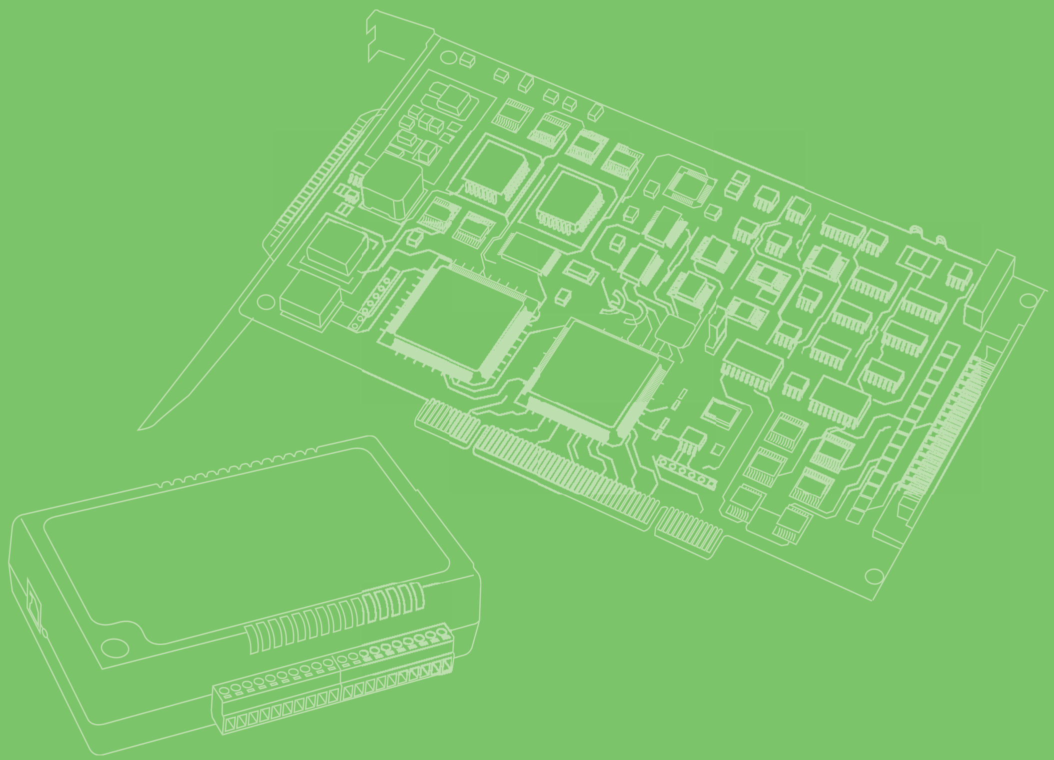

User Manual

# PCIE-1841

## 1MS/s/ch, 18-Bit, Simultaneous Analog Input Card

Enabling an Intelligent Planet

# Copyright



# Acknowledgments

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# Product Warranty (2 years)

Advantech warrants the original purchaser that each of its products will be free from defects in materials and workmanship for two years from the date of purchase.

This warranty does not apply to any products that have been repaired or altered by persons other than repair personnel authorized by Advantech, or products that have been subject to misuse, abuse, accident, or improper installation. Advantech assumes no liability under the terms of this warranty as a consequence of such events.

Because of Advantech's high quality-control standards and rigorous testing, most customers never need to use our repair service. If an Advantech product is defective, it will be repaired or replaced free of charge during the warranty period. For out-of-warranty repairs, customers will be billed according to the cost of replacement materials, service time, and freight. Please consult your dealer for more details.

If you believe your product to be defective, follow the steps outlined below.

1. Collect all the information about the problem encountered. (For example, CPU speed, Advantech products used, other hardware and software used, etc.) Note anything abnormal and list any onscreen messages displayed when the problem occurs.
2. Call your dealer and describe the problem. Please have your manual, product, and any helpful information readily available.
3. If your product is diagnosed as defective, obtain a return merchandise authorization (RMA) number from your dealer. This allows us to process your return more quickly.
4. Carefully pack the defective product, a completed Repair and Replacement Order Card, and a proof of purchase date (such as a photocopy of your sales receipt) into a shippable container. Products returned without a proof of purchase date are not eligible for warranty service.
5. Write the RMA number clearly on the outside of the package and ship the package prepaid to your dealer.

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# Declaration of Conformity

### CE

This product has passed the CE test for environmental specifications when shielded cables are used for external wiring. We recommend the use of shielded cables. This type of cable is available from Advantech. Please contact your local supplier for ordering information.

Test conditions for passing also include the equipment being operated within an industrial enclosure. In order to protect the product from damage caused by electrostatic discharge (ESD) and EMI leakage, we strongly recommend the use of CE-compliant industrial enclosure products.

### FCC Class A

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

# Technical Support and Assistance

1. Visit the Advantech website at www.advantech.com/support where you can find the latest information about the product.
2. Contact your distributor, sales representative, or Advantech's customer service center for technical support if you need additional assistance. Have the following information ready before you call:
   - Product name and serial number
   - Description of your peripheral attachments
   - Description of your software (operating system, version, application software, etc.)
   - A complete description of the problem
   - The exact wording of any error messages

# Warnings, Cautions, and Notes

**Warning!** *Warnings indicate conditions that if not observed can cause personal injury!*

**Caution!** *Cautions are included to help prevent hardware damage and data losses. For example,*

*"Batteries are at risk of exploding if incorrectly installed. Do not attempt to recharge, force open, or heat the battery. Replace the battery only with the same or equivalent type as recommended by the manufacturer. Discard used batteries according to the manufacturer's instructions."*

# Document Feedback

To assist us with improving this manual, we welcome all comments and constructive criticism. Please send all feedback in writing to support@advantech.com.

# Packing List

- PCIE-1841 or PCIE-1841L x 1
- Startup Manual x 1

# Ordering Information

| | |
|---|---|
| **PCIE-1841-A** | 1MS/s/ch, 18-bit, 16-ch, simultaneous AI card |
| **PCIE-1841L-A** | 1MS/s/ch, 18-bit, 8-ch, simultaneous AI card |

# Accessories

| | |
|---|---|
| **PCL-10162-1E** | 62-pin D-SUB shielded cable, 1 m |
| **PCL-10162-3E** | 62-pin D-SUB shielded cable, 3 m |
| **ADAM-3962-AE** | 62-pin D-SUB DIN-rail wiring board |
| **1700030423-01** | 10-pin flat cable for MDSI synchronization, 10 cm |

# Safety Instructions

1. Read these safety instructions carefully.
2. Retain this user manual for future reference.
3. Disconnect the equipment from all power outlets before cleaning. Use only a damp cloth for cleaning. Do not use liquid or spray detergents.
4. For pluggable equipment, the power outlet socket must be located near the equipment and easily accessible.
5. Protect the equipment from humidity.
6. Place the equipment on a reliable surface during installation. Dropping or letting the equipment fall may cause damage.
7. The openings on the enclosure are for air convection. Protect the equipment from overheating. Do not cover the openings.
8. Ensure that the voltage of the power source is correct before connecting the equipment to a power outlet.
9. Position the power cord away from high-traffic areas. Do not place anything over the power cord.
10. All cautions and warnings on the equipment should be noted.
11. If the equipment is not used for a long time, disconnect it from the power source to avoid damage from transient overvoltage.
12. Never pour liquid into an opening. This may cause fire or electrical shock.
13. Never open the equipment. For safety reasons, the equipment should be opened only by qualified service personnel.
14. If any of the following occurs, have the equipment checked by service personnel:
    - The power cord or plug is damaged.
    - Liquid has penetrated the equipment.
    - The equipment has been exposed to moisture.
    - The equipment is malfunctioning, or does not operate according to the user manual.
    - The equipment has been dropped and damaged.
    - The equipment shows obvious signs of breakage.
15. Do not leave the equipment in an environment with a storage temperature of below -20 °C (-4 °F) or above 60 °C (140 °F) as this may damage the components. The equipment should be kept in a controlled environment.
16. CAUTION: Batteries are at risk of exploding if incorrectly replaced. Replace only with the same or equivalent type as recommended by the manufacturer. Discard used batteries according to the manufacturer's instructions.
17. In accordance with IEC 704-1:1982 specifications, the sound pressure level at the operator's position does not exceed 70 dB (A).

DISCLAIMER: These instructions are provided according to IEC 704-1 standards. Advantech disclaims all responsibility for the accuracy of any statements contained herein.

# Safety Precaution - Static Electricity

Follow these simple precautions to protect yourself from harm and the products from damage.

1. To avoid electrical shock, always disconnect the power from your PC chassis before you work on it. Don't touch any components on the CPU card or other cards while the PC is on.
2. Disconnect the power before making any configuration changes. The sudden rush of power as you connect a jumper or install a card may damage sensitive electronic components.

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# Chapter 1

## Start Using PCIE-1841/L

This chapter provides an overview of Advantech PCI express cards for PCIE-1841 & PCIE-1841L, covering the product lineup, features, and accessories.

PCIE-1841 is a 16-channel simultaneous sampling module. PCIE-1841L on the other hand, is a reduced version with 8 acquisition channels. They all feature maximum 18-bit resolution, a sampling rate of 1MS/s for each channel, maximum input range of +/-20V, and selectable digital filters. They are suitable for high-speed dynamic signal-sensing scenarios.

