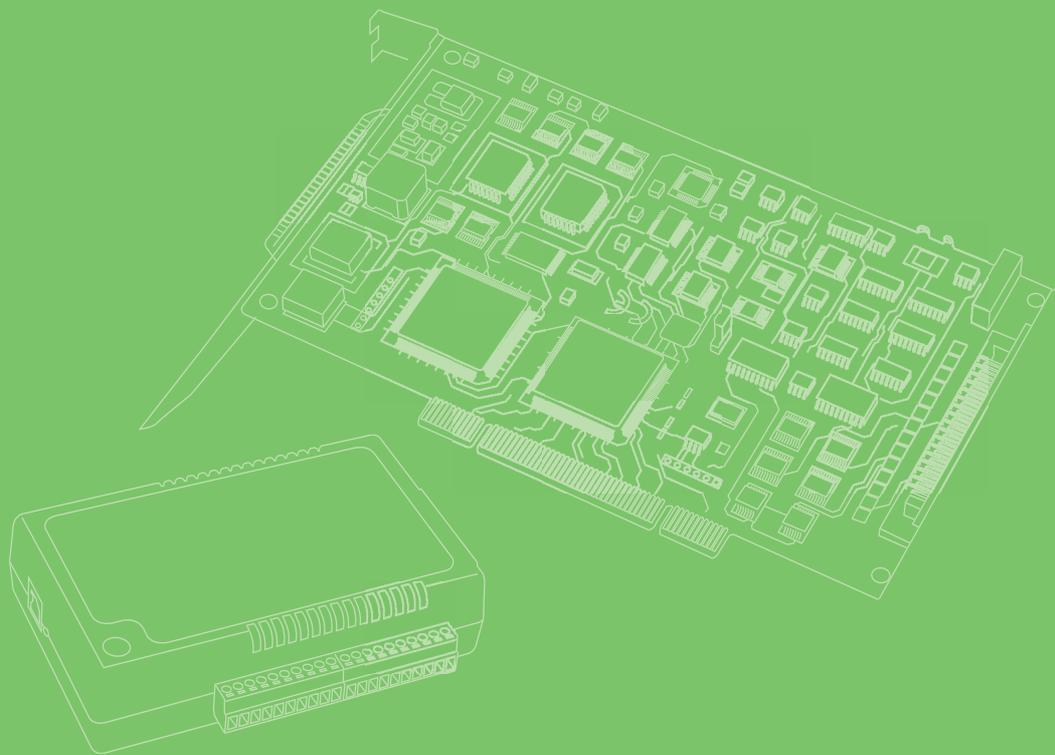


User Manual



USB-5820

4-ch, 16-bit, 200 kS/s Isolated
Analog Output 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 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. 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-5820 module
- 3 x terminal blocks
- 1 x USB-5820 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-5820 and its typical applications.

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

Advantech's USB-5820 is an industrial isolated analog output USB 3.0 I/O module. To ensure easy installation in cabinet computers, USB-5820 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
- 4 x 16-bit analog output channels with 2,500 V_{DC} isolation
- Multiple voltage and current output ranges
- 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.

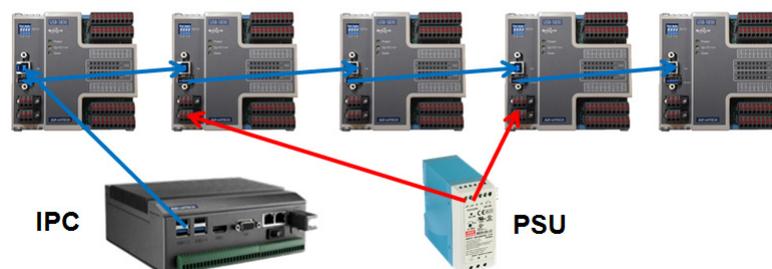
Compact Size

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 Chain 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-5820 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-5820 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-5820 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-5820 module
- 1 x USB-5820 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-5820 module. Figure 1.1 is a flowchart that provides a broad overview of the software and hardware installation procedures.

