.

The outputs should not drive loads less than 2 KOhms. Output accuracy may be degraded with a lower resistance load. The outputs are short circuit current limited, but care should be taken to avoid long duration output shorts as the thermal strain may eventually damage the output driver.

Digital I/O

Each XM Series board has several digital I/O pins. The number of digital I/O's is equal to the number of analog inputs on the board. The digital I/O's are grouped into 8 bit ports. Each port can be configured as an input or output port. All 8 lines in each port are configured in the same direction. Upon reset, the port is configured as an input.

The digital I/O architecture uses a 74ACT gate as the driver and receiver, along with a 10 KOhm pull up resistor on each I/O. The 74ACT receiver has TTL compatible input logic thresholds and the driver can source or sink 24 mA output current.

The digital I/O's are capable of quasi-static operation or clocked mode. In clocked mode, each digital I/O is read on a clock which can be synchronous with the analog input clock. Thus, every digital I/O can be read at the maximum

sample rate of the board. Output is similar. All digital I/O's can be updated on a clock which can be synchronous with the analog output clock. In clocked mode, the digital I/O's share FIFO space with the analog inputs and outputs, but this has no detrimental effect on the analog signals since the FIFOs on the XM Series of boards are so large.

Counter/Timers

The XM series of boards are equipped with two or three identical counter/timer circuits. Each counter/timer circuit is fully available to the user; they are not used to provide timing clocks to either the analog inputs or analog outputs. The counter/timers emulate 82C54 operating modes as described below:

- **Mode 1: Retriggerable One Shot**
Out is high. Rising edge on gate triggers out to go low and down counting to start. Out stays low until count expires, at which point out goes high.
- **Mode 2: Rate Generator**
Out is high. Gate high enables down counting. When count expires, out goes low for one clock cycle, then high again. Count is reloaded and down counting continues. This results in a sequence of negative pulses of width $1/\text{clockFreq}$ and period $\text{countReg}/\text{clockFreq}$ being generated while gate is active.
- **Mode 3: Square Wave Generator**
Out is high. Gate high enables down counting. When count reaches $\text{count}/2$, out goes low. When count expires, out goes high. Count is reloaded and down counting continues. This results in a square wave of approximately 50% duty cycle and period $\text{countReg}/\text{clockFreq}$ being generated while gate is active.
- **Mode 5: Retriggerable Strobe**
Out is high. Rising edge on gate triggers down counting to start. Out stays high until count expires, at which point out goes low for one clock, then high again.

Note the countReg on the XM Series timers is 24 bits as compared to the 16 bit count registers on the 82C54. This provides for more versatility at high clock rates.

The clock source is software selectable from either the on-board sample clock or the external clock input pin. The gate source is also software selectable between software controlled gating or gating from an external pin. The counter/timer

output is available on a pin and can also trigger an interrupt in the onboard DSP. There is a separate external clock, gate, and output pin for each counter. The Acquiretek Data Acquisition SDK has documentation on the functions used for programming the counter/timers.

Triggers

The XM Series have many triggering options. Digital trigger inputs and outputs are available on the main connector to signal the start of a conversion, the start of an input sequence, the start of an output sequence, or an output update. Analog triggering is typically implemented in the board hardware by comparing the past and present A/D converter output values with register values corresponding to the trigger voltage and slope. Additionally, an analog trigger is available. It lies between the PGIA and the A/D converter as shown in Figure 3-10, and thus operates on a scaled, multiplexed input signal. The analog comparator triggering can be useful in detecting glitches on a signal which is being sampled at a low rate relative to the glitch duration.

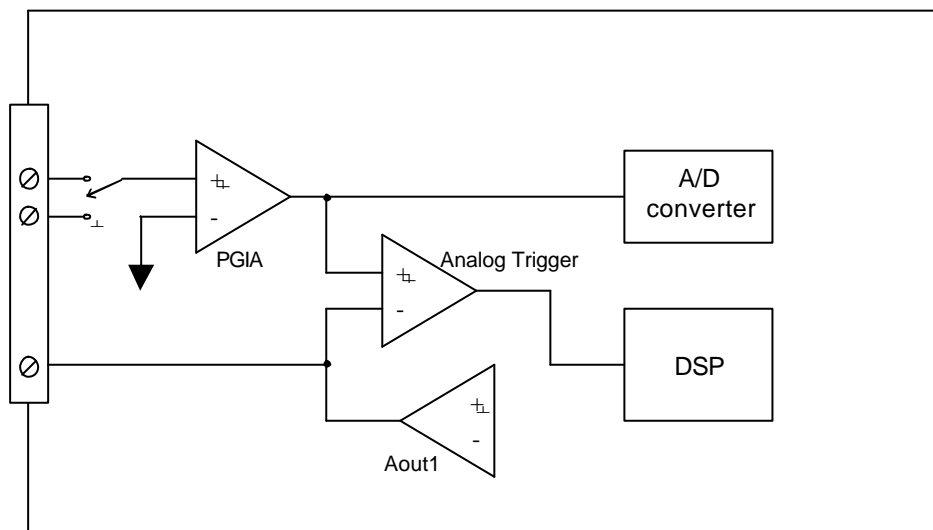


Figure 3-10 – Analog Trigger Architecture

As can be seen from Figure 3-10, analog output 1 is used to set the trigger level, and thus can not be used as a general purpose output while analog triggering is operational. Also, on XM Series boards without analog outputs, the analog trigger reference is connected to ground, so the analog trigger becomes a zero-crossing detector on such boards.

The Acquitek software API implements all the necessary signal switching and register programming to make triggering work. However, it should be noted that both analog triggering methods – A/D value based and analog comparator based – operate on the multiplexed signal. If an input set as the trigger channel is not present in the input sequence, it will never generate an analog trigger.

Clocking

The clocking mechanism on the XM Series boards provides maximum flexibility to the user. The architecture is shown in Figure 3-11.

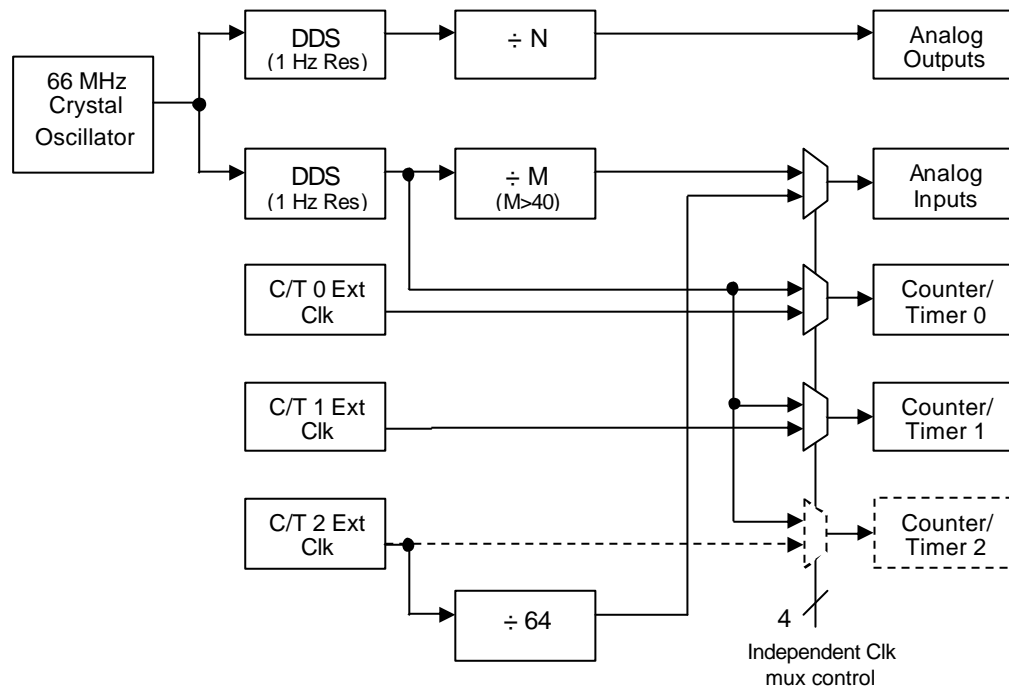


Figure 3-11 – CM Clock Architecture

As shown in Figure 3-11, the analog inputs and counter/timers can be driven from an external clock. The external clock source must be a TTL-compatible square wave. The analog input section shares its external clock source with Counter/Timer 2 on XM-24xx boards. On XM-23xx boards with only two counter/timers, the analog input external clock is not shared. It must still be applied to the connector pin labeled *Cntr2 Clk*. In external clock mode, the analog input sample rate is equal to the external clock frequency divided by 64. This factor is required for the pipeline delay of the A/D converter and the trim DACs which calibrate the analog input on a sample by sample basis according to the range setting in the channel-gain list. In internal clock mode, the counter/timers run off a clock that is an integer multiple M of the analog input sample rate. Again, M is large (between 40 and 64k) to facilitate the analog input pipeline. The Acquiretek Data Acquisition SDK has documentation on the functions used for programming the clock sources and frequencies.

Accessories

There are several accessories available to simplify connecting signals to and from the XM Series boards. All XM Series boards use a VHDCI-68 female connector as the main signal connector. The analog inputs 0-15, digital I/O Ports A and B, the analog outputs (if applicable) and timing and reference signals are available on this connector. The Acquitek B-1150/1155 is a breakout board for this connector, and is connected to the XM board with L-485x cables. The layout of the B-1150/1155 is shown in Figure 3-12 below.

The B-1150/1155 is available in either a stand alone board format (B-1155) or in a rackmountable box format (B-1150). In the standalone board format, connectors J9, J10, and J11 will not be populated. In the rackmountable box format, connectors J2, J3, J5, J6, and J8 will not be populated since they are duplicated by J9, J10, and J11. J4 and J7 will be populated since there is not enough space to bring the signals on these connectors out to the box edge.

With a 32 input XM Series board, the analog inputs 16-31 and digital I/O Ports C and D are brought out to a second VHDCI-68 female connector on the XM board. An additional B-1150/1155 breakout board and an additional L-485x cable are required for this connector.

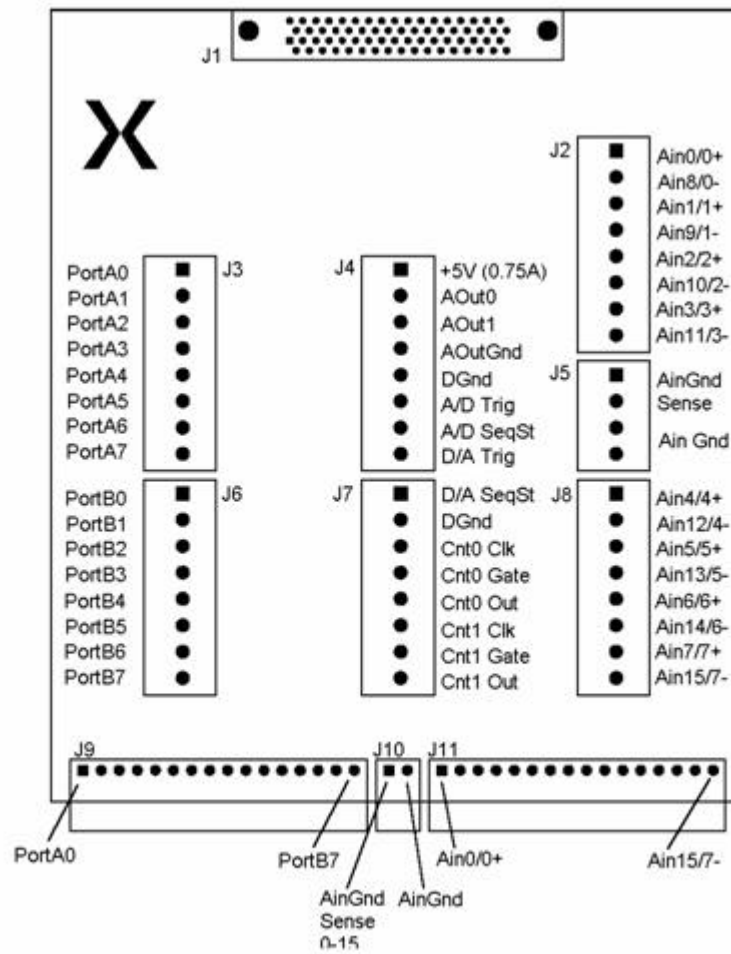


Figure 3-12 – B-1150/1155 Layout

PXI Implementation Details

As the name PCI Extensions for Instrumentation, or PXI, implies, PXI boards are built on PCI technology. The PXI extensions are described briefly below. For more information, please see the PXI specifications, which are available at the PXI System Alliance web site (www.pxisa.org). Correspondingly, Acquitek XM-series PXI boards are very similar to the CM-series PCI boards; however, the XM-series boards implement a subset of the PXI extensions, which are also detailed below.

PXI Extensions

In addition to the enhanced mechanical ruggedness inherent in the PXI form factor, PXI extends the PCI electrical interface in four primary ways to benefit system designers using the PXI bus.

Star Triggers – Slot number two, which is immediately to the right of the controller slot in the PXI chassis, is defined as the Star Trigger Controller slot. From this slot, a dedicated individual connection is available to each of up to thirteen peripheral slots in the PXI chassis. Each peripheral slot has a dedicated Star Trigger pin from which the peripheral can receive or generate unique triggers from/to the Star Trigger Controller. The signal level on the Star Trigger line must be 5V or less. Since the driver of the Star Trigger line is not specified, both the controller and peripherals must not drive the line at power up. A pull up resistor is allowed on peripherals to prevent an indeterminate electrical state.