## 1.1 Product Overview

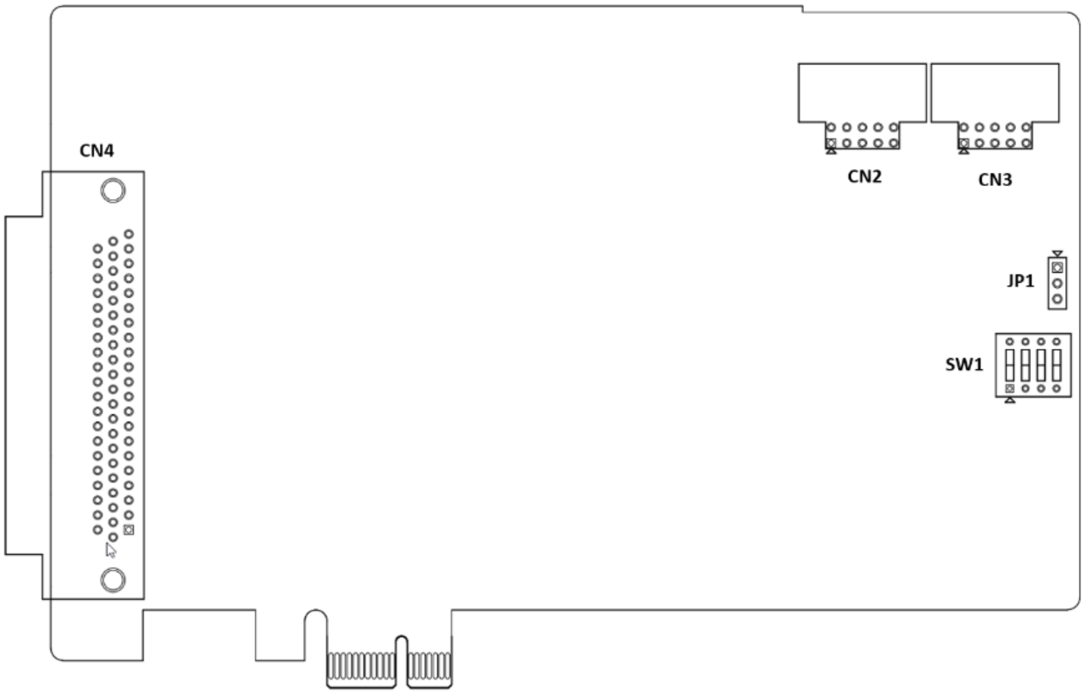


**Figure 1.1 Card layout of PCIE-1841/1841L**

**Table 1.1: List of connectors and switches**

| Component | Description | Function |
|---|---|---|
| SW1 | Board ID (BID) | Board ID function |
| JP1 | Reserved | Reserved (empty component) |
| CN2 | MDSI IN | Interface for MDSI synchronization |
| CN3 | MDSI OUT | Interface for MDSI synchronization |
| CN4 | D-SUB 62-pin Connector | Main-function signal connection |

## 1.2 Product Features

### 1.2.1 Board ID

A board ID (BID) can be assigned to Advantech DAQ devices (PCI/PCIe cards and USB modules) by the DIP switch. The board ID will be shown in the software and can be used to distinguish modules/devices. When there are multiple cards on the same chassis, this board ID switch is useful for identifying each card’s device number.

# 1.3 Driver Installation

The driver package can be found on the Advantech Support Portal (https://www.advantech.com/support). Search for PCIE-1841 or PCIE-1841L to locate the corresponding driver/SDK package. You'll receive the XNavi installer with the download which will start when the download finishes.

Execute the installer, then it will guide you through the session. You can choose the device and software components you'd like to install in the system (Figure 1.2). After selecting, click on "start" to begin the installation.

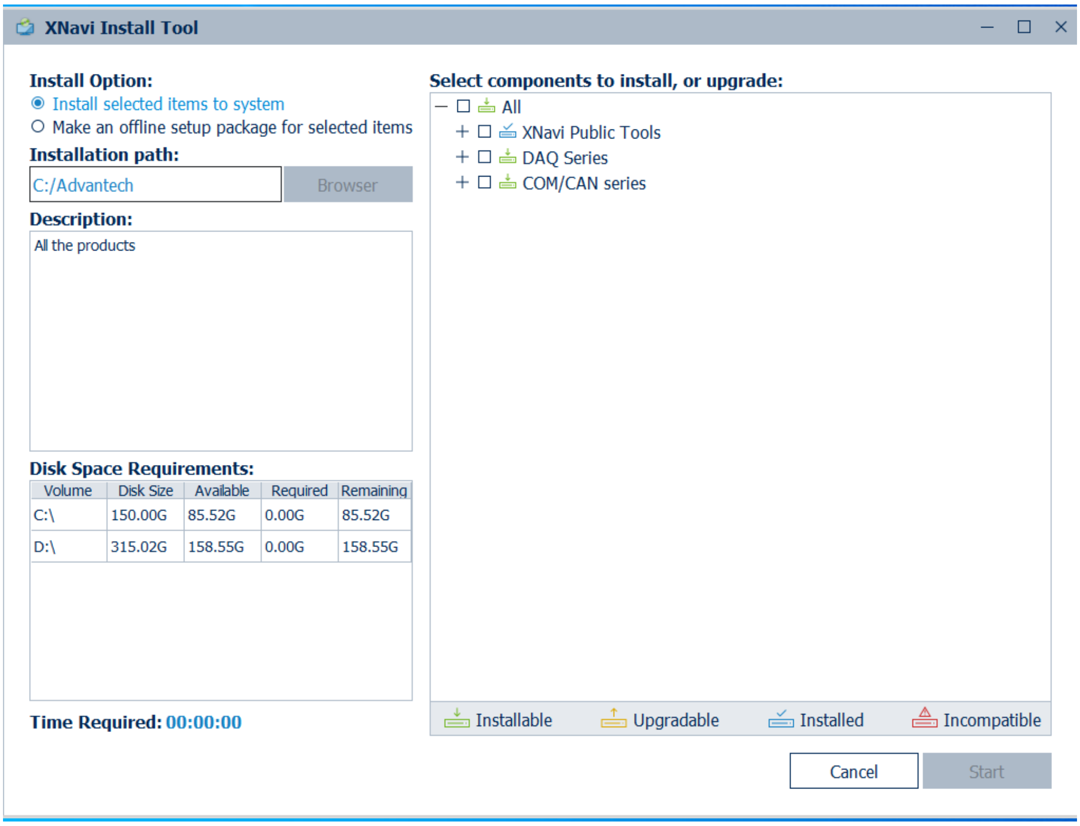


**Figure 1.2 XNavi installation interface**

# 1.4 Software Utility

Advantech offers device drivers, SDKs, third-party driver support and application software to help fully exploit the functions of your DAQ devices. All these software packages are available on the Advantech website: http://www.advantech.com/.

The Advantech Navigator is a utility that allows you to set up, configure and test your device, and later stores your settings in a proprietary database.

1. To set up the I/O device for your card, you can first run the Advantech Navigator program (by accessing Start/Programs/Advantech Automation/DAQNavi/Advantech Navigator). The settings can also be saved.
2. You can then view the device(s) already installed on your system (if any) on the Installed Device tree view. When the software and hardware installations are completed, you will see the DAQ devices in the Installed Devices list.

## 1.5 Software Development Using DAQNavi SDK

DAQNavi SDK is the software development kit for programming applications with Advantech DAQ products. The necessary runtime DLL, header files, software manual and tutorial videos can be installed via the XNavi installer. They can be found under C:\Advantech\DAQNavi (default directory) after finishing the installation.

## 1.6 FPGA Code Updates

The FPGA can also be updated via the interface in Navigator. However, it is not advised to update FPGA without first doing some research. Advantech strongly suggests you consult your technical support before starting an FPGA update.

# Chapter 2

## Installation Guide

## 2.1 Initial Unpacking Check

Before you install your DAQ devices, please make sure you have the following necessary components when unpacking the package:

- 1 x PCIE-1841 or PCIE-1841L card
- 1 x Startup Manual

If any of the above is missing, please contact your local support for further assistance.

## 2.2 Hardware Installation

After installation of the device drivers is complete, you can install the PCIE-1841/1841L card on your computer. However, it is suggested that you refer to the computer's user manual or related documentation if you have any doubts. Please follow the steps below to install the card onto your system.

1. Turn off your computer and unplug the power cord and cables. TURN OFF your computer before installing or removing any components on the computer.
2. Remove the cover of your computer.
3. Remove the slot cover on the back panel of your computer.
4. Touch the metal part on the surface of your computer to neutralize the static electricity that might be on your body.
5. Insert the PCIE-1841/1841L card into the PCI Express interface. Hold the card only by its edges and carefully align it with the slot. Insert the card firmly into place. Use of excessive force must be avoided; otherwise, the card might be damaged.
6. Connect the appropriate accessories (62-pin D-SUB Shielded Cable, wiring terminals, etc.) to the card.
7. Replace the cover of your computer chassis. Re-connect the cables you removed in step 2.
8. Plug in the power cord and turn on the computer.

After your card is properly installed on your system, you can then configure your device using the Advantech Navigator Program that has already been installed on your system during driver setup. A complete device installation procedure should include device setup, configuration, and testing. The following sections will guide you through the setup, configuration, and testing of your device.

# 2.3 Signal Connection and Pin Assignment

## 2.3.1 Analog Input Connection

An analog input channel measures the voltage ($V_S$) or current ($I_S$) of the external source.

If a voltage source is being measured, the voltage difference between the positive terminal and the negative terminal is being measured.

When measuring current, the current value which flows into the positive terminal is being measured. The current value will be converted into a voltage value by the measuring resistor ($R_{MEA}$).

The voltage is then amplified or attenuated by a programmable gain instrumentation amplifier (PGIA), conditioned by a low-pass filter (LPF), and sampled and converted into a digital form of data by an analog-to-digital converter (ADC). The ADC of every channel samples the signal at the same time, and this architecture is thus called simultaneous sampling analog input.

The analog input signal connection and internal functional block diagram is shown in Figure 2.1.

