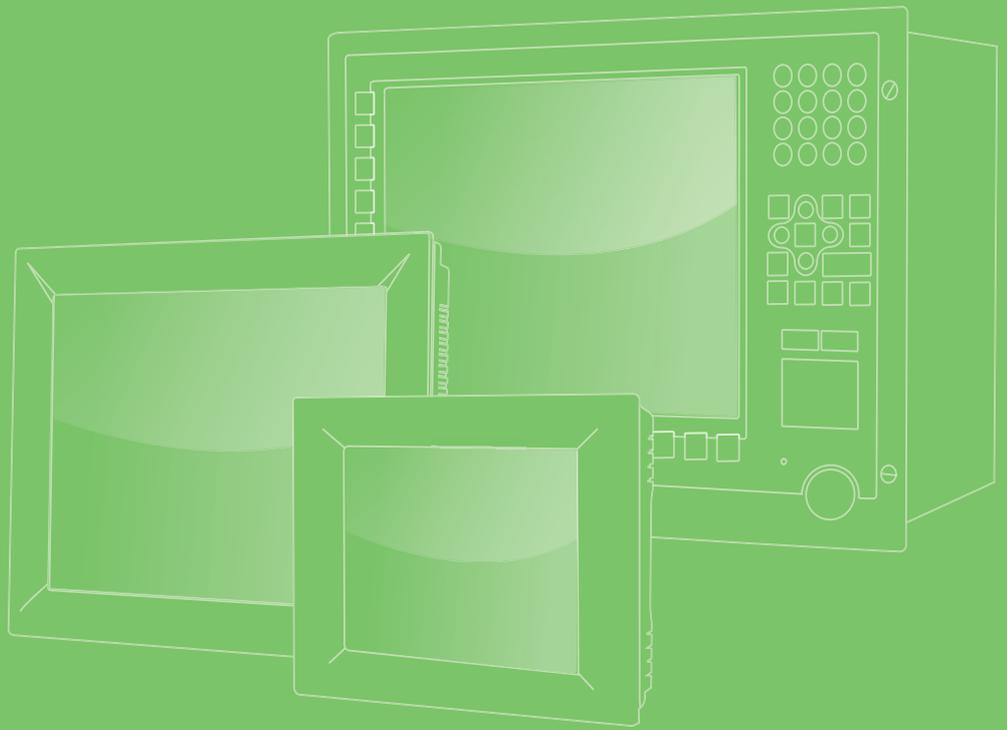


User Manual



USB-4716

200 kS/s, 16-bit, USB Multifunction
Module

ADVANTECH

Enabling an Intelligent Planet

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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 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 are billed according to the cost of replacement materials, service time, and freight. Please consult your dealer for more details.

If you believe your product is 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. Have your manual, product, and any relevant 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 proof of purchase date are not eligible for warranty service.
5. Write the RMA number visibly on the outside of the package and ship it prepaid to your dealer.

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. Contact your local supplier for ordering information.

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 instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference. In such cases, 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 to obtain the latest product information.
2. Contact your distributor, sales representative, or Advantech customer service center for technical support if you need additional assistance. Please have the following information ready before calling:
 - 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

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.

Warnings, Cautions, and Notes

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



Caution! *Cautions are included to prevent hardware damage and data losses. E.g.*



“Batteries are at risk of exploding if incorrectly installed. Replace the battery only with the same or equivalent type as recommended by the manufacturer. Discard used batteries according to the manufacturer's instructions.”

