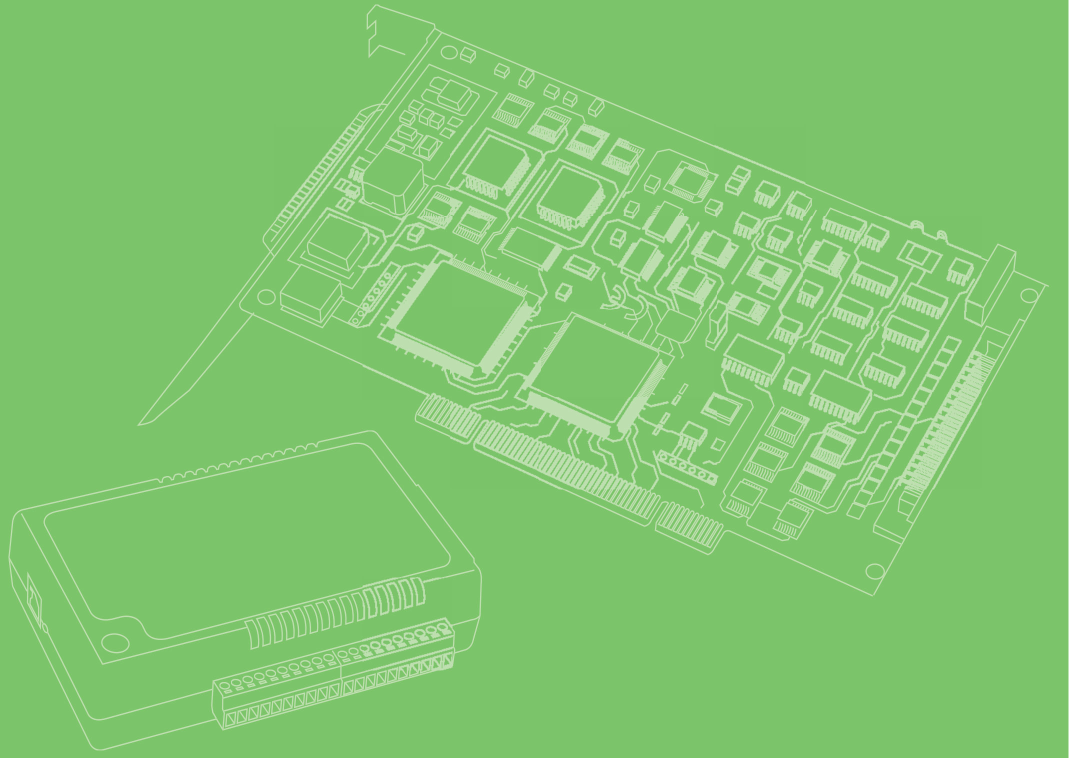

User Manual

iDAQ-871/873

Bridge Input Industrial DAQ Modules

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 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. 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 instruction 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 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

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."

Note! *Notes provide additional optional information.*

Document Feedback

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

Packing List

Before system installation, check that the items listed below are included and in good condition. If any item does not accord with the list, contact your dealer immediately.

iDAQ-871

- iDAQ-871 x 1
- Startup Manual x 1

iDAQ-873

- iDAQ-873 x 1
- Startup Manual x 1

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 show 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.

Consignes de sécurité

1. Lisez attentivement ces consignes de sécurité.
2. Gardez ce manuel pour référence future.
3. Déconnectez cet équipement de toute prise secteur avant de le nettoyer. Utilisez un chiffon humide. Ne pas utilisez de liquide ou de sprays détergents pour le nettoyage.
4. La prise de courant doit être située près de l'équipement et doit être facilement accessible.
5. Gardez cet équipement à l'abri de l'humidité.
6. La chute de l'équipement pouvant l'endommager, celui-ci doit être installé sur une surface stable.
7. Les ouvertures du boÎtier sont nécessaires au refroidissement de l'appareil. Veillez à protéger l'appareil contre la surchauffe. NE PAS COUVRIR LES OUVERTURES.
8. Assurez-vous que la tension de la source d'alimentation est correcte avant de brancher l'appareil à la prise de courant.
9. Placez le cordon d'alimentation de manière à éviter que des personnes marchent dessus. Veillez à ce qu'aucun objet ne soit placé sur le cordon d'alimentation.
10. Tous les conseils et avertissements concernant ce matériel et son utilisation doivent être lus et compris.
11. Si l'appareil n'est pas utilisé pendant une longue période, débranchez-le de la source d'alimentation pour éviter les dommages causés par des surtensions transitoires.
12. Ne jamais verser de liquide dans une ouverture. Cela peut provoquer un incendie ou un choc électrique.
13. Ne jamais ouvrir l'équipement. Pour des raisons de sécurité, l'équipement ne peutêtre ouvert que par du personnel qualifié.
14. Si l'une des situations suivantes se présente, faites vérifier le matériel par le personnel de service:
    - Le cordon d'alimentation ou la prise est endommagé.
    - Du liquide a pénétré dans l'appareil.
    - L'équipement a été exposé à l'humidité.
    - L'équipement ne fonctionne pas bien, ou vous ne pouvez pas le faire fonctionner selon le manuel d'utilisation.
    - L'appareil est tombé et est endommagé.
    - L'équipement présente des signes évidents de casse
15. Ne pas laissez ce matériel dans un environnement où la température de stockage peut descendre en dessous de -20° C (-4° F) ou être supérieure à 60° C (140° F). Ceci pourrait endommager l'équipement. L'équipement doit être maintenu dans un environnement contrôlé.
16. ATTENTION: RISQUE D'EXPLOSION SI LA BATTERIE EST REMPLACEE DE MANIERE INCORRECTE. Remplacer uniquement avec un modèle recommandé par le fabricant, et éliminer les piles usages selon les instructions du fabricant.
17. Conformément à la norme CEI 704-1:1982, l'opérateur ne doit pas experimenter un niveau sonore supérieur à 70 dB (A).

AVERTISSEMENT: Ces consignes suivent la norme CEI 704-1.

Advantech décline toute responsabilité concernant l'exactitude des déclarations contenues dans ce document.

Safety Precautions - Static Electricity

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

- 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.
- Disconnect the power before making any configuration changes. A sudden rush of power after connecting a jumper or installing a card may damage sensitive electronic components.

Précautions de sécurité – Électricité statique

Suivez ces précautions simples pour vous protéger des dangers et protéger les produits de dommage.

- Pour éviter les chocs électriques, débranchez toujours l'alimentation du châssis du PC avant toute manipulation manuelle. Ne touchez aucun composant de la carte CPU ou d'autres cartes lorsque le PC est sous tension.
- Coupez l'alimentation avant d'effectuer des modifications de configuration. Une ruée soudaine de puissance après avoir connecté un cavalier ou installé une carte peut endommager les capteurs sensibles composants electroniques.

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Chapter 1

Start Using iDAQ-871/873

1.1 Overview

This chapter presents an overview of Advantech's industrial data acquisition (iDAQ) modules, focusing on the iDAQ-871 and iDAQ-873 models, including their product lineups, features, and accessories. Both iDAQ-871 and iDAQ-873 are 24-bit bridge type acquisition modules. The iDAQ-871 is a 4-channel acquisition module that supports various bridge inputs (full, half, and quad bridges) and offers multiple resistance and excitation voltages to accommodate different types of strain gauges. On the other hand, the iDAQ-873 is an 8-channel acquisition module designed specifically for quarter-bridge measurement. These modules are suitable for the precise measurement of strain gauges, force sensors, load cells, and similar devices.

1.2 Product Overview

iDAQ-871

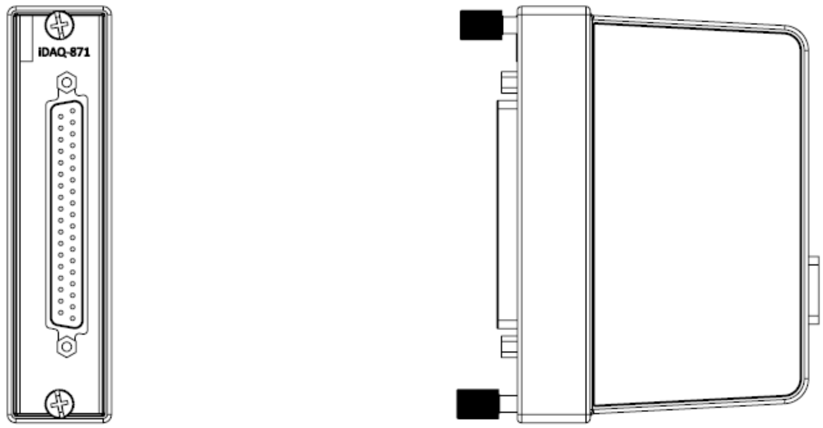


Figure 1.1 Overview of iDAQ-871

iDAQ-873

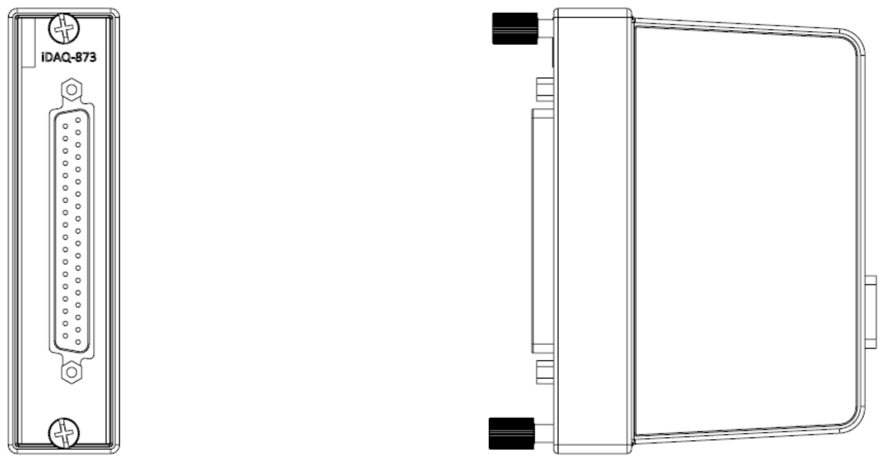


Figure 1.2 Overview of iDAQ-873

1.3 Product Features

1.3.1 Power Input

The power input of all the iDAQ I/O modules come from iDAQ chassis via the DB 15-pin connector. The iDAQ I/O modules are powered on when the power of iDAQ chassis is connected.

1.3.2 BoardID

A board ID (BID) can be assigned to the iDAQ chassis by the rotary switch and slot number. The board ID will be shown in the software and can be used to distinguish modules. The number shown around the rotary switch is in hexadecimal format. For example, “A” represents 10 in decimal format, and “F” represents 15 in decimal format. The number assigned to each iDAQ module follows a rule combining the ChassisID and slot number.

1.3.3 Plug and Play Device

The iDAQ modules are hot-swappable in the iDAQ chassis. The modules will be recognized instantly in the software (Installed Devices list) when they are plugged into the iDAQ slots and they can be removed as soon as they are disabled in the software. Therefore, it’s strongly recommended to operate these actions whilst the system is in idle mode not data acquisition mode.

1.4 Driver Installation

The driver package could be found on Advantech Support Portal (https://www.advantech.com/support). Search for iDAQ 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 and it will guide you through the session. You can choose the device and software components you’d like to install in the system (Figure 1.3). After the selection, click on “start” to begin the installation.

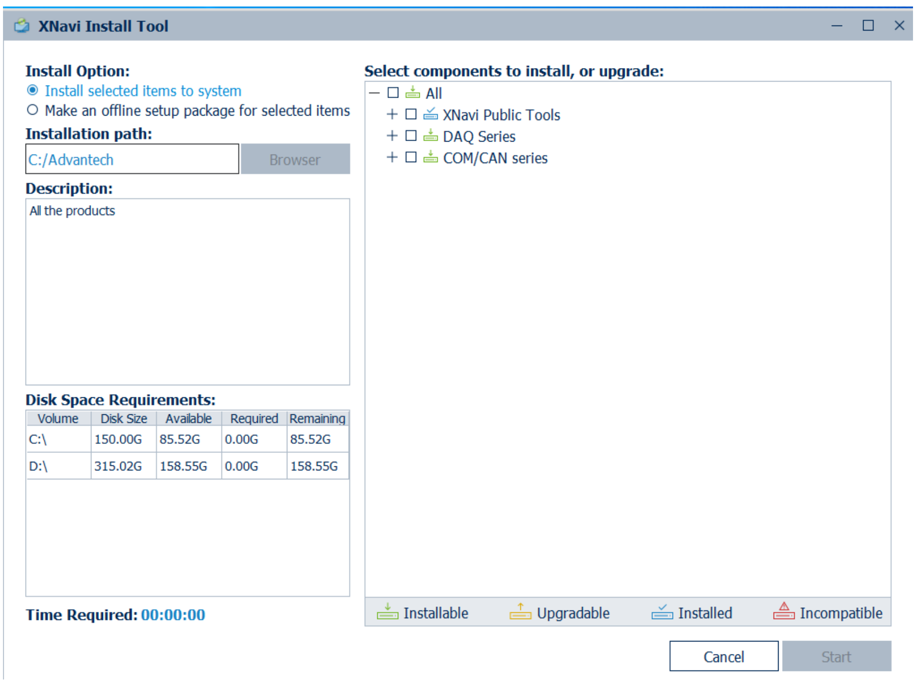


Figure 1.3 XNavi Installation Interface

1.5 Software Utility

Advantech offers device drivers, SDKs, third-party driver support and application software to help fully exploit the functions of your iDAQ 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 store your settings in a proprietary database.