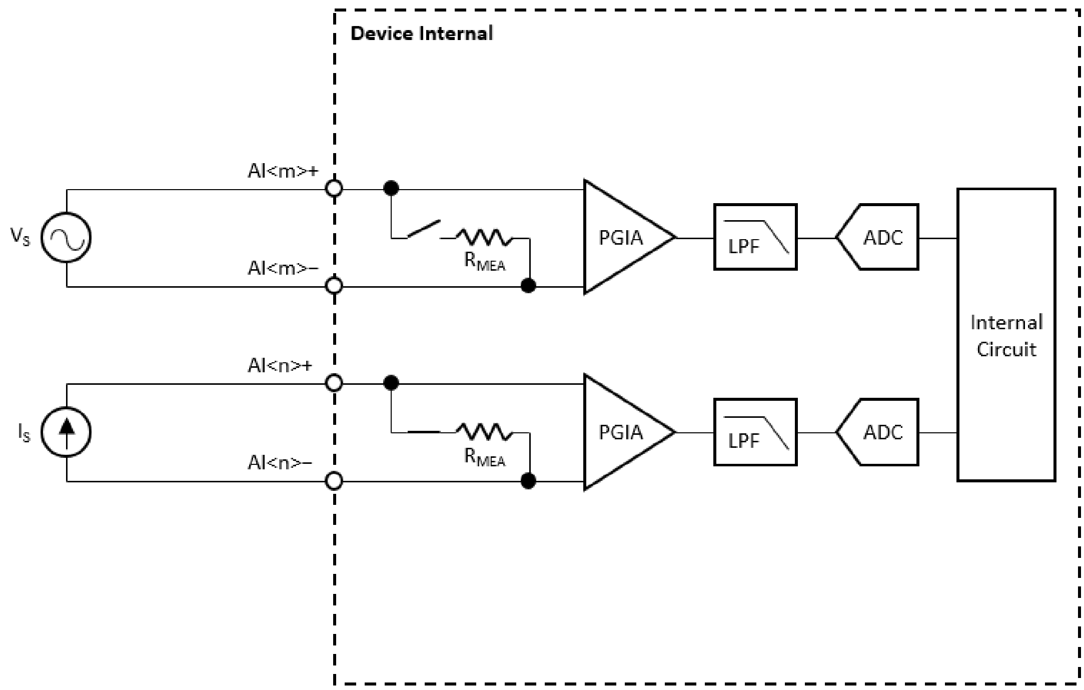


**Figure 2.1 Analog input signal connection**

The device only accepts differential input configuration. Connect the external source between the positive analog input (AI+) terminal and the negative analog input (AI−) terminal.

## 2.3.2 Digital Trigger Input Connection

A digital trigger can be configured as rising edge active or falling edge active, as shown in Figures 2.2 and 2.3, respectively. Figure 2.4 shows the signal connection of the digital trigger.

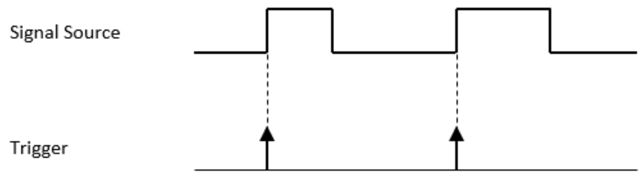


**Figure 2.2 Rising edge active digital trigger**

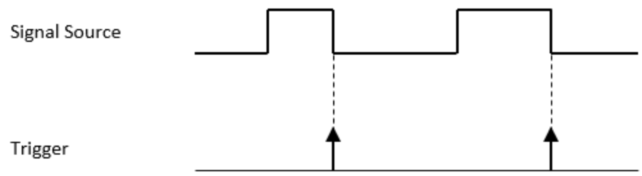


**Figure 2.3 Falling edge active digital trigger**

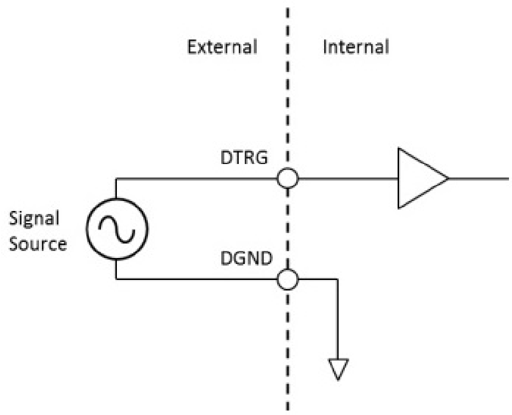


**Figure 2.4 Signal connection of the digital trigger**

### 2.3.3 Pin Assignment (CN4)

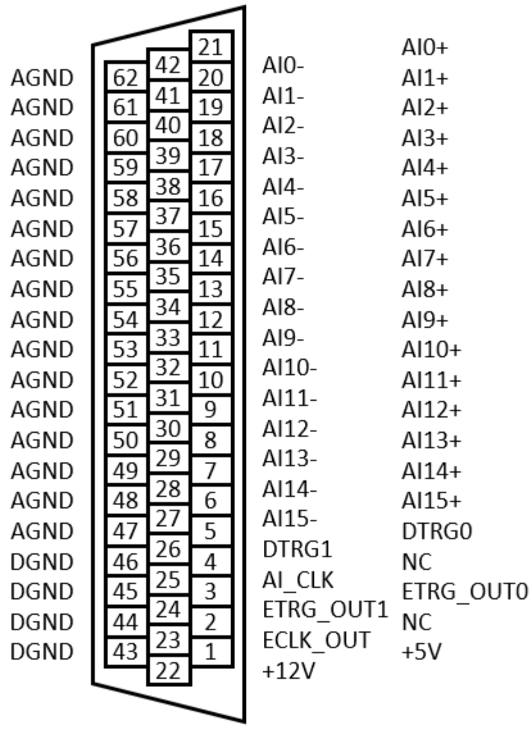


**Figure 2.5 Pin assignment for PCIE-1841/PCIE-1841L**

**Table 2.1: Pin assignment for PCIE-1841/PCIE-1841L**

| Pin Name | Direction | Description | Pin Number |
|---|---|---|---|
| AI<0..7>+ | I | Analog input positive terminals for channel 0 ~ 7. | 14 ~ 21 |
| AI<0..7>- | I | Analog input negative terminals for channel 0 ~ 7. | 35 ~ 42 |
| AI<8..15>+* | I | Analog input positive terminals for channel 8 ~ 15. | 6 ~ 13 |
| AI<8..15>-* | I | Analog input negative terminals for channel 8 ~ 15. | 27 ~ 34 |
| AGND | - | Ground terminals for analog signals. | 47 ~ 62 |
| DTRG<0..1> | I | Digital trigger input terminals. | 5, 26 |
| AI_CLK | I | Analog input external clock input terminal. | 25 |
| ETRG_OUT<0..1> | O | External trigger output terminals. | 3, 24 |
| ECLK_OUT | O | External clock output terminal. | 23 |
| DGND | - | Ground terminals for digital signals. | 43 ~ 46 |
| NC | - | Not Connected terminals. | 2, 4 |
| +12V | O | +12 V supply output. | 22 |
| +5V | O | +5 V supply output. | 1 |

* Not available for PCIE-1841L.

## 2.4 Grounding Considerations

### 2.4.1 Signal Source Type

Signal sources can be categorized as grounded (ground-referenced) signal sources or ungrounded (floating) signal sources. This is shown in Figure 2.6.

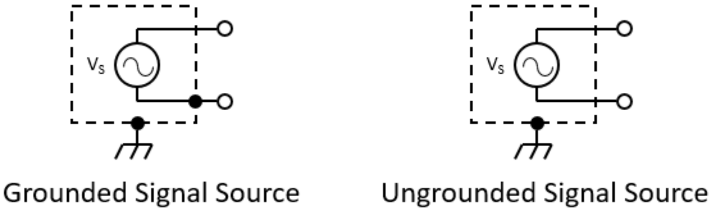


**Figure 2.6 Signal source type**

The voltage of a grounded signal source is referenced to a system ground, such as an earth or building ground. That is, the negative terminal of the signal source is connected to the system ground. Examples of grounded signal sources are devices that are plugged into the building ground through a wall outlet. The grounding of two independently grounded devices may not be at the same potential.

An ungrounded signal source is that in which the voltage is not referenced to a system ground. Examples of ungrounded signal sources are battery powered devices, thermocouples, and isolated devices.

### 2.4.2 Measuring a Grounded Signal Source

For a grounded signal source, it is recommended to measure the signal using differential input configuration.

As described in the previous section, the grounding of two grounded devices may not be at the same potential. If a single-ended (grounded) input configuration is used to measure a grounded signal source, a ground loop is formed and there will be current flowing between the two grounds, which generates common-mode noise for the measurement. This is shown in Figure 2.7.

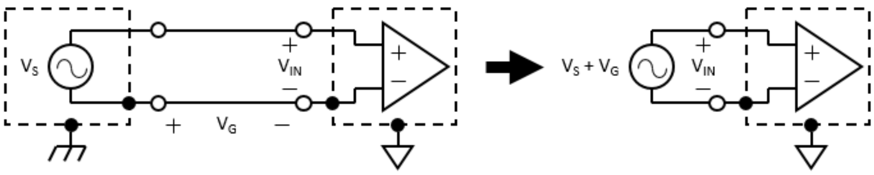


**Figure 2.7 Ground loop effect**

If a differential (ungrounded) input configuration is used instead, the high input impedance of the negative input terminal prevents ground loop current from flowing, and therefore rejects the common-mode noise.

### 2.4.3 Measuring an Ungrounded (Floating) Signal Source

For an ungrounded (floating) signal source, both differential input configuration and single-ended input configuration are suitable.

When using differential input configuration, however, care must be taken to ensure the input common-mode voltage level remains in the allowable range of the measuring device. Due to the lack of a DC path to the ground, the input bias current of the input stage amplifier may move the common-mode voltage level of the ungrounded signal source out of the allowable range of the measuring device. When this happens, the measured result will be incorrect or saturated (positive full-scale or negative full-scale). Resistors with equal resistance value connecting between each input terminal and the ground can be used to alleviate this issue as shown in Figure 2.8. These resistors are called bias resistors.