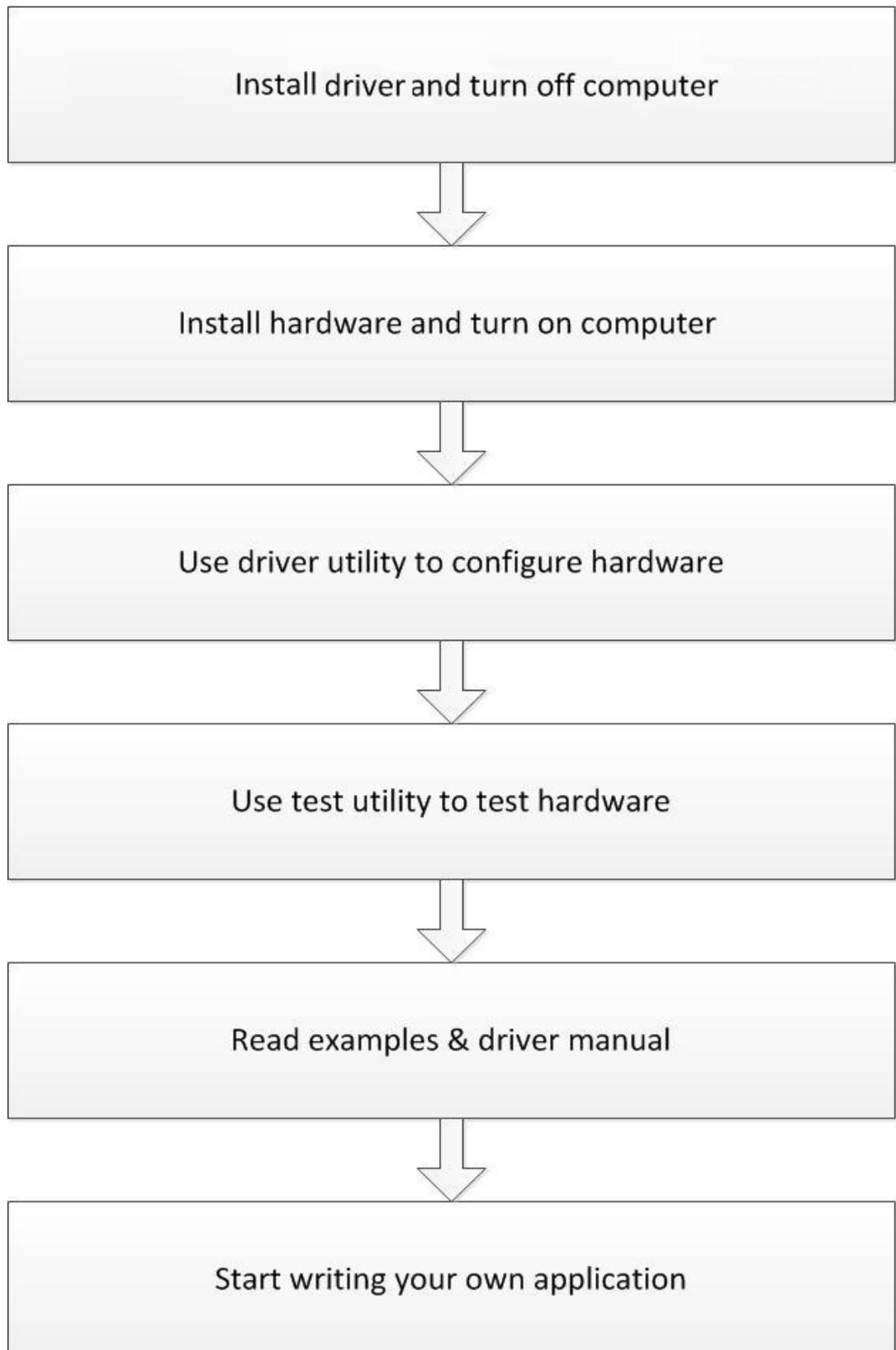


Figure 1.1 Installation Flowchart

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-5820 module.

- Device drivers
- Advantech DAQNav

DAQNav Software

Advantech's DAQNav 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 DAQNav 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 DAQNav Device Driver Programming Roadmap

This section provides a roadmap for building an application from scratch using Advantech's DAQNav 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 DAQNav SDK manual. Please refer to the corresponding sections in the DAQNav 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 DAQNav SDK manual can be downloaded from the Advantech website. Alternatively, if the device drivers are already installed on the computer, the DAQNav SDK manual can be accessed via the Start button.

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

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

Advantech\DAQNav\Examples

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

Programming with DAQNav Device Drivers Function Library

Advantech offers a comprehensive function library for DAQNav 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 DAQNav SDK” in the DAQNav SDK manual.

Troubleshooting DAQNav 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 DAQNav SDK manual.

1.5 Accessories

Advantech offers the following accessories to support the USB-5820 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-5820 module, inspect the package contents to ensure that the following items are present:

- 1 x USB-5820 module
- 3 x Terminal blocks
- 1 x USB-5820 startup manual
- 1 x USB 3.0 lockable cable (1 m)

The USB-5820 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-5820 module to guarantee a problem-free installation process.

The Advantech DAQNav i 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-5820 driver package.
2. The Advantech DAQNav i driver installation wizard program should launch automatically. Figures 2.1 to 2.5 show the various pages of the installation wizard interface.