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

1.6 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 could be installed via XNavi installer. They could be found under C:\Advantech\DAQNavi (default directory) after the finishing the installation.

1.7 FPGA Code Update

The FPGA could also be updated via the interface in Navigator. However, it isn't normal to update an FPGA. Advantech strongly suggests you to consult your technical support before considering an FPGA update.

1.8 Ordering Information

IDAQ-871-A	4-ch, 24-bit, 25.6kS/s/ch, 3-in-1 Bridge Input iDAQ Module
IDAQ-873-A	8-ch, 24-bit, 25.6kS/s/ch, Quarter Bridge Input iDAQ Module

1.9 Accessories

PCL-10137-1E	DB-37 Shielded Cable, 1m
PCL-10137-2E	DB-37 Shielded Cable, 2m
PCL-10137-3E	DB-37 Shielded Cable, 3m
ADAM-3937-BE	DB-37 Wiring Terminal, DIN-rail Mount

Chapter 2

Installation Guide

2.1 Initial Unpacking Check

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

- DAQ module*1
- Startup manual*1

If anything in the packing list is missing, please contact your local support for further assistance.

2.2 Installation

Below are the steps to insert the iDAQ modules into the iDAQ chassis.

1. Insert the module follow the guide rail to the end
2. Screw the two thumb screws tight onto the chassis

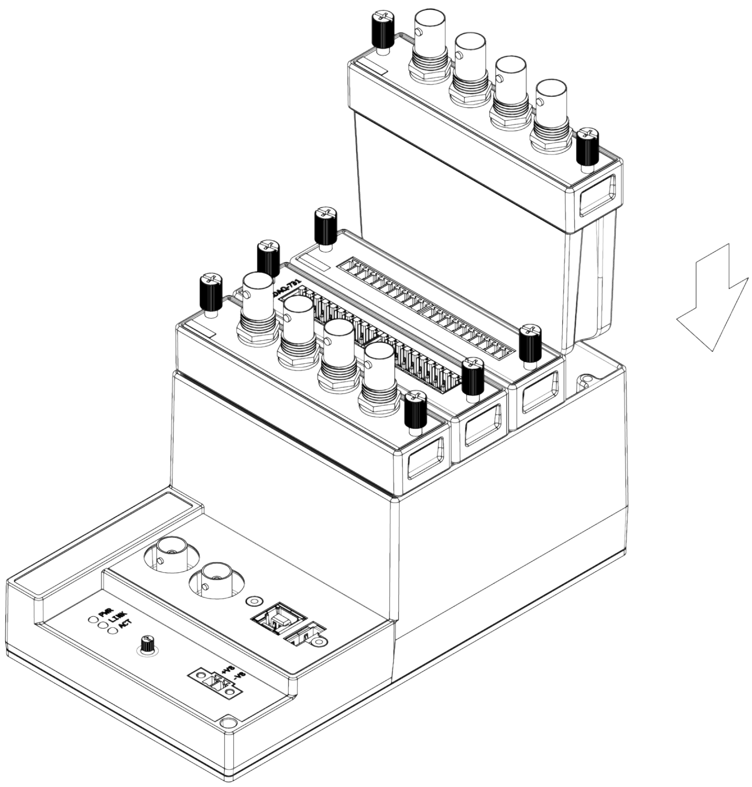


Figure 2.1 iDAQ Module Install into iDAQ Chassis

2.3 Signal Connection and Pin Assignment

The iDAQ-871 offers a choice of three bridge completion types based on the sensor connected to the module, whereas the iDAQ-873 is specifically designed for quarter-bridge applications. Details regarding field wiring connections and pin assignments for each module are provided in the following section.

2.3.1 Quarter-Bridge Input Signal Connection

For quarter-bridge input, one of the four bridge arms serves as the external sensing element, while the other three arms are completed by the device's internal resistors. This setup is known as quarter-bridge completion. Figure 2.2 and Figure 2.3 illustrate the 3-wire quarter-bridge input signal connection for iDAQ-871 and iDAQ-873, respectively. To connect the strain gauge sensor (R_{B1}), attach one end (1-wire side) to the EX+ terminal (EX for iDAQ-873) and the other end (2-wire side) to both the QTR/SC+ and AI+ terminals (QTR/SC and AI for iDAQ-873) using separate wires. Additionally, connect the SC- terminal to the EX- terminal for shunt calibration (applicable to iDAQ-871 only). Since remote sensing does not apply to quarter-bridge input configuration, simply connect the RS+ and RS- terminals to the EX+ and EX- terminals, respectively, on iDAQ-871. Note that the resistance of the quarter-bridge completion resistor RQB must match the nominal resistance of the strain gauge R_{B1}.

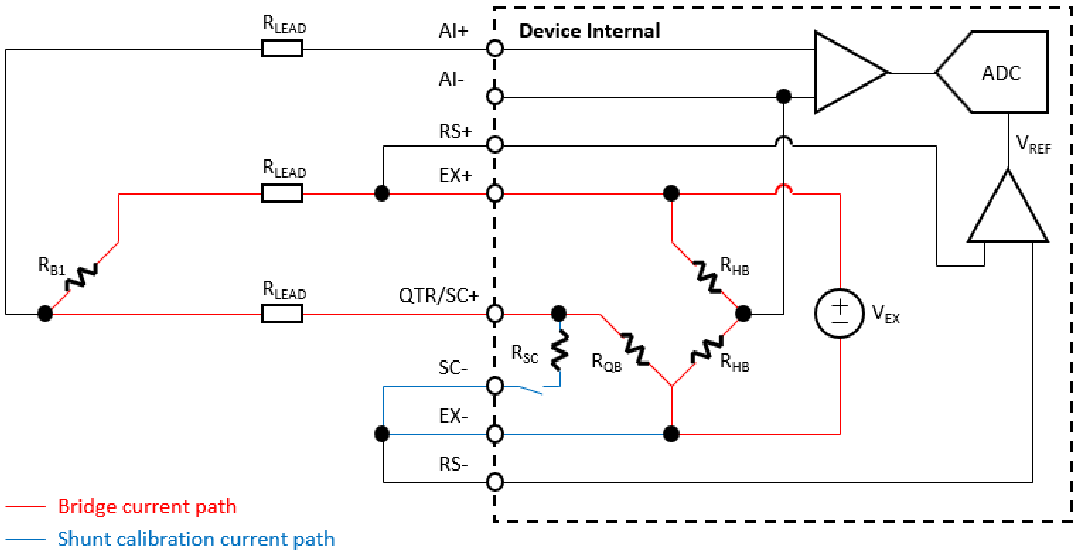


Figure 2.2 3-wire quarter-bridge input signal connection for iDAQ-871

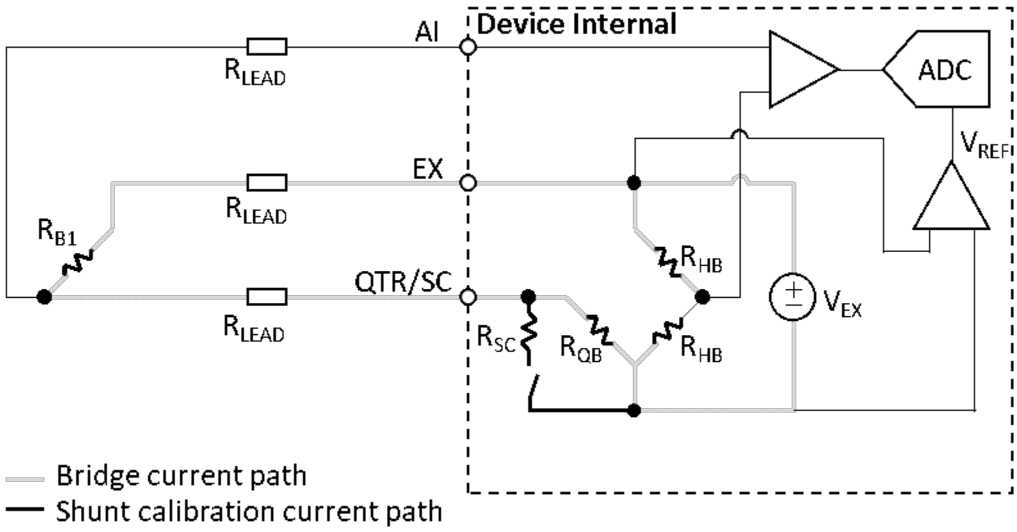


Figure 2.3 3-wire quarter-bridge input signal connection for iDAQ-873

2-wire quarter-bridge input can also be used, as shown in Figure 2.4 and Figure 2.5. One wire is used to connect both QTR/SC+ and AI+ terminals (QTR/SC and AI for iDAQ-873). However, shunt calibration in this configuration will results in more error due to imbalance of lead wire resistance (R_{LEAD}).

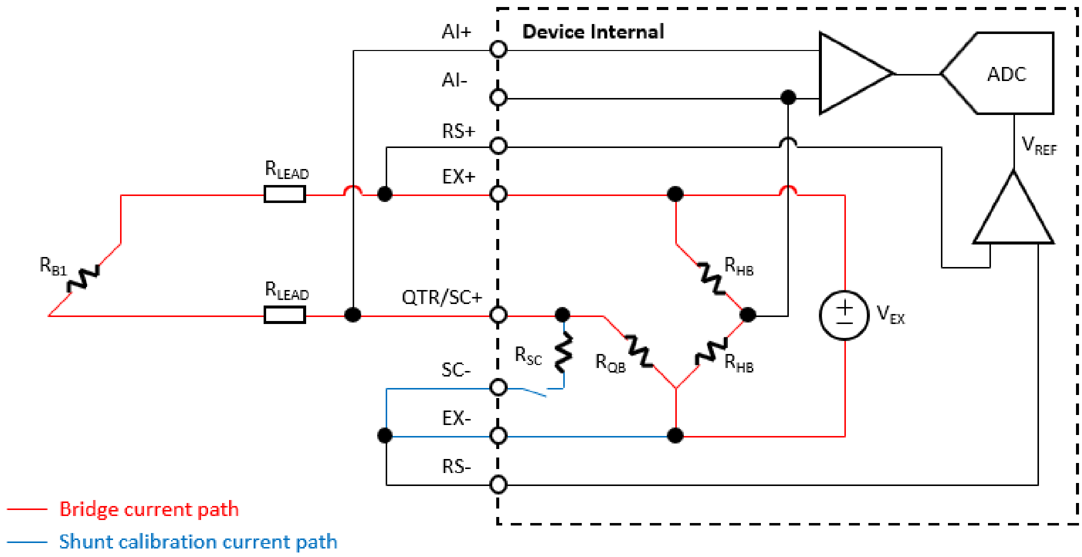


Figure 2.4 2-wire quarter-bridge input signal connection for iDAQ-871

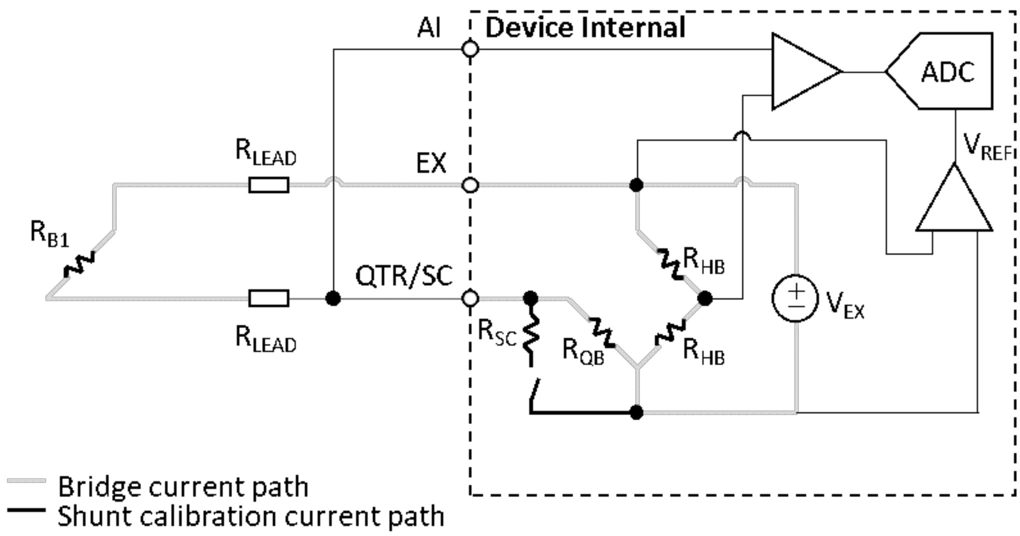


Figure 2.5 2-wire quarter-bridge input signal connection for iDAQ-873

2.3.2 Half-Bridge Input Signal Connection

For half-bridge input, two of the four bridge arms are external sensing elements, hence the name. The other two arms are provided, or completed, by device's internal resistors. This configuration is also called half-bridge completion.