Bussed Triggers – Eight general-purpose lines are available which are shared among all slots on the PXI bus segment. Signaling on these lines must be at TTL levels. Since there is no specified driver on these lines, all peripherals must set these lines at high impedance upon power up.

Local Bus – Adjacent peripheral slots are connected via thirteen wires to the left and thirteen wires to the right. These Local Busses are general purpose, and can be used for digital signals or analog signals up to +/-42V. Since there is no specified driver on these lines, all peripherals must have these lines at high impedance or ground upon power up. From the Star Trigger Controller slot,

which is leftmost in the chassis (excluding the system controller slot) the Left Local Bus lines are used to implement the Star Triggers.

Synchronizing Clock – A 10 MHz reference clock is provided by the PXI backplane to all peripheral slots, including the Star Trigger Controller slot. From the Star Trigger Controller slot, an external clock reference may be driven as a substitute for the backplane 10 MHz reference.

XM-Series PXI Implementation

Star Triggers – XM-series boards in the Star Trigger Controller slot can function as the system Star Trigger Controller. The Star Trigger lines share circuitry with digital I/O lines 16-31. Therefore, the Star Trigger functions can not operate simultaneously with the digital I/O lines 16-31. As the Star Trigger Controller, the XM-series board can issue triggers to, or receive triggers from, all thirteen peripheral slots as defined by the PXI Hardware Specification.

XM-series boards in peripheral slots can receive triggers from the Star Trigger Controller to synchronize operations between boards. This input trigger is controlled through the SDK in a similar manner as other trigger sources.

Bussed Triggers – XM-series boards can drive or receive digital trigger signals on the Bussed Trigger 7 line. This line powers up in a high impedance state. It functions similarly to any of the other triggers available on the main 68-pin I/O connector.

The XH-series boards make no connection to PXI bussed trigger lines 6-0.

Local Bus – XM-series boards do not use the Local Bus Left lines; however, since an XM-series board can be a Star Trigger Controller, it clearly makes connections to the LBL lines, which double as the Star Trigger lines in the Star Trigger Controller slot (Slot 2). However, the XM board powers on with the LBL lines in a high impedance state, and commands to drive these lines will fail unless the board is located in Slot 2

XM-series boards make no connection to any Local Bus Right lines.

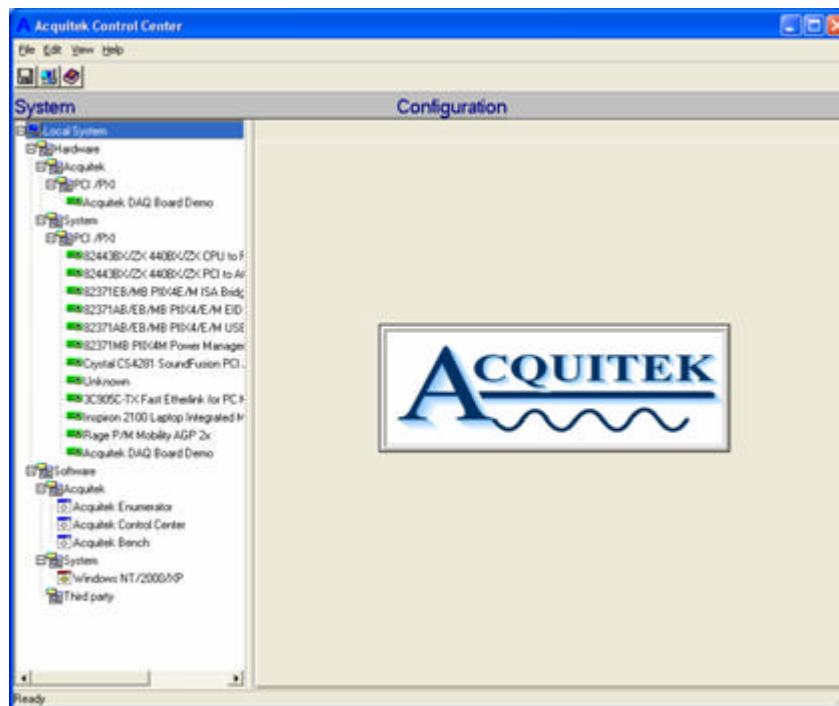
Synchronizing Clock – XM-series boards can receive the 10MHz PXI clock from the backplane and use it to generate the sampling clock for the analog input A/D converter and the analog output D/A converter.

An XM-series board in the Star Trigger slot is also capable of driving a reference clock onto the backplane. A properly designed backplane will then override its internal 10MHz clock and distribute the clock signal driven in from the Star Trigger slot. With the fine frequency resolution available from the XM clock generator, this allows precise control and synchronization of all sampling clocks in the system.

System Management – As noted in the PXI Extensions section, there is no specified driver on any of the Star Triggers, Bussed Triggers, or Local Bussed signals. As such, many peripherals may be capable of driving the same line simultaneously. To prevent this potentially hazardous conflict, the PXI specification generally states that all drivers should be disabled upon power up, and only enabled by a higher-level PXI resource manager. For Acquitek boards, the high-level system configuration management is performed by Acquitek Control Center (ECC). ECC is able to determine the slot location of all Acquitek boards and thereby provide some intelligence to prevent configuration conflicts; however, caution is required since ECC does not know the capabilities or configuration of boards from other manufacturers. In ECC, the system designer can enable the Star Trigger functions and direction, enable the use of PXI bussed trigger line 7, and enable the driving or receiving of the PXI synchronizing clock. From the AcquitekDA SDK, the state of these lines may be set or read, but errors will be returned from the SDK if the feature has not been enabled in ECC. See Section 4 of this manual, “XH Series Software – Acquitek Control Center”, as well as the ECC help file and SDK documentation for details.

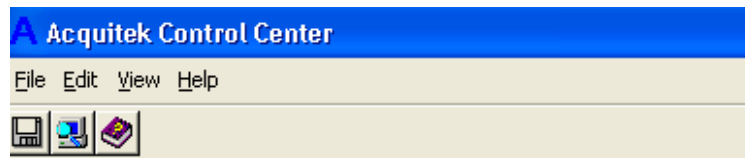
4

Acquitek Control Center



Acquitek Control Center (ECC) provides a central location for the configuration and test of data acquisition products from Acquitek . ECC is used to assign logical device numbers to Acquitek hardware devices so that those devices can be accessed from other software applications. ECC can also be used to specify default configuration parameters for Acquitek hardware devices and to verify correct installation and operation of those devices.

Menu and Toolbar



File / Load Profile

Loads a previously saved set of configuration data, making those settings active.

File / Save Profile

Save the current configuration settings for all Acquitek devices to a named file.

File / Exit

Exit Acquitek Control Center

Edit / Preferences

Set general application preferences including whether to scan hardware and software each time Acquitek Control Center is started.

View / Refresh

Scan the system for installed hardware and software

Help / Contents

View help for Acquitek Control Center

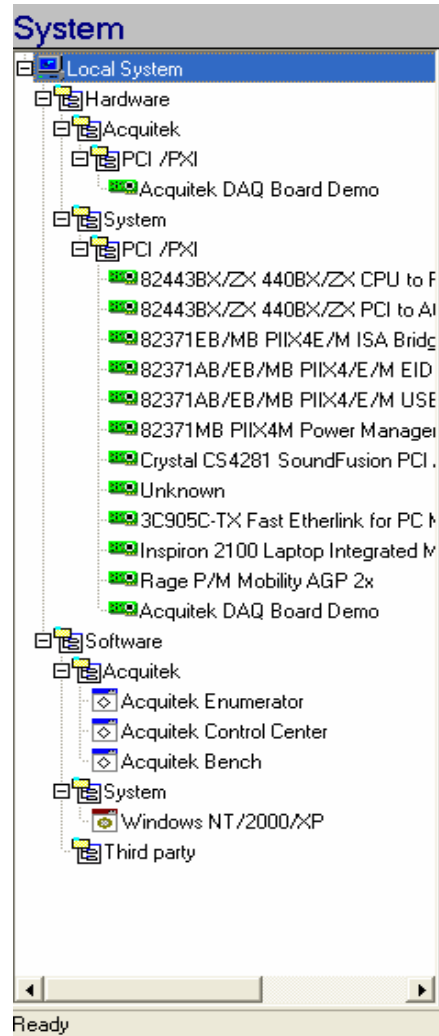
Help / Acquitek Web Site

Open the Acquitek home page in a default browser window

Help / About

Display version and copyright information for Acquitek Control Center

System Tree Pane



The System Tree Pane displays a graphical representation of the hardware and software discovered during the last system scan. This information can be updated by selecting View / Refresh from the main menu.

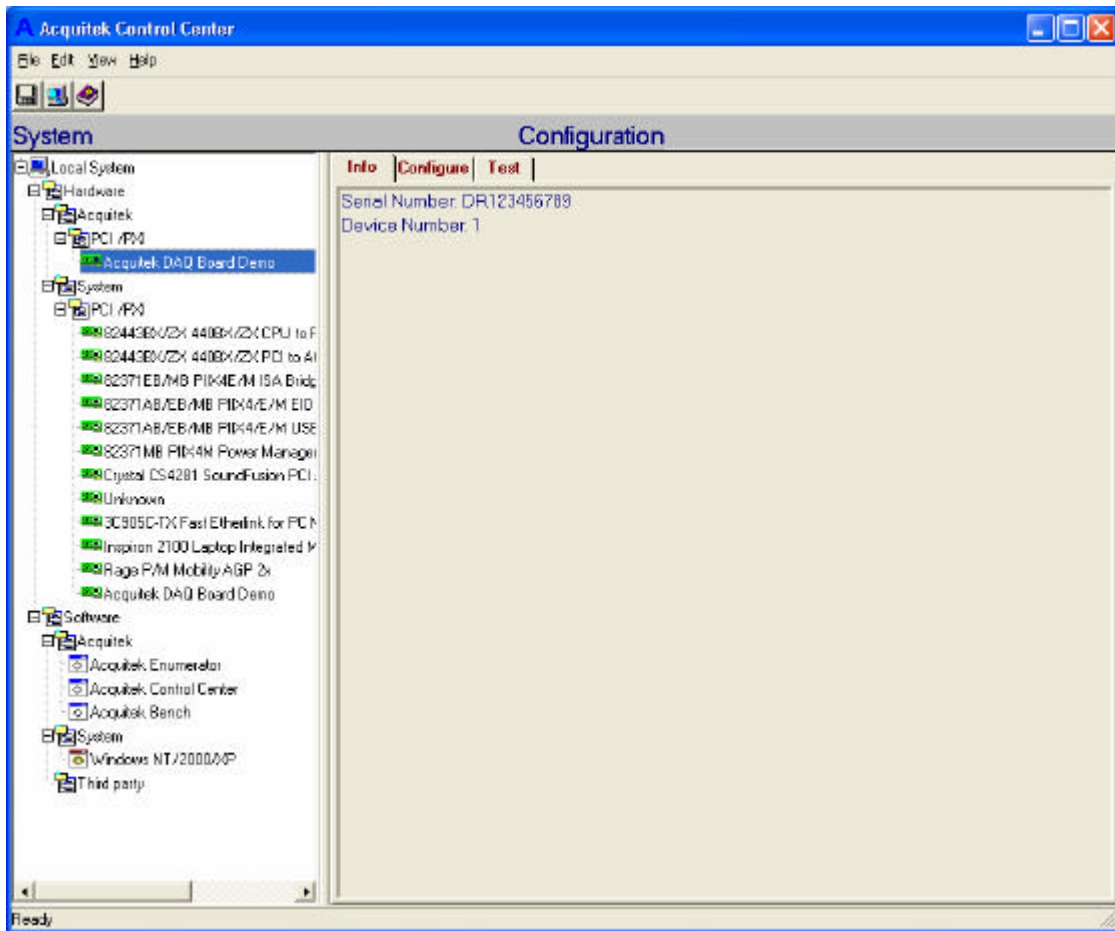
There are separate branches on the tree representing Acquitek hardware devices, system and third party hardware devices, Acquitek software components, OS software components, and third party software components. The leaves on the branches can be selected to display additional information in the Configuration Pane.

Configuration Pane



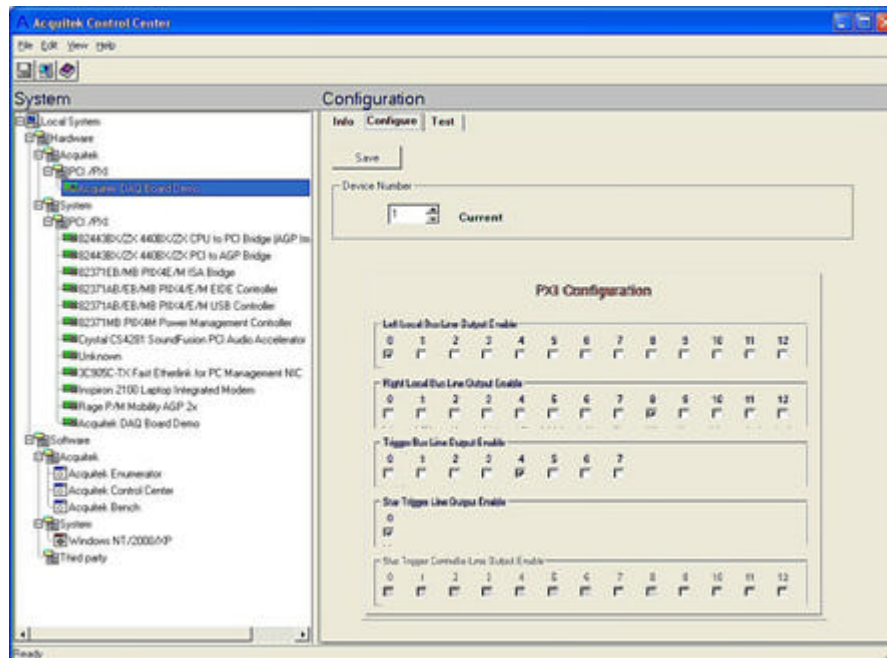
The Configuration Pane displays one or more tabbed pages with additional information about the hardware device or software module currently selected in the System Tree.

