User Manual

USB-5817

8-Channel, 16-Bit, 200 kS/s
Isolated Analog Input USB 3.0
I/O 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 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 are billed according to the cost of replacement materials, service time, and freight. Consult your dealer for more details.

If you believe that your product is defective product, follow the steps outlined below.

1. Collect all 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 helpful information readily available.
3. If your product is diagnosed as defective, obtain an return merchandize 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. Then ship the package prepaid to your dealer.

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.

Technical Support and Assistance

1. Visit the Advantech website at **http://support.advantech.com.tw/** to obtain the latest product information.
2. Contact your distributor, sales representative, or Advantech's 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

Packing List

Before setting up the system, check that the items listed below are included and in good condition. If any item is missing or damaged, contact your dealer immediately.

- 1 x USB-5817 module
- 4 x terminal blocks
- 1 x USB-5817 startup manual
- 1 x USB 3.0 lockable cable (1 m)

Safety Precautions - 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 the PC chassis before manual handling. Do not touch any components on the CPU card or other cards while the PC is powered on.
2. Disconnect the power before implementing any configuration changes. The sudden rush of power after connecting a jumper or installing a card may damage sensitive electronic components.

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Chapter 1

Introduction

This chapter provides an introduction to USB-5817 and its typical applications.

- Features
- Applications
- Installation Guide
- Software Overview
- Accessories

Advantech's USB-5817 is an industrial isolated analog input USB 3.0 I/O module. To ensure easy installation in cabinet computers, USB-5817 modules are compact and equipped with a DIN-rail mount kit. The built-in USB hub can support a daisy-chain topology, while Euro-type pluggable terminal blocks and LED indicators facilitate configuration and maintenance.

1.1 Features

- USB 3.0 SuperSpeed
- Daisy chaining support via built-in USB hub
- 8 x 16-bit analog input channels with 2,500 V_{DC} isolation
- Supports current measurements
- Wide common-mode voltage range (±275 V)
- Removable European-type connector
- Compatible with Windows XP/7/8/10 operating systems

USB 3.0 SuperSpeed

The USB-5800 series modules support USB 3.0 SuperSpeed for an accelerated response time.

Easy Maintenance

The LED indicators, rotary switch, and terminal blocks are all front-facing for easy access and wiring. The European-type pluggable terminal blocks also simplify maintenance, reducing overall service time.

Compact Size

The compact design and high-density channel count improves space utilization, while the DIN-rail mounting kit ensures easy installation in cabinets.

Built-In USB Hub with Daisy Chaining Support

The USB-5800 module is equipped with a USB hub that supports daisy chain topologies. This feature frees up the IPC USB ports by enabling more than one USB-5800 module to be integrated into a single system.

> **Note!** *Because USB 3.0 can only provide a maximum current of 900 mA, if more than two modules are connected via the hub, an external power supply unit (PSU) will be required.*
> *Please refer to the image below.*
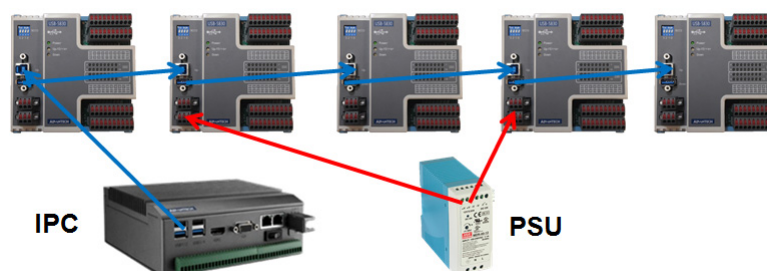
> *Note!* *The USB host (system) can support up to five levels of hubs. If more than five levels are cascaded, the USB modules may malfunction.*

Redundant Power

USB-5817 modules feature two power input terminals with an input power range of 10 ~ 30 V_{DC} and power redundancy support. For modules connected to two power input sources, if one source is inactive or interrupted, the other power source can immediately assume supply operations. Accordingly, USB-5817 modules can operate with a single power source. (The modules can also be powered via USB if there is no device connected to the downstream port.)

Board ID Switch

USB-5817 modules have a built-in DIP switch that is used to define the board ID for each module. When multiple modules are installed in the same system, the board ID switch can be used to identify each module's device number. Every module in the system should be assigned different device numbers. The default board ID value is 0.

1.2 Installation Guide

Before module installation, please ensure that you have the following necessary components:

- 1 x USB-5817 module
- 1 x USB-5817 user manual
- Advantech DAQNavi driver software
- 1 x Personal computer or workstation with a USB interface (and equipped with Windows 10/8/7/XP operating system)
- 1 x 10 ~ 30 V power supply (96PS-A40WDIN optional)

Other optional components are also available for enhanced operation:

- DAQNavi, LabVIEW, and other third-party software

Once you have the necessary components and any additional accessories for enhanced operation, you can begin installing the USB-5817 module. Figure 1.1 is a flowchart that provides a broad overview of the software and hardware installation procedures.
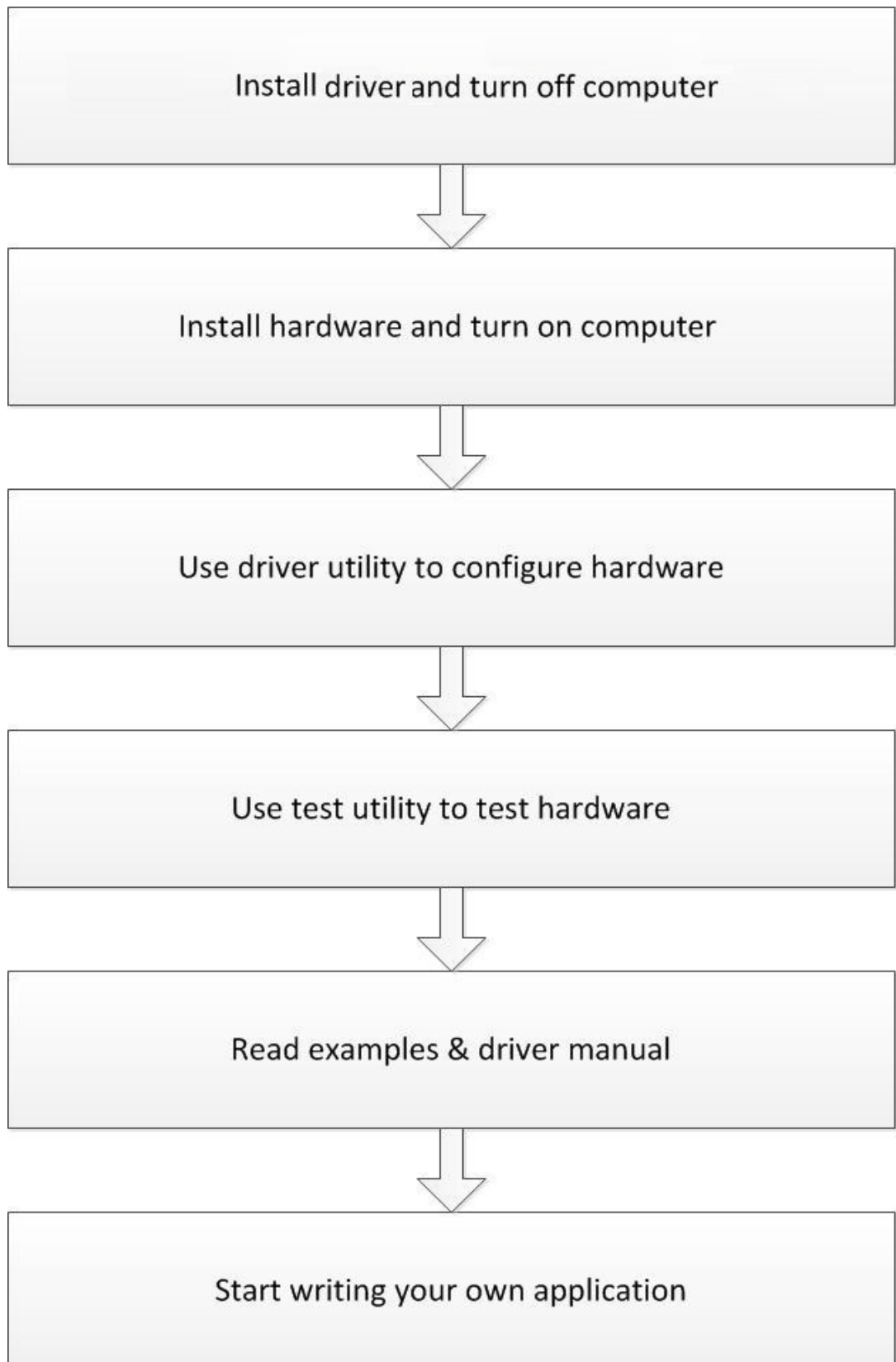
Figure 1.1 Installation Flowchart

1.3 Software Overview

Advantech offers a wide range of DLL drivers, third-party drivers, and application software for fully exploiting the functions of your USB-5817 module.

■ Device drivers
■ Advantech DAQNavi

DAQNavi Software

Advantech's DAQNavi software includes device drivers and a software development kit (SDK), which features a comprehensive I/O function library to boost application performance. This software can be downloaded from the Advantech website (at www.advantech.com). The Advantech DAQNavi software for Windows XP/7/8/10 (desktop mode) works seamlessly with most major development tools, including Visual Studio.NET, Visual C++, Visual Basic, and Borland Delphi.

1.4 DAQNavi Device Driver Programming Roadmap

This section provides a roadmap for building an application from scratch using Advantech's DAQNavi Device Driver with a range of development tools such as Visual Studio.NET, Visual C++, Visual Basic, Delphi, and C++ Builder. Step-by-step instructions for application development using each tool are provided in the device driver manual. A large library of example source codes is also provided for reference.

Programming Tools

Programmers can develop application programs using their preferred development tools.

■ Visual Studio.NET
■ Visual C++ and Visual Basic
■ Delphi
■ C++ Builder

For instructions on programming using each development tool, Advantech offers a tutorial chapter in the DAQNavi SDK manual. Please refer to the corresponding sections in the DAQNavi SDK manual to begin programming. Users should also review the example source codes provided for each programming tool. The examples can help jump start a project.

The DAQNavi SDK manual can be downloaded from the Advantech website. Alternatively, if the device drivers are already installed on the computer, the DAQNavi SDK manual can be accessed via the Start button.

Start/Programs/Advantech Automation/DAQNavi/DAQNavi Manuals/DAQNavi SDK Manual

The example source codes can be found under the corresponding installation folder/ default installation path.

\Advantech\DAQNavi\Examples

For information about using other function groups or development tools, refer to the chapter titled "Using DAQNavi SDK" in the DAQNavi SDK manual, or watch the video tutorials provided with the Advantech Navigator.

Programming with DAQNavi Device Drivers Function Library

Advantech offers a comprehensive function library for DAQNavi device drivers that can be utilized when developing various application programs. This function library comprises numerous APIs that support many development tools, such as Visual Studio.NET, Visual C++, Visual Basic, Delphi and C++ Builder.

These APIs can be categorized into several groups according to their function or purpose.

- Analog Input Function Group
- Analog Output Function Group
- Digital Input/Output Function Group
- Counter Function Group
- Port Function Group (direct I/O)
- Event Function Group

For the usage and parameters of each function, refer to the chapter titled "Using DAQNavi SDK" in the DAQNavi SDK manual.

Troubleshooting DAQNavi Device Drivers Error

Driver functions return a status code when called to perform a certain task for an application. When a function returns a code that is not zero, this means the driver has failed to perform the designated function. To troubleshoot device driver errors, check the error code and error description in the Error Control section for each function in the DAQNavi SDK manual.

1.5 Accessories

Advantech offers the following accessories to support the USB-5817 module:

Power supply unit
- **96PSD-A40W24-MM** 40 W, 24 V DIN-rail power supply

Chapter 2

Installation

This chapter includes a packing checklist, instructions for unpacking, and step-by-step procedures for both driver and card installation.

- Unpacking Instructions
- Driver Installation
- Hardware Installation
- Device Setup and Configuration

2.1 Unpacking Instructions

After receiving your USB-5817 module, inspect the package contents to ensure that the following items are present:

- 1 x USB-5817 module
- 4 x Terminal blocks
- 1 x USB-5817 startup manual
- 1 x USB 3.0 lockable cable (1 m)

The USB-5817 module contains electronic components that are vulnerable to electrostatic discharge (ESD). ESD can easily damage the integrated circuits and components if preventive measures are not carefully implemented. Before removing the module from the antistatic plastic bag, take the following precautions to prevent possible ESD damage:

- Touch the metal part of your computer chassis with your hand to discharge any static electricity accumulated in your body. Alternatively, wear a grounding strap.
- Make contact between the antistatic bag and ground before opening. After removing the module from the packaging, first inspect the module for any signs of external damage (loose or damaged components, etc.). If the module is visibly damaged, notify our service department or your local sales representative immediately. Do not install or use a damaged module.
- Avoid contact with materials that may hold static electricity, such as plastic, vinyl, and styrofoam.

2.2 Driver Installation

We recommend installing the drivers before installing the USB-5817 module to guarantee a problem-free installation process.