Figure 2.6 shows half-bridge input without remote sensing signal connection. Connect one end of the strain gauge sensor (R_{B1}) to EX+ terminal, and the other end (R_{B2}) to both EX- and SC- terminals using different wires. In addition, connect the middle node (junction of R_{B1} and R_{B2}) of the strain gauge sensor to both AI+ and QTR/SC+ terminals using different wires. Since remote sensing is not used in this configuration, simply connect RS+ and RS- terminals to EX+ and EX- terminals, respectively.

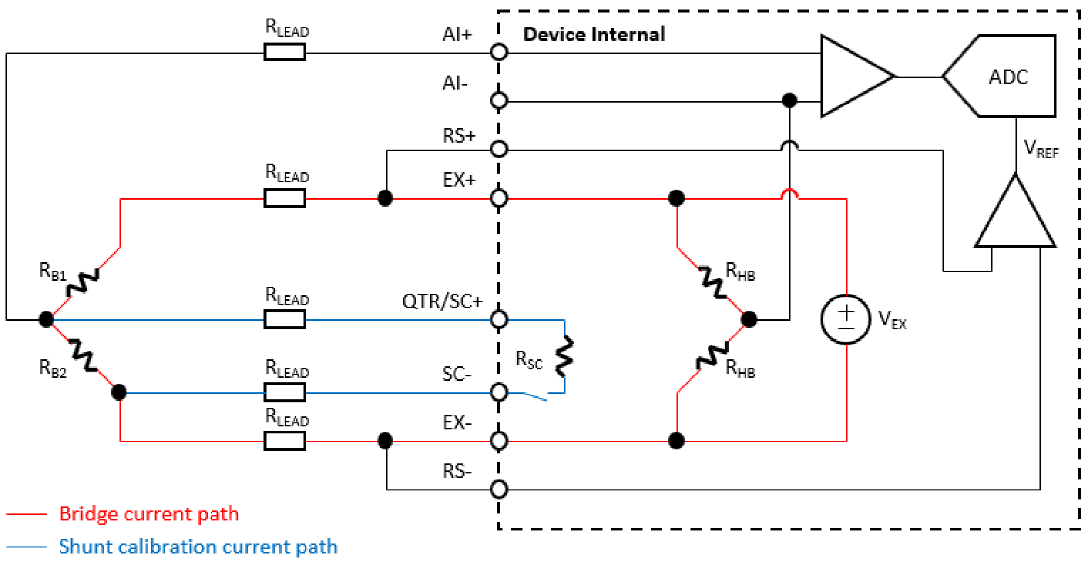


Figure 2.6 Half-bridge input without remote sensing signal connection

If remote sensing is required, connect the RS+ terminal to one end of the strain gauge (R_{B1}) by an independent wire, and connect the RS- terminal to the other end (R_{B2}) by another independent wire, as shown in Figure 2.7 Do not share the same wire for RS and EX terminals.

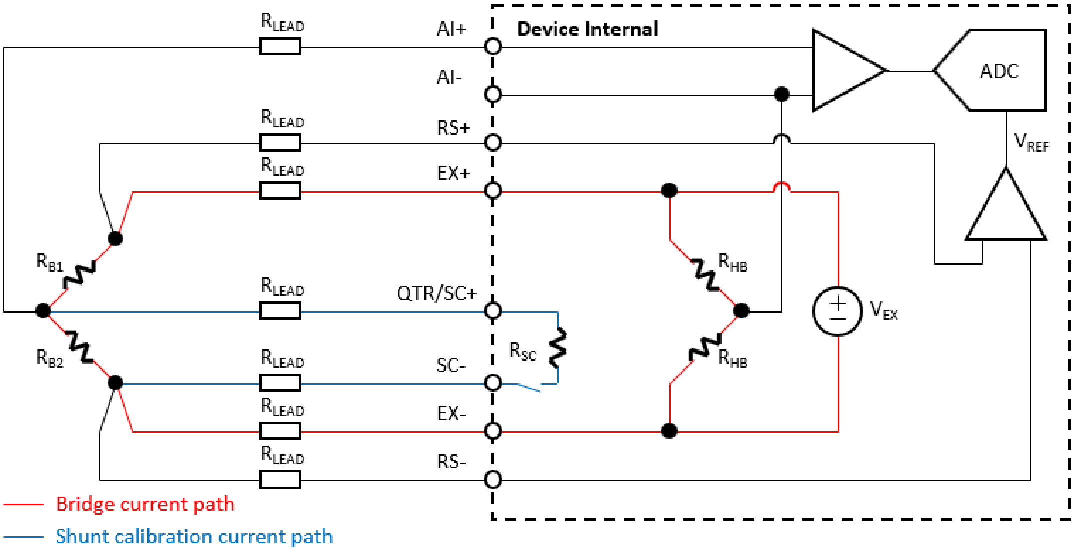


Figure 2.7 Half-bridge input with remote sensing signal connection

2.3.3 Full-Bridge Input Signal Connection

For full-bridge input, all four bridge arms are external sensing elements, hence the name. This configuration is also called full-bridge completion.

Figure 2.8 shows full-bridge input without remote sensing signal connection. Connect middle node of the two left arms (junction of R_{B1} and R_{B2}) to both AI+ and QTR/SC+ terminals using different wires, and middle node of the two right arms (junction of R_{B4} and R_{B3}) to AI- terminal. Connect the middle node of the two upper arms (junction of R_{B1} and R_{B4}) to EX+ terminal, and the middle node of the two lower arms (junction of R_{B2} and R_{B3}) to both EX- and SC- terminals using different wires. Since remote sensing is not used in this configuration, simply connect RS+ and RS- terminals to EX+ and EX- terminals, respectively.

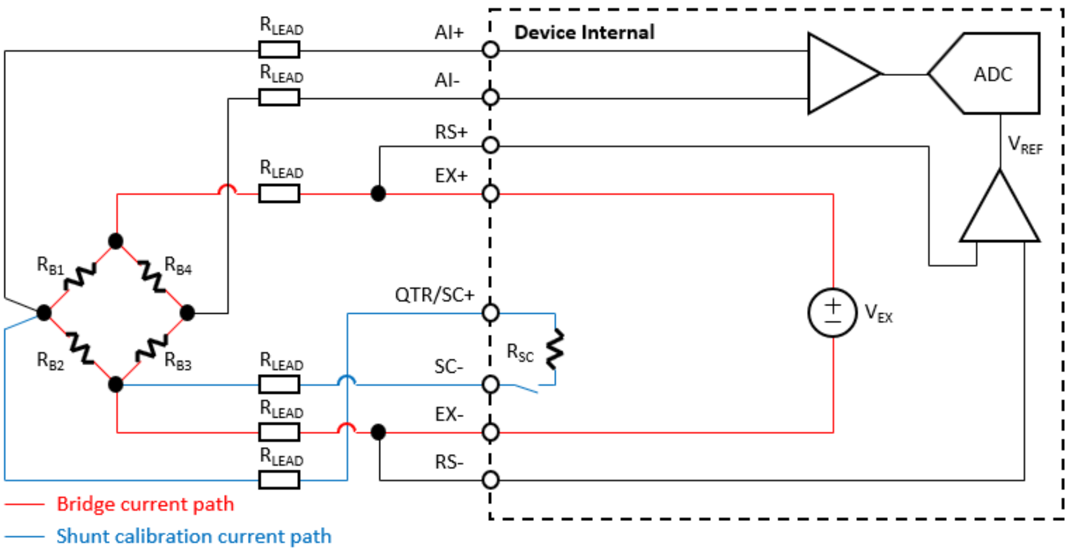


Figure 2.8 Full-bridge input without remote sensing signal connection

If remote sensing is required, connect RS+ terminal to the middle point of the two upper arms (R_{B1} and R_{B4}) by an independent wire, and connect the RS- terminal to the middle point of the two lower arms (R_{B2} and R_{B3}) by another independent wire, as shown in Figure 2.9. Do not share the same wire for RS and EX terminals.

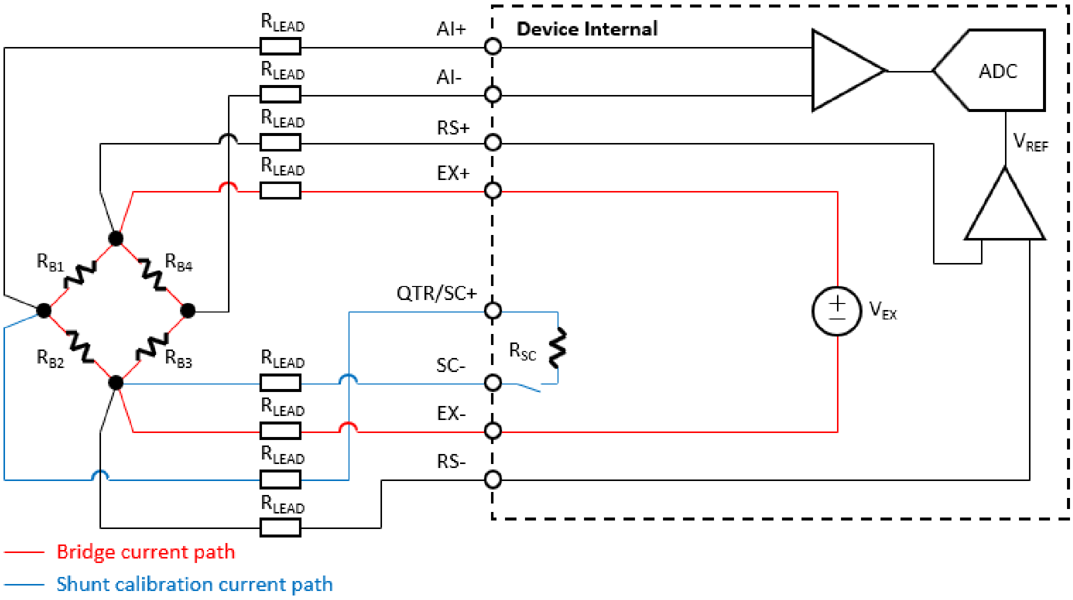


Figure 2.9 Full-bridge input with remote sensing signal connection

2.3.4 Pin Assignment

iDAQ-871

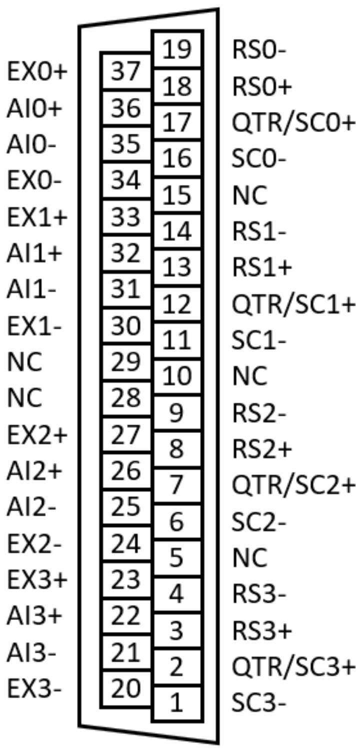


Figure 2.10 Pin Assignment Diagram of iDAQ-871

Table 2.1: Pin Assignment Diagram of iDAQ-871		
Pin Name	**Pin Number**	**Description**
RS<0..3>+	3, 8, 13, 18	Remote sensing positive terminal.
RS<0..3>-	4, 9, 14, 19	Remote sensing negative terminal.
EX<0..3>+	23, 27, 33, 37	Excitation voltage positive terminal.
EX<0..3>-	20, 24, 30, 34	Excitation voltage negative terminal.
AI<0..3>+	22, 26, 32, 36	Analog input positive terminal.
AI<0..3>-	21, 25, 31, 35	Analog input negative terminal.
QTR/SC<0..3>+	2, 7, 12, 17	Quarter bridge completion/shunt calibration positive terminal.
SC<0..3>-	1, 6, 11, 16	Shunt calibration negative terminal.
NC	5, 10, 15, 28, 29	Not connected.

iDAQ-873

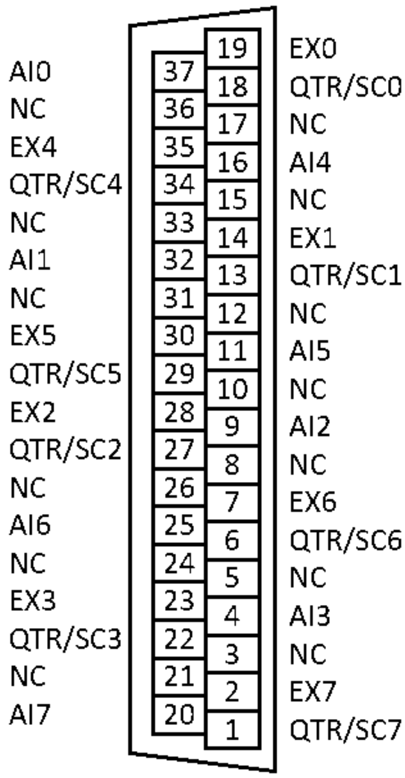


Figure 2.11 Pin Assignment Diagram of iDAQ-873

Table 2.2: Pin Assignment Diagram of iDAQ-873		
Pin Name	**Pin Number**	**Description**
QTR/ SC<0…7>	18, 13, 27, 22, 34, 29, 6, 1	Quarter bridge completion/shunt calibration terminal of AI
EXn<0…7>	19, 14, 28, 23, 35, 30, 7, 2	Excitation voltage terminal of AI
AI<0…7>	37, 32, 9, 4, 16, 11, 25, 20	Terminal of analog input channel
NC	3, 5, 8, 10, 12, 15, 17, 21, 24,26, 31, 33, 36	No Connection

Chapter 3

Function Details

3.1 Bridge Input Overview

This section gives a brief introduction to the architecture and operation of the bridge input circuit, which is also called a Wheatstone bridge. In addition, there are several methods to correct the error in bridge input measurement, including remote sensing, offset nulling, and shunt calibration, are described.