Info Tab



The information displayed on the Info Tab varies according to the device or module selected in the System Tree. Selected Acquiretek hardware devices display their serial number and the configured device number. Other hardware devices display PCI configuration data. Software modules display version resource information if available along with file date and size.

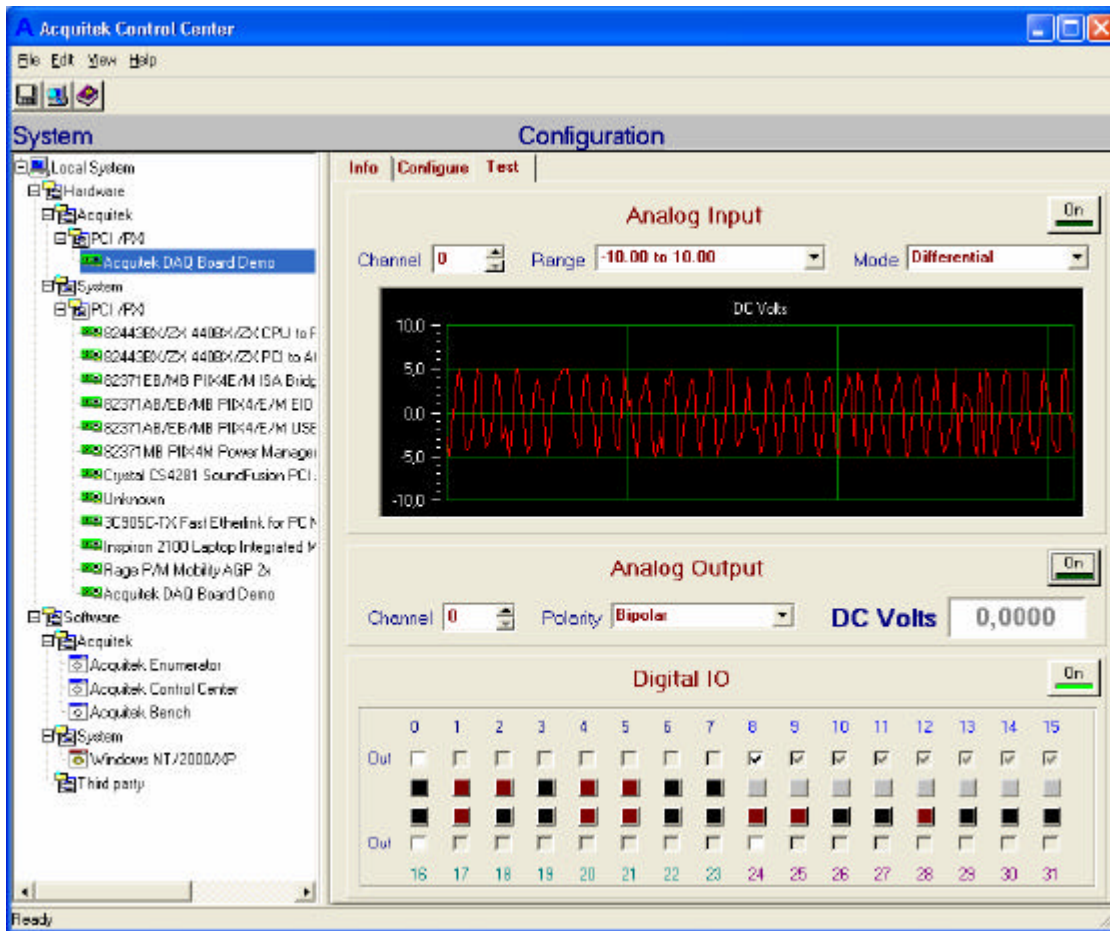
Configuration Tab



The Configuration Tab is only available when an Acquiretek hardware device is selected in the System Tree Pane. This page is used to set the logical device number for Acquiretek devices to be used by other software applications.

The PXI Configuration panel will only be displayed when an Acquiretek PXI device is selected. The checkboxes are used to enable various PXI specific outputs on these boards. It is very important that you know and understand the PXI system configuration before enabling any outputs. Driving one of the PXI output lines in a mis-configured system could damage the Acquiretek hardware device or one of the other system devices. See "PXI Implementation Details" in Section 3 of this manual for an explanation of the PXI-specific signals and information on how those signals are connected on the XM Series boards.

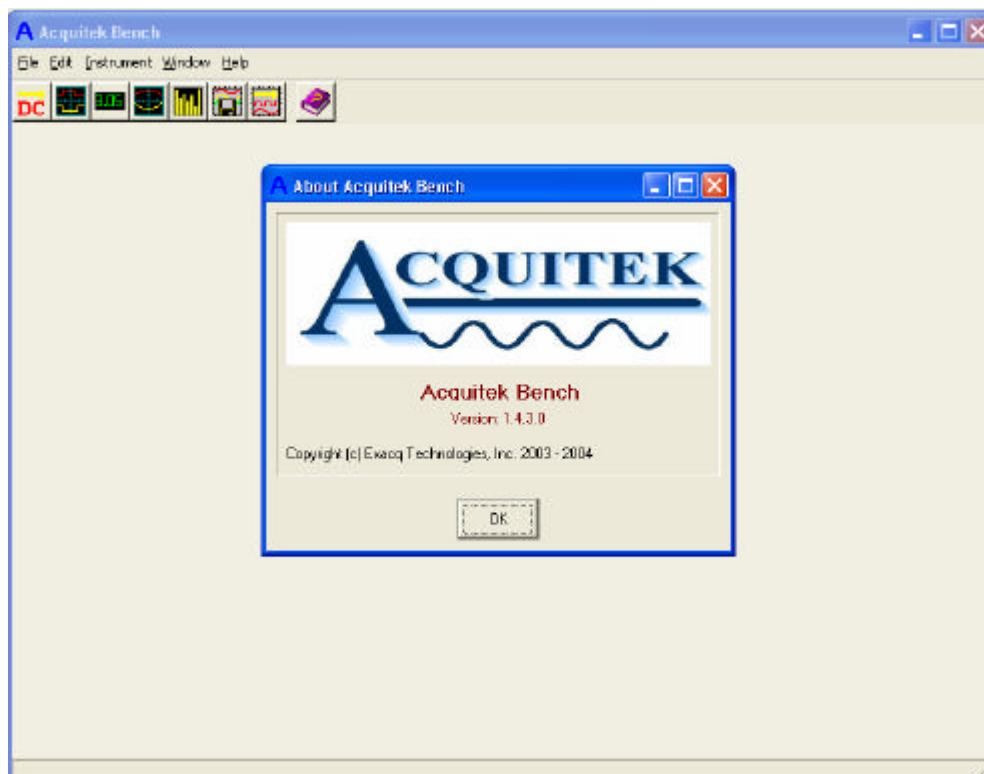
Test Tab



The Test Tab is only available when an Acquiretek hardware device is selected in the System Tree Pane. This page is used to test functionality of the selected device. Select a device channel for analog IO, or configure direction for digital IO, then activate the panel by clicking its 'On' button. Correct installation and operation can be verified for all analog and digital channels.

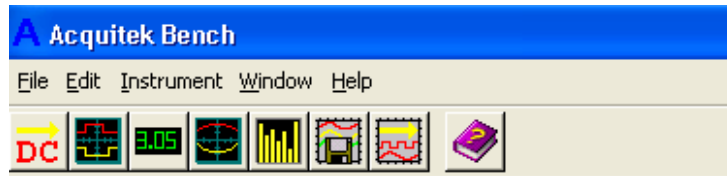
5

Acquitek Bench



Acquitek Bench™ is a collection of tools that enables a PC equipped with an Acquitek data acquisition device to function as a DC voltage source, a logic analyzer, a digital multimeter, an oscilloscope, a spectrum analyzer, a strip chart recorder, and an arbitrary wave form generator

Menu and Toolbar



The menu and toolbar are used to open and close the various instruments windows and arrange the display of those windows.

File

- Exit
- Close Acquitek Bench

Edit

- Preferences
- Set application specific preferences

View



DC Source

Open or close the DC Source window



Logic Analyzer

Open or close the Logic Analyzer window



Meter

Open or close the Meter window



Oscilloscope

Open or close the Oscilloscope window



Spectrum Analyzer

Open or close the Spectrum Analyzer window



Strip Chart

Open or close the Strip Chart window



Waveform Generator

Open or close the Waveform Generator window

Window

Cascade

Cascade all open child windows

Tile

Tile all open child windows

Minimize All

Minimize all open child windows

Close

Close the currently selected child window

Help

Contents

Display help contents

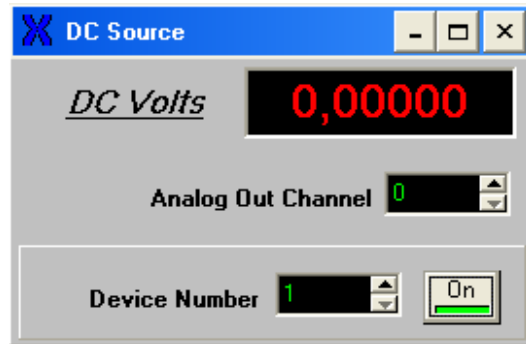
Acquitek Web Site

Launch the default browser and direct to **www.Acquitek.com**

About

Display version and copyright information

DC Source



The DC Source is used to output a constant voltage on an analog output channel.

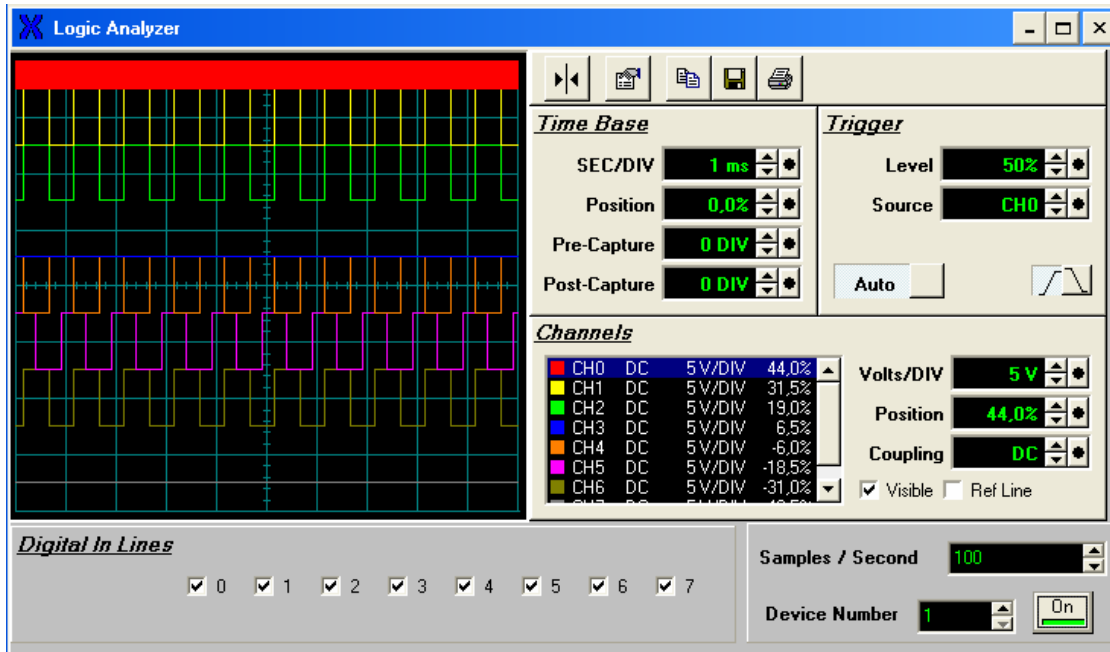
Analog Out Channel

Zero based analog output channel number.

Device Number

Data acquisition device number as configured in Acquitek Control Center. You must assign a device number to the acquisition board before it can be used in Acquitek Bench or other application software.

Logic Analyzer



The Logic Analyzer is used to capture and inspect logic level (0V - +5V) signals using the digital IO lines.

SEC/DIV

Specify the number of seconds per division on the Horizontal Axis Display

Position (Time Base)

Specify the vertical offset of the entire channel in percent of the Display.

Pre-Capture

Specify how much data to capture before the beginning of the display. The value is specified in divisions of the horizontal axis.

Post-Capture

Specify how much data to capture after the end of the display. The value is specified in divisions of the horizontal axis.

Level

Specify the level where the trigger mechanism will trigger a new frame to be displayed.

Source

Specify the channel index used as the data source by the Trigger.

Slope

Specify whether a positive or negative slope is used when triggering.

Auto

Specify whether the Trigger is Automatic or Manual. If this value is FALSE, then you must manually evaluate the Trigger by pressing the trigger button in the Trigger section of the Scope Panel.