Note! *Notes provide additional optional information.*



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. Do not expose the equipment to direct sunlight, or install the equipment in an environment with direct sunlight, as this may cause damage.
7. Place the equipment on a reliable surface during installation. Dropping or letting the equipment fall may cause damage.
8. The openings on the enclosure are for air convection. Protect the equipment from overheating. Do not cover the openings.
9. Ensure that the voltage of the power source is correct before connecting the equipment to a power outlet.
10. Position the power cord away from high-traffic areas. Do not place anything over the power cord.
11. All cautions and warnings on the equipment should be noted.
12. If the equipment is not used for a long time, disconnect it from the power source to avoid damage from transient overvoltage.
13. Be aware that the rear cover may become quite hot during operation. To avoid scalding or personal injury, do not touch the rear cover.
14. Never pour any liquid into an opening. This may cause fire or electric shock.
15. Never open the equipment. For safety reasons, the equipment should be opened only by qualified service personnel.
16. If one of the following occurs, have the equipment checked by qualified 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 work according to the user manual.
 - The equipment has been dropped and damaged.
 - The equipment shows obvious signs of breakage.
17. Do not leave the equipment in an environment with a storage temperature of below -30 °C (-22 °F) or above 70 °C (158 °F) as this may cause damage. The equipment should be located in a controlled environment.
18. Batteries are at risk of exploding if incorrectly replaced or installed. Replace only with the same or equivalent type recommended by the manufacturer. Discard used batteries according to the manufacturer's instructions.
19. The equipment is intended to be installed on a wall or in a cabinet with the following conditions: access is restricted to service personnel or users who are aware of all precautions that must be taken when using the equipment; access can only be gained with the use of a key or other means of security; access is controlled by the authority responsible for the location.
20. In accordance with the IEC 704-1:1982 specifications, the sound pressure level at the operator's position does not exceed 70 dB (A).
21. **DISCLAIMER:** These instructions are provided in accordance with IEC 704-1 specifications. Advantech disclaims all responsibility for the accuracy of any statements contained herein.

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Chapter 1

Introduction

This chapter will provide information on the features of the DAS module, a quick start guide for installation, and some brief information on software and accessories for the USB-4716 Module.

Section include:

- Features
- Software Overview

1.1 Features

Thank you for buying the Advantech USB-4716 data acquisition (DAS) module for USB port. It features a unique circuit design and complete functions for data acquisition and control.

USB-4716 has the following measurement & control functions:

- 16 single-ended/ 8 differential or combination analog input channels
- 16-bit resolution A/D converter, with up to 200 kS/s sampling rate
- 8 digital input & 8 digital output channels (TTL Level)
- 2 analog output channels
- 16-bit programmable counter/timer x 1
- Programmable gain for each analog input channel
- Automatic channel/gain scanning
- Onboard 1K samples FIFO buffer for AI channels
- Bus-powered
- Device status LED indicator
- Removable on-module wiring terminal
- Supports USB 3.0 SuperSpeed
- Auto calibration function
- Hot swappable

Note!  *The USB chip on your system may have a limitation on the number of USB devices it will support. Normally, only five USB-4716 devices can be supported.*

Note!  *The power output of an USB port is 500 mA, while the USB-4716 requires 360 mA (typical). This means that if an USB hub is used, it will need an external power supply to support more than one USB-4716 device.*

1.2 Software Overview

Advantech offers device drivers, SDKs, third-party driver support and application software to help fully exploit the functions of your DAQ system. 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 should first run the Advantech Navigator program (by accessing Start/Programs/Advantech Automation/DAQNavi/Advantech Navigator).
 2. You can then view the device(s) already installed on your system (if any) on the installed device tree view. If the software and hardware installation are completed, you will see USB modules in the installed devices list.
- DAQNavi SDK is a software development kit for programming applications with Advantech DAQ products. The necessary runtime DLL, header files, software manual and tutorial videos can all be installed via XNavi installer. They can be found under C:\Advantech\DAQNavi (default directory) after finishing the installation.

Chapter 2

Installation

Section include:

- Unpacking
- Driver Installation
- Hardware Installation
- Hardware Uninstallation

2.1 Unpacking

After receiving your USB-4716 package, please inspect its contents first. The package should contain the following items:

- USB-4716 Module
- Startup Manual

The USB-4716 Module harbors certain electronic components vulnerable to electrostatic discharge (ESD). ESD could easily damage the integrated circuits and certain components if preventive measures are not carefully paid attention to. **Before removing the module from the anti-static plastic bag, you should take following precautions to ward off possible ESD damage:**

- Touch the metal part of your computer chassis with your hand to discharge static electricity accumulated on your body. One can also use a grounding strap.
- Make contact between the anti-static bag and ground before opening.