3.1.1 Wheatstone Bridge

Many sensors, including strain gauges, load cells, pressure sensors, and torque sensors are based on the concept of a Wheatstone bridge. A Wheatstone bridge contains four elements or arms. Although these elements can be resistive or reactive, they are however almost resistive for sensors previously mentioned.

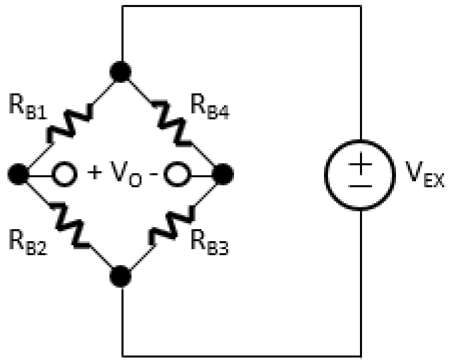


Figure 3.1 A resistive Wheatstone bridge circuit

Figure 3.1 shows a resistive Wheatstone bridge circuit. It consists of an excitation voltage source and two voltage dividers. R_{B1} and R_{B2} form one voltage divider, and R_{B4} and R_{B3} form the other voltage divider. The excitation voltage (V_{EX}) is connected to the upper node (junction of R_{B1} and R_{B4}) and the lower node (junction of R_{B2} and R_{B3}), and output voltage (V_O) is measured between the middle node of two voltage dividers. When R_{B1} = R_{B2} and R_{B3} = R_{B4}, the output voltage is 0 V.

If some of the resistors are replaced by active sensors, whose resistance change with the physical quantity, V_O will also change due to these resistance changes. By measuring the value of this voltage change, the physical quantity can be calculated.

There are three types of active sensor configuration in bridge input circuit: quarter-bridge, half-bridge, and full-bridge. Refer to Figure 3.1, for quarter-bridge, only R_{B1} is an active sensor; for half-bridge, both R_{B1} and R_{B2} are active sensors; for full-bridge, all four resistors are active sensors.

Due to the property of the voltage divider, V_O will be proportional to V_{EX}. When VEX is used as the voltage reference of an ADC, and V_O is measured by the ADC, as shown in Figure 3.2, the measurement result is an unitless ratio between V_O and V_{EX}, or V_O/V_{EX}. For specified resistances, the measurement result is independent of the variation in V_{EX}. This is called ratiometric measurement.

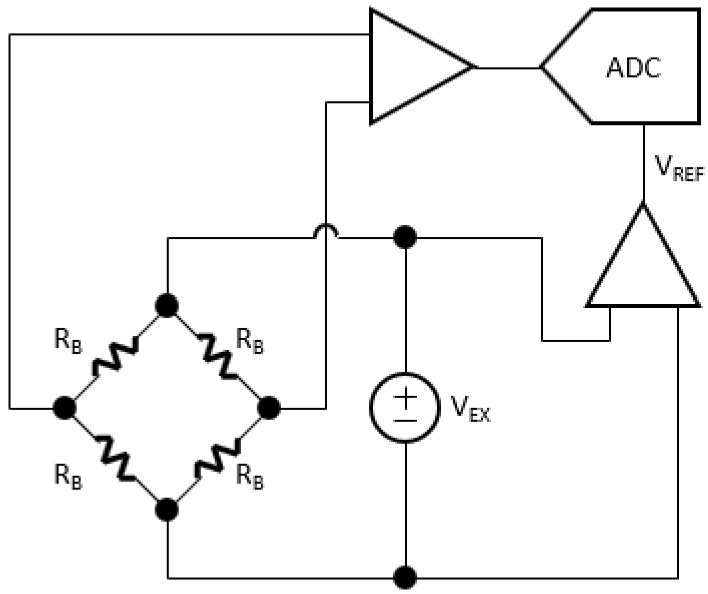


Figure 3.2 Ratiometric measurement

3.1.2 Error Correction in Bridge Input Measurement

Field wiring is used to connect sensors to measurement devices that have a non-zero resistance, and resistance of each bridge arm also has errors. These undesired factors create errors in bridge input measurement. The device provides mechanisms to correct the errors: remote sensing, offset nulling, and shunt calibration.

3.1.2.1 Remote Sensing

Remote sensing corrects for errors due to resistance of excitation voltage leads. It is useful in applications that employ long or small wires to connect the sensors to the measuring device, as the wires have high resistance.

As shown in Figure 3.3, current generated by excitation voltage source will flow through the positive terminal of the source, the bridge, to the negative terminal of the source (indicated by red lines). The wire resistance (R_{LEAD}) that connects both positive terminal and negative terminal of the source to the bridge causes voltage drops (V_{LEAD}), which results in a smaller voltage across the bridge compared to the actual excitation voltage generated by the source. This voltage difference leads to gain reduction in the measured result.

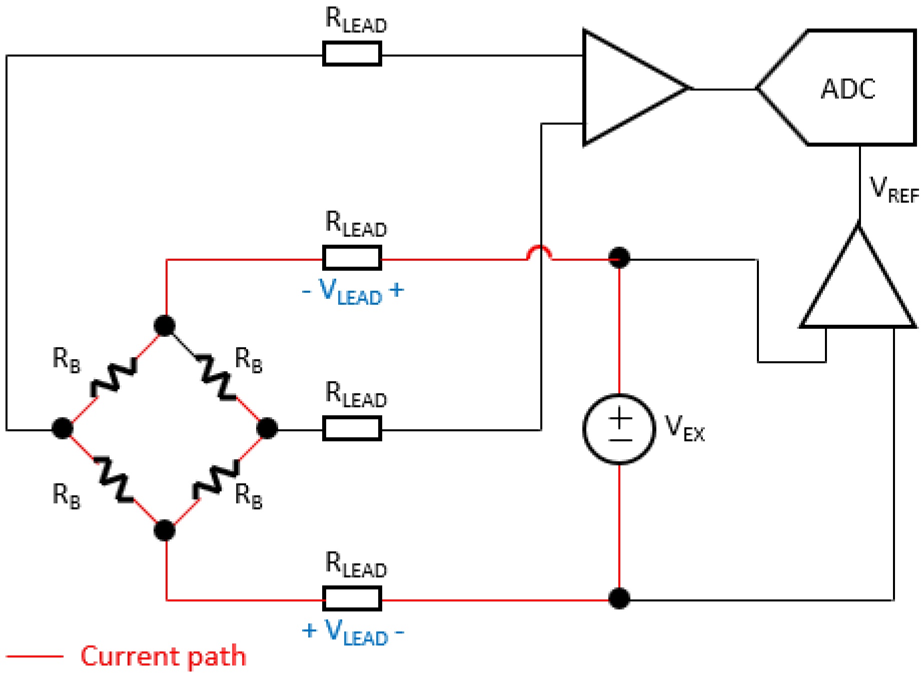


Figure 3.3 Voltage drop due to lead resistance

As shown in Figure 3.4, instead of using excitation voltage source output as the voltage reference of the ADC, in remote sensing, two additional wires (indicated by green lines) that connect to the bridge directly measure the voltage across the bridge, and use this value as the voltage reference of the ADC. Because both lines are high impedance input terminals, there is no current flowing through, and therefore no voltage drops on these wires.

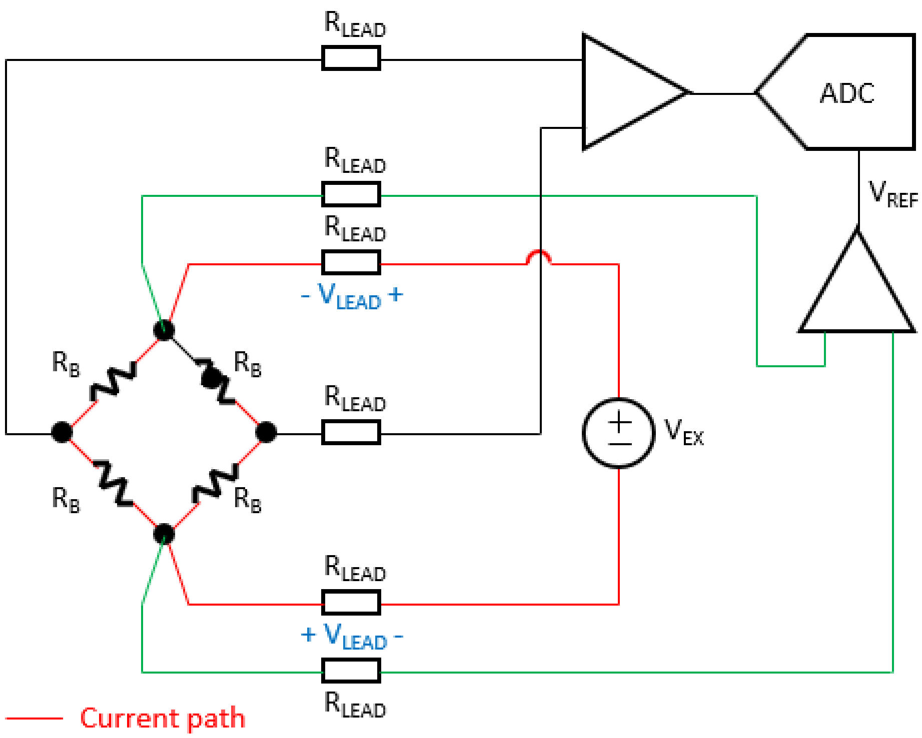


Figure 3.4 Remote sensing

Remote sensing is not applicable for quarter-bridge configuration due to the imbalance architecture (only R_{B1} has wire resistance).

3.1.2.2 Offset Nulling

In fact, output of the bridge may not be 0 V even when not loaded. This is because slight variations in resistance among the bridge arms generate nonzero offset voltage. Offset nulling performs software compensation for this offset voltage.

The software will first measure the bridge output when not loaded and stored it as an initial value. Then this initial value will be subtracted from the reading before scaling when measuring under load.

3.1.2.3 Shunt Calibration

In shunt calibration, load is simulated by shunting a shunt calibration resistor (R_{SC}) inside the device to R_{B2} of the bridge, which results in equivalent resistance change on that arm. A switch inside the device controls whether to connect R_{SC} or not. Because values of all resistors are known, and the resistance change on the shunting arm is also known, the theoretical value of this simulated load can therefore be calculated. Then the bridge output when shunting is measured, and the ratio between the theoretical value and the measured value is stored and used when scaling the reading.

3.2 Strain Gauge Sensor Configurations

This section describes the supported strain gauge sensor configurations.

3.2.1 Quarter-Bridge Configuration

This section provides information for the quarter-bridge strain gauge sensor configuration. This configuration measures either axial or bending strain. Figure 3.5 shows how to position the strain gauge sensor in both axial and bending configurations. Refer to 2.3.1 Quarter-Bridge Input Signal Connection for detailed signal wiring of this configuration.

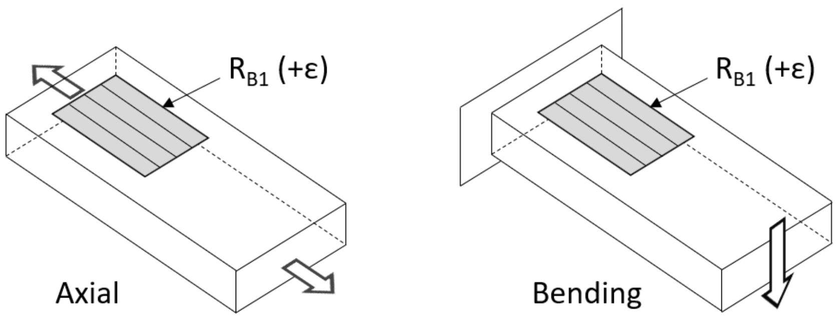


Figure 3.5 Quarter-bridge configuration measuring axial and bending strain

- The quarter-bridge configuration has the following characteristics:
- A single active strain gauge sensor R_{B1} is mounted in the principal direction of axial or bending strain.
- Sensitive to both axial and bending strain.
- A quarter-bridge completion resistor R_{QB} and two half-bridge completion resistors R_{HB} are required. They are provided by the device.
- Both a shunt calibration resistor R_{SC} and a switch are provided by the device.
- Sensitivity ≈ 0.5 μV/V per με, for GF = 2.0.

- Strain value can be calculated by the following equation:

$$strain(\varepsilon) = \frac{-4\,V_r}{GF(1 + 2\,V_r)}$$

where GF is the gauge factor of the strain gauge sensor provided by the sensor manufacturer, Vr is the ratiometric bridge output value measured by the ADC

$$V_r = \frac{V_{AI}(strained) - V_{AI}(unstrained)}{V_{EX}}$$

- Shunt calibration can be used to compensate for errors due to lead resistance.