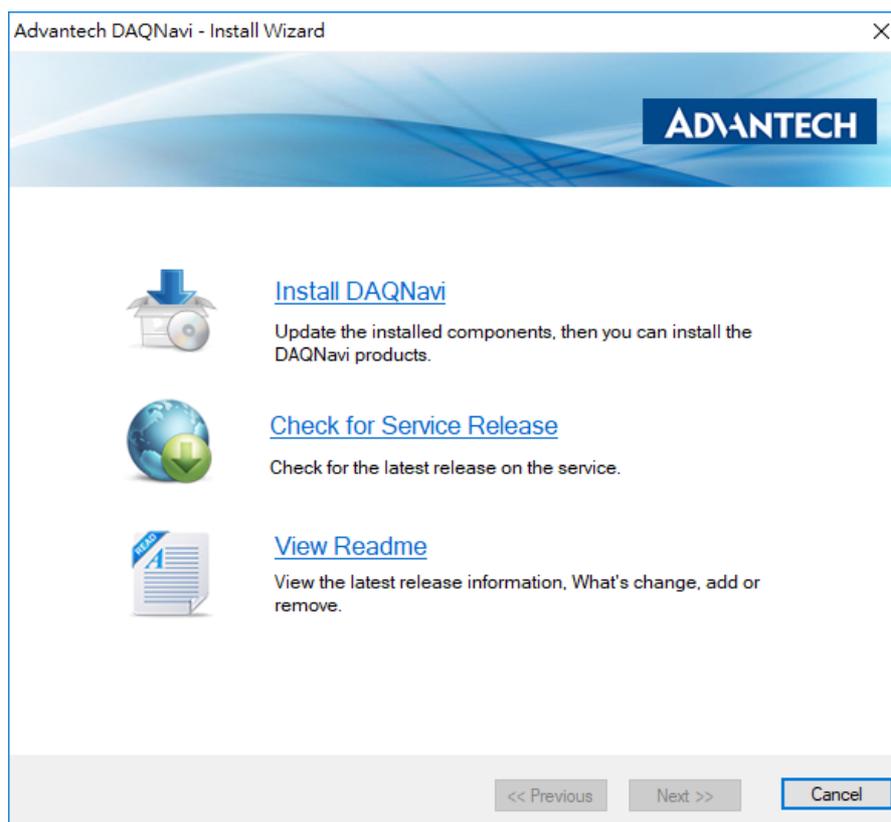


Figure 2.1 Advantech DAQNav i Installation Wizard

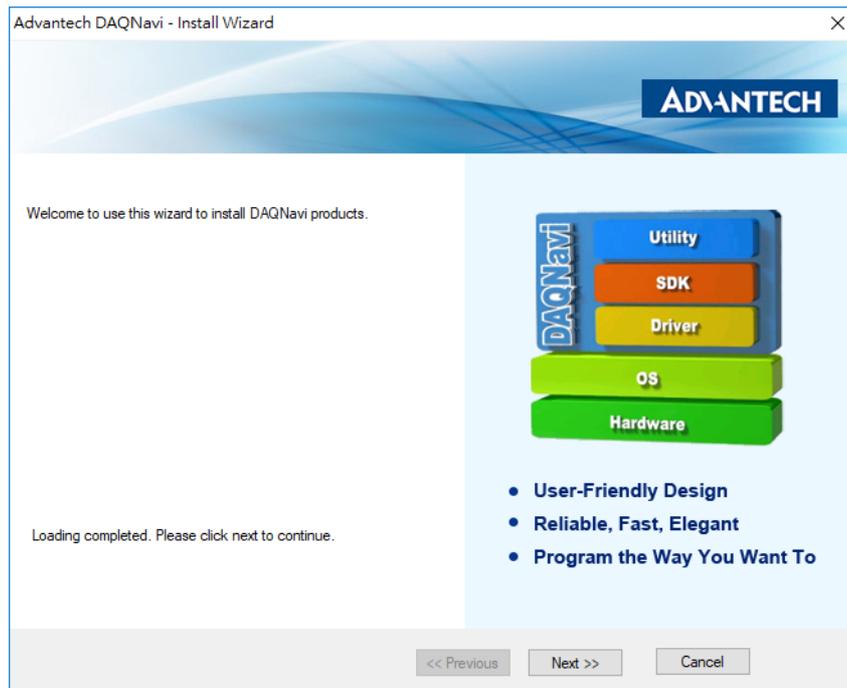


Figure 2.2 Driver Installation Setup Screen

- Once the DAQNav i driver installation wizard is launched, follow the instructions displayed in the interface to complete the driver installation.