The Advantech DAQNavi Device Drivers setup program can be downloaded from the Advantech website. Follow the steps outlined below to install the driver software.

1. Execute the USB-5817 driver package.
2. The Advantech DAQNavi driver installation wizard program should launch automatically. Figures 2.1 to 2.5 show the various pages of the installation wizard interface.
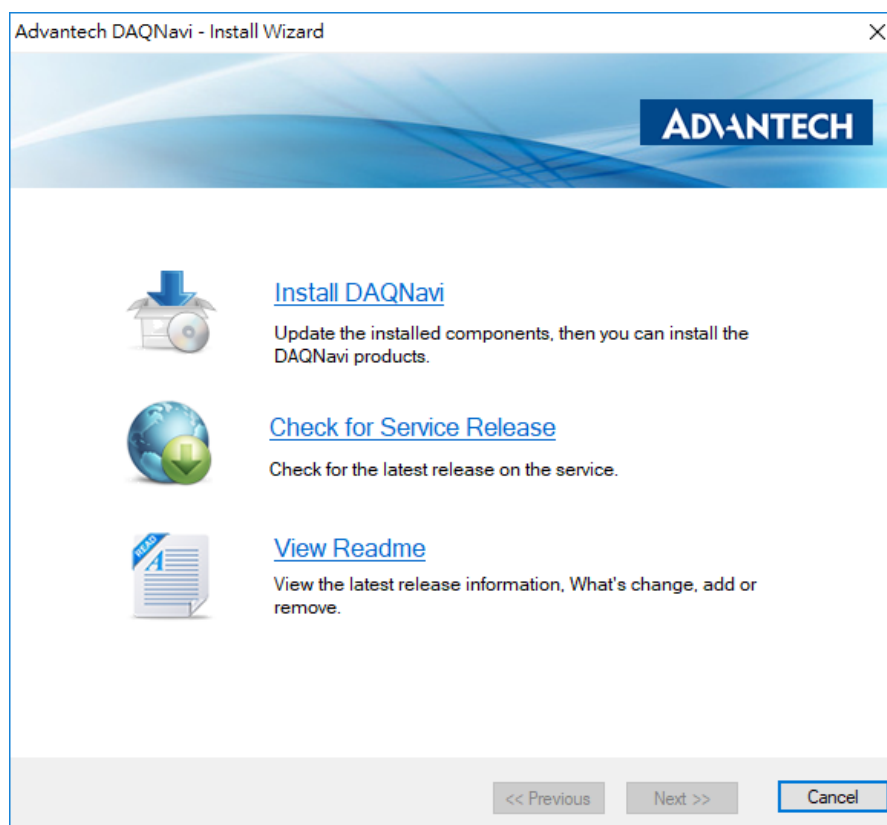

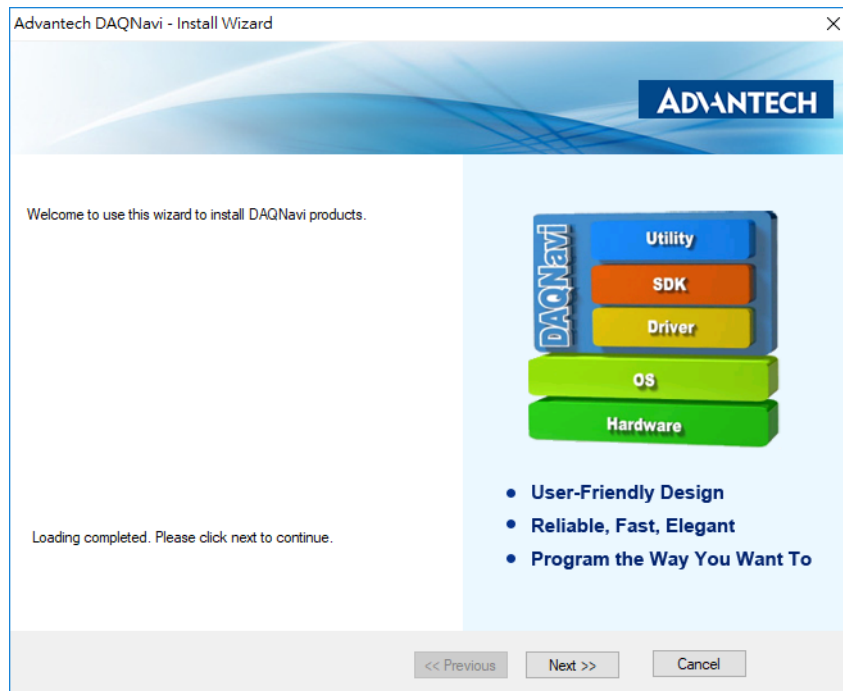**Figure 2.1 Advantech DAQNavi Installation Wizard**

Figure 2.2 Driver Installation Setup Screen

3. Once the DAQNavi driver installation wizard is launched, follow the instructions displayed in the interface to complete the driver installation.
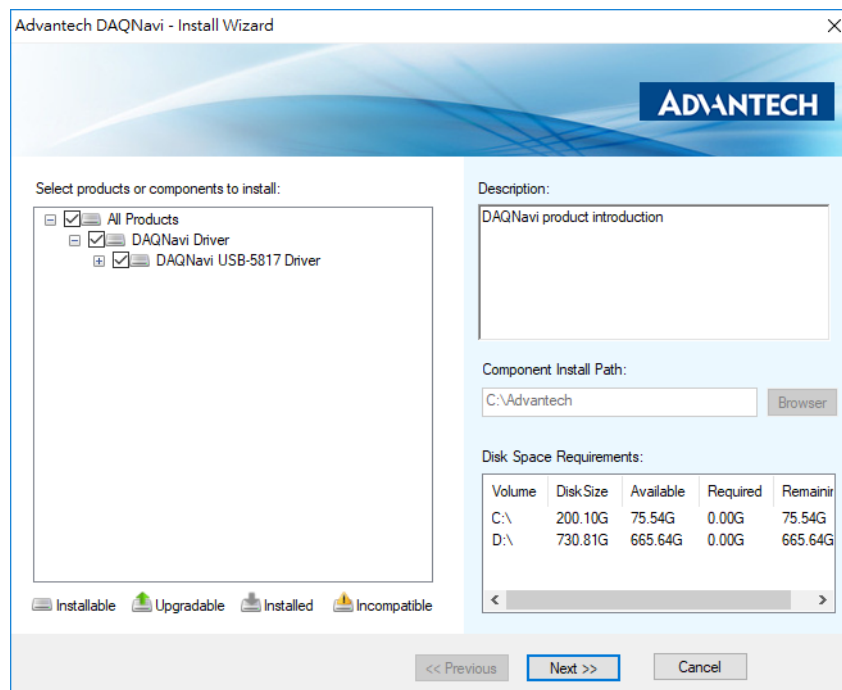