3.2.2 Half Bridge Type I Configuration

This section provides information for the half-bridge type I strain gauge sensor configuration. This configuration measures either axial or bending strain. Figure 3.6 shows how to position the strain gauge sensors in both axial and bending configurations. Refer to 2.3.2 Half-Bridge Input Signal Connection for detailed signal wiring of this configuration.

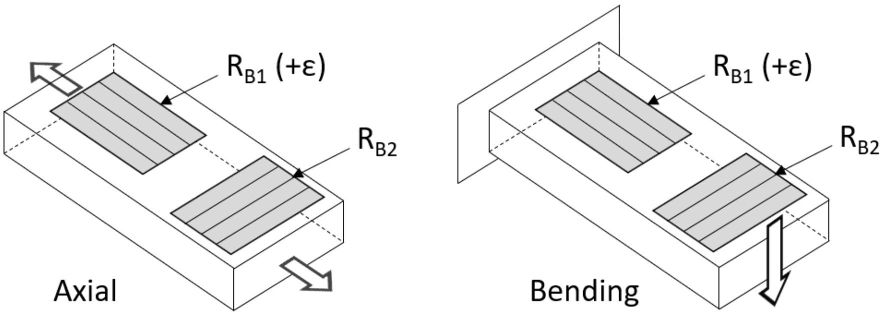


Figure 3.6 Half-bridge type I configuration measuring axial and bending strain

The half-bridge type I configuration has the following characteristics:

- One active strain gauge sensor R_{B1} measuring the strain and one dummy strain gauge sensor R_{B2} for temperature compensation. R_{B1} is mounted in the principal direction of axial or bending strain. R_{B2} is mounted in close thermal contact with the strain specimen but bonded to the specimen, and is usually mounted perpendicular to the principal axis of strain.
- Sensitive to both axial and bending strain.
- Two half-bridge completion resistor R_{HB} are required. They are provided by the device.
- Both a shunt calibration resistor R_{SC} and a switch are provided by the device.
- Sensitivity ≈ 0.5 μV/V per με, for GF = 2.0.
- Strain value can be calculated by the following equation:

$$strain(\varepsilon) = \frac{-4\,V_r}{GF(1 + 2\,V_r)}$$

where GF is the gauge factor of the strain gauge sensor provided by the sensor manufacturer, Vr is the ratiometric bridge output value measured by the ADC

$$V_r = \frac{V_{AI}(strained) - V_{AI}(unstrained)}{V_{EX}}$$

- Shunt calibration can be used to compensate for errors due to lead resistance.

3.2.3 Half Bridge Type II Configuration

This section provides information for the half-bridge type II strain gauge sensor configuration. This configuration measures either axial or bending strain. Figure 3.7 shows how to position the strain gauge sensors in both axial and bending configurations. Refer to 2.3.2 Half-Bridge Input Signal Connection for detailed signal wiring of this configuration.

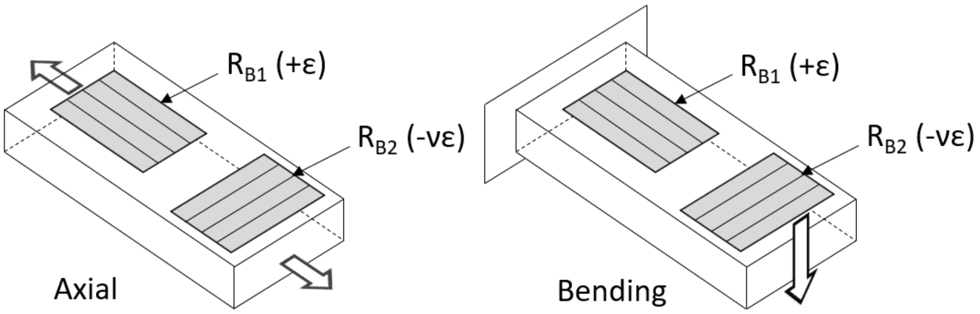


Figure 3.7 Half-bridge type II configuration measuring axial and bending strain

The half-bridge type II configuration has the following characteristics:

- There are two active strain gauge sensors R_{B1} and R_{B2}. R_{B1} measures the strain and is mounted in the principal direction of axial or bending strain. R_{B2} acts as a Poisson gauge and is perpendicular to the principal axis of strain.
- Sensitive to both axial and bending strain.
- Two half-bridge completion resistor R_{HB} are required. They are provided by the device.
- Both a shunt calibration resistor R_{SC} and a switch are provided by the device.
- Sensitivity ≈ 0.65 μV/V per με, for GF = 2.0.
- Strain value can be calculated by the following equation:

$$strain(\varepsilon) = \frac{-4V_r}{GF[(1+\nu)-2V_r(\nu-1)]}$$

where GF is the gauge factor of the strain gauge sensor provided by the sensor manufacturer, v is the Poisson’s ratio, defined as the negative ratio of transverse strain to axial (longitudinal) strain. Poisson’s ratio is a material property of the specimen being measured, and Vr is the ratiometric bridge output value measured by the ADC

$$V_r = \frac{V_{AI}(strained) - V_{AI}(unstrained)}{V_{EX}}$$

- Shunt calibration can be used to compensate for errors due to lead resistance.

3.2.4 Half Bridge Type III Configuration

This section provides information for the half-bridge type III strain gauge sensor configuration. This configuration only measures bending strain. Figure 3.8 shows how to position the strain gauge sensors in bending configuration. Refer to 2.3.2 Half-Bridge Input Signal Connection for detailed signal wiring of this configuration.

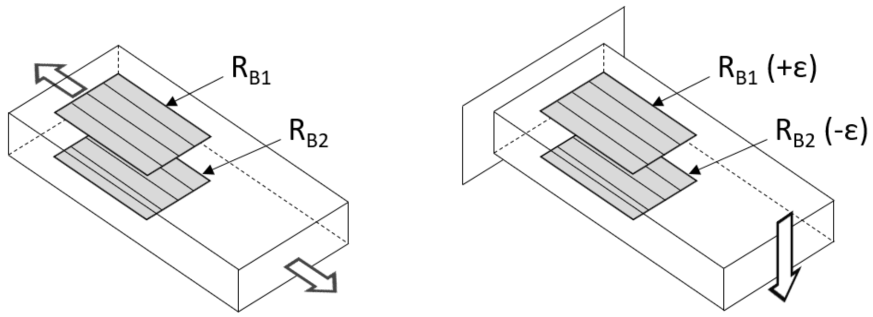


Figure 3.8 Half-bridge type III configuration rejecting axial and measuring bending strain

The half-bridge type III configuration has the following characteristics:

- There are two active strain gauge sensors R_{B1} and R_{B2}. RB1 is mounted in the principal direction of bending strain on one side of the strain specimen (top) while R_{B2} is mounted in the principal direction of bending strain on the opposite side (bottom).
- Sensitive to bending strain and rejects axial strain.
- Two half-bridge completion resistor R_{HB} are required. They are provided by the device.
- Both a shunt calibration resistor R_{SC} and a switch are provided by the device.
- Sensitivity ≈ 1 μV/V per με, for GF = 2.0.
- Strain value can be calculated by the following equation:

$$strain(\varepsilon) = \frac{-2V_r}{GF}$$

where GF is the gauge factor of the strain gauge sensor provided by the sensor manufacturer, and Vr is the ratiometric bridge output value measured by the ADC

$$V_r = \frac{V_{AI}(strained) - V_{AI}(unstrained)}{V_{EX}}$$

- Shunt calibration can be used to compensate for errors due to lead resistance.

3.2.5 Full Bridge Type I Configuration

This section provides information for the full-bridge type I strain gauge sensor configuration. This configuration only measures bending strain. Figure 3.9 shows how to position the strain gauge sensors in bending configuration. Refer to 2.3.3 Full-Bridge Input Signal Connection for detailed signal wiring of this configuration.

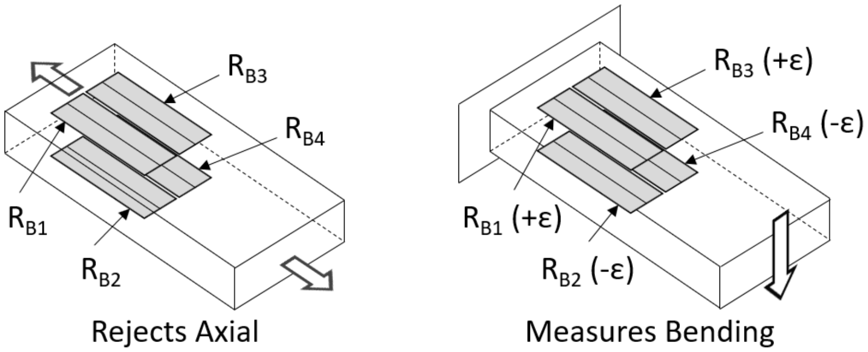


Figure 3.9 Full-bridge type I configuration rejecting axial and measuring bending strain

The full-bridge type I configuration has the following characteristics:

- There are four active strain gauge sensors R_{B1}, R_{B2}, R_{B3}, and R_{B4}. R_{B1} and R_{B3} are mounted in the principal direction of bending strain on one side of the strain specimen (top) while R_{B2} and R_{B4} are mounted in the principal direction of bending strain on the opposite side (bottom).
- Highly sensitive to bending strain and rejects axial strain.
- Both a shunt calibration resistor R_{SC} and a switch are provided by the device.
- Sensitivity ≈ 2 μV/V per με, for GF = 2.0.
- Strain value can be calculated by the following equation:

$$strain(\varepsilon) = \frac{-V_r}{GF}$$

where GF is the gauge factor of the strain gauge sensor provided by the sensor manufacturer, and Vr is the ratiometric bridge output value measured by the ADC

$$V_r = \frac{V_{AI}(strained) - V_{AI}(unstrained)}{V_{EX}}$$

- Shunt calibration can be used to compensate for errors due to lead resistance.

3.2.6 Full-Bridge Type II Configuration

This section provides information for the full-bridge type II strain gauge sensor configuration. This configuration only measures bending strain. Figure 3.10 shows how to position the strain gauge sensors in bending configuration. Refer to 2.3.3 Full-Bridge Input Signal Connection for detailed signal wiring of this configuration.

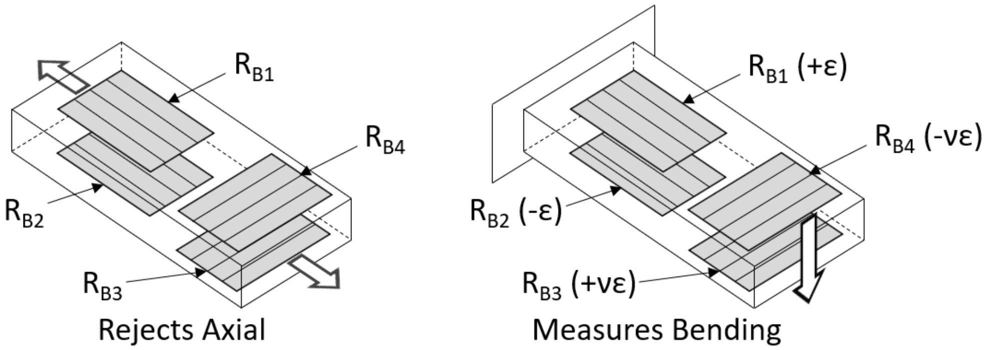


Figure 3.10 Full-bridge type II configuration rejecting axial and measuring bending strain

The full-bridge type II configuration has the following characteristics:

- There are four active strain gauge sensors R_{B1}, R_{B2}, R_{B3}, and R_{B4}. R_{B1} and R_{B2} are mounted in the principal direction of bending strain with R_{B1} on one side of the strain specimen (top) while R_{B2} on the opposite side (bottom). R_{B3} and R_{B4} act together as Poisson gauge and are mounted transverse (perpendicular) to the principal direction of bending strain with R_{B4} on one side of the strain specimen (top) and R_{B3} on the opposite side (bottom).
- Sensitive to bending strain and rejects axial strain.
- Both a shunt calibration resistor R_{SC} and a switch are provided by the device.
- Sensitivity ≈ 1.3 μV/V per με, for GF = 2.0.
- Strain value can be calculated by the following equation:

$$strain(\varepsilon) = \frac{-2V_r}{GF(1+v)}$$

where GF is the gauge factor of the strain gauge sensor provided by the sensor manufacturer, v is the Poisson's ratio, defined as the negative ratio of transverse strain to axial (longitudinal) strain. Poisson's ratio is a material property of the specimen being measured, and Vr is the ratiometric bridge output value measured by the ADC

$$V_r = \frac{V_{AI}(strained) - V_{AI}(unstrained)}{V_{EX}}$$

- Shunt calibration can be used to compensate for errors due to lead resistance.

3.2.7 Full-Bridge Type III Configuration

This section provides information for the full-bridge type III strain gauge sensor configuration. This configuration only measures axial strain. Figure 3.11 shows how to position the strain gauge sensors in axial configuration. Refer to 2.3.3 Full-Bridge Input Signal Connection for detailed signal wiring of this configuration.