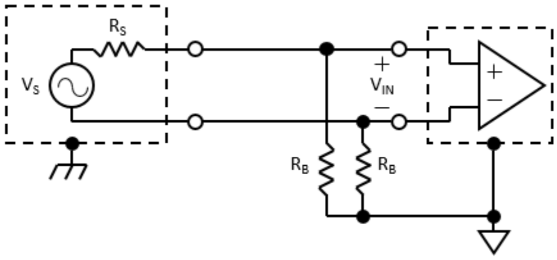


**Figure 2.8 Differential input configuration with bias resistors**

The resistance value should be large enough that it does not load the signal source and keeps it floating, but small enough to keep the input common-mode voltage level in the allowable range. Typically, resistance values of between 10 kΩ to 100 kΩ work well with low-impedance sources such as thermocouples and signal conditioning module outputs. When using a bias resistor, the measured voltage will be attenuated by the voltage divider formed by the source resistance of the signal source and bias resistors. This is shown in the following equation.

$$V_{IN} = \frac{2 \times R_B}{R_S + 2 \times R_B} V_S$$

If the source impedance of the signal source is low, only one resistor connecting the negative input terminal and the ground is required to prevent the input common-mode voltage level issue. However, this will lead to an unbalanced system if the source impedance is relatively high. A balanced system is desirable from a noise immunity point of view.

## 2.5 Field Wiring Considerations

When measuring a signal using the device, noise in the environment might significantly affect the performance of the measurement if some cautions are not taken. Follow these recommendations to avoid degradation of the resulting measurement.

- Make signal lines as short as possible.
- Use shielded, twisted-pair cables.
- Keep signal lines away from noisy environments, high-voltage/current cables, or equipment which generates large electromagnetic interference, such as power lines, motors, breakers, or welding equipment.
- Route signal lines at right angles to noise generating cables.
- Use differential input configuration to reduce common-mode noise.
- For externally powered modules, use separate power sources for modules and other noise generating equipment.

## 2.6 Board ID Configuration

The Board ID information can be viewed in Advantech Navigator. This is shown in Figure 2.9. The SW1 on the board sets the number. Table 2.2 shows the switch position and corresponding numbering.

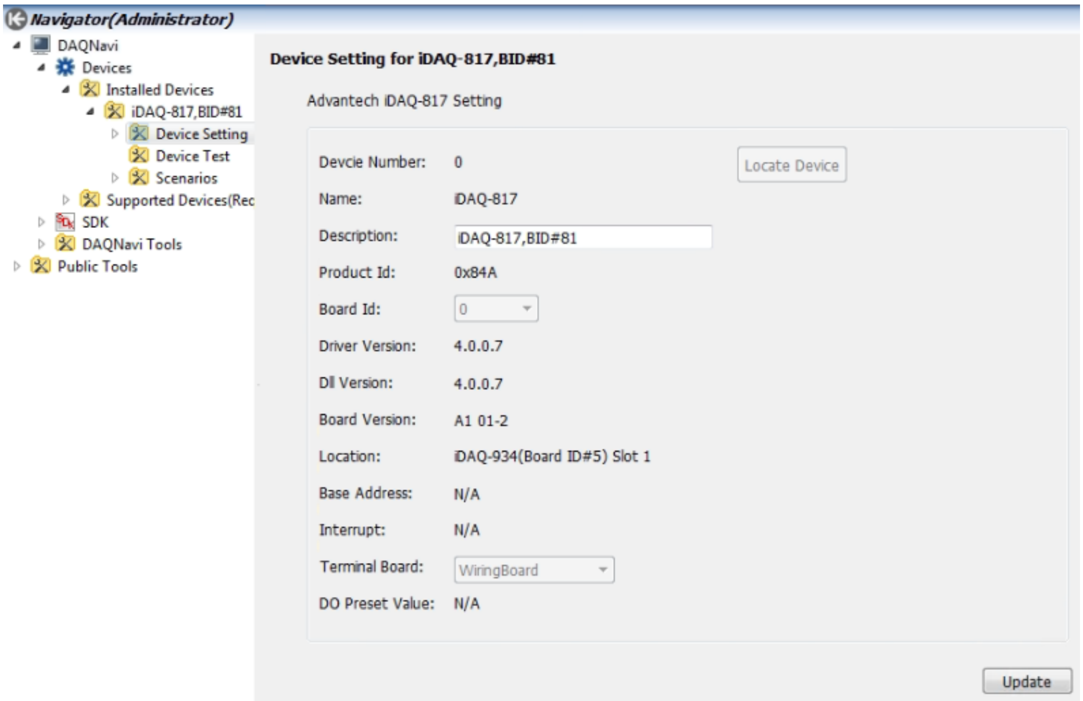


**Figure 2.9 Board ID shown in Navigator**

**Table 2.2: SW1 position for Board ID**

| Board ID | Switch Position | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 0* | UP | UP | UP | UP |
| 1 | UP | UP | UP | DOWN |
| 2 | UP | UP | DOWN | UP |
| 3 | UP | UP | DOWN | DOWN |
| 4 | UP | DOWN | UP | UP |
| 5 | UP | DOWN | UP | DOWN |
| 6 | UP | DOWN | DOWN | UP |
| 7 | UP | DOWN | DOWN | DOWN |
| 8 | DOWN | UP | UP | UP |
| 9 | DOWN | UP | UP | DOWN |
| 10 | DOWN | UP | DOWN | UP |
| 11 | DOWN | UP | DOWN | DOWN |
| 12 | DOWN | DOWN | UP | UP |
| 13 | DOWN | DOWN | UP | DOWN |
| 14 | DOWN | DOWN | DOWN | UP |
| 15 | DOWN | DOWN | DOWN | DOWN |

* Default setting.

# Chapter 3

## Function Details

This chapter describes all the functions that the PCIE-1841/PCIE-1841L provide and how they work.

# 3.1 Analog Input

The following sections describe the analog input acquisition mechanism.

## 3.1.1 Instant Analog Input Acquisition

With instant analog input acquisition, the software controls the sample timing. The analog-to-digital converter (ADC) is continuously converting the analog input signal within its maximum allowable conversion rate. Each time the software sends a "read instant analog input sample" command, the most recent conversion result is sampled as shown in Figure 3.1.

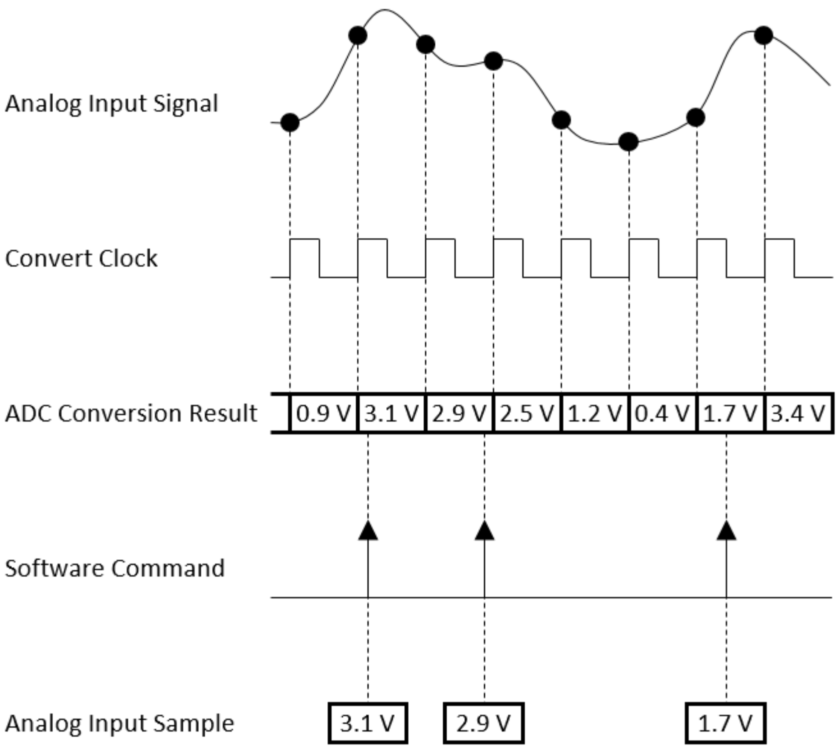


**Figure 3.1 Instant analog input acquisition**

### 3.1.2 Buffered Analog Input Acquisition

With buffered acquisition, a hardware signal called sample clock controls the rate and time of acquisition. The ADCs of all buffered acquisition enabled channels simultaneously begin to convert the analog input voltage at each rising edge of the sample clock. Figure 3.2 shows an example of analog input buffered acquisition where AI0, AI1, and AI2 are enabled.

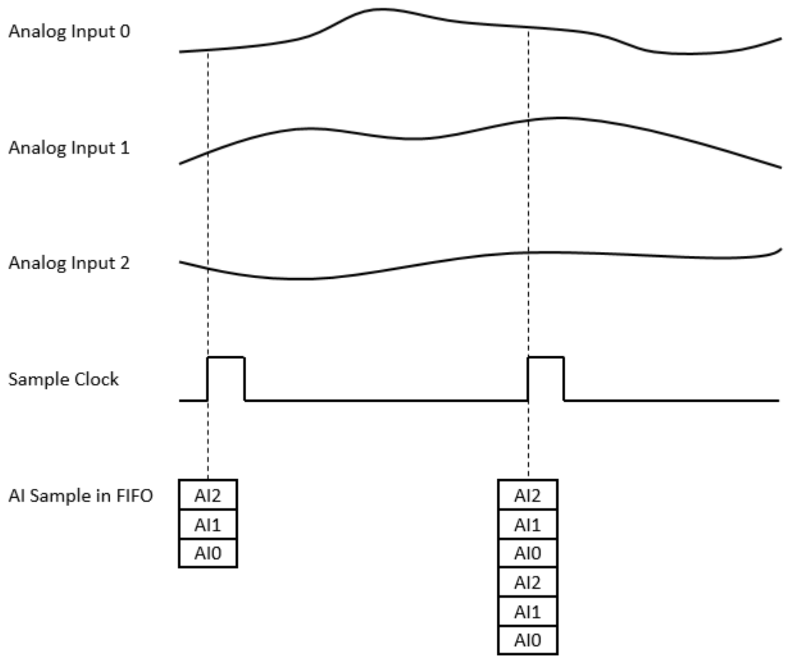


**Figure 3.2 Buffered (hardware-timed) analog input acquisition**

The sample clock can be generated internally on the device or be provided externally. Refer to the device specifications for supported sample clock sources and the maximum allowable frequency of the sample clock.