After taking out the module, you should first:

Inspect the module for any possible signs of external damage (loose or damaged components, etc.). If the module is visibly damaged, please notify our service department or our local sales representative immediately. Avoid using a damaged module with your system.

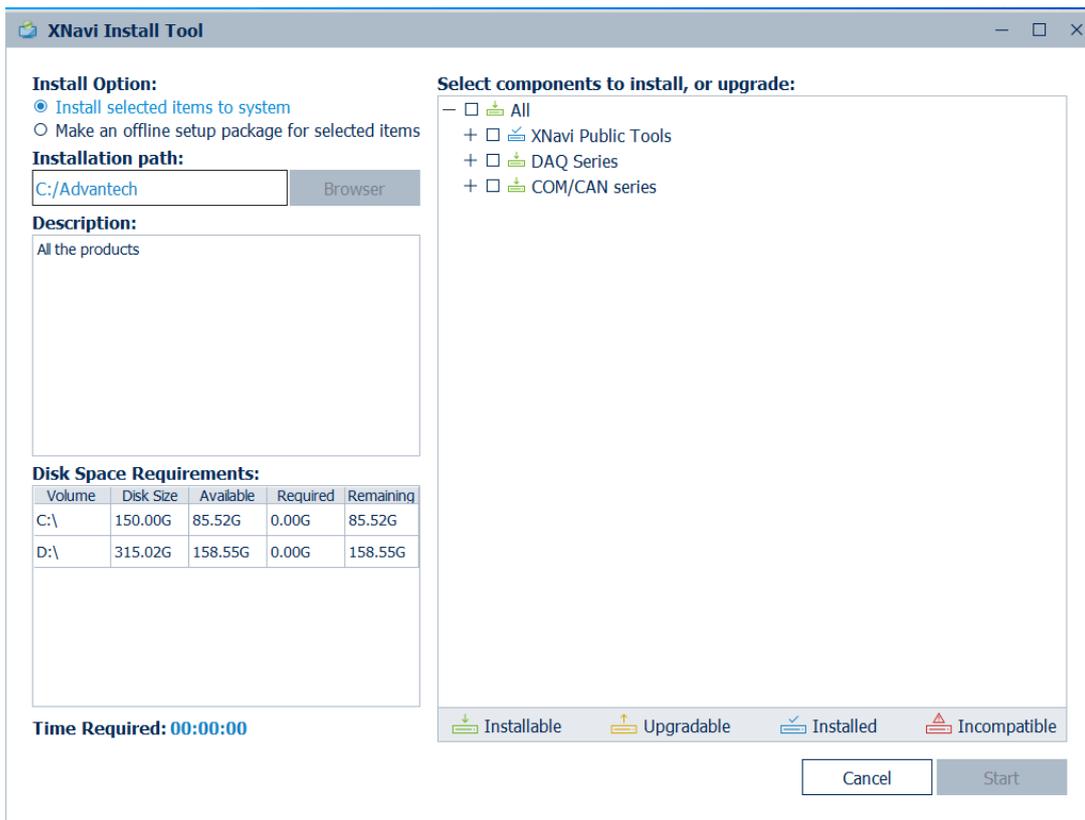
- Avoid physical contact with materials that could hold static electricity such as plastic, vinyl and styrofoam.

2.2 Driver Installation

We recommend you install the software driver before you install the USB-4716 module into your system, since this will guarantee a smooth installation process.

The driver package could be found on Advantech Support Portal (<https://www.advantech.com/support>). Search for the product model name on the support portal, then the corresponding driver/SDK package can be found. You'll get the XNavi installer after the download session 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. After the selection, click on "start" to begin the installation.



2.3 Hardware Installation

Note! *Make sure you have installed the software driver before you install the module (please refer to Section 2.2 Driver Installation)*



After the driver installation is completed, you can now go on to install the USB-4716 module in any USB port that supports USB 2.0/3.0 standard, on your computer. Please follow the steps below to install the module on your system.

Step 1: Touch the metal part on the surface of your computer to neutralize the static electricity that might be in your body.

Step 2: Plug your USB module into the selected USB port. Use of excessive force must be avoided; otherwise the module might get damaged.