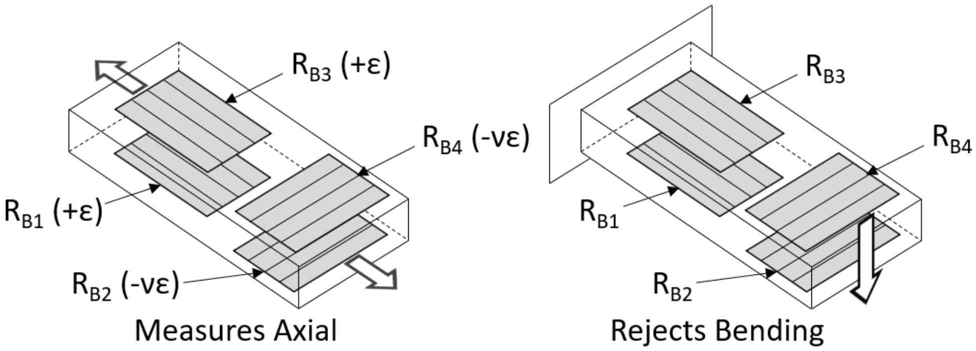


Figure 3.11 Full-bridge type III configuration rejecting bending and measuring axial strain

The full-bridge type III configuration has the following characteristics:

- There are four active strain gauge sensors R_{B1}, R_{B2}, R_{B3}, and R_{B4}. R_{B1} and R_{B3} are mounted in the principal direction of bending strain with R_{B3} on one side of the strain specimen (top) while R_{B1} on the opposite side (bottom). R_{B2} and R_{B4} act together as Poisson gauge and are mounted transverse (perpendicular) to the principal direction of bending strain with R_{B4} on one side of the strain specimen (top) and R_{B2} on the opposite side (bottom).
- Sensitive to axial strain and rejects bending strain.
- Both a shunt calibration resistor R_{SC} and a switch are provided by the device.
- Sensitivity ≈ 1.3 μV/V per με, for GF = 2.0.
- Strain value can be calculated by the following equation:

$$strain(\varepsilon) = \frac{-2V_r}{GF[(v+1)-V_r(v-1)]}$$

where GF is the gauge factor of the strain gauge sensor provided by the sensor manufacturer, v is the Poisson's ratio, defined as the negative ratio of transverse strain to axial (longitudinal) strain. Poisson's ratio is a material property of the specimen being measured, and Vr is the ratiometric bridge output value measured by the ADC

$$V_r = \frac{V_{AI}(strained) - V_{AI}(unstrained)}{V_{EX}}$$

- Shunt calibration can be used to compensate for errors due to lead resistance.

3.3 Force, Pressure, and Torque Sensor Configuration

The device can be used with force sensors (such as load cells), pressure sensors, or torque sensor that have the following characteristics:

- Wheatstone bridge based.
- Unamplified mV/V or V/V output.

These sensors typically use a full-bridge configuration with a 350Ω nominal bridge resistance, but other configurations and nominal bridge resistances also can be used. Refer to 2.3.3 Full-Bridge Input Signal Connection for detailed signal wiring of this configuration.

In Advantech DAQNavi, linear scaling for bridge-based force, pressure, and torque sensors is based on two points which are specified as pairs of corresponding physical and electrical values: “EV_1, PV_1”, and “EV_2, PV_2”. These should be based on the calibration certificate of the sensor, if one is available; otherwise, they can be based on the specifications or datasheet of the sensor. Any two points can be used assuming that they are far enough apart to accurately determine the slop of the linear scaling equation. For example:

- PV_1: The zero point of the sensor. Zero force, zero pressure, or zero torque.
- EV_1: The electrical output (ratiometric bridge output) corresponding to the zero point of the sensor, in mV/V or V/V.
- PV_2: The maximum physical reading of the sensor, or capacity. Maximum load, maximum pressure, or maximum torque.
- EV_2: The electrical output (ratiometric bridge output) corresponding to the maximum physical reading of the sensor, in mV/V or V/V.

Note! *Some sensor calibration certificates specify the electrical output in mV or V, not mV/V or V/V. If this is the case, divide the specified electrical output by the excitation voltage at which the calibration was performed.*

The two-point linear conversion uses the following equations:

$$m = \frac{PV_1 - PV_2}{EV_1 - EV_2}$$

$$b = PV_1 - m \times EV_1$$

$$Physical\ reading = m \times V_r + b$$

where Vr is the ratiometric bridge output value measured by the ADC.

3.4 Analog Input Methods

3.4.1 Instant Analog Input Acquisition

With instant analog input acquisition, the software controls the sample timing. The analog-to-digital converter (ADC) is continuously converting analog input signals by 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 3.12.

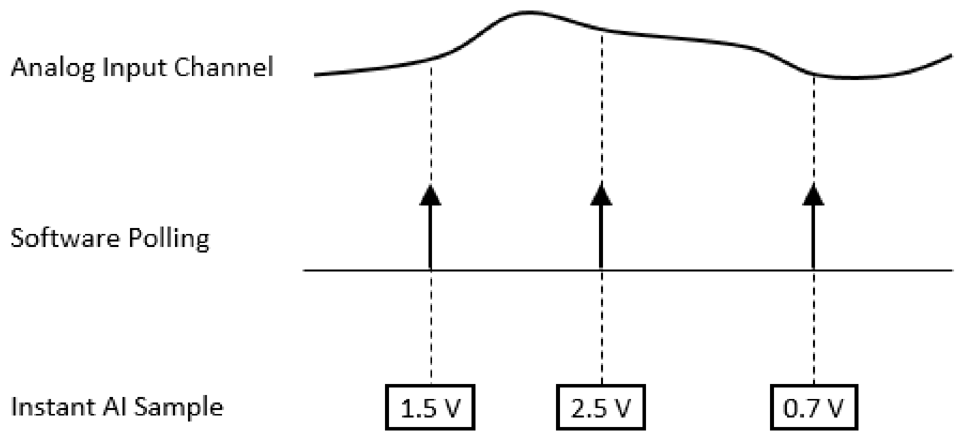


Figure 3.12 Instant analog input acquisition

The advantage of instant acquisition is low latency. It is typically used for reading a single sample of analog input.

3.4.2 Buffered Analog Input Acquisition

With buffered analog input acquisition, the ADC conversion rate and the duration of the acquisition is controlled by hardware timing signals. All conversion results are sampled and stored in the buffer memory before sending back to the host computer as shown in Figure 3.13.

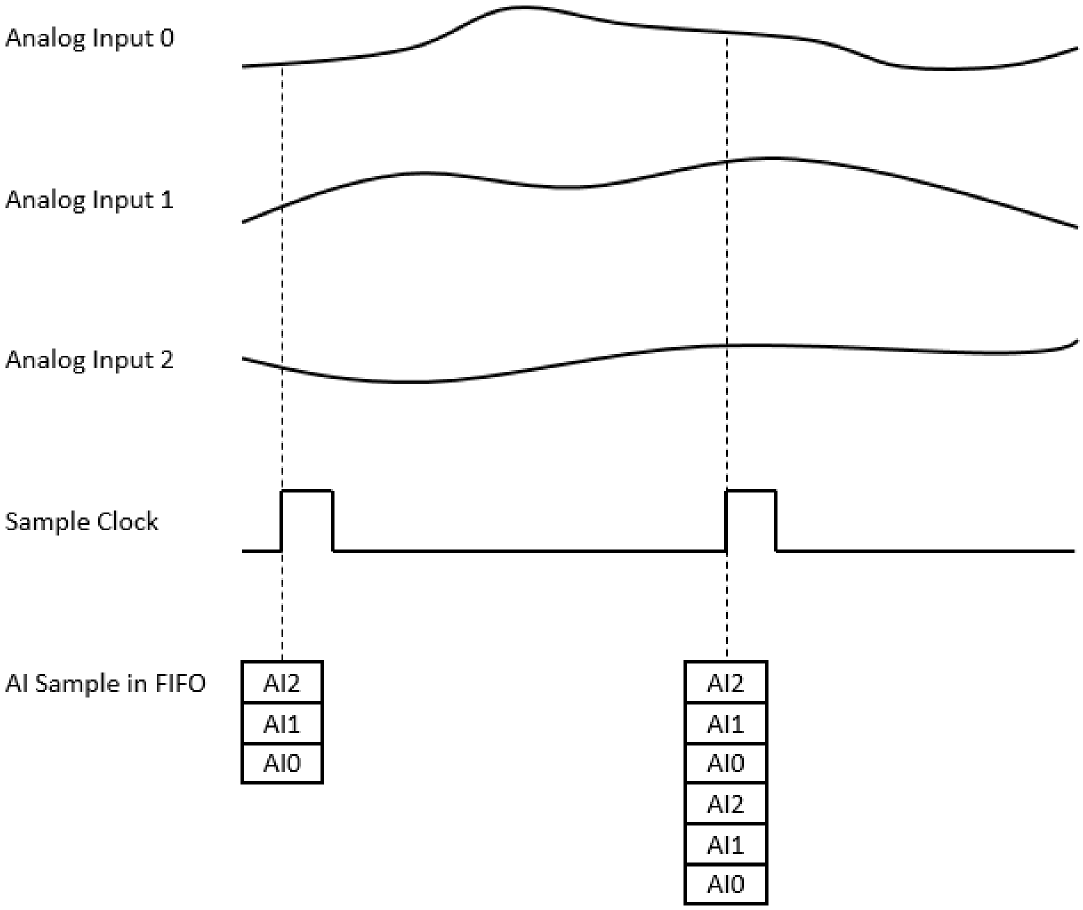


Figure 3.13 Buffered analog input acquisition

The start and stop of the acquisition are controlled by the start trigger and stop trigger, respectively. When configuration is completed, the acquisition engine of the iDAQ chassis is at standby state. After receiving a start trigger, acquisition becomes active and each rising edge of the sample clock acquires one analog input sample. The acquisition active period lasts until a stop trigger is received, which ends the acquisition. This is shown in Figure 3.14.

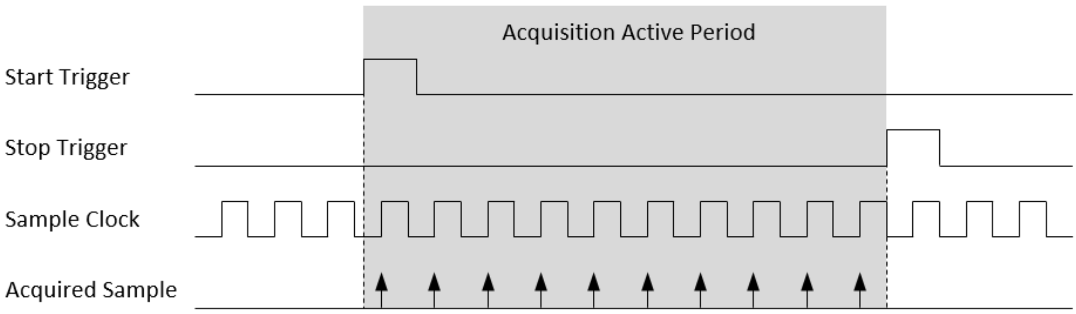


Figure 3.14 Start and stop of the analog input acquisition

The start and stop of acquisition can also be delayed in number of samples after receiving the corresponding trigger signal. As shown in Figure 3.15, the start of acquisition is delayed by 3 samples after receiving a start trigger, and the stop of acquisition is delayed by 2 samples after receiving a stop trigger.

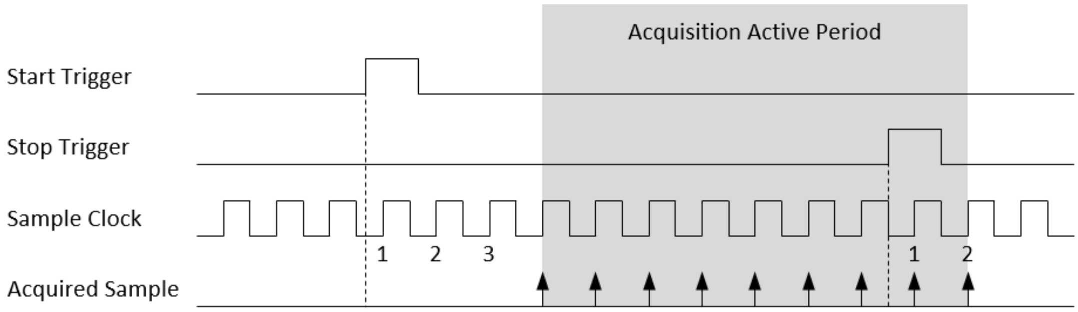


Figure 3.15 Start and stop of the analog input acquisition with delay

Buffered analog input acquisition has several advantages over instant analog input acquisition:

- The start and stop time of acquisition (or duration of the acquisition) can be precisely controlled by hardware trigger signals.
- ADC conversion rate is configurable, and sample rate can be much higher by using hardware sample clock signal.
- Time between samples is deterministic.

3.5 Buffered Analog Input Configuration

3.5.1 One-buffered Acquisition

For one-buffered acquisition, only a specified number of samples is acquired. The start or stop 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 3.16.