Figure 2.3 Driver Installation Path and Space Requirements
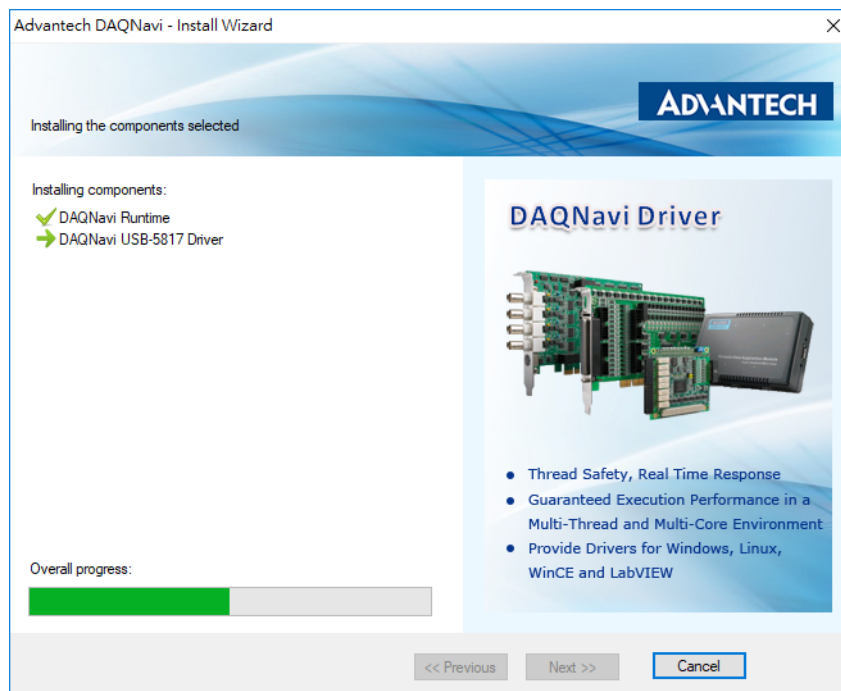
Figure 2.4 Driver Installation Process

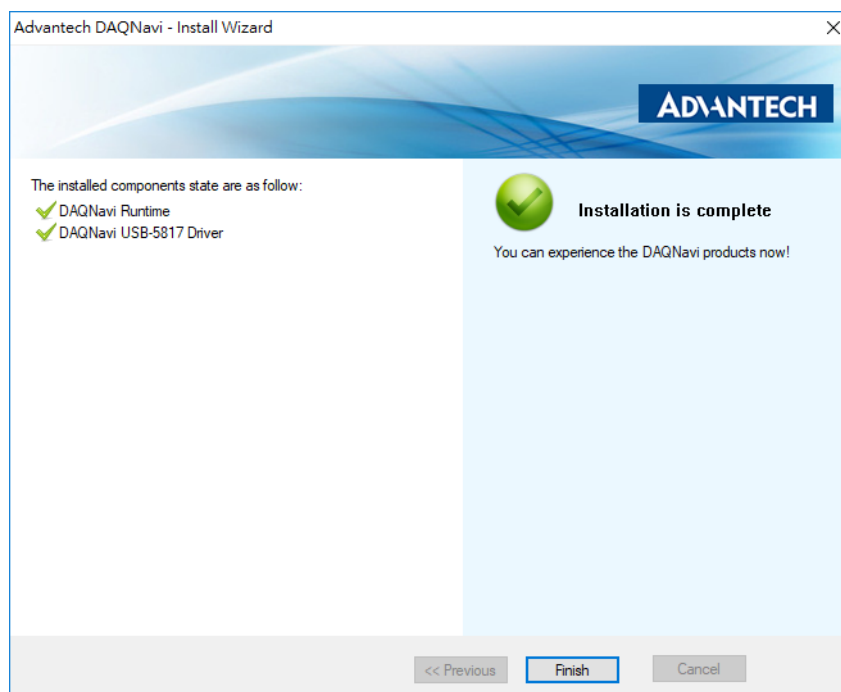4. After the driver is successfully installed, click the "Finish" button to exit the installation wizard.

Figure 2.5 Exit the Driver Installation Wizard

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2.3 Hardware Installation

Note! *Ensure that the relevant driver is installed before installing the USB-5817 module. (Refer to Section 2.2 "Driver Installation" for more information.)*

After the device drivers are installed, the USB-5817 module can be installed in your computer. We recommend referring to the computer user manual or related documentation if you have any concerns. Follow the steps outlined below to install the module.

1. Touch any metal surface of your computer to discharge any static electricity that may have accumulated in your body.
2. Plug the USB-5817 module into the selected USB port. To avoid damaging the module, do not use excessive force when inserting the module into the USB port.

After the module is installed, your device can be configured using the Advantech Navigator program automatically installed during driver installation. The complete device installation process should include device setup, configuration, and testing. The following sections provide information for guiding users through the device setup, configuration, and testing procedures.

2.4 Device Setup and Configuration

The Advantech Navigator program is a utility for setting up, configuring, and testing devices. The program also stores the system configuration settings in the system registry for subsequent reference. These settings are used when a device driver API is called. Figure 2.6 shows an example of the USB-5817 device settings.

Setting Up a Device

1. To install an I/O device or module, first initialize the Advantech Navigator program (***Start/Programs/Advantech Automation/Navigator for DN4***).
2. Users can view the device(s) already installed on the system (if any) by accessing the Installed Devices list. Once the software/hardware installation is complete, the USB-5817 module should be included in the Installed Devices list.
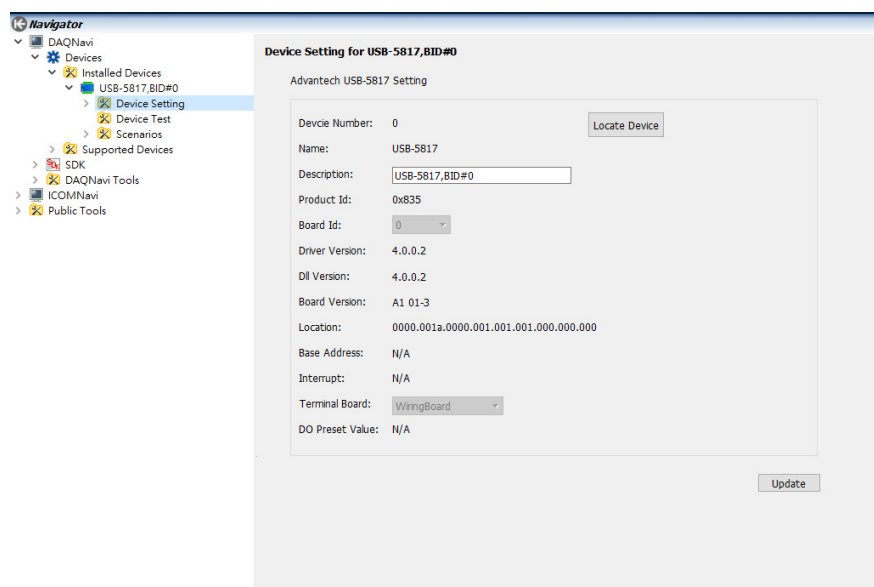