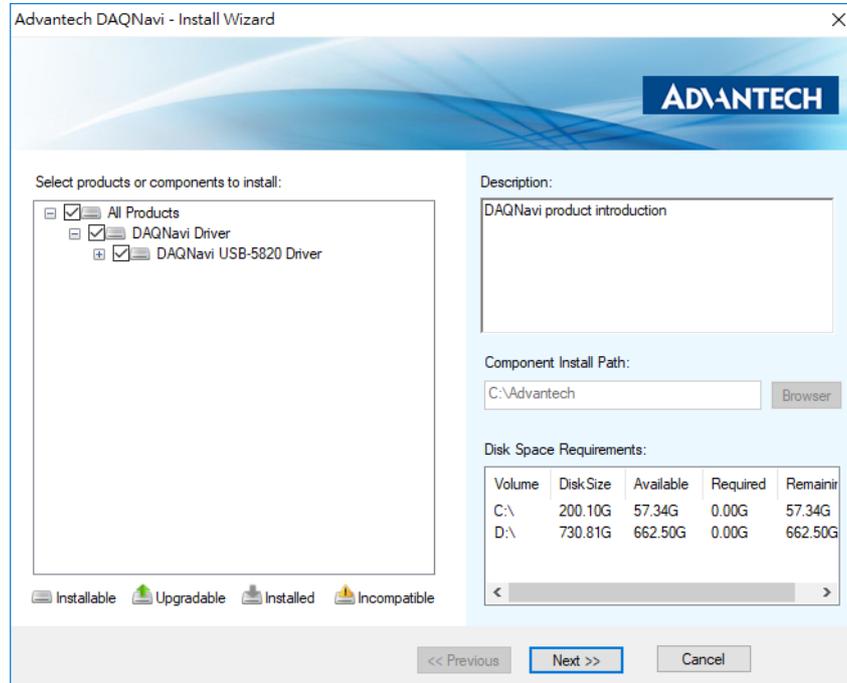


Figure 2.3 Driver Installation Path and Space Requirements



Figure 2.4 Driver Installation Process

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

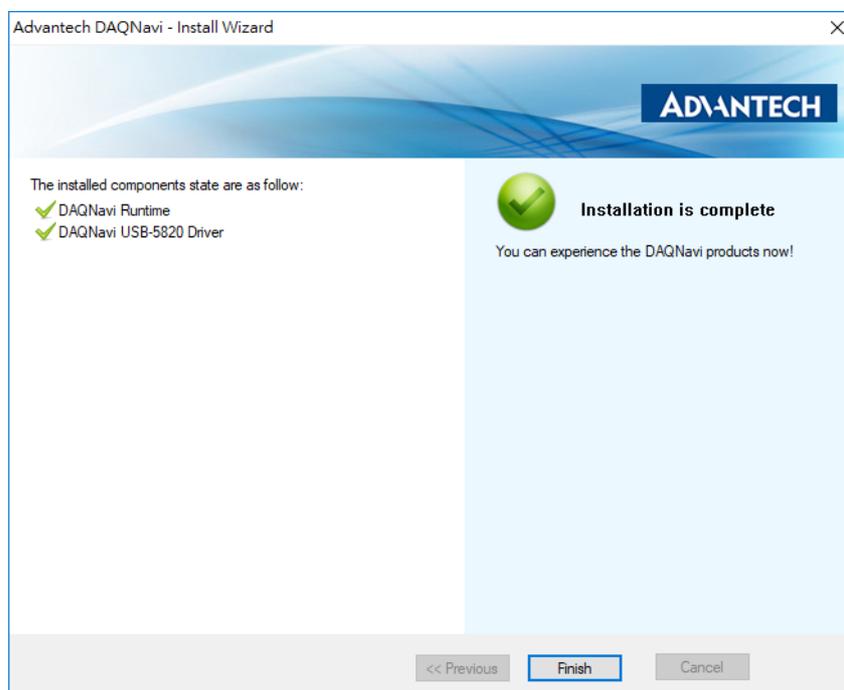


Figure 2.5 Exit the Driver Installation Wizard

2.3 Hardware Installation

Note! *Ensure that the relevant driver is installed before installing the USB-5820 module. (Refer to Section 2.2 “Driver Installation” for more information.)*



After the device drivers are installed, the USB-5820 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-5820 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-5820 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-5820 module should be included in the Installed Devices list.

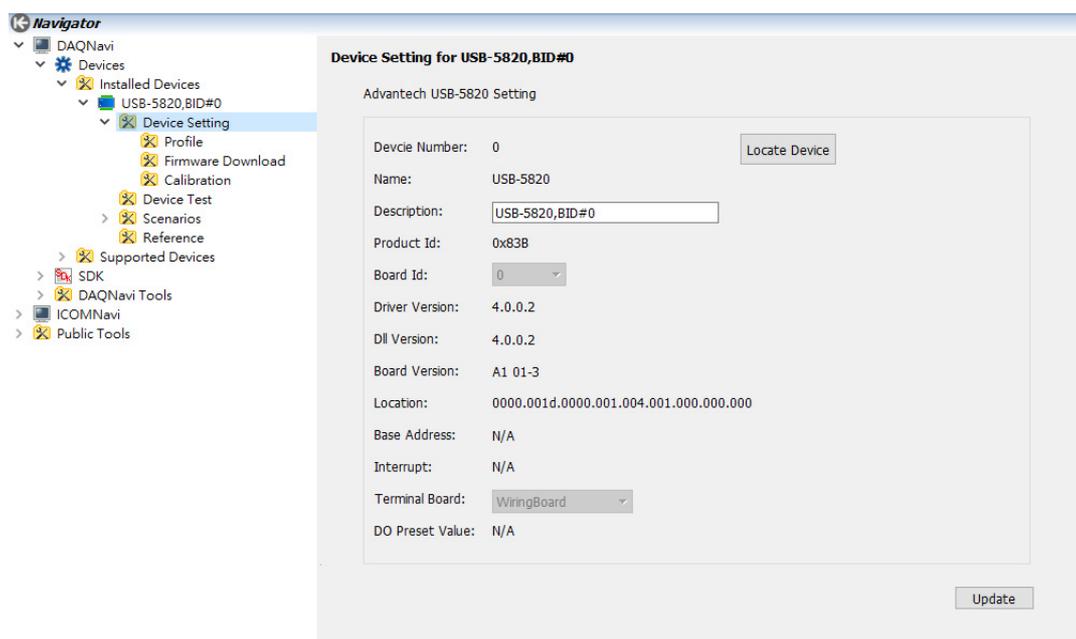


Figure 2.6 USB-5820 Device Settings

Configuring the Device

- Go to the Device Setting page to configure the device. The items in the page allow users to configure the USB-5820 modules' analog output.