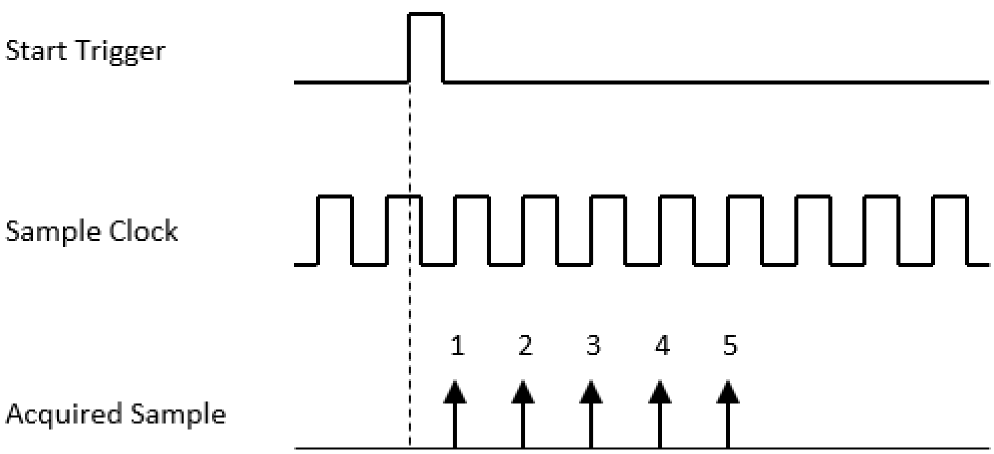


Figure 3.16 Post-trigger acquisition

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 3.17 shows an example of a 2-sample delay post-trigger acquisition. Refer to the device specifications for possible signal sources.

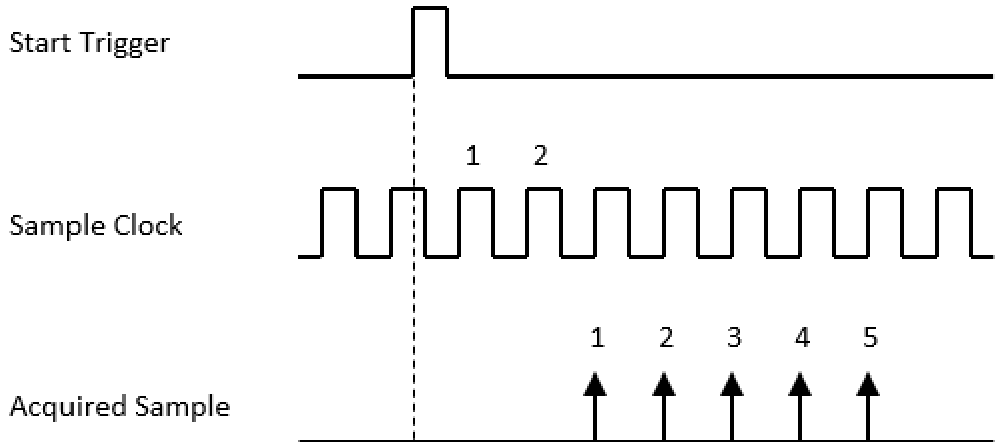


Figure 3.17 Post-trigger acquisition with delay

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 stopped when a hardware stop trigger is received. Figure 3.18 shows an example of a 5-sample pre-trigger acquisition. Only the samples in the shaded area are returned.

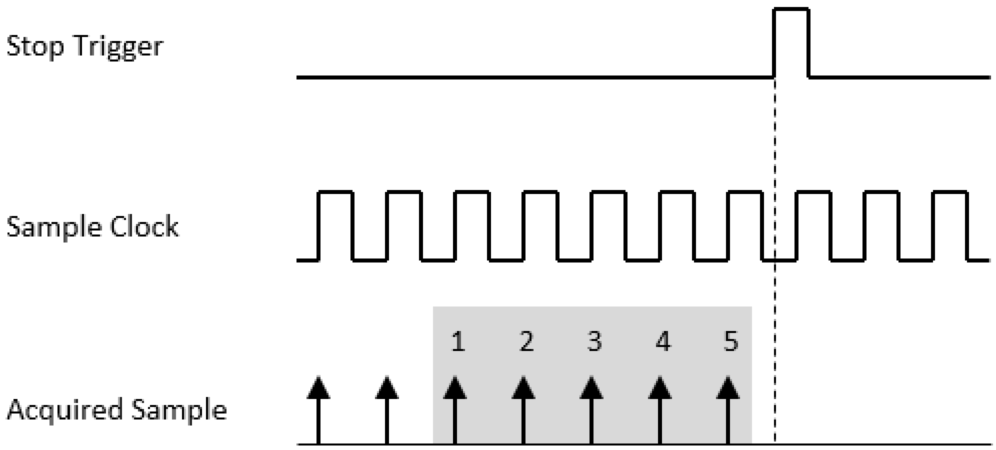


Figure 3.18 Pre-trigger acquisition

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 3.19 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.

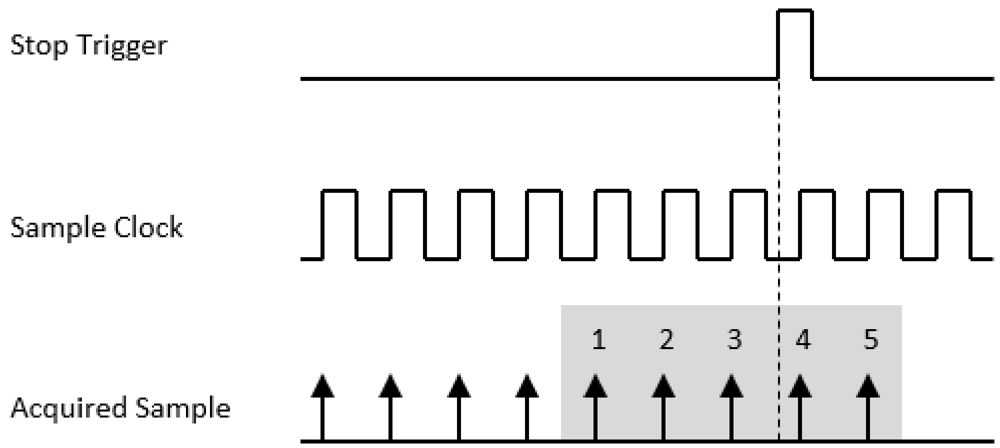


Figure 3.19 About-trigger acquisition

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 3.20.

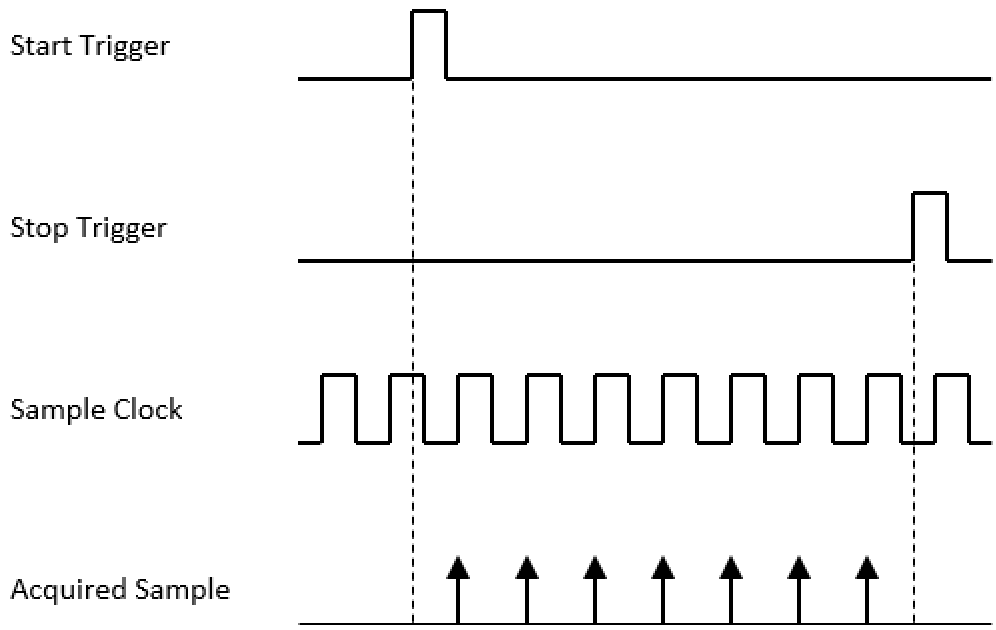


Figure 3.20 Streaming acquisition

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 Retriggerable 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 3.21 to 3.24 show examples of retrigger 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.

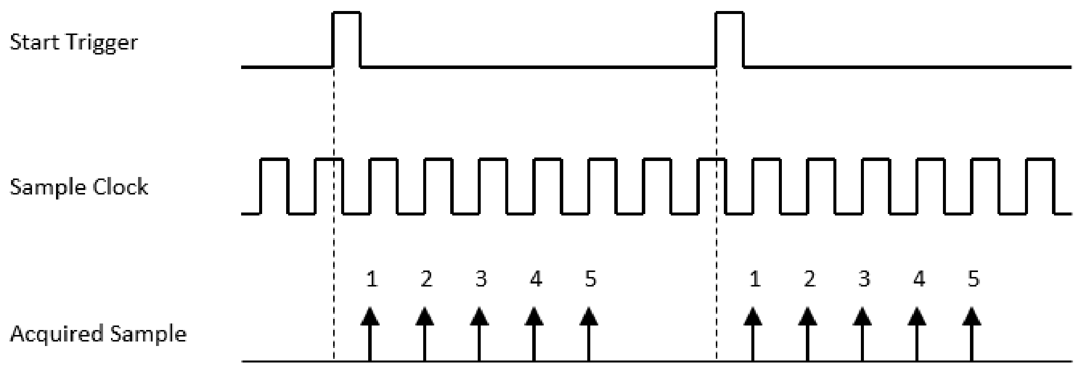


Figure 3.21 Post-trigger acquisition with retrigger

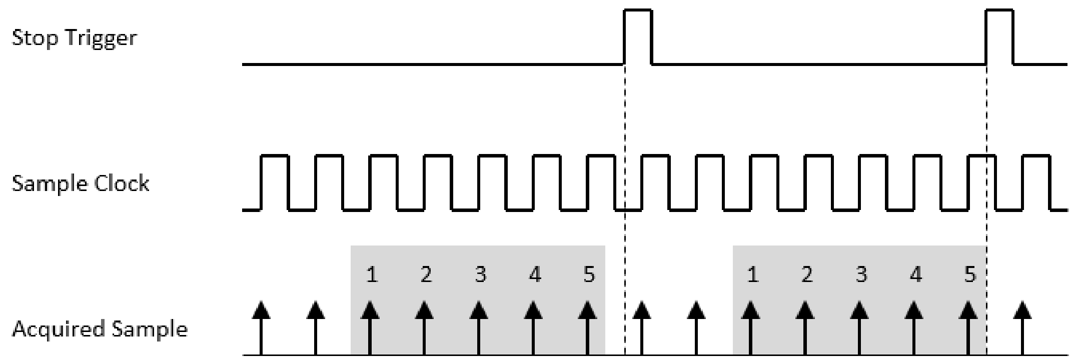


Figure 3.22 Pre-trigger acquisition with retrigger

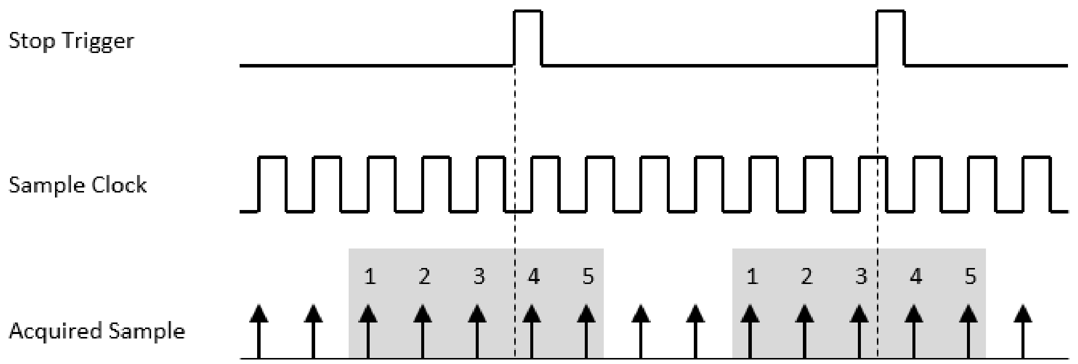


Figure 3.23 About-trigger acquisition with retrigger

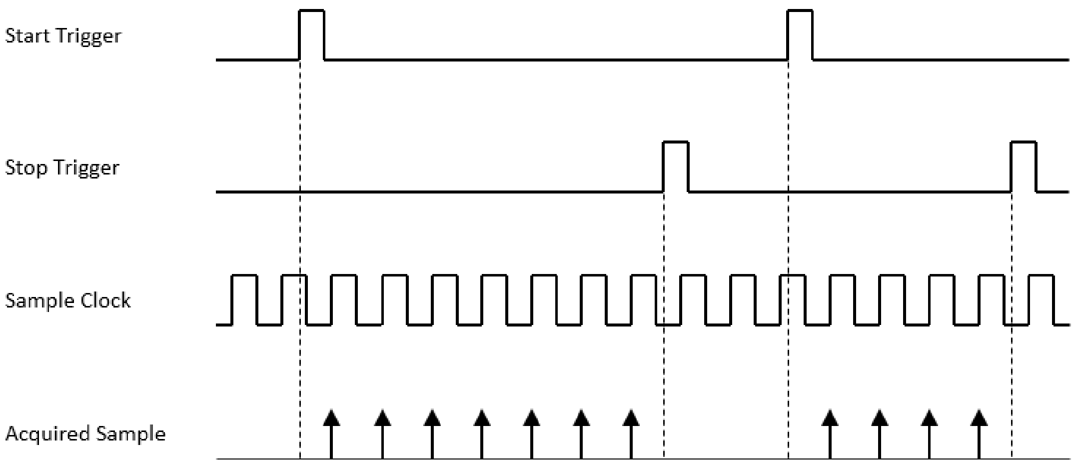


Figure 3.24 Streaming acquisition with retrigger

3.6 Device Description and Configuration

The Device Description is used to differentiate the modules in the iDAQ system. It's given following a naming rule of combining chassis ID, model name and slot number. You can change the description in Navigator, or just leave it as default. The description is used in your own program, in order to get control or device handler from the device.