Figure 2.6 USB-5817 Device Settings

Configuring the Device

3. Go to the Device Setting page to configure the device. The items in the page allow users to configure the USB-5817 modules' analog input.
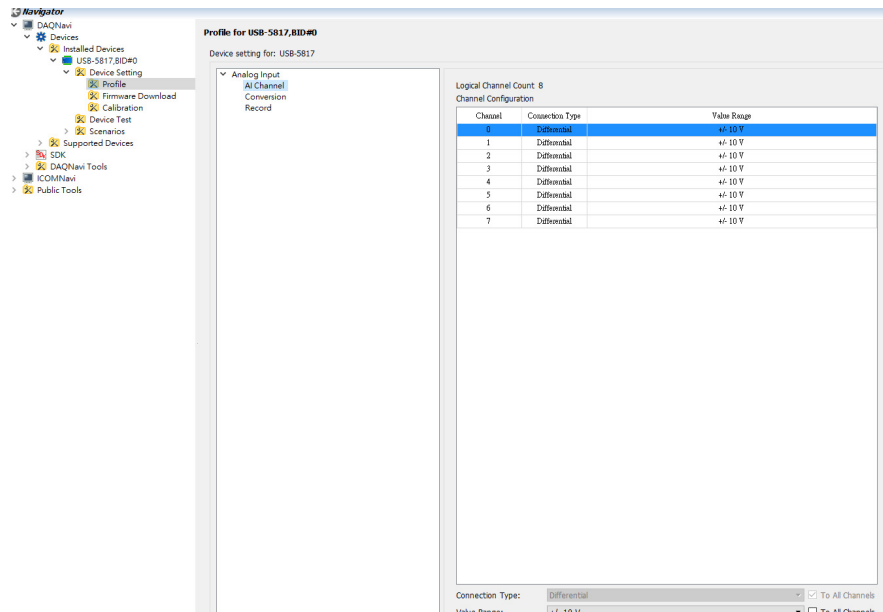

Figure 2.7 Device Settings Page

4. After the module is installed and configured, access the Device Testing page to test the hardware using the test utility provided.
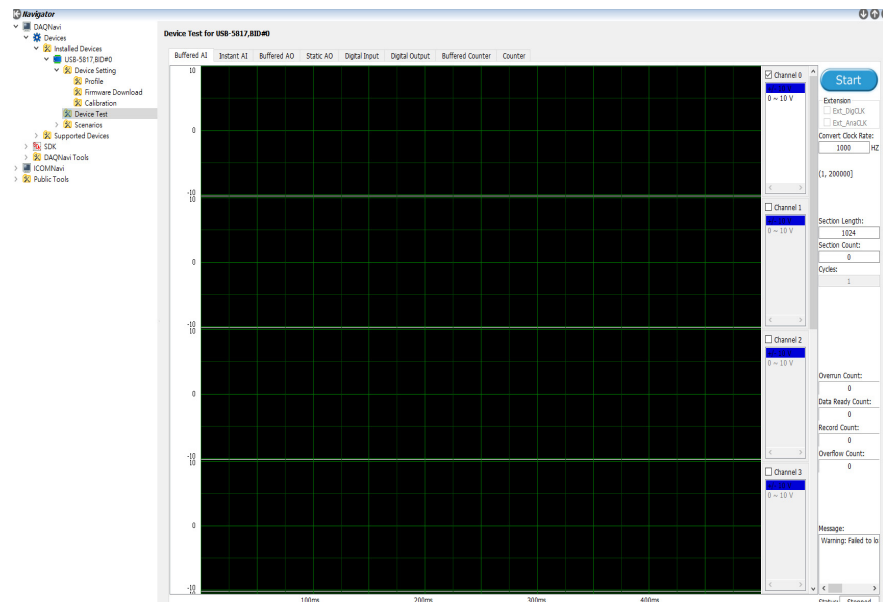

Figure 2.8 USB-5817 Device Testing

For more detailed information, please refer to the DAQNavi SDK manual or the Advantech Navigator user interface manual.

Chapter 3

Signal Connections

This chapter explains how to connect input and output signals to the USB-5817 module via the I/O connector.

- Overview
- Board ID Settings
- Signal Connections
- Field Wiring Considerations

3.1 Overview

Maintaining 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 prevent unnecessary and costly damage to your PC and other hardware devices. This chapter provides information about connecting input and output signals to the USB-5800 module via the I/O connector.

3.2 Dimensions
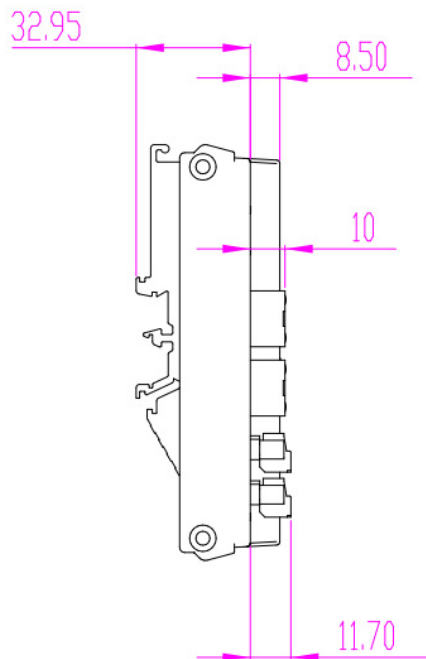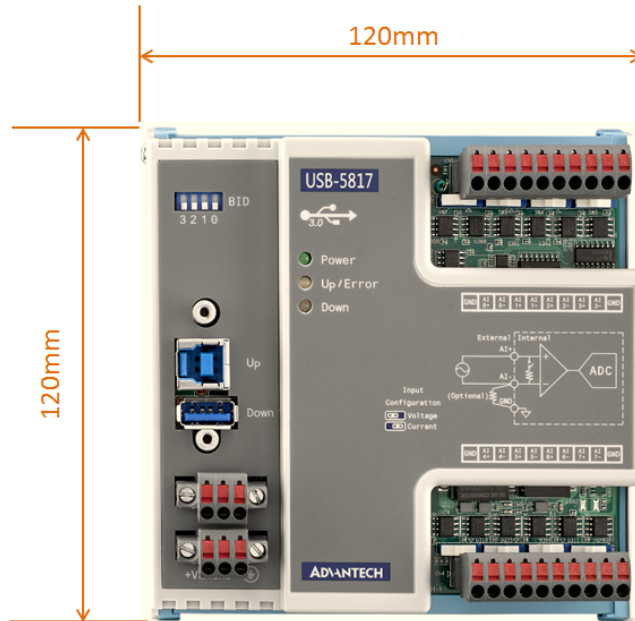
3.3 Switch and Pin Assignments