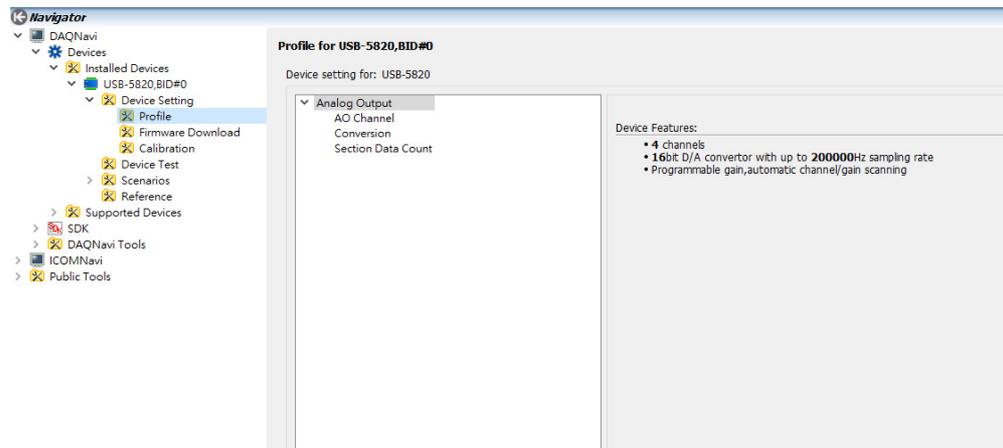


Figure 2.7 Device Settings Page

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

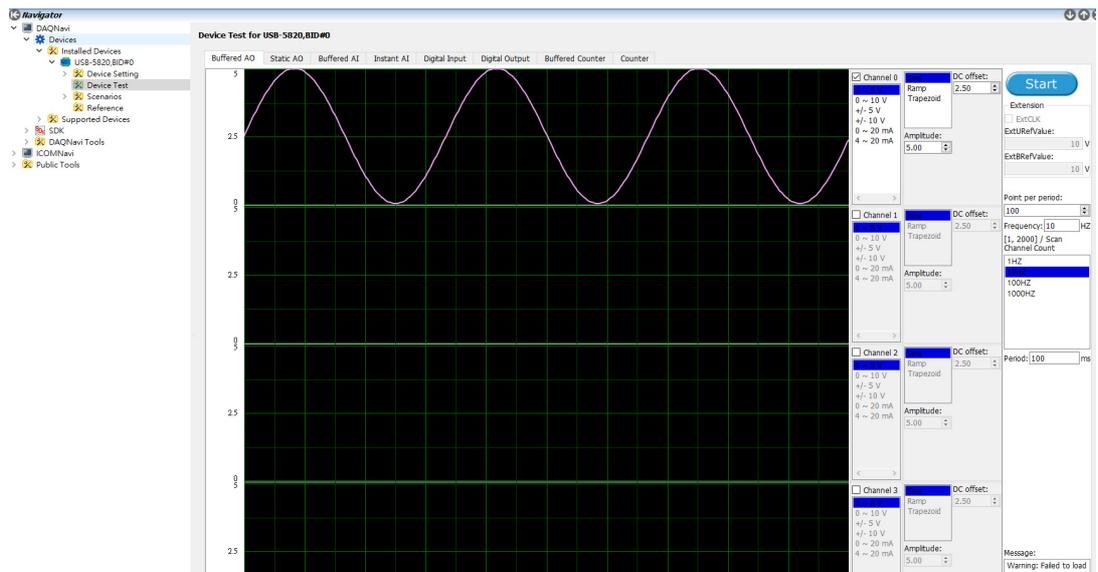


Figure 2.8 USB-5820 Device Testing

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

Chapter 3

Signal Connections

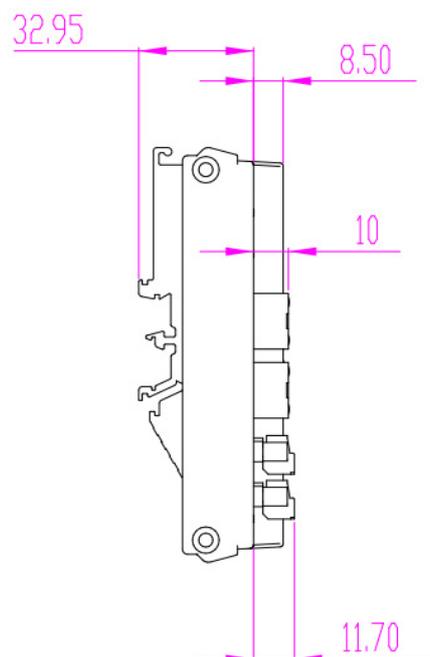
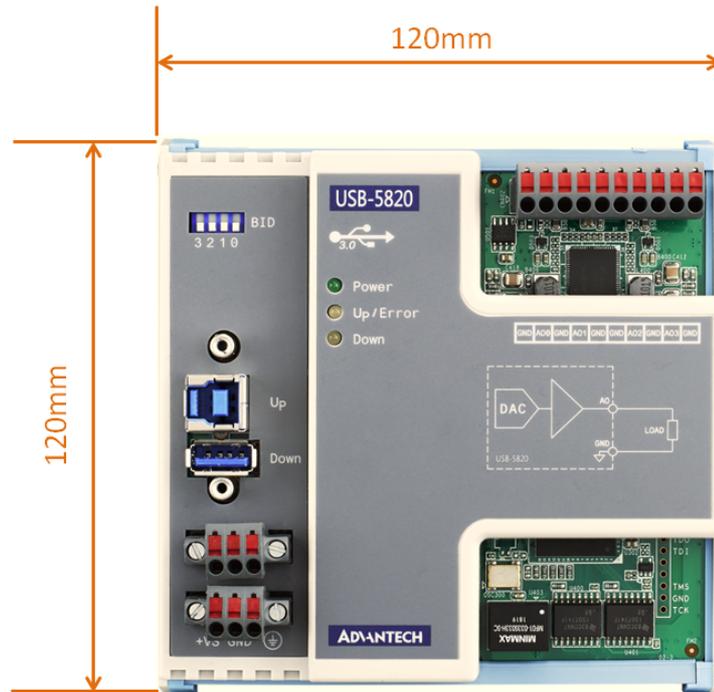
This chapter explains how to connect input and output signals to the USB-5820 module via the I/O connector.

- 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-5820 module are shown in Figure 3.1.