Volts/DIV

Specify the number of volts per division on the vertical axis display.

Position (Channel)

Specify the vertical offset of the entire channel in Percent of the Display.

Coupling

Specify the signal coupling of this channel.

Visible

Specify whether the channel trace line is visible.

Digital In Lines

Digital inputs which will be sampled and displayed. Only the first 8 DIOs can currently be used.

Samples / Second

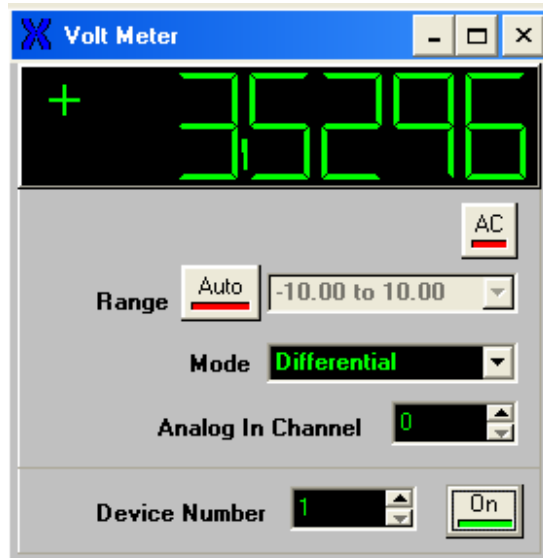
Input sampling rate.

Device Number

Data acquisition device number as configured in Acquitek Control Center. You must assign a device number to the acquisition board before it can be used in Acquitek Bench or other application software.

Note: Additional configuration options can be accessed by right clicking on the instrument.

Volt Meter



The Volt Meter is used to measure voltages on analog input channels.

AC

Enable RMS AC signal measurement

Range

Voltage range of signal under test. Selecting 'Auto' will cause the volt meter to automatically determine the smallest range which encompasses the measured voltage, thereby yielding the highest precision.

Mode

Analog input type – differential (2 wire), single ended (1 wire), or non-referenced single ended (1 wire)

Coupling

Analog input coupling and impedance

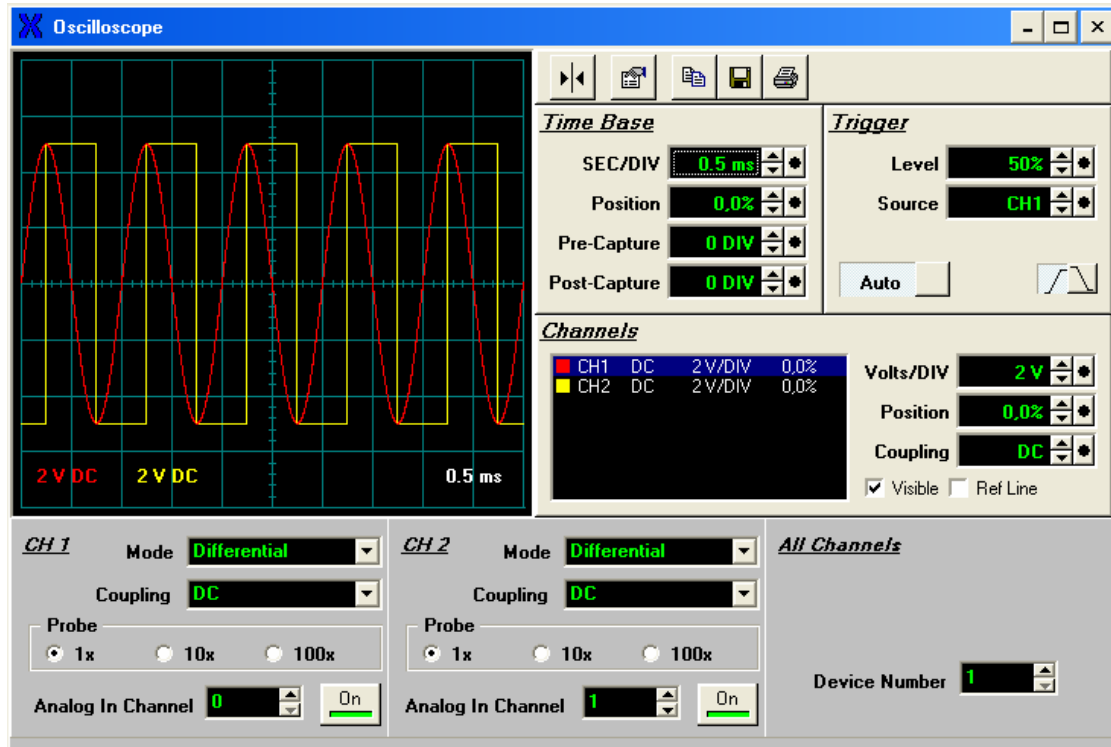
Analog In Channel

Zero based analog input channel number

Device Number

Data acquisition device number as configured in Acquitek Control Center. You must assign a device number to the acquisition board before it can be used in Acquitek Bench or other application software.

Oscilloscope



The Oscilloscope is used to provide a two-dimensional visual display of an analog signal. Most commonly it is used to show signal amplitude versus time, displaying the waveform of the signal being monitored.

SEC/DIV

Specify the number of seconds per division on the Horizontal Axis Display

Position (Time Base)

Specify the vertical offset of the entire channel in percent of the Display.

Pre-Capture

Specify how much data to capture before the beginning of the display. The value is specified in divisions of the horizontal axis.

Post-Capture

Specify how much data to capture after the end of the display. The value is specified in divisions of the horizontal axis.

Level

Specify the level where the trigger mechanism will trigger a new frame to be displayed.

Source

Specify the channel index used as the data source by the Trigger.

Slope

Specify whether a positive or negative slope is used when triggering.

Auto

Specify whether the Trigger is Automatic or Manual. If this value is FALSE, then you must manually evaluate the Trigger by pressing the trigger button in the Trigger section of the Scope Panel.

Volts/DIV

Specify the number of volts per division on the vertical axis display.

Position (Channel)

Specify the vertical offset of the entire channel in Percent of the Display.

Coupling

Specify the signal coupling of this channel.

Visible

Specify whether the channel trace line is visible.

Mode

Analog input type – differential (2 wire), single ended (1 wire), or non-referenced single ended (1 wire)

Coupling

Analog input coupling and impedance

Probe

Specifies a 1x, 10x, or 100x probe for scaling of display values.

Analog In Channel

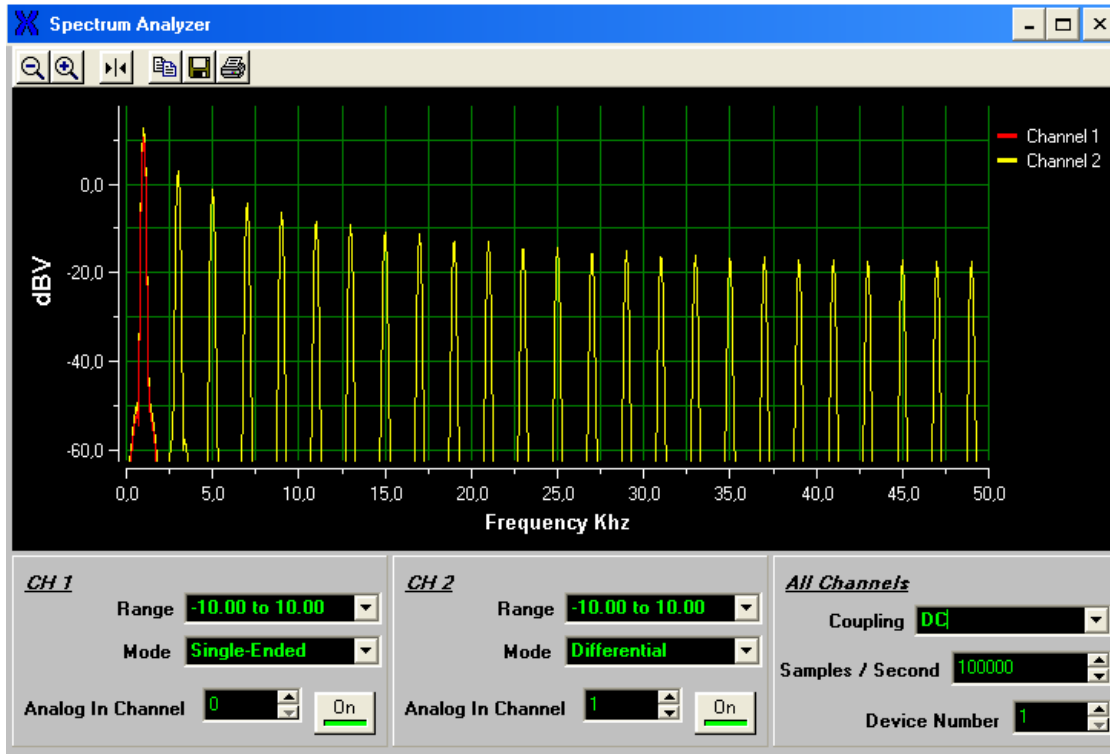
Zero based analog input channel number

Device Number

Data acquisition device number as configured in Acquitek Control Center. You must assign a device number to the acquisition board before it can be used in Acquitek Bench or other application software.

Note: Additional configuration options can be accessed by right clicking on the instrument.

Spectrum Analyzer



The Spectrum Analyzer is used to measure the frequency spectrum of a signal on an analog input channel.

Range

Voltage range of signal under test

Mode

Analog input type – differential (2 wire), single ended (1 wire), or non-referenced single ended (1 wire)

Coupling

Analog input coupling and impedance

Analog In Channel

Zero based analog input channel number

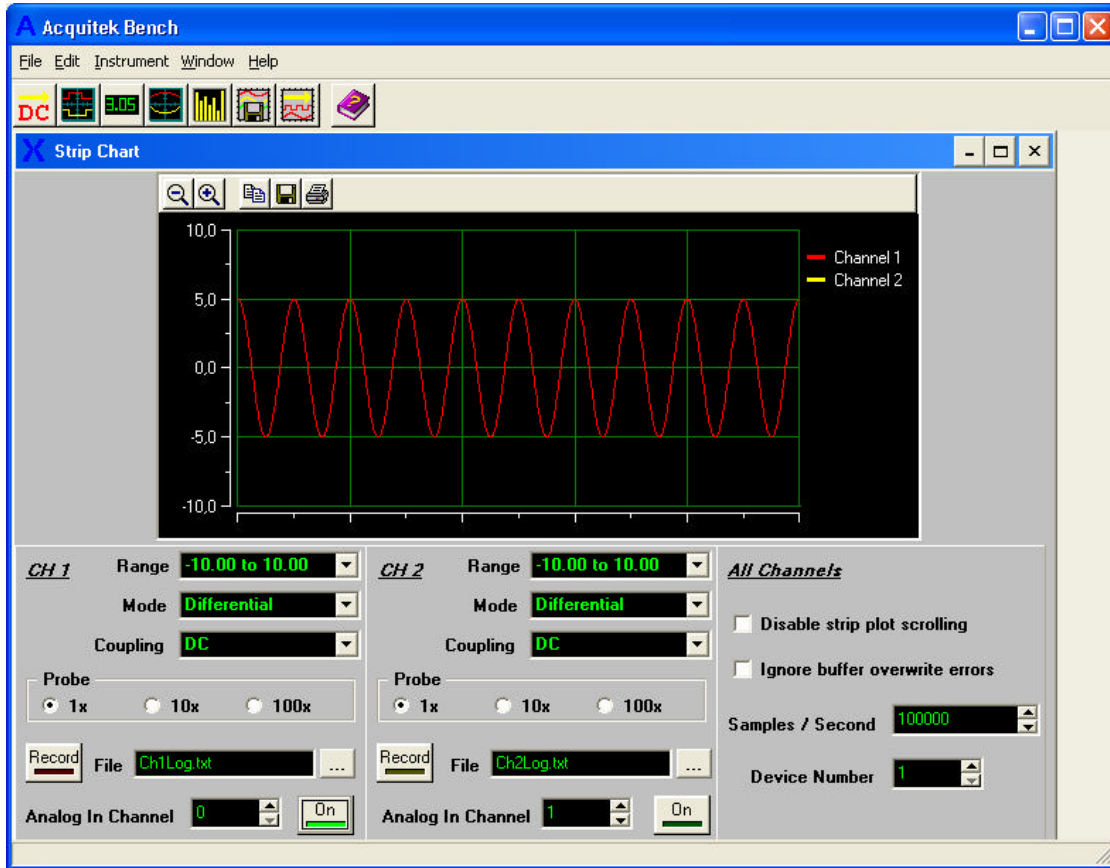
Samples / Second

Input sampling rate.

Device Number

Data acquisition device number as configured in Acquitek Control Center. You must assign a device number to the acquisition board before it can be used in Acquitek Bench or other application software.

Strip Chart Recorder



The Strip Chart Recorder is used to capture and save voltage levels from the analog input channels.

Range

Voltage range of signal under test

Mode

Analog input type – differential (2 wire), single ended (1 wire), or non-referenced single ended (1 wire)

Coupling

Analog input coupling and impedance

Probe

Specifies a 1x, 10x or 100x probe for scaling of display values.

Record

Activate logging of data to disk

File

Name of data log text file. Each line of the file contains a time offset value followed by a tab, then the sample value and a carriage return

Analog In Channel

Zero based analog input channel number

Samples / Second

Input sampling rate.