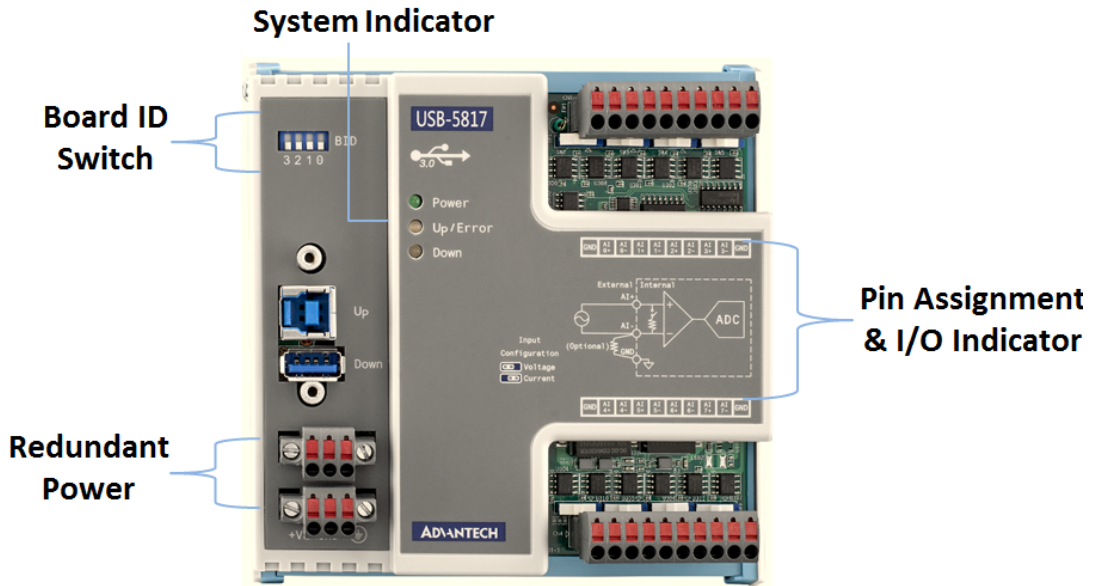The jumper and switch locations on the USB-5817 module are shown in Figure 3.1.

Figure 3.1 Jumper and Switch Locations

3.3.1 Board ID

USB-5817 modules have a built-in DIP switch that is used to define the board ID for each module. When multiple modules are installed in the same system, the board ID switch can be used to identify each module's device number. Every module in the system should be assigned different device numbers. The default board ID value is 0.

When configuring the board ID to any other value, refer to the settings in the following table:

Table 3.1: Board ID Setting				
SW1	Position 1	Position 2	Position 3	Position 4
BoardID	ID3	ID2	ID1	ID0
0	ON	ON	ON	ON
1	ON	ON	ON	OFF
2	ON	ON	OFF	ON
3	ON	ON	OFF	OFF
4	ON	OFF	ON	ON
5	ON	OFF	ON	OFF
6	ON	OFF	OFF	ON
7	ON	OFF	OFF	OFF
8	OFF	ON	ON	ON
9	OFF	ON	ON	OFF
10	OFF	ON	OFF	ON
11	OFF	ON	OFF	OFF
12	OFF	OFF	ON	ON
13	OFF	OFF	ON	OFF
14	OFF	OFF	OFF	ON
15	OFF	OFF	OFF	OFF

Note: The default setting is 0.

3.3.2 Switch

SW2 ~ SW9 are used to configure the analog input signals to measure either the voltage (±10 V) or current (0 ~ 20 mA). The default setting is voltage.
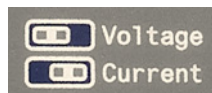
3.3.3 LED Indicators

Table 3.2: Power	
State	Description
Off	Module is not powered on
Green	Module is powered on using either USB bus power or external power

Table 3.3: Up/Error	
State	**Condition**
Green	Upstream port is connected. Module is functioning normally
Red	Upstream port is not connected/disconnected. Module function is halted

Table 3.4: Down	
State	**Description**
Off	Downstream port is not connected
Blue	Downstream port is connected

3.4 Analog Input Connections

3.4.1 Analog Input Overview

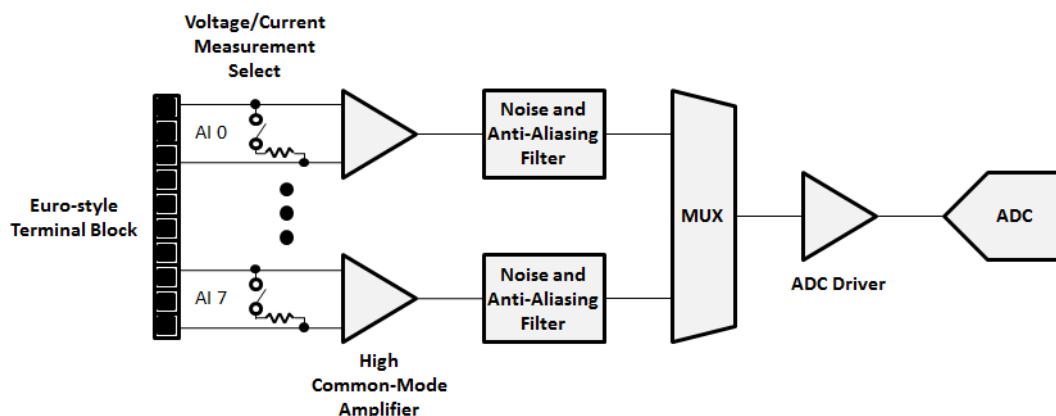A block diagram of the USB-5817 analog input front end is provided as Figure 3.2.

Figure 3.2 Analog Input Front End

The analog input signals enter the USB-5817 through Euro-style terminal blocks. Each channel can be individually configured as a voltage or current measurement using DIP switches. Additionally, every channel is equipped with a high common-mode voltage amplifier for applications where the common-mode voltage of the measured signal is very high. Each channel also has a low-pass noise and anti-aliasing filter for removing unwanted out-of-band noise and alias components. The multiplexer (MUX) routes one analog input channel at a time to the analog-to-digital converter (ADC) through the ADC driver.