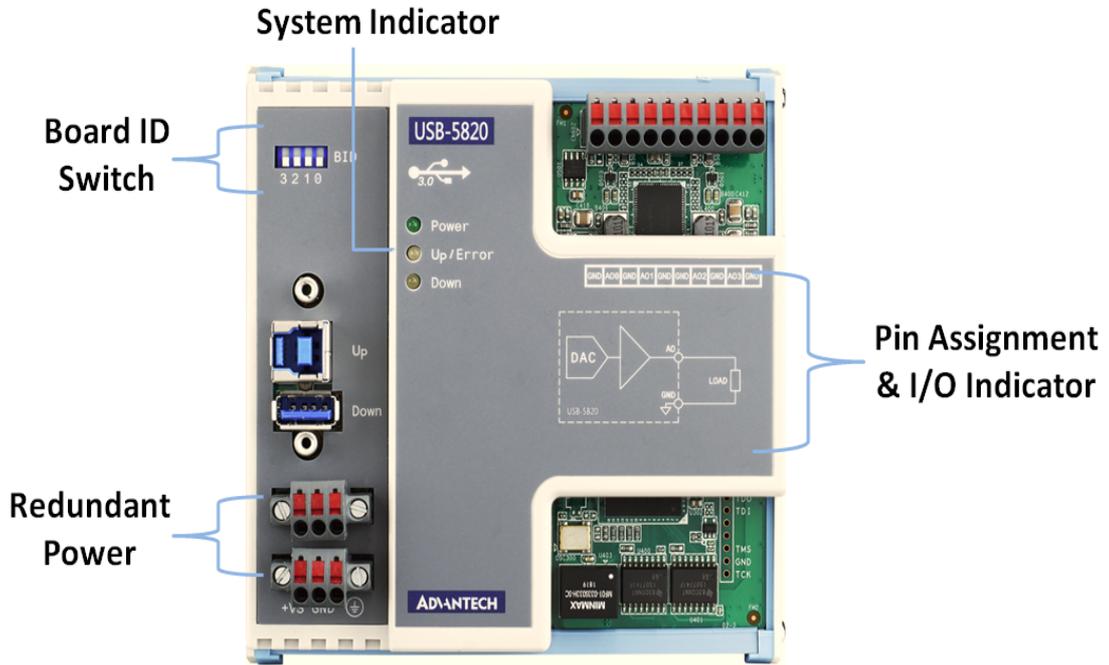


Figure 3.1 Jumper and Switch Locations

3.3.1 Board ID

USB-5820 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:

Switch	Description				
	Board ID switch. Refer to the following table for board ID configuration.				
	Board ID	3	2	1	0
	0	↑	↑	↑	↑
	1	↑	↑	↑	↓
	2	↑	↑	↓	↑
	3	↑	↑	↓	↓
	4	↑	↓	↑	↑
	5	↑	↓	↑	↓
	6	↑	↓	↓	↑
SW1	7	↑	↓	↓	↓
	8	↓	↑	↑	↑
	9	↓	↑	↑	↓
	10	↓	↑	↓	↑
	11	↓	↑	↓	↓
	12	↓	↓	↑	↑
	13	↓	↓	↑	↓
	14	↓	↓	↓	↑
	15	↓	↓	↓	↓

3.3.2 LED Indicators

Table 3.1: Power

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

Table 3.2: 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 3.3: Down

State	Description
Off	Downstream port is not connected
Blue	Downstream port is connected

3.4 Analog Output

3.4.1 Analog Output Overview

Figure 3.2 shows the functional block diagram of the USB-5820 analog output circuitry.

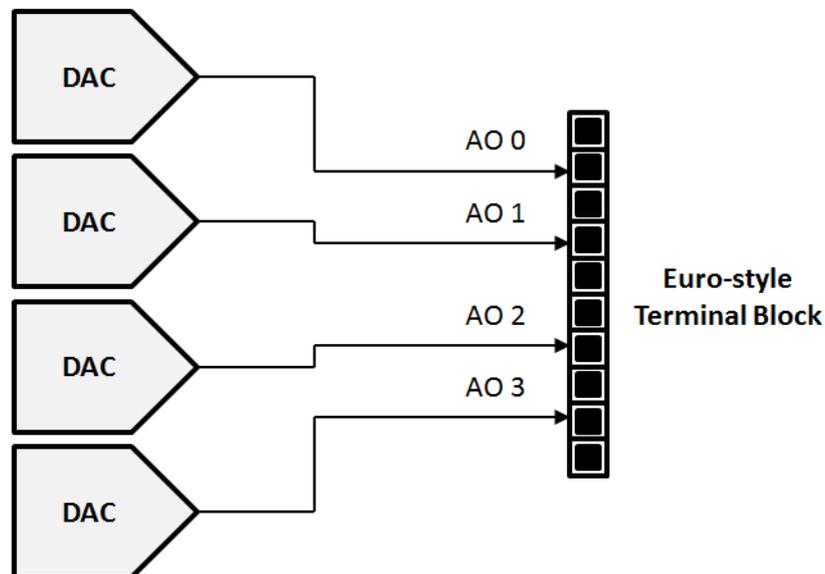


Figure 3.2 Analog output circuitry

The analog output (AO) signals are generated by the DACs. Each channel provides multiple voltage and current output ranges, which can be individually configured by software.

For buffered AO generation, blocks of digital data received from the host are first queued in a first-in-first-out (FIFO) buffer. After offset and gain correction, the data will be written into the DAC at a constant rate and are converted into analog waveforms. For static AO generation, digital data received from the host directly go through offset and gain correction, and are written into the DAC. This is shown in Figure 3.3.

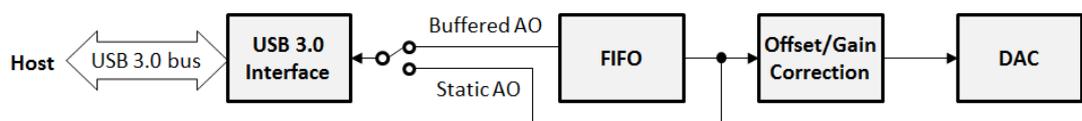


Figure 3.3 Analog output data processing

3.5 Analog Output Range

Each AO channel of the USB-5820 can generate multiple ranges of voltage or current signal output. They can be configured by software for every channel individually.

3.5.1 Voltage Output Generation

The USB-5820 supports the following voltage output ranges: ± 10 V, ± 5 V, $0 \sim +10$ V, and $0 \sim +5$ V. The output voltage is referenced to ground. Therefore, the load should be connected between each AO pin and the ground pin. This is shown in Figure 3.4.