Device Number

Data acquisition device number as configured in Acquitek Control Center. You must assign a device number to the acquisition board before it can be used in Acquitek Bench or other application software.

Note: Additional configuration options can be accessed by right clicking on the instrument.

Wave Form Generator



The Waveform Generator is used to output analog waveforms including sine, square, triangle, DC, and arbitrary.

Wave Type

Selects sine, square, triangle, DC, or arbitrary (File) waveform

Amplitude

Sets the amplitude of the generated waveform

Offset

Sets a DC offset for the generated waveform

WF File

When File wavetype is chosen, selects the file containing waveform data. Each line of the file should contain a time offset value followed by a tab, then the sample value and a carriage return.

Analog Out Channel

Zero based analog output channel number.

Frequency

Output cycles per second. Waveform files are assumed to be 1024 points per cycle.

Range

Waveform amplitude min and max values.

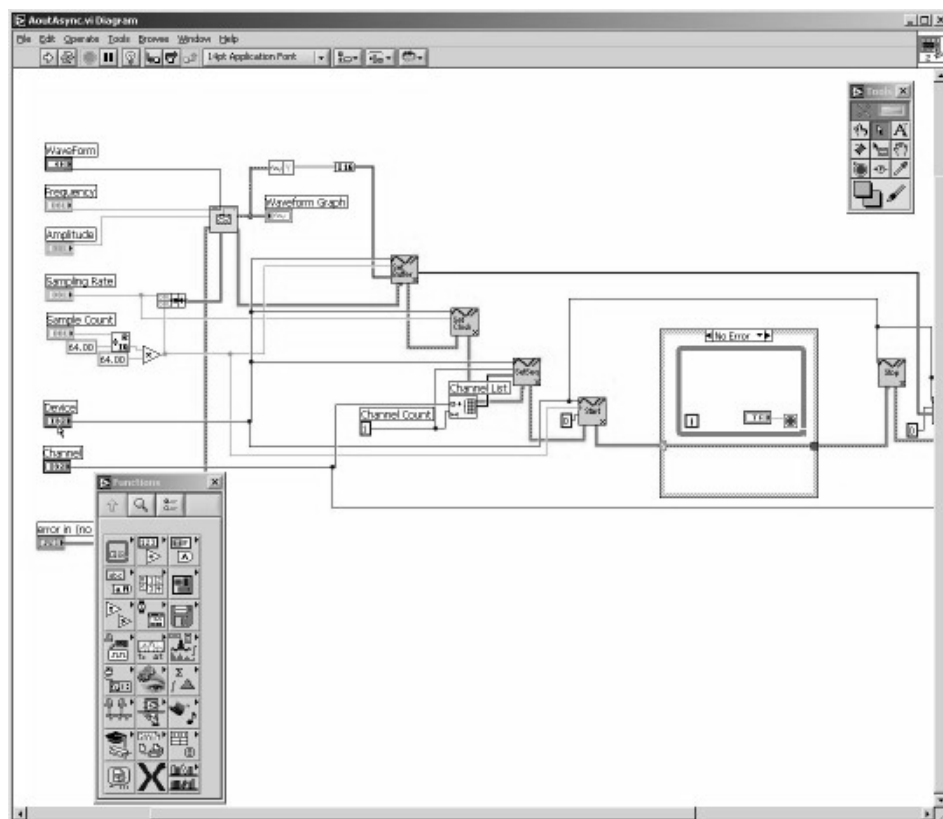
Device Number

Data acquisition device number as configured in Acquitek Control Center. You must assign a device number to the acquisition board before it can be used in Acquitek Bench or other application software.

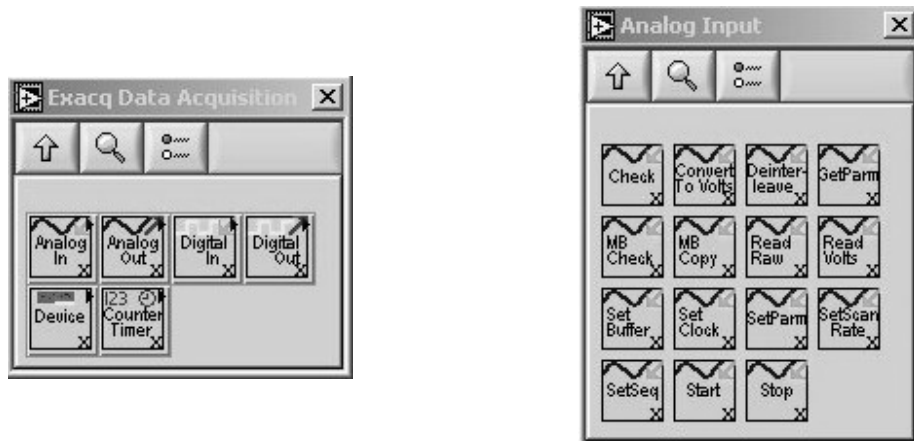
6

XM Series – Third Party Drivers

LabVIEW



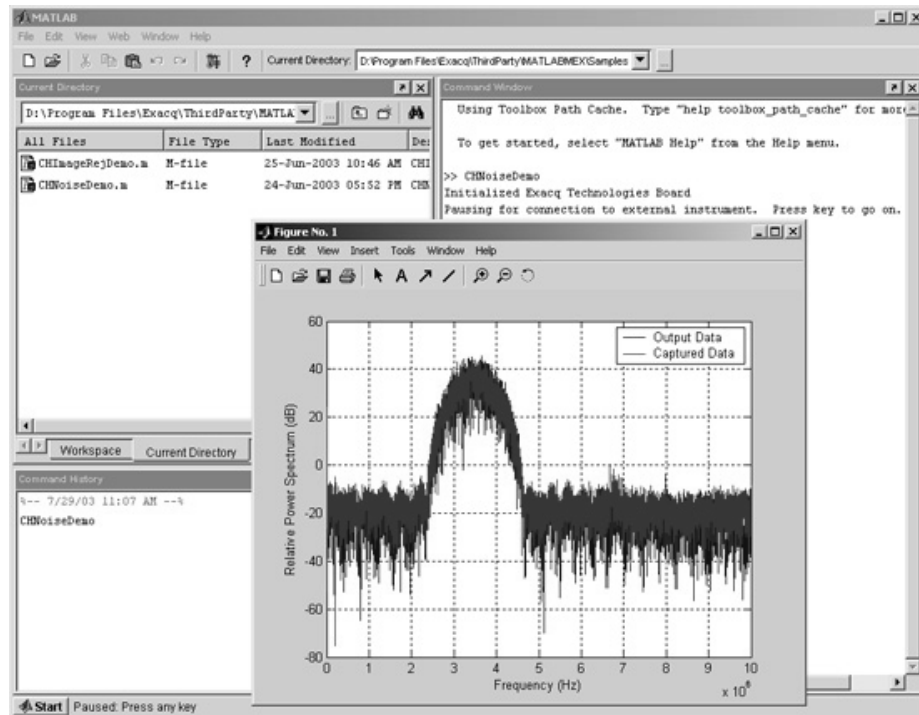
The Acquitek Data Acquisition LabVIEW VIs provide a LabVIEW interface for all calls available through the Acquitek Data Acquisition API. The names and parameters are identical to those exported by XDADAQ.DLL.



If the installation application was able to locate a LabVIEW installation on your computer, the Acquitek VIs have been installed into the LabVIEW directory and can be accessed from the LabVIEW function palette by choosing the Acquitek Data Acquisition palette view. If a LabVIEW installation was not detected, manual installation can be completed by copying the XDADaQLV and Menus directories from the [installdir]\ThirdParty\LabVIEW directory into the main LabVIEW installation directory (the directory containing LabVIEW.exe).

A number of sample VIs are included and can be found in the [installdir]\ThirdParty\LabVIEW\Samples directory. These samples demonstrate wiring of the API level VIs and can also be used as higher level building blocks within new LabVIEW applications. The first time you attempt to open one of the samples from the [installdir]\ThirdParty\LabVIEW\Samples subdirectory, LabVIEW will not be able to find the AcquitekDA VIs used by the sample. You can either browse to the correct [LabVIEW_Install]\XDADaQLV* directory using the 'find vi' dialog displayed by LabVIEW while loading the sample, or you can permanently fix the problem for all samples by opening the LabVIEW 'Tools / Options' menu, selecting 'Paths' and 'VI Search Path' then entering '[LabVIEW_Install]\XDADaQLV*' and clicking 'Insert Before'. Note '[LabVIEW_Install]' should be replaced by the actual name of the directory where LabVIEW is installed on your system. Also note that the '*' after XDADaQLV is needed so that LabVIEW will search the subdirectories under XDADaQLV.

MATLAB



Acquitek currently provides access to its data acquisition API in MATLAB via MEX-files. These functions are contained in .dll files in the \Acquitek\ThirdParty\MATLABMEX directory. Their help text documentation is contained in .m files with filenames that correspond to the .dll files. To see this documentation, type "help XXX" at the MATLAB prompt, where "XXX" is the part of the filename before the .dll extension, such as "XDA_Ain_Volts." The functions can be called just as any M-function is called. For example, to read a sequence of 5000 input voltages between -5V and 5V from analog input channels 0 and 1 of device 1 at 10000 Hz, type the following at the MATLAB prompt:

```
[ch0 ch1] = XDA_Ain_Volts(1, [0 1], [5.0 5.0], 10000, 5000)
```

The \Acquitek\ThirdPary\MATLABMEX directory currently contains MEX-files for analog input and output, digital input and output, and counter/timer functions. The analog input functions can be found in the following files:

XDA_Ain_Coupling.dll
XDA_Ain_Raw.dll
XDA_Ain_Volts.dll

Analog output functions can be found in the following files:

XDA_Aout_Func.dll
XDA_Aout_Raw.dll
XDA_Aout_Volts.dll

Digital input and output functions can be found in the following files:

XDA_Din_Read.dll
XDA_Dout_Write.dll

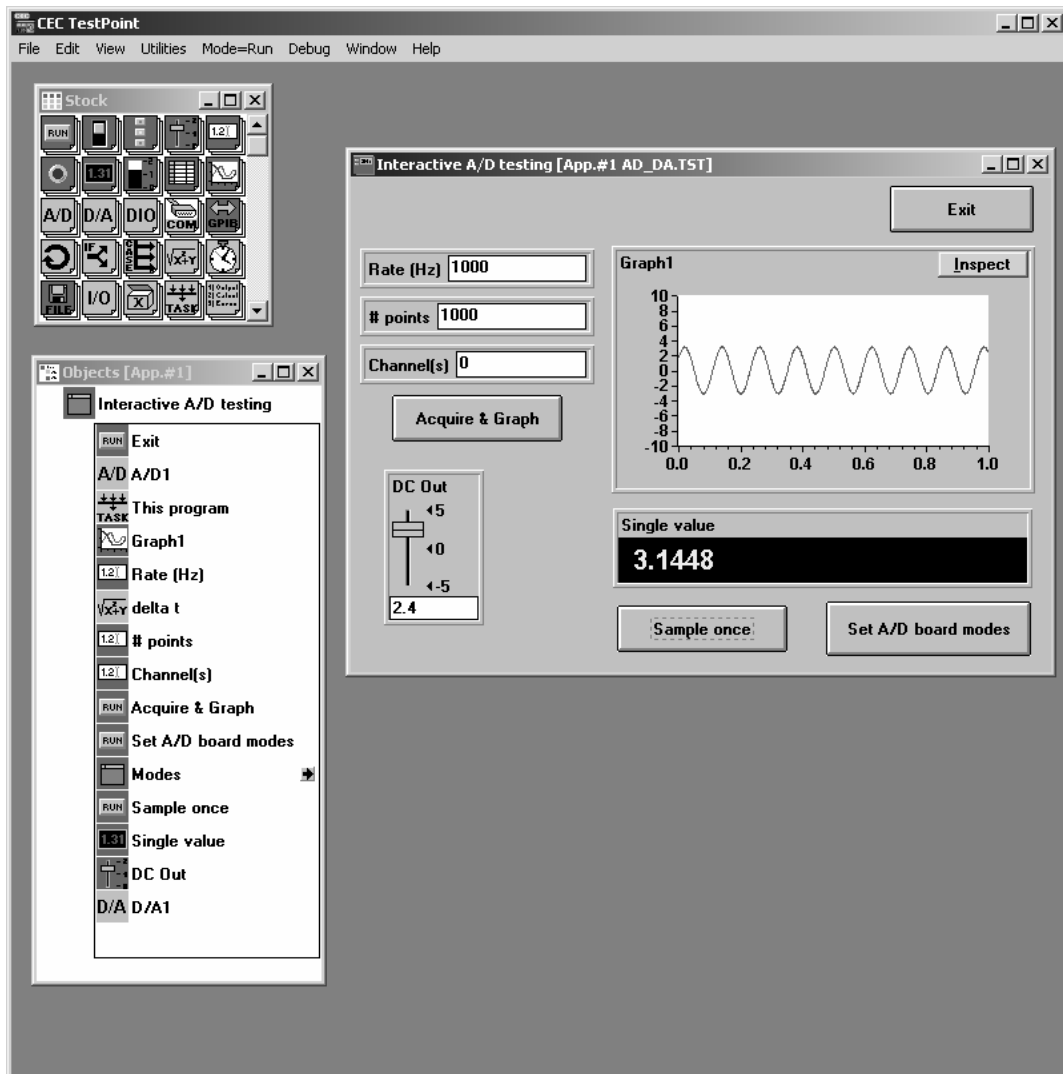
Counter/timer functions can be found in the following files:

XDA_CT_Config.dll
XDA_CT_Gate.dll
XDA_CT_Read.dll

Example M-functions that use these MEX-files can be found in the \Acquitek\ThirdPary\MATLABMEX\Samples directory.