Note! *In case you installed the module without installing the DLL driver, OS will recognize your module as an “unknown device”. After reboot, it will prompt you to provide necessary driver. You should ignore the prompting messages and set up the driver according to the steps described in Sec.2.2.*



Chapter 3

Signal Connections

This chapter provides useful information on how to connect input and output signals to the USB-4716 via the I/O connectors.

Sections include:

- Overview
- I/O Connectors
- Analog Input Connections
- Analog Output Connections
- Trigger Source Connections
- Field Wiring Considerations

3.1 Overview

Maintaining good signal connections is one of the most important factors in ensuring that your application system is sending and receiving data correctly. A good signal connection can avoid unnecessary and costly damage to your PC and other hardware devices.

3.2 I/O Connectors

USB-4716 is equipped with plug-in screw-terminal connectors that facilitate connection to the module without terminal boards or cables.

3.2.1 Pin Assignment

Figure 3.1 on next page shows the pin assignments for the five 10-pin I/O connectors on USB-4716.

Warning! *The two ground references AGND and DGND should be used separately for their designated purpose. Do not connect them together.*

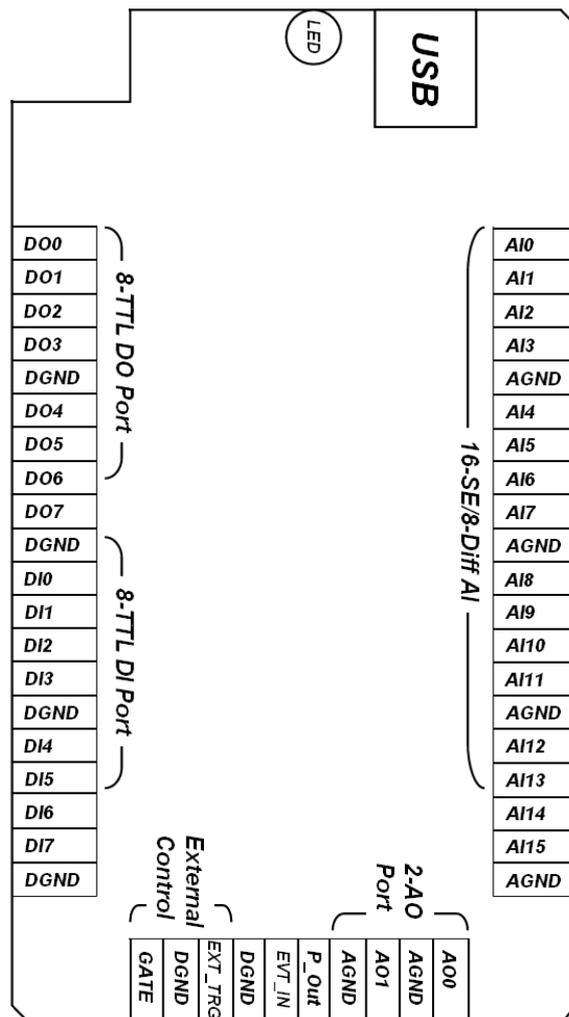


Figure 3.1 I/O Connector Pin Assignment

3.2.2 I/O Connector Signal Description

Table 3.1: I/O Connector Signal Description

| Signal Name | Reference | Direction | Description |
|-------------|-----------|-----------|--|
| AI<0...15> | AGND | Input | Analog Input Channels 0 through 15. |
| AIGND | - | - | Analog Input Ground. |
| AO0 AO1 | AGND | Output | Analog Output Channels 0/1. |
| AOGND | - | - | Analog Output Ground. The analog output voltages are referenced to these nodes. |
| DI<0..7> | DGND | Input | Digital Input channels. |
| DO<0..7> | DGND | Output | Digital Output channels. |
| DGND | - | - | Digital Ground. This pin supplies the reference for the digital channels at the I/O connector. |
| GATE | DGND | Input | A/D External Trigger Gate. When GATE is connected to +5 V, it will disable the external trigger signal to input. |
| EXT_TRG | DGND | Input | A/D External Trigger. This pin is external trigger signal input for the A/D conversion. A low-to-high edge triggers A/D conversion to start. |
| EVT_IN | DGND | Input | External events input channel. |
| P_OUT | DGND | Output | Pulse output channel |

3.2.3 LED Indicator Status Description

The USB Module is equipped with a LED indicator to show the current status of the device. When you plug the USB device into the USB port, the LED indicator will blink five times and then stay lit to indicate that it is on. Please refer to the following table for detailed LED indicator status information.