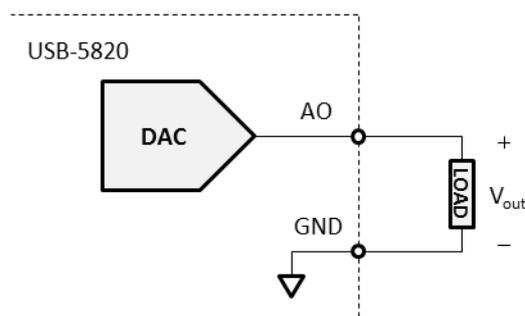


Figure 3.4 Voltage output generation

The USB-5820 is equipped with four 16-bit digital-to-analog converters (DACs), which means that the output voltage can be generated from one of 65,536 (2¹⁶) codes. Take ± 10 V output range as an example, the voltage resolution can be calculated as

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

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

3.5.2 Current Input Measurement

The USB-5820 supports the following current output ranges: 0 ~ 20 mA and 4 ~ 20 mA. The current is sourced from the AO pin and return to the ground pin. Therefore, the load should be connected between each AO pin and the ground pin. This is shown in Figure 3.5.

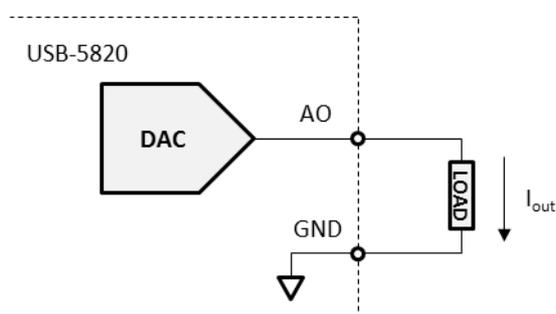


Figure 3.5 Current output generation

The USB-5820 is equipped with four 16-bit digital-to-analog converters (DACs), which means that the output current can be generated from one of 65,536 (2¹⁶) codes. Take 0 ~ 20 mA output range as an example, the current resolution can be calculated as

$$\frac{20\text{ mA} - 0\text{ mA}}{65,536} = 305\ \text{nA}$$

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

3.6 Analog Output Update Rate

The maximum update rate of the DACs in USB-5820 is 200 kS/s, and this update rate is shared by all enabled channels. For example, if only one AO channel is enabled, the maximum update rate of the output signal is 200 kS/s. On the other hand, if all four AO channels are enabled, the maximum update rate for each channel decreases to 50 kS/s (200 kS/s divided by 4). The aggregate update rate is still 200 kS/s.

The actual update rate, however, may differ from the configured value by a small amount. The update clock for the DACs is generated from dividing an internal 66.666 MHz clock by an integer value divisor. To calculate the divisor, one needs to divide the 66.666 MHz by the desired aggregate update rate. For example, if all 4 AO channels are enabled and the update rate is 50 kS/s, the aggregate update rate is 200 kS/s (50 kS/s multiplied by 4), and the divisor is calculated as

$$\text{Divisor} = \frac{66.666 \text{ MHz}}{\text{Desired Aggregate Update Rate}} = \frac{66.666 \text{ MHz}}{200 \text{ kHz}} = 333.33 \approx 333$$

The actual aggregate update rate can be calculated as:

$$\text{Actual Aggregate Update Rate} = \frac{66.666 \text{ MHz}}{\text{Divisor}} = \frac{66.666 \text{ MHz}}{333} = 200.2 \text{ kHz}$$

And actual update rate of each channel is:

$$\begin{aligned} \text{Actual Update Rate of Each Channel} &= \frac{\text{Actual Aggregate Update Rate}}{\text{Number of Enabled Channels}} = \frac{200.2 \text{ kHz}}{4} \\ &= 50.05 \text{ kHz} \end{aligned}$$

The divisor range is between 333 and 4,294,967,295 ($2^{32} - 1$), and the actual aggregate update rate is between 200.2 kHz and 0.01552 Hz.

3.7 Analog Output Triggering

The USB-5820 only supports software trigger.

3.8 Analog Output Signal Connection

3.8.1 Pin Assignment

Figure 3.6 shows the pin assignment of the USB-5820, and table 1-1 describes the functions of each pin.

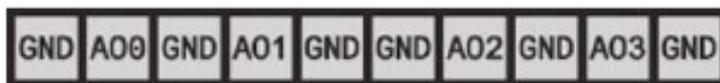


Figure 3.6 Pin assignment

Table 3.4: Function description for each pin.

Pin Name	Type	Description
AO<0...3>	Output	Analog output channel 0 through 3
GND	N/A	Ground

3.8.2 Analog Output Signal Connection

For both voltage and current output, the load should be connected between each AO pin and the ground pin as shown in Figure 3.4 and Figure 3.5. The load resistance must be larger than 1 k Ω for voltage output ranges and smaller than 625 Ω for current output ranges to assure proper operation of the AO function.

3.9 Analog Output Calibration

Follow the steps below for analog output calibration:

1. Connect a digital multimeter (DMM) with resolution not less than 6.5 digits to the AO channel to be calibrated.
2. Select one of the AO channels to be calibrated.
3. Select one of the output ranges to be calibrated.
4. Select "Offset" for type and click "Start" to begin offset calibration.
5. Compare DMM reading to "Target Value" and adjust "Parameter" value. If the reading is too small, increase the "Parameter" value; on the other hand, decrease the "Parameter" value. Repeat this step until DMM reading is within the range specified by "Target Value".
6. Click "Finish", select "Gain" for type, and click "Start" to begin gain calibration.
7. Compare DMM reading to "Target Value" and adjust "Parameter" value. If the reading is too small, increase the "Parameter" value; on the other hand, decrease the "Parameter" value. Repeat this step until DMM reading is within the range specified by "Target Value".
8. Click "Finish" and select "Offset" for type again. Then click "Start".
9. If DMM reading is still within the range specified by "Target Value", proceed to the next step. Otherwise, go back to step 4.
10. If all output ranges of current AO channel are calibrated, proceed to the next step. Otherwise, go back to step 3 for the next output range calibration.
11. If all AO channels are calibrated, proceed to the next step. Otherwise, go back to step 2 for the next AO channel calibration.
12. Analog output calibration is finished.