TestPoint

Capital Equipment Corporation's TestPoint is software for designing test, measurement, and data acquisition applications. The Acquitek TestPoint driver enables the use of all Acquitek hardware with TestPoint to simplify data acquisition.



Installation

- Copy the file TPAcquitek.dll from [AcquitekInstallDirectory]\ThirdParty\TestPoint to the directory where TestPoint is installed.
- Edit the TestPoint.ini file found in the TestPoint directory. Replace the entire [AD0] section with this text:
[AD0]
manufacturer=AUTO
MODE=Bipolar
TYPE=Pseudo
COUPLING=DC
DACOUPLING=DC
- Edit the TPAD.ini file found in the TestPoint directory. Find the [ADDIVERS32] section and add this line:
ACQUITEK WDM=TPACQUITEK.DLL

The Acquitek data acquisition board assigned logical device number one using Acquitek Control Center can now be accessed in TestPoint as AD device zero. To use multiple boards, or change the logical device that will be used, copy the board configuration information added for [AD0] into another section ([ADn]). The Acquitek device number will always be one greater than the TestPoint AD number.

Notes

You must run Acquitek Control Center to assign logical device numbers to all Acquitek devices and verify basic functionality before using the devices with TestPoint.

The TestPoint driver will be copied to the [AcquitekInstallDirectory]\ThirdParty\TestPoint directory by Acquitek Setup. You must complete the installation as documented above.

A sample TestPoint application called AD_DA.tst is copied to [AcquitekInstallDirectory]\ThirdParty\TestPoint\samples by Setup. This application can be used to verify basic functionality.

ExcelDA – Microsoft Excel Add-In

ExcelDA is a Microsoft Excel Add-In that enables data acquisition from within Excel using any Acquitek hardware device. It is included with all Acquitek products and installed into the ThirdParty directory when Acquitek Data Acquisition Setup is run.

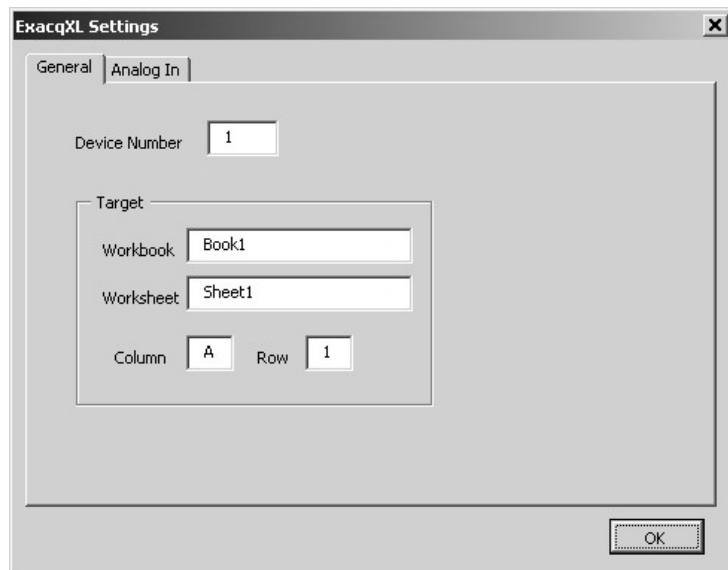
Installation

To Install ExcelDA follow these steps:

- Start Microsoft Excel
- Choose 'Add-Ins...' from the Excel 'Tools' menu
- Click the 'Browse...' button on the Add-Ins dialog
- Navigate to [AcquitekInstallDirectory]\ThirdParty\ExcelDAL
- Double click ExcelDA.xla
- Click the 'OK' button on the Add-Ins dialog
- Choose 'ToolBars' from the Excel 'View' menu
- Select 'Acquitek Data Acquisition' from the ToolBars list

Once you have completed these steps, the Acquitek Data Acquisition toolbar will be available for use with any workbook within Excel. You can drag and dock the toolbar to a convenient spot on the Excel toolbar, or let it float within the work area as you prefer.

General Configuration



Display the General Configuration tab on the configuration dialog by clicking 'Configure' on the Acquitek Data Acquisition toolbar, then choosing the 'General' tab.

Device Number

Logical device number of the Acquitek hardware device that will be used for acquisition. This number must be assigned in Acquitek Control Center.

Target Workbook

The workbook to which data will be acquired. You must provide the entire name including the .xls extension if one is present.

Target Worksheet

The worksheet to which data will be acquired. This sheet must already be present in the specified workbook.

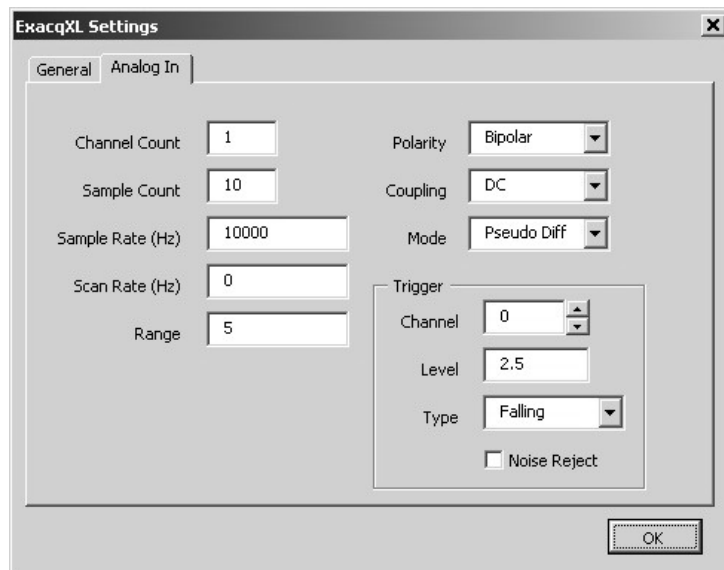
Target Column

Starting Column for data acquisition. Data for a single channel will be captured to the specified column. Data for multiple channels will be captured to consecutive columns.

Target Row

Starting row for data acquisition. Samples for each channel will be captured in consecutive rows starting with the specified row.

Analog In Configuration



Display the Analog In Configuration tab on the configuration dialog by clicking 'Configure' on the Acquitek Data Acquisition toolbar, then choosing the 'Analog In' tab.

Channel Count

The number of channels from which data will be acquired.

Sample Count

The number of samples to acquire from each channel. Note that Excel limits this value to about 65000.

Sample Rate

The sampling clock frequency to be used for the acquisition.

Scan Rate

The time between channel sample sets when using hardware that does not support simultaneous sampling. Set this value to 0 when acquiring one channel or when you wish to use the frequency specified by 'Sample Rate'.

Range

The maximum voltage of the input signal. Valid values for this parameter depend on the particular hardware device being used. Please see the hardware reference manual for a list of valid values.

Polarity

Input signal polarity - Bipolar or Unipolar.

Coupling

Input signal coupling - AC, DC, or DC Terminated.

Mode

Input signal mode - Differential, Single Ended, or Pseudo Differential.

Trigger Channel

Analog channel used to trigger acquisition.

Trigger Level

Voltage level at which data acquisition will trigger.

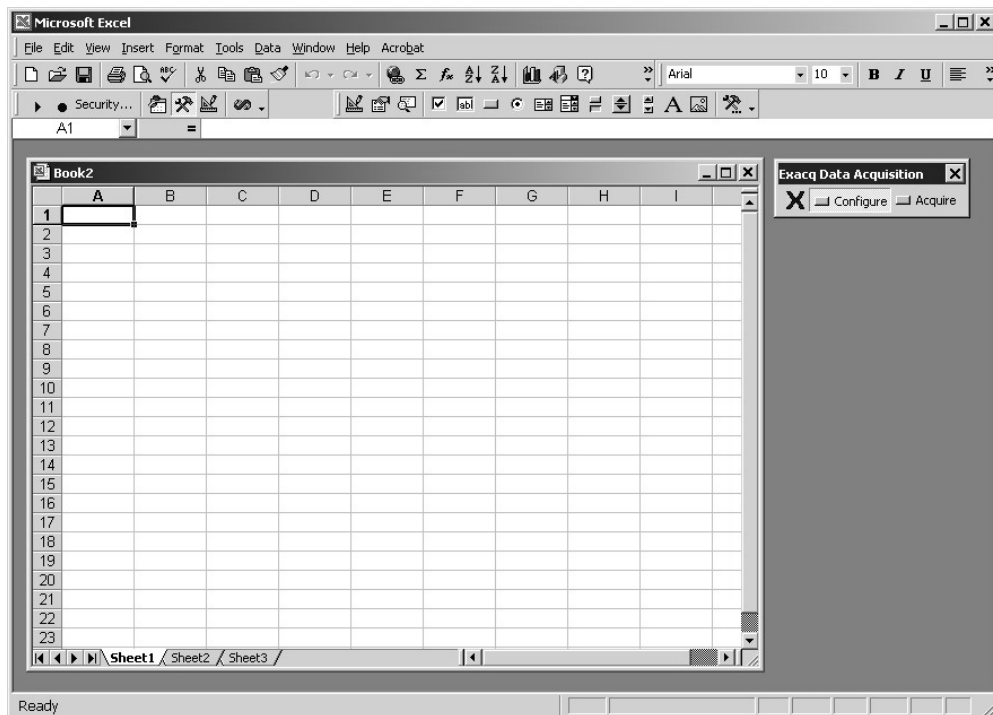
Trigger Type

Trigger mode - Falling, Rising, External, or None. To begin acquisition as soon as the 'Acquire' toolbar button is clicked, set this value to none.

Trigger Noise Reject

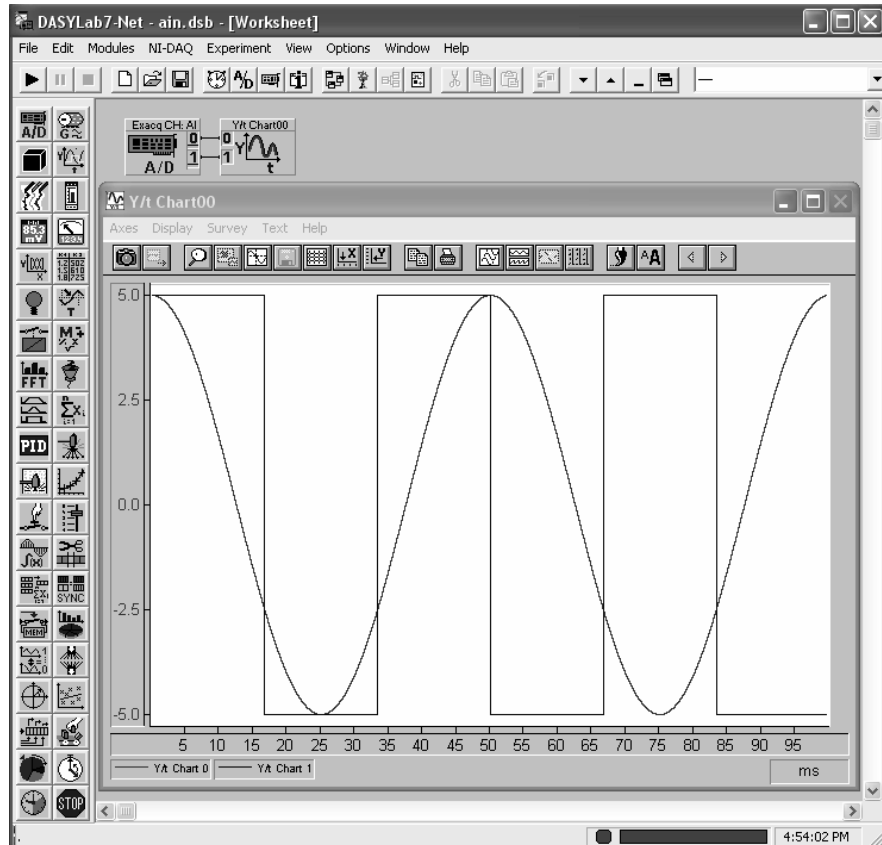
Enable Trigger Noise Reject to avoid triggering on noise from the trigger input signal.

Acquisition



Once all data acquisition parameters have been set using the configuration dialog, simply click the 'Acquire' button on the Acquitek Data Acquisition toolbar to acquire data directly into your Excel spreadsheet. If you have specified a non-existent target for acquisition, or your configuration parameters are otherwise incorrect, an error message will be displayed. You can then click 'Configure' again to display the configuration dialog and correct the problem.

DASYPab



DASYPab is an easy-to-use, Windows-based graphical data acquisition software package with which you build data acquisition and control applications more quickly. By using an icon-based flowchart, you develop your application with point-and-click ease -- no programming required.

Installing the Acquitek DASYPab[®] Driver

1. Copy XDADASY.dll from the [installdir]\ThirdParty\DASYPab folder (most likely C:\Program Files\Acquitek\ThirdParty\DASYPab) to DASYPab's root folder (most likely C:\Program Files\DASYPab).
2. Open DASYPab.

3. Choose Select Driver... from the Experiment menu in DASYSLab.
4. Find XDADASY.dll in this dialog box. Highlight it and click OK. If XDADASY.dll does not show up in this dialog, the file may be in the wrong place. Make sure you have completed step 1 correctly.
5. DASYSLab will inform you that you must restart DASYSLab for the changes to take effect. Restart DASYSLab.