Table 3.2: LED Indicator Status Description

| LED Status | Description |
|-------------------------|--------------------------|
| On | Device ready for work |
| Off | Device not ready to work |
| Slow Blinking (5 times) | Device initialization |

3.3 Analog Input Connections

USB-4716 supports 16 single-ended/8 differential (or combination) analog inputs. Each individual input channel is software-selected.

3.3.1 Single-ended Channel Connections

The single-ended input configuration has only one signal wire for each channel, and the measured voltage (V_m) is the voltage of the wire as referenced against the common ground.

A signal source without a local ground is also called a “floating source”. It is fairly simple to connect a single-ended channel to a floating signal source. In this mode, USB-4716 provides a reference ground for external floating signal sources.

Figure 3.2 shows a single-ended channel connection between a floating signal source and an input channel on USB-4716.

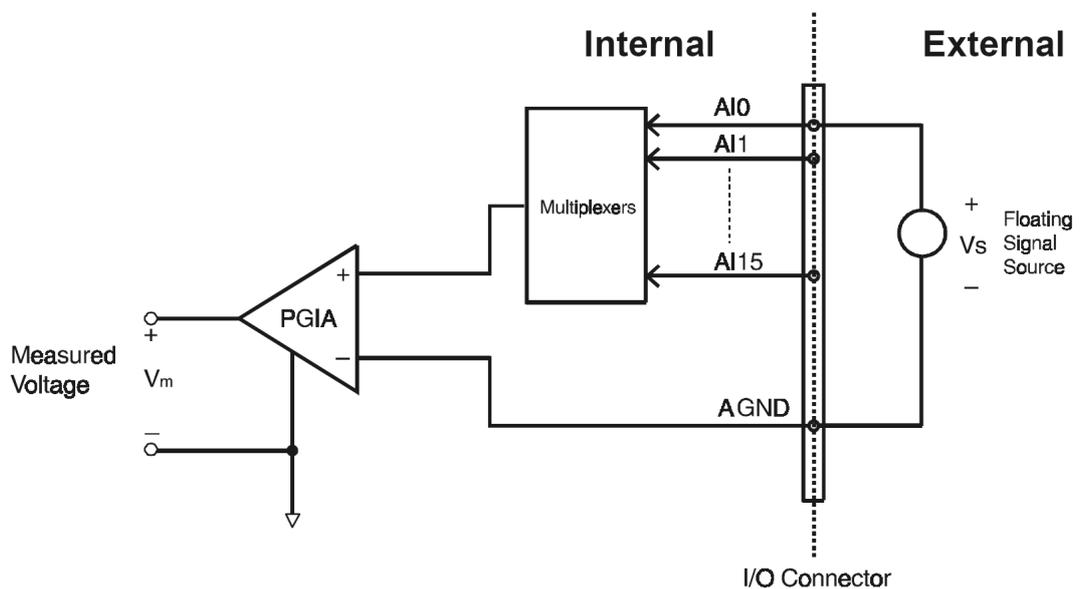


Figure 3.2 Single-Ended Input Channel Connection

3.3.2 Differential Input Connections

The differential input channels operate with two signal wires for each channel, and the voltage difference between both signal wires is measured. On USB-4716, when all channels are configured to differential input, up to 8 analog channels are available.

If one side of the signal source is connected to a local ground, the signal source is ground-referenced. Therefore, the ground of the signal source and the ground of the card will not be exactly of the same voltage. The difference between the ground voltages forms a common mode voltage (V_{cm}).

To avoid the ground loop noise effect caused by common-mode voltages, you can connect the signal ground to the Low input. Figure 3-3 shows a differential channel connection between a grounded-reference signal source and an input channel on USB-4716. With this connection, the PGA rejects a common-mode voltage V_{cm} between the signal source and USB-4716 ground, shown as V_{cm} in Figure 3.3.