Users can click "Load Default" to recover all calibration parameters to factory default values.

Table 3.5: Analog output calibration.

Range	Type	Target Value
0 V ~ 5 V	Offset	+0.00481 V ~ +0.00496 V
	Gain	+4.9950 V ~ +4.9952 V
0 V ~ 10 V	Offset	+0.00961 V ~ +0.00992 V
	Gain	+9.9901 V ~ +9.9904 V
-5 V ~ +5 V	Offset	-4.9904 V ~ -4.9901 V
	Gain	+4.9901 V ~ +4.9904 V
-10 V ~ +10 V	Offset	-9.9808 V ~ -9.9802 V
	Gain	+9.9802 V ~ +9.9808 V
0 mA ~ 20 mA	Offset	0.0192 mA ~ 0.0198 mA
	Gain	19.9802 mA ~ 19.9808 mA
4 mA ~ 20 mA	Offset	4.0154 mA ~ 4.0158 mA
	Gain	19.9872 mA ~ 19.9876 mA

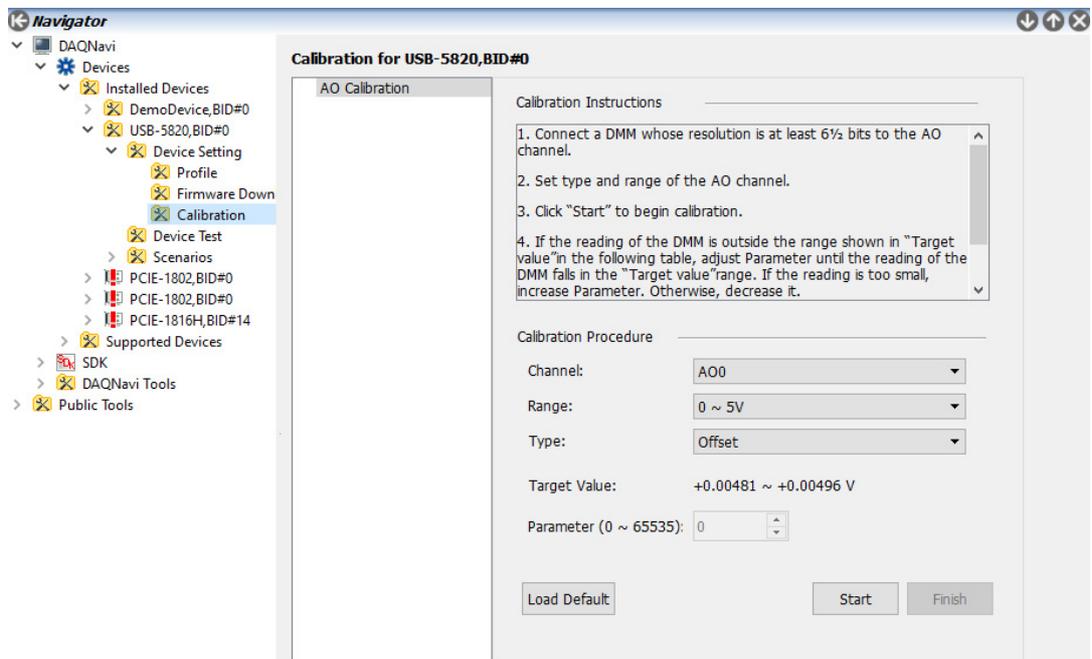


Figure 3.7 Calibration tool in the Navigator

Appendix **A**

Specifications

A.1 Analog Output

Number of output channels	4 single-ended, can be enabled/disabled each channel independently by software
D/A converter (DAC) resolution	16 bits
Maximum update rates (f_s)	200 kS/s shared by all channels
Output coupling	DC
Output voltage	0 ~ +5 V, 0 ~ +10 V, ± 5 V, ± 10 V, 0 ~ 20 mA, 4 ~ 20 mA
Output load	Voltage output: > 1 k Ω Current output: < 625 Ω
Absolute accuracy	Offset error: < 1 mV
	Gain error: < 0.01% of full-scale range ^[1]
Temperature drift	Offset drift: 25 ppm/ $^{\circ}$ C
	Gain drift: 15 ppm/ $^{\circ}$ C
Output slew rate	1 V/ μ s
DC performance	Idle channel noise: 0.17 mV _{RMS} Effective resolution: 16 bits
Isolation protection	2,500 V _{DC}
Output FIFO size	4,096 samples shared among enabled channels

Note [1]: Due to calibration mechanism, a tiny range (< 0.02% of full-scale range) near maximum or minimum output range may be clipped. This will be observed, for example, when output voltages are in the range of -9.99756 V to -10 V (for ± 10 V output range) but the actual values are all -9.99756V.

A.2 General Specifications

Connectors	10-pin terminal block, 3.81 mm (AO) 3-pin screw terminal block, 3.81 mm x 2 (power) USB 3.0 type A (downstream) USB 3.0 type B (upstream)
Dimensions	120 x 120 x 40 mm ³ (4.72 x 4.72 x 1.57 in ³)
Operating temperature	0 to 60 $^{\circ}$ C (32 to 140 $^{\circ}$ F)
Storage temperature	-40 to 70 $^{\circ}$ C (-40 to 158 $^{\circ}$ F)
Operating humidity	10 to 90% RH, non-condensing
Storage humidity	5 to 95% RH, non-condensing
Power consumption	When using USB bus power: 450 mA typ. / 770 mA max. @ 5 V
	When using external power: 100 mA typ./ 130 mA max. @ 24 V
ESD protection	Air: 8 kV/Contact: 6 kV
DC surge protection	2 kV

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