The Acquitek DASYSLab Driver should now be installed and can be accessed from the Input/Output item in the Modules menu.

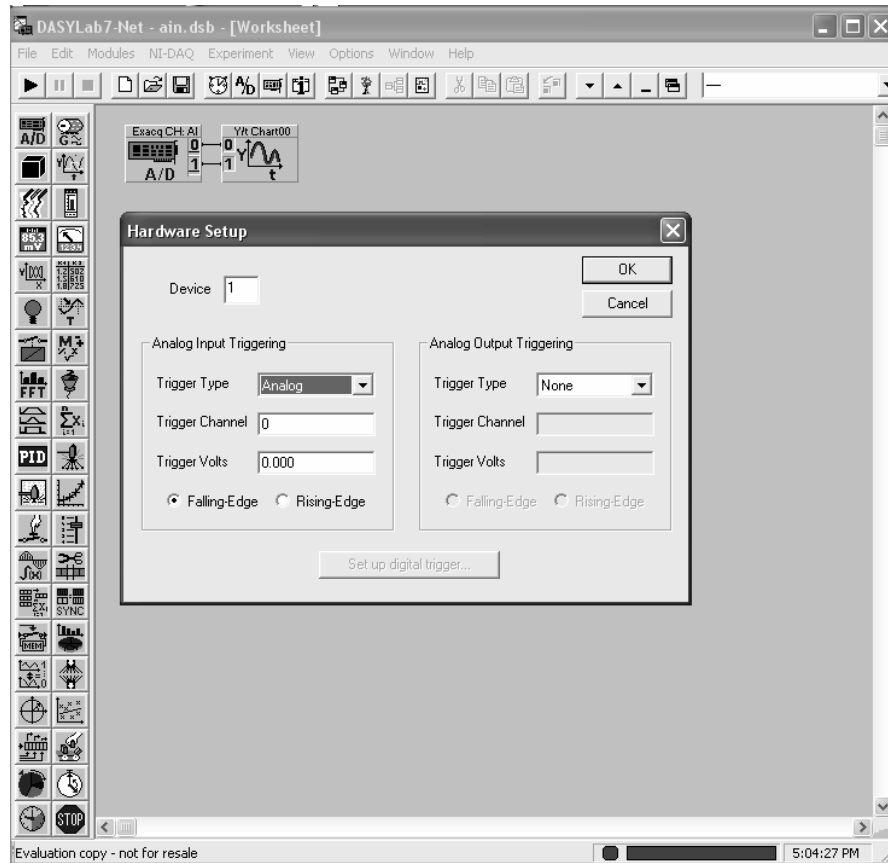
Adding Acquitek Driver Modules to your DASYSLab Worksheet

To add modules using the Acquitek DASYSLab driver to your worksheet, select Analog Input, Analog Output, Digital Input, or Digital Output from the Input/Output submenu of the Modules menu.

Selecting a Device

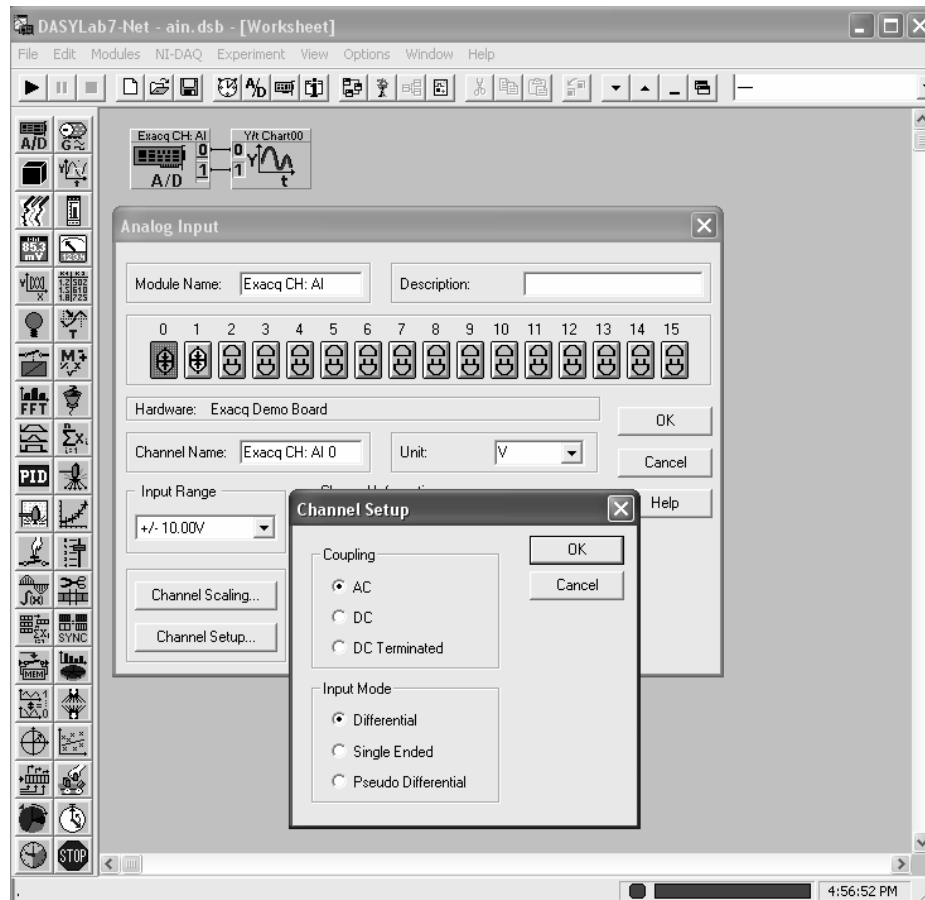
To choose a device, select “Hardware Setup” from the Experiment menu. Choose a device number (as defined in Acquitek Control Center) and click OK.

Setting up Triggering



To set up analog input triggering (CM/XM or CH/XH) or analog output triggering (CH/XH), select “Hardware Setup” from the Experiment menu. Select trigger options from the dialog box. To set up digital trigger mode, click the “Set up digital trigger” button and specify a port, mode, and which lines to enable. If you select Edge trigger, the bottom row of checkboxes allows you to specify which ports require a rising edge and which ports require a falling edge. If you select Pattern trigger, you can specify which ports will be logic high in the pattern and which ports will be logic low.

Setting Input Channel Options



To set coupling or input mode, double-click on an analog input module. In the dialog box that opens, select the channel you wish to set up and click “Channel Setup”. Specify options for each of these and click OK.

For More Information

For more information, please consult the DASyLab User Guide.

7

XM Series – Technical Specifications

Analog Inputs		XM-23x0	XM-24x0	XM-23x1	XM-24x1
Number of Channels	16-input XM boards	16SE/8D	16SE/8D	16SE/8D	16SE/8D
	32-input XM boards	32SE/16D	32SE/16D	32SE/16D	32SE/16D
Resolution		16 bits	16 bits	16 bits	16 bits
Max Sample Rate		250 kHz	1000 kHz	250 kHz	1000 kHz
Ranges	range=0, polarity = 0	+10 V	+10 V	+10 V	+10 V
	range=1, polarity = 0	+5 V	+5 V	+1 V	+1 V
	range=2, polarity = 0	+2.5 V	+2.5 V	+0.1 V	+0.1 V
	range=3, polarity = 0	+1.25 V	+1.25 V	+0.01 V	+0.01 V
	range=0, polarity = 1	0-10 V	0-10 V	0-10 V	0-10 V
	range=1, polarity = 1	0-5 V	0-5 V	0-1 V	0-1 V
	range=2, polarity = 1	0-2.5 V	0-2.5 V	0-0.1 V	0-0.1 V
	range=3, polarity = 1	0-1.25 V	0-1.25 V	0-0.01 V	0-0.01 V
Input Coupling		DC	DC	DC	DC
Input Impedance		10M Ohms	10M Ohms	10M Ohms	10M Ohms
Input Bias Current	at 25C	2 pA	2 pA	10 pA	10 pA
Input Protection		-40 - +55V	-40 - +55V	-40 - +55V	-40 - +55V
Input Operating Voltage	potential diff from sys ground	+10 V	+10 V	+10 V	+10 V
Charge Injection		4 pC	4 pC	4 pC	4 pC
Settling Time		3.5 uS	3.5 uS	2 uS (10 uS on range 3)	2 uS (10 uS on range 3)
Analog Bandwidth (3dB)	range=0	600 kHz	600 kHz	800 kHz	1000 kHz
	range=1	800 kHz	1300 kHz	800 kHz	1000 kHz
	range=2	800 kHz	4000 kHz	800 kHz	1000 kHz
	range=3	800 kHz	5000 kHz	250 kHz	250 kHz
DNL		<1 LSB (no missing codes)			
INL	max	+3 LSB	+2.5 LSB	+3 LSB	+2.5 LSB
System Noise (typical)	range=0	0.9 LSB	1.5 LSB	2 LSB	2.5 LSB
	range=1	0.9 LSB	1.5 LSB	2 LSB	3 LSB
	range=2	1.1 LSB	1.8 LSB	6 LSB	7.5 LSB
	range=3	1.2 LSB	1.9 LSB	22 LSB	28 LSB

Analog Inputs (cont'd)

		XM-23x0	XM-24x0	XM-23x1	XM-24x1
Accuracy (1 year)	range=0, polarity = 0	3.175 mV	3.1805 mV	4.89663 mV	4.81565 mV
at full scale for range	range=1, polarity = 0	1.71 mV	1.7155 mV	1.22078 mV	1.22395 mV
+/- 10C from cal temp	range=2, polarity = 0	0.985 mV	0.983 mV	0.91231 mV	0.91928 mV
100 samples avg	range=3, polarity = 0	0.618 mV	0.6167 mV	0.91288 mV	0.93796 mV
	range=0, polarity = 1	2.587 mV	2.5895 mV	4.15098 mV	4.21791 mV
	range=1, polarity = 1	1.406 mV	1.4091 mV	1.13872 mV	1.14952 mV
	range=2, polarity = 1	0.82 mV	0.819 mV	0.88945 mV	0.89719 mV
	range=3, polarity = 1	0.524 mV	0.5239 mV	0.89414 mV	0.9172 mV
Gain Stability (typical)	range=0	3 ppm/C	3 ppm/C	5 ppm/C	5 ppm/C
	range=1	3 ppm/C	3 ppm/C	5 ppm/C	5 ppm/C
	range=2	3 ppm/C	3 ppm/C	42 ppm/C	42 ppm/C
	range=3	3 ppm/C	3 ppm/C	102 ppm/C	102 ppm/C
Clock Source		internal, <1 Hz resolution on sampling clock			
Data Transfer Modes	DMA	SG	SG	SG	SG
	PIO	Yes	Yes	Yes	Yes
Channel gain list		64k	64k	64k	64k
FIFO size		<4M	<8M	<4M	<8M

Analog Outputs

		XM-23xx	XM-24xx
Number of Output Channels		2	2
Resolution		16 bits	16 bits
Maximum Update Rate		250 kHz	1000 kHz
FIFO Size		<4M samples	<8M samples
Data Transfer Modes	DMA	Scatter Gather	Scatter Gather
	PIO	Yes	Yes
Relative Accuracy (INL)	typical	+/-0.5 bits	+/-0.5 bits
	max	+/-4 bits	+/-4 bits
DNL		<1 bits	<1 bits
Monotonicity		16 bits	16 bits
Voltage Output Ranges	Unipolar	0 – 10V	0 - 10V
	Bipolar	-10 - 10V	-10 - 10V
Output Coupling		DC	DC
Output Impedance	DC	<0.1 Ohms	<0.1 Ohms
	10 KHz	0.3 Ohms	0.3 Ohms

Analog Outputs (cont'd)

		XM-23xx	XM-24xx
Output Current (Max)		+/-15 mA	+/-15mA
Protection (Short to Gnd)		Yes	Yes
Power On State		< 0.100 abs (V)	< 0.100 abs (V)
Settling Time for Full-Scale Step	to 0.1%	1.0 us	1.0 us
	to 0.01%	1.3 us	1.3 us
	to 1 LSB	1.7 us	1.7 us
		27 V/s	27 V/s
Slew Rate			
Noise	DC - 1 MHz	200 uV rms	200 uV rms
Accuracy (1 year)	Unipolar	2.02 mV	2.02 mV
	Bipolar	2.13 mV	2.13 mV
	unipolar and bipolar	2 ppm/C	2 ppm/C
Gain stability (typical)			

Digital I/O

Number of I/O	Up to 32 (four 8 Bit ports). Each port selectable as input or output
Input High:	2.0 V, 5 V max
Input Low:	0.8 V, 0 V min
Logic family compatibility:	TTL
Output High:	2.4 V min @ 24 mA
Output Low:	0.4 V max @ 24 mA
Power Up State:	Input (High Impedance)
Pull-up resistor:	10 K Ohm

Counter/Timers

	XM-23xx	XM-24xx
Num of counter/timers:	3	3
Bits per counter:	24	24
Clock speed:	20 MHz max	40 MHz max
Clock Source:	internal clock or external pin	
Gate source:	software control or external pin	
Supported modes:	82C54 Mode 1 - Triggered pulse	
	82C54 Mode 2 - Rate Generator	
	82C54 Mode 3 - Square Wave	
	82C54 Mode 5 - Triggered Strobe	