Note! In differential input mode, the input channel n should be used with channel $n+1$.
($n=0,2,4\dots14$)

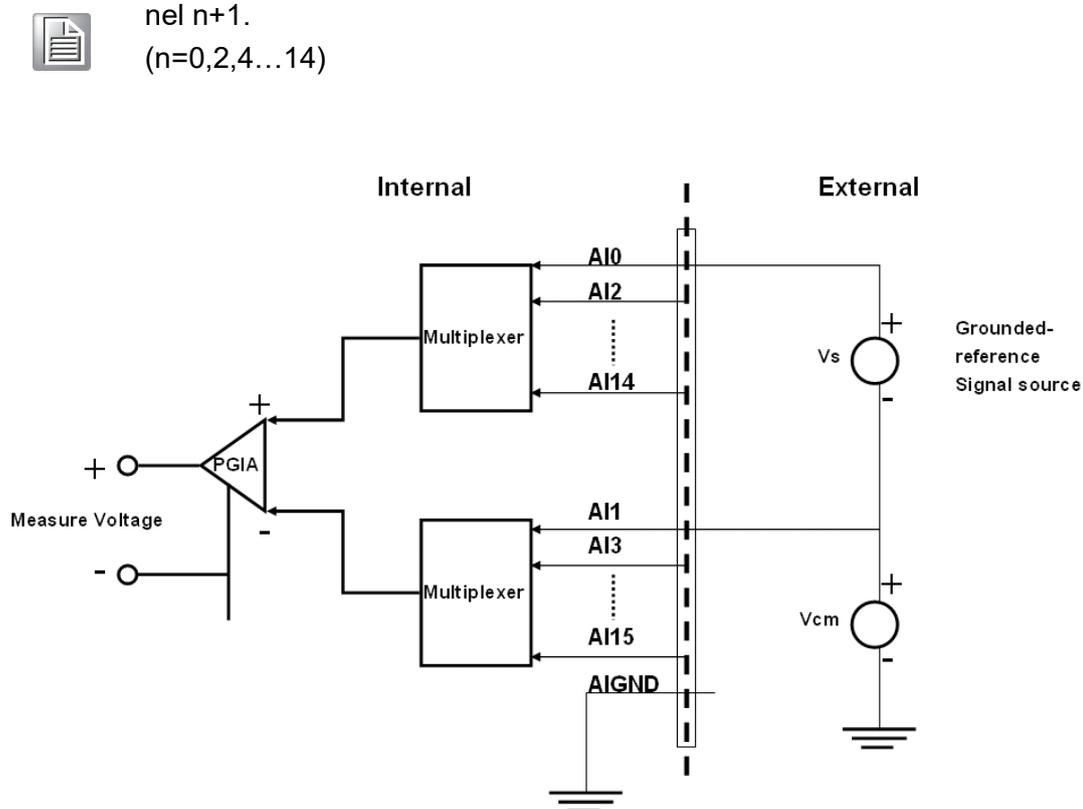


Figure 3.3 Differential Input Channel Connection

3.4 Analog Output Connections (Voltage)

USB-4716 provides two analog output channels, AO0 and AO1. Figure 3.4 shows how to make analog output connections on USB-4716.