The acquired samples are first accumulated in the onboard first-in-first-out (FIFO) memory of the device, and then moved to the buffer in the PC by a direct memory access (DMA) engine. A buffer is a block of memory in the PC for temporarily storing the data to be transferred to the application memory. Because the data is moved in large blocks instead of one point at a time, buffered acquisition typically allows much higher transfer rates. Buffered acquisition is also called hardware-timed acquisition.

The advantages of buffered acquisition over instant acquisition include:

- The sample rate can be much higher.
- The time of a sample is deterministic.
- Hardware triggers can be used.

### 3.1.3 Analog Input Low-Pass Filter

The low-pass filter removes high frequency noise of the input signal and the noise that is added by the high common-mode voltage amplifier. It can also act as an anti-aliasing filter which avoids alias generation due to ADC conversion.

## 3.2 Trigger Signal

The trigger can come from one of various signal sources. If the signal source is of a digital type (logic high or low), it is called a digital trigger. On the other hand, if the signal source is of an analog type (voltage level), it is called an analog trigger.

### 3.2.1 Digital Trigger

A digital trigger can be configured as rising edge active or falling edge active, as shown in Figures 3.3 and 3.4, respectively.

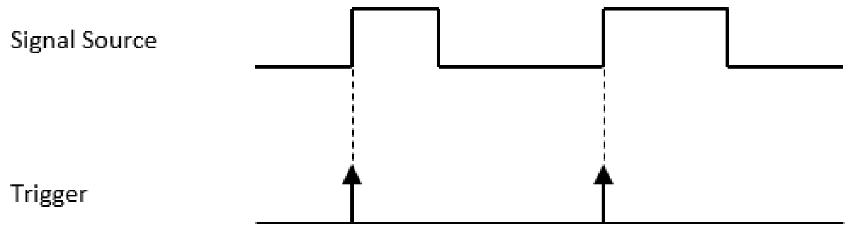


**Figure 3.3 Rising edge active digital trigger**

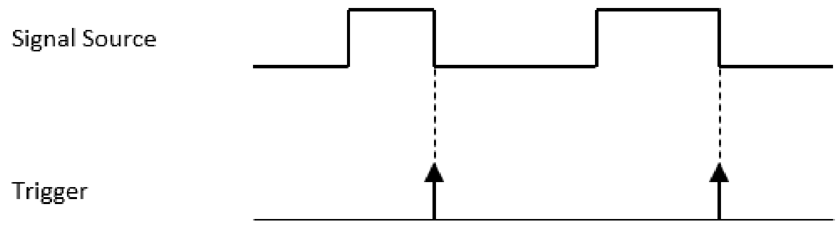


**Figure 3.4 Falling edge active digital trigger**

### 3.2.2 Analog Trigger

In addition to active edge, the user can configure the threshold level and the hysteresis value for an analog trigger. The threshold level specifies the analog input voltage level where the trigger occurs. The hysteresis value prevents unwanted triggers due to noisy signals.

A rising edge active analog trigger occurs when the signal crosses the threshold level from below. And another trigger occurs only if the signal has crossed the voltage specified by the threshold level minus the hysteresis value from above before it crosses the threshold level from below again. This is shown in Figure 3.5.

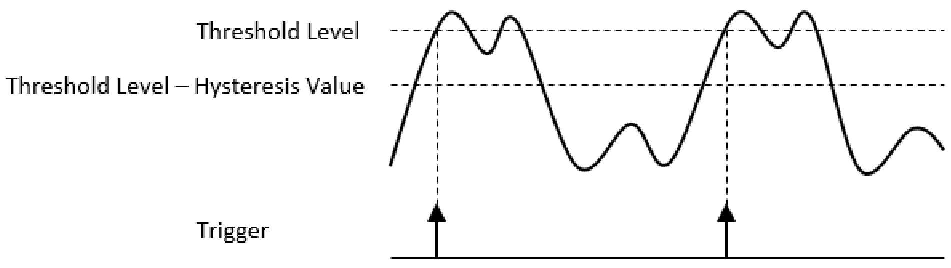


**Figure 3.5 Rising edge active analog trigger**

A falling edge active analog trigger occurs when the signal crosses the threshold level from above. And another trigger occurs only if the signal has crossed the voltage specified by the threshold level plus the hysteresis value from below before it crosses the threshold level from above again. This is shown in Figure 3.6.

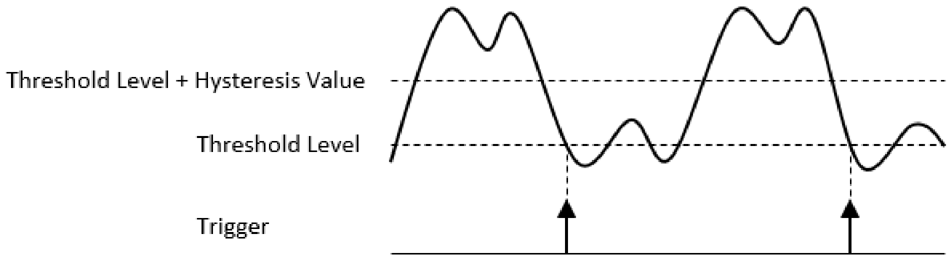


**Figure 3.6 Falling edge active analog trigger**

## 3.3 Clock Signal

The clock signal can be generated internally or provided from an external source. For an internal clock, when configuration is done, the clock frequency cannot be changed on the fly during the acquisition or generation operation. For an external clock, on the other hand, clock frequency can be controlled by the external source in real time.

## 3.4 Synchronization

To synchronize the acquisition of multiple devices, the required timing signals must be wired correctly. All devices must use the same sample clock for the equivalent sample rate and be triggered at the same time. One of the devices is selected as the source device, and the others as follower devices. The source device sends the required timing signals to all the follower devices for synchronized acquisition.

The timing signals can be wired externally through cables, or internally by the Multi-Device Synchronization Interface (MDSI) cables.

### 3.4.1 Synchronization via External Wiring

One of the devices is selected to be the source device, and others are follower devices. The source device may generate trigger and clock signals internally, or accept them from external sources. It then routes these signals to the output terminals and sends them to all the follower devices through external wiring for synchronized acquisition. To synchronize more than two devices, both daisy-chain and star topology can be used as shown in Figure 3.7 and Figure 3.8, respectively. Star topology reduces intermediate signal delay between devices. However, it also introduces signal degradation if too many loads are present for one signal source. It is recommended to keep the number of loads for one signal source as three or fewer.

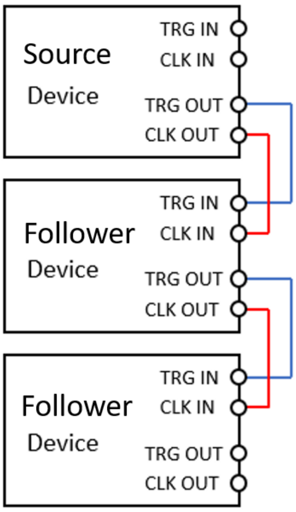


**Figure 3.7 Multiple device synchronization with daisy-chain topology**

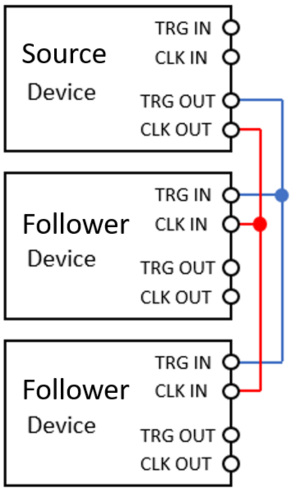


**Figure 3.8 Multiple device synchronization with star topology**

## 3.4.2 Synchronization via MDSI Cables

To use MDSI cables for synchronization, connect each cable from the MDSI OUT of one device to the MDSI IN of the next device as shown in Figure 3.9.

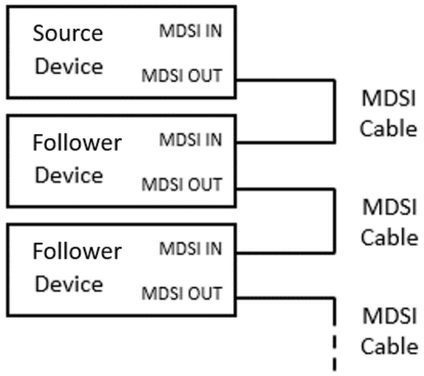


**Figure 3.9 Synchronize multiple devices through MDSI cables**

“Convert Clock Source” and “Trigger Source” configurations for the source can be selected as required. However, for the followers, these configurations must be selected according to Table 3.1.

**Table 3.1: Software configuration for synchronization by using an MDSI cable**

| Card | Source | Follower |
|---|---|---|
| Convert Clock Source | Internal Clock | External Digital Clock from MDSI pin |
| Trigger Source | None<br>One of the AI channels<br>External Digital Trigger 0/1 | MDSI Trigger 0/1 |

After all configurations are done, start all the followers before the source. This ensures all the followers are ready when the source sends synchronization signals.

## 3.5 Configuration for Buffered Analog Input Acquisition

According to software configurations, buffered analog input acquisition can be classified into two types:

- One-buffered analog input acquisition
- Streaming analog input acquisition

### 3.5.1 One-Buffered Analog Input Acquisition

For one-buffered acquisition, only a specified number of samples is acquired. The starting or stopping of acquisition can be controlled by a software command or a hardware signal. Three types of acquisitions can be achieved: post-trigger acquisition, pre-trigger acquisition, and about-trigger acquisition.

#### 3.5.1.1 Post-Trigger acquisition

A post-trigger acquisition acquires a specified number of samples after the start trigger. The acquisition starts when a start trigger is received and automatically stops when the specified number of samples is acquired. An example of 5-sample post-trigger acquisition is shown in Figure 3.10.