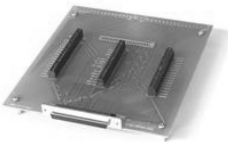


Physical/Environmental

Dimensions:	4 HP (single-slot) 3U PXI (160 x 100 mm)
Power Consumption:	50 mA +5 V
	30 mA +12 V
	610 mW
Operating Temperature:	0°C to 55°C
Storage Temperature:	-20°C to 70°C
Connectors:	68 Pin VHDCI female (analog and digital I/O 0-15)
	68 Pin VHDCI female (analog and digital I/O 16-31, if applicable)

8

XM Series – Cables & Connectors (*Optional*)

Acquitek offer a wide array of breakout boxes, connector panels, cables and cable assemblies to assist in making analog and digital I/O connections to the CH Series boards. Available connectivity options include:

	<p>B-1150</p> <p>Breaks out analog and digital I/Os 0-15 or analog and digital I/Os 16-31 on XM boards. Connects to board via 68-pin VHD connector. Requires L-4851 or L-4852 cable to connect.</p>
	<p>B-1155</p> <p>Same as above, but without enclosure.</p>
	<p>B-1410</p> <p>Rackmount kit for XM Series.</p>
	<p>L-4851, L-4852</p> <p>Use with all XM Series boards. Connects from 68-pin VHD connector on XM board to B-1150/1155. Available in 1M (L-4851) and 2M (L-4852) lengths.</p>

The complete line of breakout boxes and cables is as follows:

Breakout Boxes & Connector Boards

B-1150	<i>Breaks out analog and digital I/Os 0-15 or analog and digital I/Os 16-31 on XM boards. Connects to board via 68-pin VHD connector. Requires L-4851 or L-4852 cable to connect.</i>
B-1155	<i>Same as above, but without enclosure</i>
B-1410	<i>Rackmount kit: front panel and 2 empty hole covers (use with B-115x)</i>

Cables

L-4851	<i>VHD68 Ext 1m: For XM boards. Connects from VHD 68 connector on XM boards to B-115x 68-pin breakout unit</i>
L-4852	<i>VHD68 Ext 2m: For XM boards. Connects from VHD 68 connector on XM boards to B-115x 68-pin breakout unit</i>

9

Glossary

Aliasing - The term used to describe the observed effect of sampling an analog signal at a sampling frequency less than two times the highest frequency content of the signal. Signal processing theory, specifically Nyquist's Theorem, states that an analog signal can be exactly reconstructed from a periodic sampling of that signal if the sampling rate is greater than twice the highest frequency contained in the analog signal.

With the exception of some specialized undersampling applications it is important to prevent aliasing before it happens through the use of high sampling rates and/or anti-aliasing filters. Once a signal has been corrupted by aliasing, it can no longer be exactly reconstructed from its samples.

Anti-Aliasing filter - A filter with a frequency cutoff below one half the sampling rate. It is used to prevent aliasing during the sampling of an analog signal.

A/D - Analog to digital converter. A component which produces a digital representation of the voltage of an input analog signal at an instant in time called the sample time. Typically an A/D will sample an input signal periodically at a rate called the sample frequency.

Bessel filter - A type of filter which has excellent time domain distortion properties (i.e. pulse response with very little ringing) but poor frequency domain cutoff properties. This filter characteristic can be implemented in either the analog or digital domain.

Butterworth filter - A type of filter which has a good compromise between frequency domain cutoff properties and time domain distortion such as "ringing". This filter characteristic can be implemented in either the analog or digital domain.

Charge Injection - An undesirable property of a multiplexer in which a small amount of electrical charge is injected into the selected multiplexer input when the multiplexer switches. A voltage error is introduced which is equal to the injected charge divided by the input capacitance. The voltage error decays over time as a function of the source resistance. Lower source resistance results in faster decay of the voltage error.

CMRR - Common Mode Rejection Ratio. See common mode range.

Common Mode Range - With a differential voltage, the relevant measurement is the difference in voltage between the two signals in the pair. The absolute voltage between either signal and ground should not affect the differential measurement. In practice, voltages between the differential signals and ground can distort the differential measurement. Common mode

rejection ratio (CMRR) is a measure of how much the voltage between the differential pair and ground distorts the differential measurement. The common mode range defines how large the voltage between either signal and ground can be before the differential inputs no longer function.

D/A – Digital to analog converter. A component which produces an analog output signal which is proportional to a digital input value. Typically a D/A will hold the same analog output voltage for a period of time called the sample time, and be updated periodically with digital input values at a rate called the sample frequency.

dB – A decibel, or dB, is $10 * \log_{10}$ (power ratio between to signals). Since power is proportional to voltage squared, when dealing with voltages a dB is $20 * \log_{10}$ (voltage ratio).

dBfs – dB relative to a full scale A/D or D/A signal

dBV – dB relative to one Volt.

dBm – dB relative to one milliWatt.

dBmV – dB relative to one milliVolt.

Differential Input - An input through which the difference of two signals at the positive and negative inputs is measured rather than the difference between a signal and system ground. There is a limit to how far the two signals can be from the system ground before the input is no longer able to measure simply the difference between the two inputs but instead is distorted by the difference between the signals and ground. This limit is called the common mode voltage range.

Elliptic Filter - A type of filter which has excellent frequency domain cutoff properties but poor time domain distortion properties (i.e. pulse response with excessive ringing). This filter characteristic can be implemented in either the analog or digital domain.

FFT – Fast Fourier Transform. A mathematical tool for analyzing the frequency content of a signal.

FIFO – First In, First Out. A temporary storage memory with no addressing in which data is stored and retrieved in first in, first out order.

On a data acquisition board, a FIFO is used to free the host processor from servicing the data acquisition hardware on a periodic interval. Typically, the hardware accesses one side of the FIFO at the periodic sample rate (or a multiple of it). The host accesses the other side of the FIFO to either fill it with data for output or read the input data. The host can do so in burst mode, which is much more efficient. For example, a burst transfer across the host PCI bus can reach nearly 132 Mbytes/sec whereas non-burst transfers are a small fraction of that rate.

With a non-realtime operating system such as Windows, it is important for the FIFO to hold enough data to sustain periodic data acquisition during intervals when the processor is not available to service the data acquisition hardware.

Floating Source – A voltage source in which the voltage at the positive or negative terminal is referenced only to the other terminal, not to an absolute reference or ground. Batteries and thermocouples are common floating sources.

Gibbs Phenomena – Signals with sharp edges in their time domain response, such as square waves, require high frequency content in their frequency domain response to produce the rapid time domain changes. If such a signal is passed through a low pass filter which removes the high frequency energy, there may be substantial “ringing” at the time domain edges. This is known as Gibbs Phenomena. Careful design of the lowpass filter transition band can greatly reduce the amount of time domain ringing.

Harmonic distortion – Typically expressed in dB, this is the ratio of power at the fundamental signal frequency to the power at N times the fundamental frequency, where N is an integer. The largest distortion typically occurs at N equal two or three.

Non-linearities in components through which a signal passes change the characteristics of the signal. Typically, these changes are best observed in the frequency domain through the use of tools such as the Fast Fourier Transform (FFT). Harmonic distortion results in energy in a signal being increased at integer multiples of the fundamental frequency of the input signal.

Instrumentation Amplifier – A electrical circuit with two inputs and one output. An ideal instrumentation amplifier presents no load to the two inputs, and the output voltage with respect to ground is proportional to the difference between the two input voltages.

In practice, an input bias current must flow through the instrumentation amplifier inputs. The input bias current is a measure of the extent to which the instrumentation amplifier will disturb the inputs to be measured, with a smaller bias current causing less disturbance. A practical instrumentation amplifier will also have an offset voltage which is present at the output when the difference between the inputs is zero. Calibration of this offset voltage, along with external nulling circuitry, can eliminate this offset prior to analog to digital conversion.

Multiplexer – A device with several inputs and one output. External controls cause the desired input to be connected to the output. In a multifunction board, the multiplexer can operate at high speed to allow many inputs to be measured with a single instrumentation amplifier and analog to digital converter.

Mux – Multiplexer.

Noise – Any undesired modification of a signal is called noise. Unfortunately, everything adds noise to a signal, but some components or systems add more than others. The noise can be thermal noise, which is caused by the random motion of charge carriers in conductors (or semiconductors). This random motion increases as temperature increases, hence the name “thermal noise”. The noise can also be from interference “leaking” into a signal from other circuitry. In particular, high speed digital circuitry is prone to corrupt analog signals. Quantization is another type of noise imparted by the conversion between analog and digital signal.

In general, it is good for the noise to be small. Since noise is generally a random process, it is best measured in terms of an RMS voltage. Statistically, the peak value of random noise is

unlimited, but the likelihood of such peaks is infinitesimally small. The likelihood of a noise magnitude exceeding two times the RMS value is less than 5%.

Nyquist Frequency – Nyquist’s Sampling Theorem states that an analog signal can be exactly reconstructed from a periodic sampling of that signal if the sampling rate is greater than twice the highest frequency contained in the analog signal. Therefore, the Nyquist Frequency is $\frac{1}{2}$ the sampling rate ($F_s/2$). Any frequencies contained in the analog signal above the Nyquist Frequency will be aliased into the band $0 - F_s/2$ by the sampling process.

PGIA – Programmable Gain instrumentation Amplifier.

Programmable Gain Instrumentation Amplifier – An instrumentation amplifier in which the scaling coefficient which multiplies the difference between the input voltages to produce the output voltage can be changed via control signals. In an instrumentation amplifier which is not programmable, the scaling coefficient is typically set by a resistor.

Pseudodifferential Input - A differential input in which the negative input is intended as a voltage reference only, not to carry signal information. The negative input is isolated from the system ground, and the pseudodifferential input is therefore useful for preventing ground loops. In a multichannel system, many pseudodifferential inputs may share the same reference input; while it is common to the inputs, it is still isolated from system ground.

Quantization noise – Because of the limited number of bits available in a practical A/D, the digital output of the A/D does not exactly represent the input analog voltage. In an ideal A/D, the quantization noise is, on average, equal to the voltage represented by $\frac{1}{2}$ of the least significant output bit. Quantization noise can usually be effectively modeled as flat frequency spectrum between 0 and $\frac{1}{2}$ the sampling frequency, i.e. the Nyquist Frequency. Quantization noise improves by 6 dB for every bit in an A/D.

Reconstruction filter – Also known as a smoothing filter. A D/A converter typically operates by generating a voltage proportional to a digital value, and holding that voltage constant for a time period equal to the $1/\text{sample rate}$. This operation, known as a “zero-order hold”, has consequences in the frequency spectrum of the analog signal output from the D/A converter. Specifically, the desired frequency spectrum of the D/A output is replicated at every integer multiple of the D/A sampling frequency (F_s). A reconstruction filter “smoothes” the D/A output in the time domain, or attenuates the undesired replicas of the output signal at higher order multiples of the D/A sample rate.

A second effect of the “zero-order hold” architecture of the D/A is that within the desired signal range, (i.e. from 0 Hz up to F_s) there is an amplitude rolloff proportional to $\sin(\pi f/F_s) / (\pi f/F_s)$. This ratio is known as the sinc function, and results from the rectangular “stair step” shape of the D/A converter time-domain output. The sinc response causes the output of a D/A converter to be attenuated by 3.9 dB at the Nyquist Frequency, $F_s/2$. Some reconstruction filters will have sinc (or $\sin(x)/x$) compensation. In this case, the filter not only attenuates signals outside the $0 - F_s/2$ frequency band, but also provides an inverse sinc amplitude response within the $0 - F_s/2$ band.

Referenced Source – A voltage source in which not only the difference in voltage between the positive and negative terminal is defined, but also the difference between either terminal's voltage and a reference voltage such as ground.

Settling Time – The time taken for a system to respond to a transient event, such as a voltage step when switching from one input to the next in a multiplexed data acquisition system. Settling time is typically measured in microseconds from the transient input event until the measurement output is within some small tolerance of the final output, such as 0.1%, 0.01%, or 1LSB.

Single Ended Input – An input whose voltage is measured with respect to system ground.

SNR – Signal to noise ratio. Typically expressed in dB, this is the ratio of the desired signal power to the undesired noise power.

SFDR – Spur free dynamic range. Typically expressed in dB, this is the ratio between the power in an input signal and the largest spurious signal, either harmonically related to the input signal or not.

Successive Approximation – An analog to digital converter architecture capable of high resolution conversion at moderate speed. Unlike pipelined converters and sigma-delta converters, the input sampling rate does not need to be periodic and the start and end of a conversion are well-defined, making it the most suitable architecture for multiplexing inputs.

10

Technical Support

Acquitek is committed to providing exceptional technical and engineering support. When you need help with your Acquitek XM Series product, please have the following information available:

- A complete description of the problem, including any error messages or instructions on re-creating the error.
- Your computer configuration, including brand, processor, speed, memory, and other hardware installed.
- Description of what is connected to the XM Series boards.
- Operating System Environment (Windows, Linux, etc).
- Information on the compiler you are using, if applicable.
- Sample code, if applicable.

Technical support can be contacted as follows:

Acquitek , SAS.

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78059 St Quentin en Yvelines

France

Phone: +33 1 61 37 32 11

Fax: +33 1 61 37 32 13

e-mail: support@acquitek.com

Web: <http://www.acquitek.com>

Technical Support Hours

Monday – Friday:

9:00 am – 6:00 pm (GMT +1)

Saturday, Sunday & Holidays:

Closed