The analog signals are converted into digital data by the ADC. After offset and gain correction, the data is written into the first-in-first-out (FIFO) buffer for buffered analog input measurement, or directly transmitted to the USB 3.0 interface for an immediate analog input measurement (see Figure 3.3).
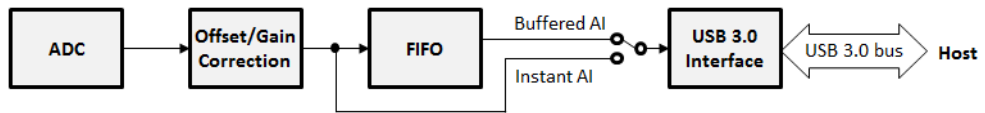
Figure 3.3 Analog Input Data Processing

3.4.2 Analog Input Range

All of the USB-5817 module's analog input channels can measure either voltage or current signal input. The voltage/current measurement settings can be configured for each channel separately using a DIP switch.

3.4.2.1 Voltage Input Measurement

For voltage measurement, the input range is ±10 V. Users should not apply an input voltage outside of this range because this may damage the hardware.
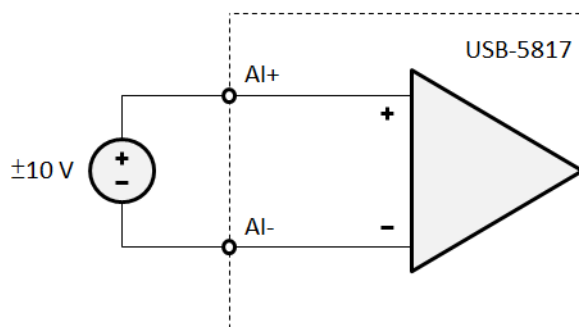

Figure 3.4 Voltage Input Measurement

The USB-5817 module is equipped with a 16-bit ADC, which means the input voltage can be converted to one of 65,536 (2^{16}) codes. For a ±10 V input range, the voltage resolution can be calculated as

$$\frac{10\,V - (-10\,V)}{65{,}536} = 305\ \mu V$$

Due to offset and gain correction, the resolution may vary, but only by a small quantity that can be neglected.

3.4.2.2 Current Input Measurement

For current measurement, the input range is 0 ~ 20 mA. Users should not apply an input current outside of this input range because this may damage the hardware.
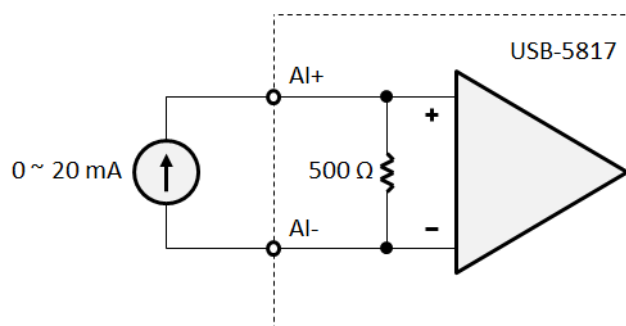

Figure 3.5 Current Input Measurement

A precision 500 Ω resistor converts the 0 ~ 20 mA input current into a 0 ~ 10 V voltage for measurement. The conversion formula can be expressed as

$$I = \frac{V}{0.5 \ k\Omega}$$

where I is the measured current in mA and V is the measured voltage in V.

Because the voltage resolution is equal to the voltage measurement, the current resolution can be calculated as

$$\frac{305 \ \mu V}{500 \ \Omega} = 0.61 \ \mu A$$

Due to offset and gain correction, the resolution may vary, but only for a small quantity that can be neglected.

3.4.3 Analog Input Common-Mode Voltage

Every analog input channel of the USB-5817 module is equipped with a high common-mode voltage amplifier. This enables the analog input to accept signals with a common-mode voltage of up to ±275 V.
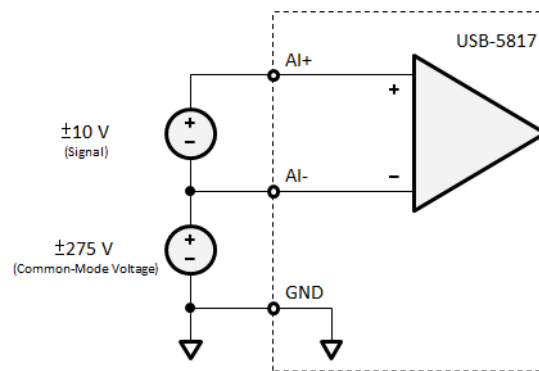

Figure 3.6 High Common-Mode Voltage Input

High common-mode voltage input is suitable for applications such as battery cell voltage monitoring, high-voltage current sensing, or power-supply current monitoring. With these applications, the measured signals may include a high common-mode voltage value. Such signals can damage measurement devices without the ability to withstand high common-mode voltage.
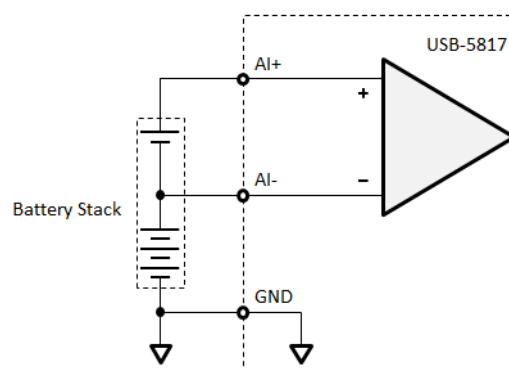

Figure 3.7 Battery Stack Measurement Application

3.4.4 Analog Input Acquisition Method

USB-5817 uses a channel scanning-type structure for analog input. A MUX routes signals from enabled analog input channels to the ADC, one channel at a time.
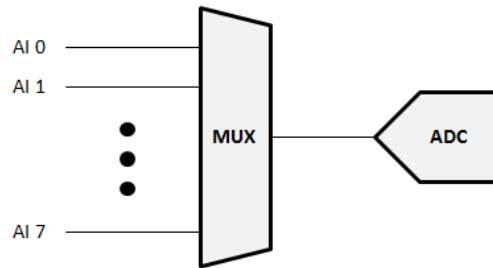

Figure 3.8 Channel Scanning Structure

Each analog input channel can be enabled or disabled independently via software. Only the enabled channels will be routed to the ADC by the MUX. The scanning sequence is determined by the channel number. For example, if only Channels 1, 2, 4, and 5 are enabled, the scanning sequence will be Channel 1, Channel 2, Channel 4, Channel 5, Channel 1, Channel 2, and so on.