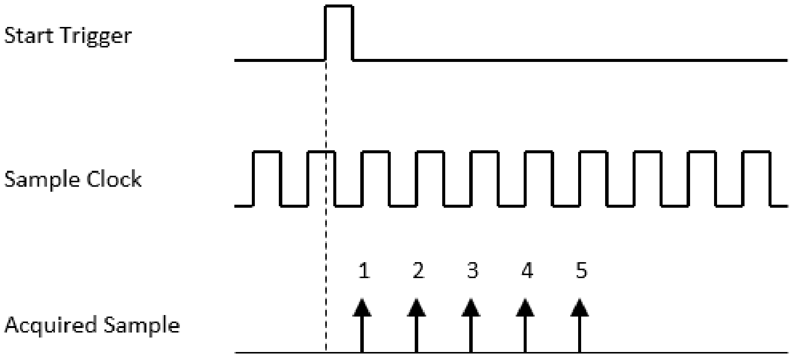


**Figure 3.10 Post-trigger acquisition**

The start trigger can be a software command or a hardware signal. If a hardware signal is used as the start trigger, the start of acquisition can be delayed for a specified number of sample clock cycles after a start trigger is received. Figure 3.11 shows an example of a 2-sample delay post-trigger acquisition. Refer to the device specifications for possible signal sources.

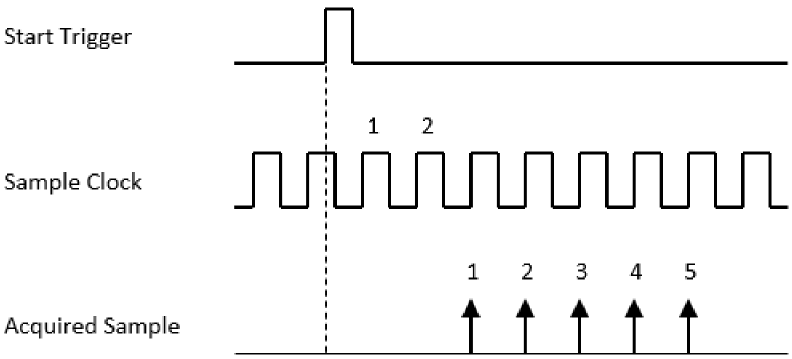


**Figure 3.11 Post-trigger acquisition with delay**

#### 3.5.1.2 Pre-trigger acquisition

A pre-trigger acquisition acquires a specified number of samples before the stop trigger. The acquisition is started by a software command and stops when a hardware stop trigger is received. Figure 3.12 shows an example of a 5-sample pre-trigger acquisition. Only the samples in the shaded area are returned.

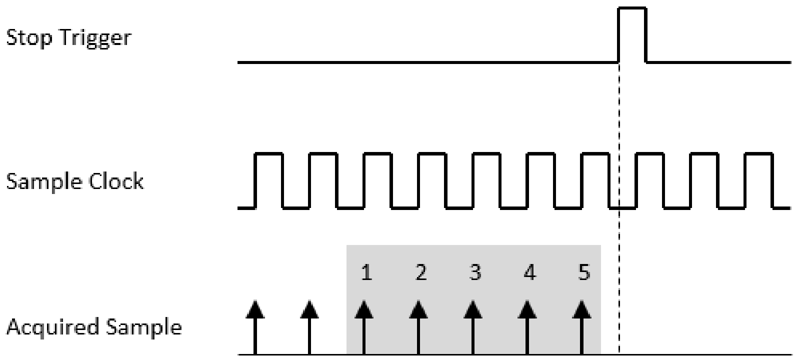


**Figure 3.12 Pre-trigger acquisition**

The stop trigger can only be a hardware signal. Refer to the device specifications for possible signal sources.

#### 3.5.1.3 About-trigger acquisition

An about-trigger acquisition is the same as a pre-trigger acquisition except that the time when the acquisition stops can be delayed by a specified number of sample clock cycles. Figure 3.13 shows an example of a 5-sample about-trigger acquisition with 2 cycles of stop delay. Only the samples in the shaded area are returned.

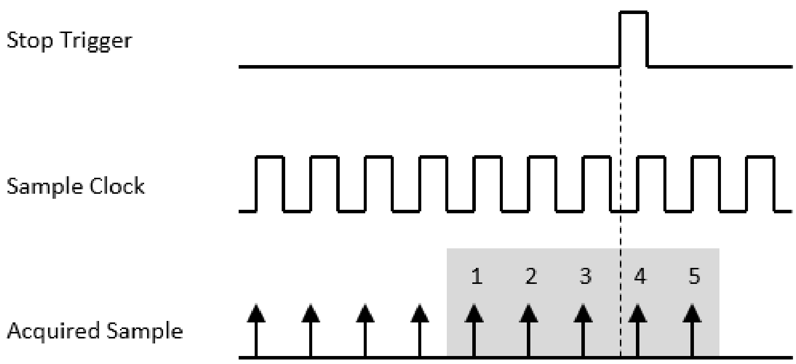


**Figure 3.13 About-trigger acquisition**

The stop trigger can only be a hardware signal. Refer to the device specifications for possible signal sources.

### 3.5.2 Streaming Analog Input Acquisition

For a streaming acquisition, the number of samples to be acquired is set to infinite. The acquisition starts when a start trigger is received and continues until a stop trigger is received as shown in Figure 3.14.

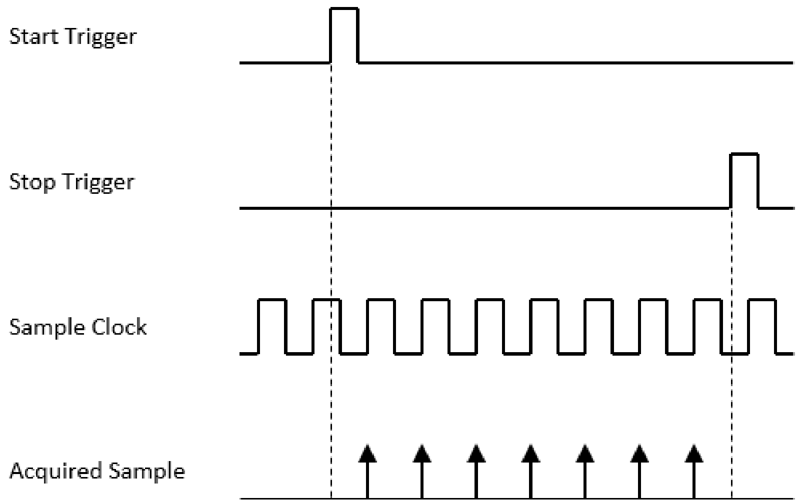


**Figure 3.14 Streaming acquisition**

Both the start trigger and the stop trigger can come from a software command or a hardware signal. If a hardware signal is used, the start (for the start trigger) or the stop (for the stop trigger) of the acquisition can also be delayed. Refer to the device specifications for possible signal sources.

### 3.5.3 Re-Triggerable Analog Input Acquisition

The acquisition can be re-triggerable. When re-trigger is enabled, after the acquisition stops, it restarts whenever the required trigger is received, and reconfiguration of the acquisition is not required.

Figures 3.15 to 3.18 show examples of re-trigger acquisition for post-trigger, pre-trigger, about-trigger, and streaming acquisitions, respectively. In a post-trigger acquisition, a start trigger is ignored while the acquisition is in progress. In an about-trigger acquisition, a stop trigger is ignored while the acquisition is being stopped.