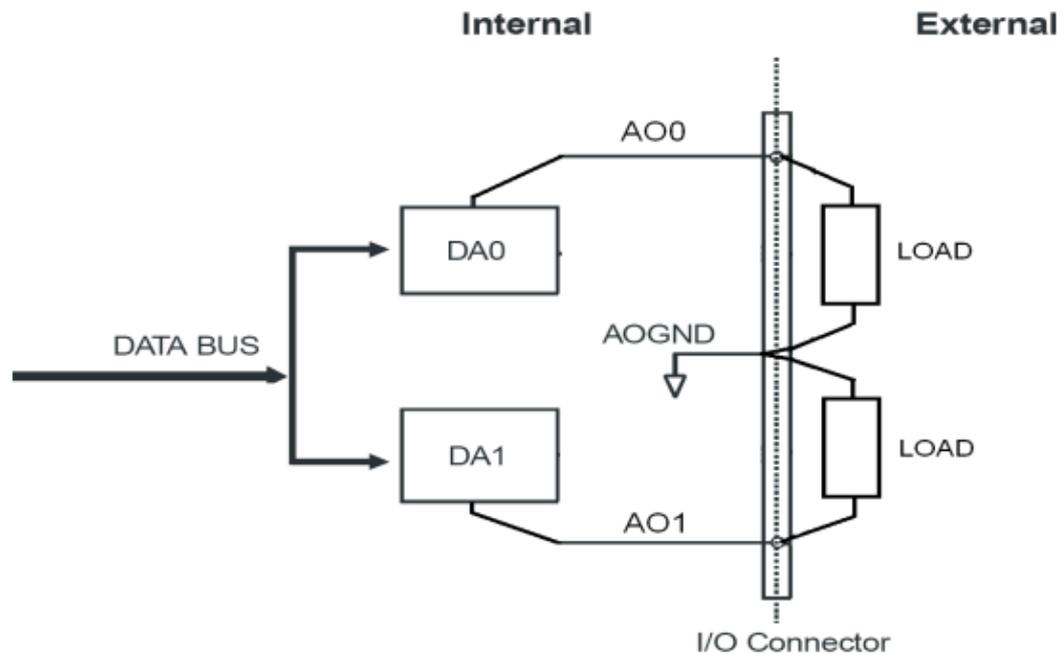


Figure 3.4 Analog Output Channel Connections

3.5 Trigger Source Connections

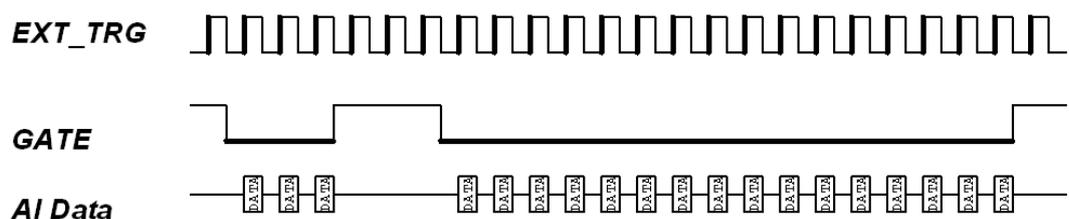
3.5.1 Internal Pacer Trigger Connection

USB-4716 provides two 16-bit counters connected to a 10 MHz clock. Counter 0 is a counter that counts events from an input channel. Counter 1 is a 16-bit timer for pacer triggering. A low-to-high edge from the Counter 1 output will trigger an A/D conversion on USB-4716.

3.5.2 External Trigger Source Connection

In addition to pacer triggering, USB-4716 also allows external triggering for A/D conversions. When GATE is connected to a +5V DC source, the external trigger function is thereby disabled. The external trigger function will be enabled once the +5V DC source is removed.

External Trigger Mode :



3.6 Field Wiring Considerations

- When you use USB-4716 to acquire data from outside, noise in the environment might significantly affect the accuracy of your measurements if due precautions are not taken. The following measures will be helpful to reduce possible interference running signal wires between signal sources and USB-4716.
- The signal cables must be kept away from strong electromagnetic sources such as power lines, large electric motors, circuit breakers or welding machines, since they may cause strong electromagnetic interference. Keep the analog signal cables away from any video monitor, since it can significantly affect a data acquisition system.
- If the cable travels through an area with significant electromagnetic interference, you should adopt individually shielded, twisted-pair wires as the analog input cable. This type of cable has its signal wires twisted together and shielded with a metal mesh. The metal mesh should only be connected to one point at the signal source ground.
- Avoid running the signal cables through any conduit that might have power lines in it.
- If you have to place your signal cable parallel to a power line that has a high voltage or high current running through it, try to keep a safe distance between them. Or place the signal cable in a right angle to the power line to minimize the undesirable effect.