3.4.5 Analog Input Sample Rate

The USB-5817 module uses an internal 40 MHz clock as the time base. The sample clock of the ADC is generated by dividing the time base by a specified integer. However, the frequency of the sample clock cannot exceed the ADC's specification, which is 200 kS/s. Therefore, the possible ADC sample rate (f_{ADC}) is

$$f_{ADC} = \frac{40\,MHz}{N}$$

where N is an integer with a range of 200 to 2^{32} - 1.

Because all analog input channels use the same ADC for data conversion, the ADC sample rate is shared. The actual sample rate for each channel (f_S) depends on the number of enabled channels (N_{CH}) and can be calculated as

$$f_S = \frac{f_{ADC}}{N_{CH}} = \frac{40\,MHz}{N \times N_{CH}}$$

3.4.6 Analog Input Triggering

The USB-5817 module only supports analog input triggering via software.

3.4.7 Analog Input Signal Connection

3.4.7.1 Pin Assignments

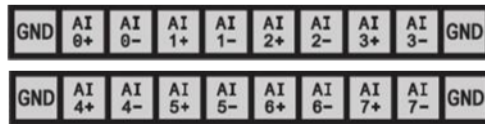The pin assignments for the USB-5817 module are shown in Figure 3.9. The function of each pin is listed in Table 3.5.

Figure 3.9 Pin Assignments

Table 3.5: Pin Functions		
Pin Name	**Type**	**Description**
AI<0…7>+	Input	Positive terminal of analog input channel 0 through 7
AI<0…7>-	Input	Negative terminal of analog input channel 0 through 7
GND	N/A	Ground

3.4.7.2 Signal Connection Function

The signal connection of the USB-5817 module's analog input function is shown in Figure 3.10. To prevent the input voltage from drifting outside of the acceptable range for a floating source, a bias resistor must be connected between the negative terminal of the analog input and ground. The resistance should be approximately 100 times the source impedance of the floating source.
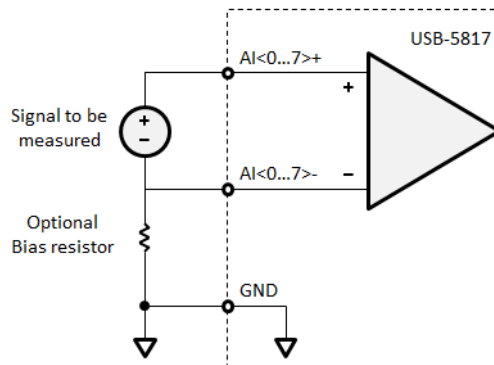

Figure 3.10 Analog Input Signal Connection

3.4.8 Analog Input Calibration

Follow the steps below to calibrate the analog inputs.

1. Set all analog input channels to "voltage input" mode using DIP switches (SW2 ~ SW9).
2. Select one analog input channel to calibrate.
3. Select "Offset" for type.
4. Input a DC voltage within the range specified by "Input Voltage" into the analog input channel undergoing offset calibration.
5. Click "Start" to begin calibration.
6. Compare "AI Value" with "Target Value" and adjust the offset calibration parameter. If the value is too low, increase the parameter. Alternatively, if the value is too high, reduce the parameter. Repeat this step until the "AI Value" is within the range specified by "Target Value".
7. Click "Finish" and select "Gain" for type.
8. Input a DC voltage within the range specified by "Input Voltage" into the AI channel undergoing gain calibration.
9. Click "Start" to begin calibration.
10. Compare "AI Value" with "Target Value" and adjust the gain calibration parameter. If the value is too low, increase the parameter. Alternatively, if the value is too high, reduce the parameter. Repeat this step until the "AI Value" is within the range specified by "Target Value".
11. Click "Finish" and again select "Offset" for type.
12. Input a DC voltage within the range specified by "Input Voltage" into the AI channel being calibrated. Then click "Start".
13. If the "AI value" is still within the range specified by "Target Value", proceed to the next step. Otherwise, go back to Step 3.
14. If all analog input channels are calibrated, proceed to the next step. Otherwise, go back to Step 2 to calibrate the next analog input channel.
15. Continue calibration until all the analog input channels are calibrated.

Table 3.6: Analog Input Calibration.

Type	Input Voltage	Target Value
Offset	-9.9955 ~ -9.9945 V	15 ~ 17
Gain	+9.9945 ~ +9.9955 V	65519 ~ 65521

Appendix A

Specifications

A.1 Analog Input

Number of Input Channels	8 differential channels, can be enabled/disabled independently via software
A/D Converter (ADC) Resolution	16 bits (15 bits for current measurement)
A/D Converter (ADC) Type	Successive approximation (SAR)
Maximum Sample Rates (f_s)	200 kS/s shared by all channels
Input Coupling	DC
Input Range	±10 V, 0 ~ 20 mA
Input Common-Mode Voltage Range	±275 V
Absolute Accuracy	Offset error: < 1 mV
	Gain error: < 0.01% of full-scale range[1]
Temperature Drift	Offset drift: 25 ppm/°C
	Gain drift: 15 ppm/°C
Bandwidth (-3dB)	10 kHz
Idle Channel Noise	0.27 mV$_{RMS}$ (16 bits ENOB)
Signal-to-Noise Ratio (SNR)	87 dB
Total Harmonic Distortion (THD)	-98 dB
Total Harmonic Distortion Plus Noise (THD+N)	-87 dB
Spurious-Free Dynamic Range (SFDR)	102 dB
Input Impedance	Differential: 800 kΩ
	Common mode: 200 kΩ
Input FIFO Size	4,096 samples shared among enabled channels

1 Because of the calibration mechanism, a tiny range (<0.02% of full-scale range) near the maximum or minimum input range may be clipped. This will be observed, for example, when input voltages are in the range of -9.99756 V to -10 V but the measured values are all -9.99756 V.

A.2 General Specifications

Connectors	2 x 10-pin terminal block (3.81 mm, analog input) 2 x 3-pin screw terminal block (3.81 mm, power) USB 3.0 type A (downstream port) USB 3.0 type B (upstream port)
Dimensions	120 x 120 x 40 mm^3 (4.72 x 4.72 x 1.57 in^3)
Operating Temperature	0 ~ 60 °C (32 ~ 140 °F)
Storage Temperature	-40 ~ 70 °C (-40 ~ 158 °F)
Operating Humidity	10 to 90% RH, non-condensing
Storage Humidity	5 to 95% RH, non-condensing
Power Consumption	When using USB bus power: 350 mA typ. @ 5 V
	When using external power: 100 mA typ. @ 24 V
ESD Protection	Air: ±8 kV/Contact: ±6 kV
DC Surge Protection	2 kV

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