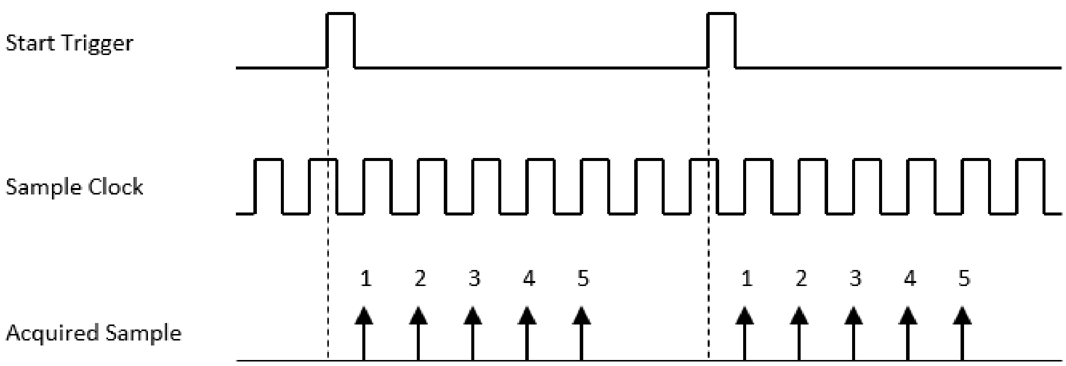


**Figure 3.15 Post-trigger acquisition with re-trigger**

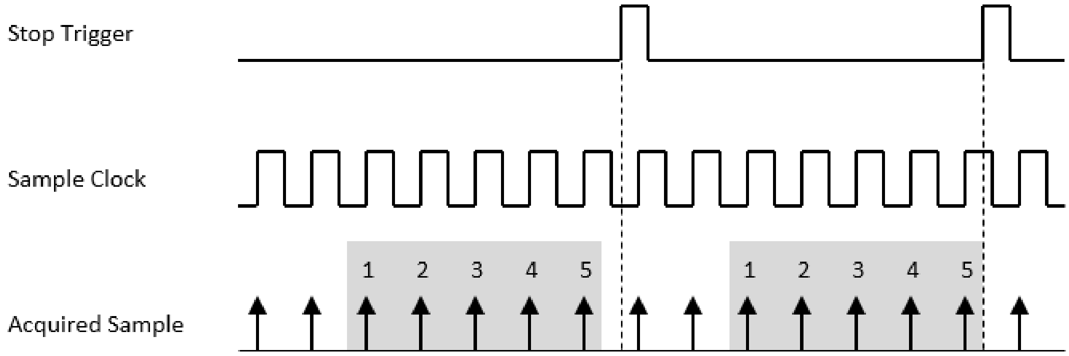


**Figure 3.16 Pre-trigger acquisition with re-trigger**

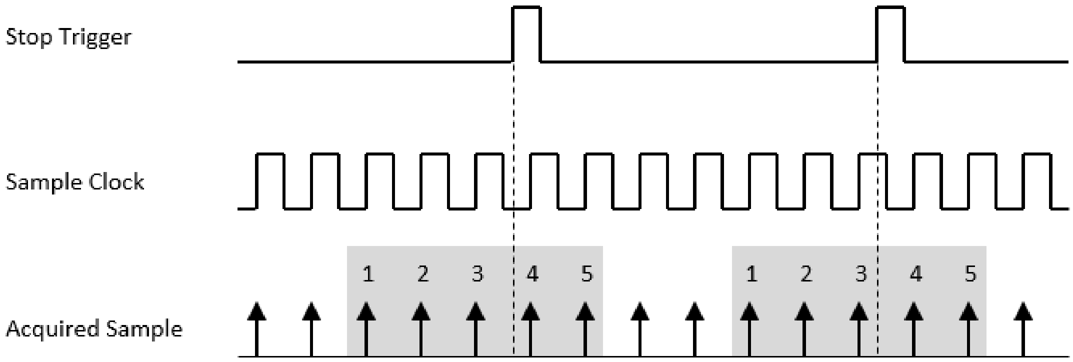


**Figure 3.17 About-trigger acquisition with re-trigger**

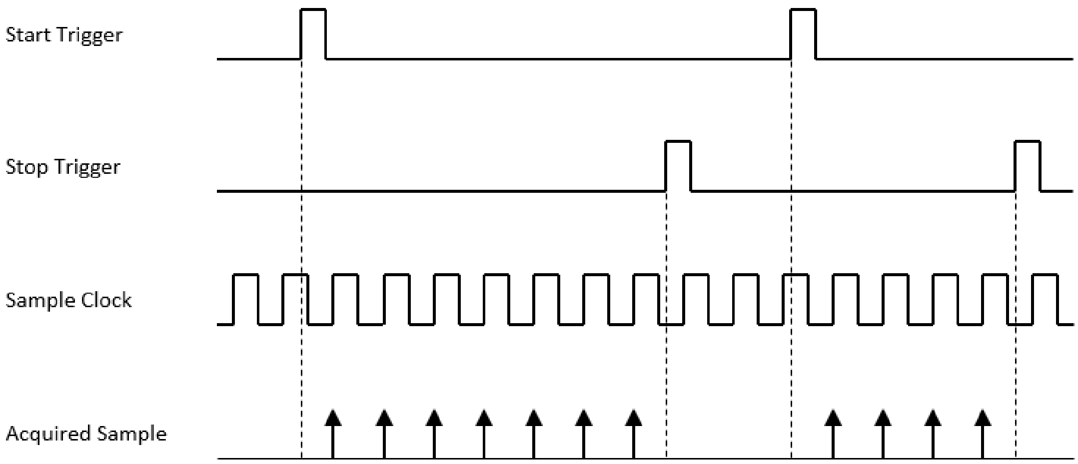


**Figure 3.18 Streaming acquisition with re-trigger**

# 3.6 Analog Input Calibration

The Navigator of Advantech DAQNavi provides the calibration utility to calibrate the analog input and analog output circuitry of the device. Figure 3.19 shows the interface of the calibration utility. Follow the instructions shown to calibrate the device. For a multi-function device, which contains both analog input and analog output functions, analog input calibration must be performed before analog output calibration.

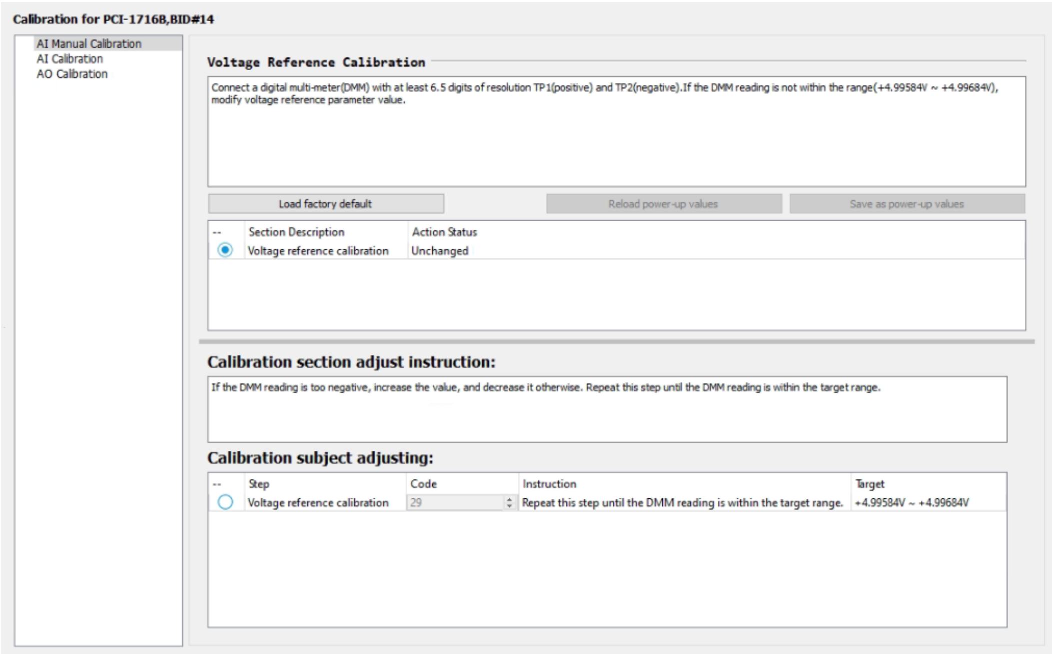


**Figure 3.19 Calibration utility**

When any of the calibration parameters are changed, the user can save the change by clicking the “Save as power-up values” button, or can reload power-up values by clicking the “Reload power-up values” button. The status of the calibration parameters is shown in the “Action Status” column. If required, the user can also load factory default calibration parameters by clicking the “Load factory default” button.

# Appendix A

## Specifications

## A.1 Analog Input

- **Channels**
  - PCIE-1841: 16 differential
  - PCIE-1841L: 8 differential
- **Analog-to-digital converter (ADC) resolution:** 18-bit
- **Input coupling:** DC
- **Input range:** ±20 V, ±12.5 V, ±10 V, ±5 V, or ±20 mA, software configurable per channel
- **Maximum input voltage:** ±20 V
- **Input common-mode voltage range:**
  - ±20 V range: ±10 V
  - ±12.5 V range: ±6.25 V
  - ±10 V range: ±5 V
  - ±5 V range: ±2.5 V
- **Over-voltage protection:** ±30 V
- **Input impedance**
  - Voltage input: 1 MΩ
  - Current input: 500 Ω
- **Analog low-pass filter**
  -3 dB bandwidth: 22.5 kHz or 220 kHz, software configurable per channel
- **Absolute accuracy**
  - Voltage input
    Operating temperature within ±5°C of last auto-calibration temperature: ±0.01% of full-scale range max.
    Over full operating temperature range: ±0.05% of full-scale range max.
  - Current input
    Operating temperature within ±5°C of last auto-calibration temperature: ±0.1% of full-scale range max.
    Over full operating temperature range: ±0.5% of full-scale range max.
- **Acquisition type:** Instant or buffered, software configurable
- **Buffered acquisition**
  - Enabled channel combination: Each channel can be enabled/disabled independently by software
  - Sample clock rate: 1 MHz max., for all channels, simultaneous sampling, software configurable

## A.2 Analog Input Characteristics

- DC performance

| Idle Channel Noise | | | | | | |
|---|---|---|---|---|---|---|
| Range | 10 kS/s | | 100 kS/s | | 1 MS/s | |
| | Noise (µVRMS) | Effective Resolution (bits) | Noise (µVRMS) | Effective Resolution (bits) | Noise (µVRMS) | Effective Resolution (bits) |
| ±20 V | 275 | 17.14 | 273 | 17.16 | 284 | 17.14 |
| ±12.5 V | 194 | 16.98 | 193 | 16.98 | 188 | 17.01 |
| ±10 V | 154 | 16.97 | 154 | 16.98 | 154 | 16.98 |
| ±5 V | 92 | 16.73 | 91 | 16.75 | 91 | 16.73 |

- AC performance

| Signal-to-Noise Ratio (SNR, 1 kHz Input Tone, -1 dBFS Amplitude, 25 kHz Bandwidth) | | | |
|---|---|---|---|
| Range | 10 kS/s | 100 kS/s | 1 MS/s |
| ±20 V | 85.91 dB | 86.07 dB | 86.80 dB |
| ±12.5 V | 86.09 dB | 85.88 dB | 86.60 dB |
| ±10 V | 85.95 dB | 85.96 dB | 87.21 dB |
| ±5 V | 85.65 dB | 85.13 dB | 88.36 dB |

| Signal-to-Noise Ratio (SNR, 1 kHz Input Tone, -1 dBFS Amplitude, 220 kHz Bandwidth) | | | |
|---|---|---|---|
| Range | 10 kS/s | 100 kS/s | 1 MS/s |
| ±20 V | 81.63 dB | 81.30 dB | 81.41 dB |
| ±12.5 V | 80.94 dB | 79.75 dB | 80.15 dB |
| ±10 V | 78.95 dB | 78.21 dB | 78.51 dB |
| ±5 V | 75.33 dB | 73.33 dB | 73.75 dB |

| Total Harmonic Distortion (THD, 1 kHz Input Tone, -1 dBFS Amplitude, 25 kHz Bandwidth) | | | |
|---|---|---|---|
| Range | 10 kS/s | 100 kS/s | 1 MS/s |
| ±20 V | -98.53 dB | -101.85 dB | -102.09 dB |
| ±12.5 V | -98.72 dB | -102.75 dB | -102.84 dB |
| ±10 V | -99.85 dB | -103.54 dB | -101.62 dB |
| ±5 V | -102.06 dB | -105.08 dB | -103.09 dB |