Appendix **A**

Specifications

A.1 Analog Input

| | | | | | | | |
|---------------------------------------|---|------------------------------|--------------|------|-------|--------|-----|
| Channels | 16-ch single-ended/ 8-ch differential | | | | | | |
| Resolution | 16 bits | FIFO Size | 1024 Samples | | | | |
| Sampling Rate | 200 kS/s | | | | | | |
| Input Range and Gain List | Gain | 0.5 | 1 | 2 | 4 | 8 | |
| | Gain Code | 4 | 0 | 1 | 2 | 3 | |
| | Bipolar (V) | ±10 | ±5 | ±2.5 | ±1.25 | ±0.625 | |
| | Unipolar (V) | N/A | 0~10 | 0~5 | 0~2.5 | 0~1.25 | |
| Drift | Gain | 0.5 | 1 | 2 | 4 | 8 | |
| | Zero ($\mu\text{V}/^\circ\text{C}$) | ±30 | | | | | |
| | Gain ($\text{ppm}/^\circ\text{C}$) | 30 | 30 | 30 | 30 | 30 | |
| Small Signal Bandwidth for PGA | Gain | 0.5 | 1 | 2 | 4 | 8 | |
| | Bandwidth (MHz) | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | |
| Input Protection | 30 V max. | | | | | | |
| Input Impedance | 1GW | | | | | | |
| Input Comm. Mode Voltage | | 11V | | | | | |
| Accuracy | DC | INLE | 1LSB | | | | |
| | | DNLE | 3LSB | | | | |
| | | Gain | 0.5 | 1 | 2 | 4 | 8 |
| | | Gain Error (% of FSR) | 0.015 | 0.03 | 0.03 | 0.05 | 0.1 |
| | AC | SINAD | 83 dB | | | | |
| | | THD | -88 dB | | | | |
| | | ENOB | 13.5 bit | | | | |

A.2 Analog Output

| | | | |
|----------------------------|----------------------|---|-------|
| Channels | 2 | | |
| Resolution | 16 bits | FIFO Size | N/A |
| Throughput | 2 kHz | | |
| Operating Mode | Single output | | |
| Output Range | 0~5, 0~10, ±5, ±10 V | | |
| Accuracy | DC | INLE | ±2LSB |
| | | DNLE | ±1LSB |
| Dynamic Performance | Slew Rate | 0.125 V/ μs | |
| | Settling Time | 150 μs (to $\pm 1/2$ LSB of FSB) | |
| Driving Capability | 5 mA | | |
| Output Impedance | 0.1W max. | | |

A.3 Non-Isolated Digital Input/Output

| | | |
|------------------------|---------------------|------------------------------|
| Input Channels | 8 Non-Isolation TTL | |
| Input Voltage | Low | 0.0 Vdc (Min) / 1.0Vdc (Max) |
| | High | 2.0 Vdc (Min) / 5.0Vdc (Max) |
| Output Channels | 8 Non-Isolation TTL | |
| Output Voltage | Low | 0.4 Vdc / -6mA (Sink) |
| | High | 2.4 Vdc / 6mA (Source) |

A.4 Counter

| | | | |
|------------------------|----------------------|-------------------------------|-----------|
| Channels | 1 | | |
| Resolution | 32-bit software base | Capability | TTL level |
| Input Frequency | 1 kHz max. | | |
| Clock Input | Low | 0.0 Vdc (Min) / 1.0 Vdc (Max) | |
| | High | 2.0 Vdc (Min) / 5.0 Vdc (Max) | |
| Gate Input | Low | 0.0 Vdc (Min) / 1.0 Vdc (Max) | |
| | High | 2.0 Vdc (Min) / 5.0 Vdc (Max) | |

A.5 General

| | | | |
|---------------------------|---|--|--|
| I/O Connector Type | Removable 10-pin screw terminal x 5 | | |
| Dimensions | 132 X 80 X 32 mm (5.2" X 3.2" X 1.3") | | |
| Power Consumption | 360 mA @ +5.0V Typical 450 mA @ +5.0 V max. | | |
| Temperature | Operation | 0~60° C (32~140° F) (refer to IEC 68-2-1, 2) | |
| | Storage | -20~70° C (-4~158° F) | |
| Relative Humidity | 5~ 95% RH non-condensing (refer to IEC 68-2-1, 2) | | |

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Please verify specifications before quoting. This guide is intended for reference purposes only.

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