| Total Harmonic Distortion (THD, 1 kHz Input Tone, -1 dBFS Amplitude, 220 kHz Bandwidth) | | | |
|---|---|---|---|
| Range | 10 kS/s | 100 kS/s | 1 MS/s |
| ±20 V | -95.52 dB | -102.65 dB | -101.70 dB |
| ±12.5 V | -90.49 dB | -100.99 dB | -100.32 dB |
| ±10 V | -93.56 dB | -101.73 dB | -100.57 dB |
| ±5 V | -91.94 dB | -99.06 dB | -99.51 dB |

| Total Harmonic Distortion Plus Noise (THD+N, 1 kHz Input Tone, -1 dBFS Amplitude, 25 kHz Bandwidth) | | | |
|---|---|---|---|
| Range | 10 kS/s | 100 kS/s | 1 MS/s |
| ±20 V | -85.68 dB | -85.96 dB | -86.68 dB |
| ±12.5 V | -85.85 dB | -85.79 dB | -86.49 dB |
| ±10 V | -85.77 dB | -85.88 dB | -87.06 dB |
| ±5 V | -85.55 dB | -85.09 dB | -85.29 dB |

| Total Harmonic Distortion Plus Noise (THD+N, 1 kHz Input Tone, -1 dBFS Amplitude, 220 kHz Bandwidth) | | | |
|---|---|---|---|
| Range | 10 kS/s | 100 kS/s | 1 MS/s |
| ±20 V | -81.46 dB | -81.27 dB | -81.37 dB |
| ±12.5 V | -80.48 dB | -79.71 dB | -80.11 dB |
| ±10 V | -78.80 dB | -78.18 dB | -78.48 dB |
| ±5 V | -75.24 dB | -73.32 dB | -73.74 dB |

| Spurious-Free Dynamic Range (SF, 1 kHz Input Tone, -1 dBFS Amplitude, 25 kHz Bandwidth) | | | |
|---|---|---|---|
| Range | 10 kS/s | 100 kS/s | 1 MS/s |
| ±20 V | 101.95 dB | 107.40 dB | 95.72 dB |
| ±12.5 V | 101.53 dB | 105.36 dB | 95.46 dB |
| ±10 V | 101.60 dB | 103.29 dB | 96.70 dB |
| ±5 V | 101.32 dB | 97.35 dB | 95.94 dB |

| Spurious-Free Dynamic Range (SF, 1 kHz Input Tone, -1 dBFS Amplitude, 220 kHz Bandwidth) | | | |
|---|---|---|---|
| Range | 10 kS/s | 100 kS/s | 1 MS/s |
| ±20 V | 94.21 dB | 90.55 dB | 93.75 dB |
| ±12.5 V | 94.71 dB | 88.81 dB | 91.25 dB |
| ±10 V | 93.36 dB | 86.28 dB | 89.57 dB |
| ±5 V | 86.12 dB | 80.28 dB | 83.82 dB |

| **Dynamic Range (DR, 1 kHz Input Tone, -60 dBFS Amplitude, 25 kHz Bandwidth)** | | | |
|---|---|---|---|
| Range | 10 kS/s | 100 kS/s | 1 MS/s |
| ±20 V | 94.71 dB | 94.77 dB | 94.73 dB |
| ±12.5 V | 93.96 dB | 93.89 dB | 94.06 dB |
| ±10 V | 93.98 dB | 93.77 dB | 93.70 dB |
| ±5 V | 92.59 dB | 92.09 dB | 92.03 dB |

| **Dynamic Range (DR, 1 kHz Input Tone, -60 dBFS Amplitude, 220 kHz Bandwidth)** | | | |
|---|---|---|---|
| Range | 10 kS/s | 100 kS/s | 1 MS/s |
| ±20 V | 86.82 dB | 86.41 dB | 86.45 dB |
| ±12.5 V | 84.44 dB | 82.73 dB | 83.25 dB |
| ±10 V | 82.49 dB | 81.46 dB | 81.88 dB |
| ±5 V | 79.33 dB | 77.62 dB | 77.90 dB |

| **Crosstalk (1 kHz Input Tone, -1 dBFS Amplitude, 25 kHz Bandwidth)** | | | |
|---|---|---|---|
| Range | 10 kS/s | 100 kS/s | 1 MS/s |
| ±20 V | -101.12 dB | -101.45 dB | -104.13 dB |
| ±12.5 V | -105.01 dB | -104.32 dB | -102.24 dB |
| ±10 V | -102.42 dB | -106.54 dB | -104.45 dB |
| ±5 V | -104.24 dB | -115.01 dB | -101.15 dB |

| **Crosstalk (1 kHz Input Tone, -1 dBFS Amplitude, 220 kHz Bandwidth)** | | | |
|---|---|---|---|
| Range | 10 kS/s | 100 kS/s | 1 MS/s |
| ±20 V | -87.52 dB | -104.22 dB | -102.11 dB |
| ±12.5 V | -99.91 dB | -103.55 dB | -103.45 dB |
| ±10 V | -94.78 dB | -102.78 dB | -101.45 dB |
| ±5 V | -92.15 dB | -105.12 dB | 104.45 dB |

## A.3 Trigger

- **Number of triggers:** 2
- **Trigger action:** Start, delay to start, stop, or delay to stop
- **Trigger delay range:** 0 ~ 16,777,215 samples
- **Sample number:** 0 ~ 16,777,215 samples

### A.3.1 Analog Trigger

- **Source:** One of the analog input channels, software configurable
- **Input range:** Full scale of analog input range
- **Resolution:** 18-bit
- **Hysteresis:** 1/256 of analog input range, software configurable
- **Accuracy:** ±0.01% of full-scale range max.
- **Polarity:** Rising edge or falling edge, software configurable
- **Minimum width:** 1/(sample rate)

### A.3.2 Digital Trigger

- **Source:** 2 external pins
- **Input logic level:**
  - Logic high: 2.0 V min.
  - Logic low: 0.8 V max.
- **Working voltage:** -0.25 V ~ 5.25 V
- **Polarity:** Rising edge or falling edge, software configurable
- **Input protection voltage:** -0.5 V ~ 6.5 V
- **Pull-up resistor:** 10 kΩ
- **Minimum width:** 100 ns

## A.4 External Clock Input

- **Channels:** 1
- **Input type:** 5 V TTL
- **Input logic level**
  - Logic high: 2.0 V min.
  - Logic low: 0.8 V max.
- **Working voltage:** -0.25 V ~ 5.25 V
- **Polarity:** Rising edge
- **Input protection voltage:** -0.5 V ~ 6.5 V
- **Pull-up resistor:** 10 kΩ
- **Minimum width:** 100 ns

## A.5 Trigger Output

- **Channels:** 2
- **Output type:** 5 V TTL
- Output logic level
  - Logic high: 4.0 V min. @ 2 mA source/5.2 V max.
  - Logic low: 0.4 V max. @ 2 mA sink
- **Load current:** 8 mA max.

# A.6 Clock Output

- **Channels:** 1
- **Output type:** 5 V TTL
- **Output logic level**
  - **Logic high:** 4.0 V min. @ 2 mA source/5.2 V max.
  - **Logic low:** 0.4 V max. @ 2 mA sink
- **Load current:** 8 mA max.

# A.7 Multi-Device Synchronization Interface (MDSI)

- **MDSI:** Yes, connected by 10-pin flat cable

# A.8 General

- **Power consumption**
  - +3.3 V (±5%): 800 mW typ./820 mW max.
  - +12 V (±5%): 1 W typ./1.3 W max.
- **Dimensions:** 175 x 100 x 18 mm (6.9 x 3.9 x 0.7 in.)
- **Operating temperature:** 0 °C to 60 °C (32 °F to 140 °F)
- **Storage temperature:** -40 °C to 70 °C (-40 °F to 158 °F)
- **Operating humidity:** 10% to 90% RH, non-condensing
- **Storage humidity:** 5% to 95% RH, non-condensing

# A.9 Function Block

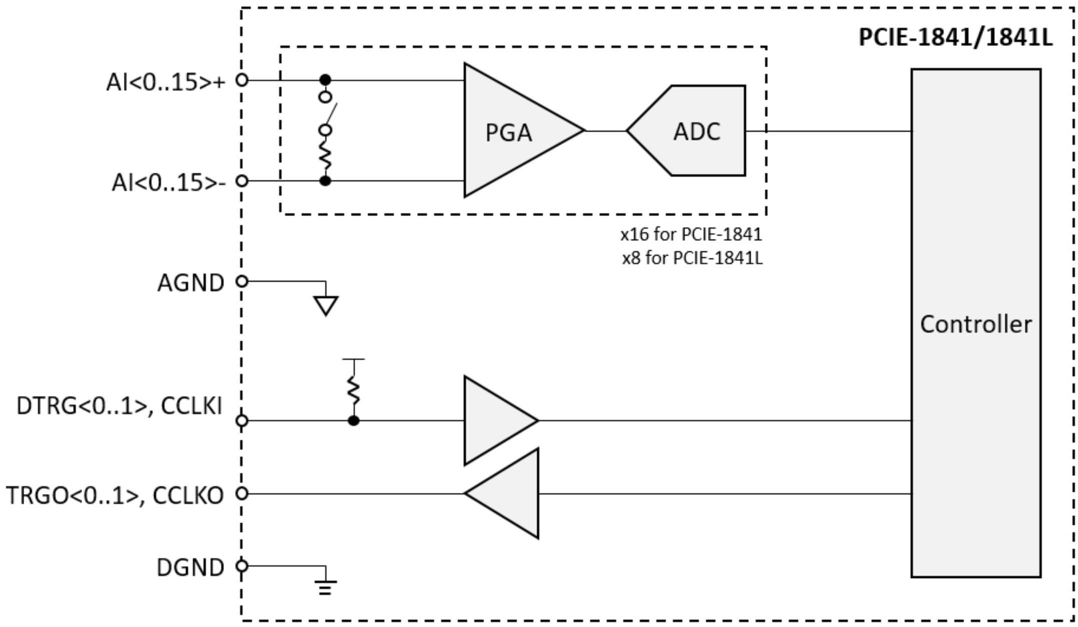


**Figure A.1 Function block of PCIE-1841/1841L**

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