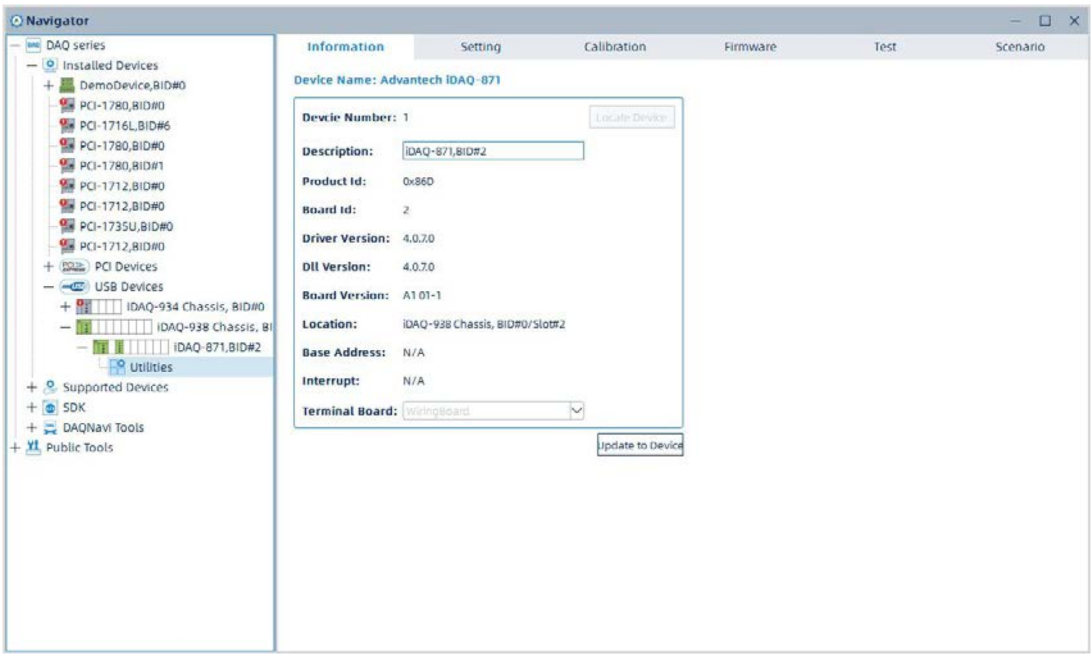


Figure 3.25 Device Information of iDAQ-871

Appendix A

Specifications

A.1 Bridge Input

Table A.1: Bridge Input specification of iDAQ-871 and iDAQ-873		
Item	**iDAQ-871**	**iDAQ-873**
ADC Resolution	24-bit	
Channels	4	8
Input Range	±1 V/V, ±500 mV/V, ±250 mV/V, ±125 mV/V, ±62.5 mV/V, ±31.25 mV/V, ±15.63 mV/V, or ±7.81 mV/V Auto configured by software according to physical input range settings	
Bridge Mode	Full, half, quarter	Quarter
Bridge Resistance	120 Ω, 350 Ω, 1 kΩ	120 Ω
Shunt Calibration	100 kΩ	100 kΩ
Excitation Voltage	2.5V, 5V	2V

- **Digital low-pass filter**
  – Filter type: FIR or SINC1, selected by sampling rate. Refer to Table A2 for detailed information

Table A.2: Filter type in different sampling rate setting		
Sampling Rate (SPS)	**-3-dB Bandwidth (Hz)**	**Filter Type**
2.5	1.2	FIR
5	2.4	FIR
10	4.7	FIR
16.6	7.38	SINC1
20	13	FIR
50	22.1	SINC1
60	26.6	SINC1
100	44.3	SINC1
400	177	SINC1
1200	525	SINC1
2400	1015	SINC1
4800	1798	SINC1
7200	2310	SINC1
14400	2940	SINC5
19200	3920	SINC5
25600	5227	SINC5

- **-3 dB bandwidth:** Configured along with sampling rate. Refer to Figure A1~A4 for detailed frequency response for each filters under different sampling rate settings.

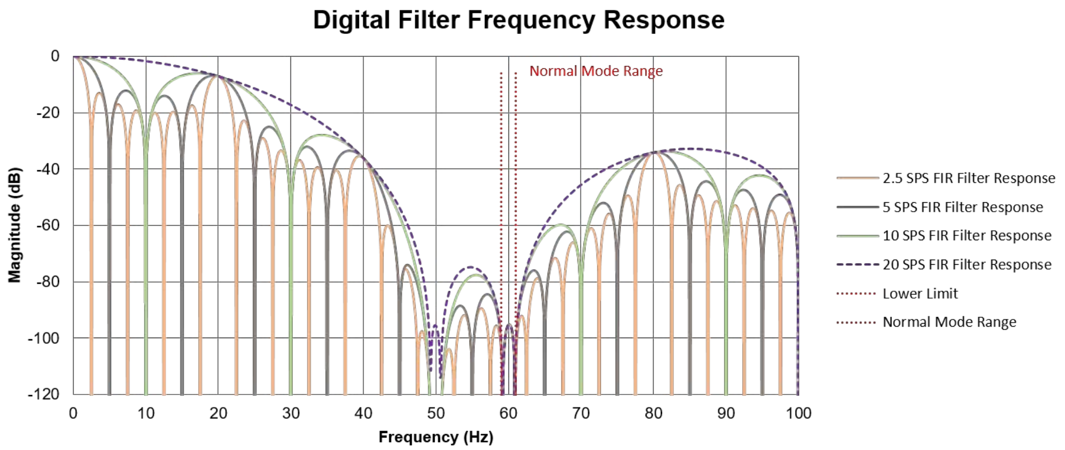


Figure A.1 Frequency response of FIR filter under different sampling rates

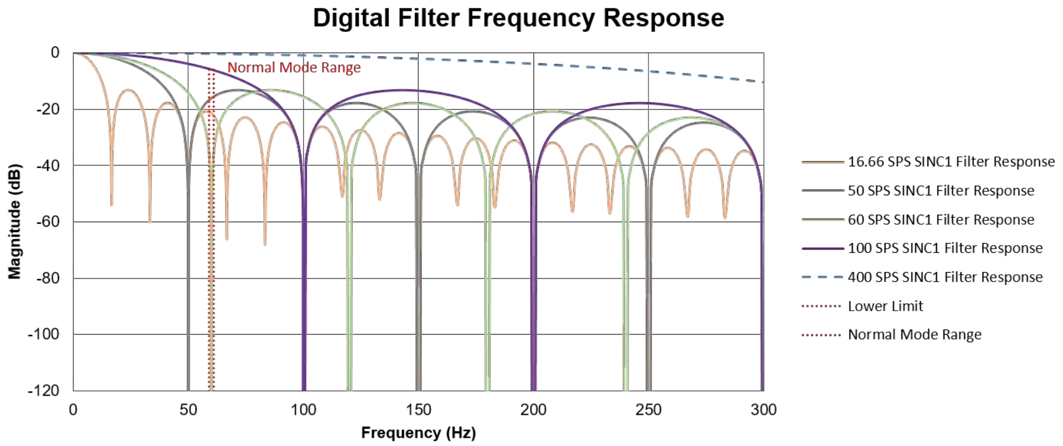


Figure A.2 Frequency response of SINC1 filter under different sampling rates (16.66 SPS to 400 SPS)

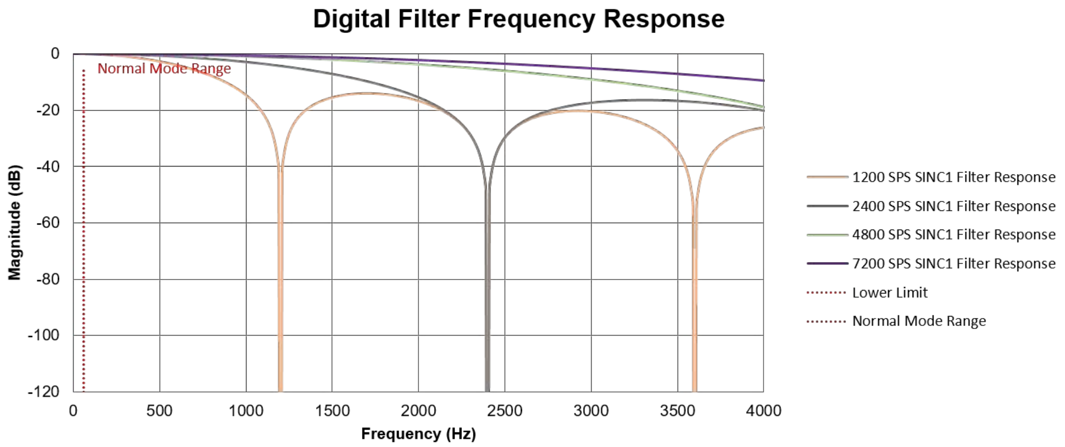


Figure A.3 Frequency response of SINC1 filter under different sampling rates (1.2 kSPS to 7.2 kSPS)

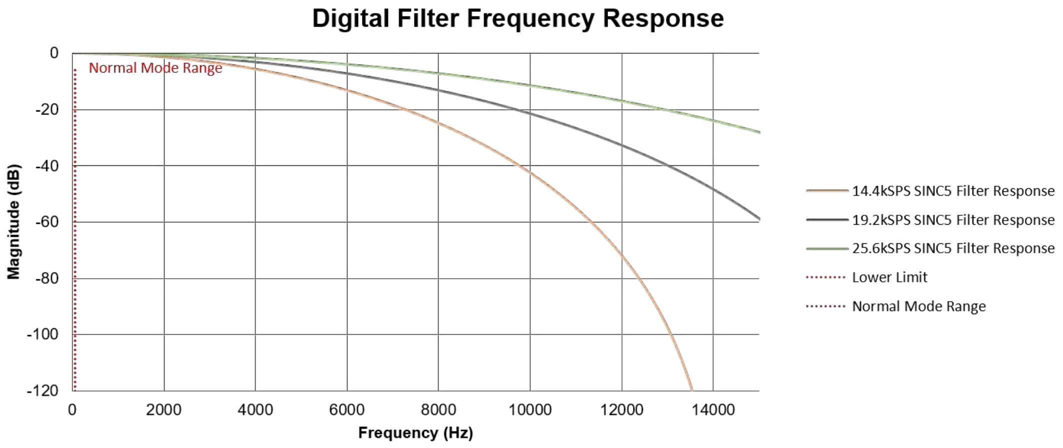


Figure A.4 Frequency response of SINC5 filter under different sampling rates

- **Isolation protection:** 600 V_{DC}, Channel to FGND
- **Accuracy**

Operating temperature within ±5°C of last, system-calibration temperature (25°C)

Table A.3: Accuracy									
		±1 V/V	±500mV/V	±250mV/V	±125mV/V	±62.5mV/V	±31.25 mV/V	±15.63 mV/V	±7.81 mV/V
Calibrated Typ.	Gain	±0.05%				±0.05%			
	Offset								
Non-Cali-brated Typ.	Gain	±0.10%				±0.20%			
	Offset								

Out of calibration temperature ±5°C of last

Table A.4: Accuracy									
		± 1 V/V	±500m V/V	±250mV/V	±125m V/V	±62.5m V/V	±31.25 mV/V	±15.63 mV/V	±7.81 mV/V
Calibrated Typ.	Gain	±0.20%	±0.20%	±0.20%	±0.20%	±0.20%	±0.20%	±0.20%	±0.20%
	Offset	±0.25%	±0.25%	±0.25%	±0.25%	±0.25%	±0.25%	±0.25%	±0.25%
Non-cali-brated Typ.	Gain	±0.60%	±0.60%	±0.60%	±0.60%	±0.70%	±0.70%	±0.70%	±0.70%
	Offset	±0.30%	±0.30%	±0.30%	±0.30%	±0.35%	±0.35%	±0.35%	±0.35%

- **DC Performance**

Table A.5: Idle Channel Noise						
Range	**10 S/s**		**1.2 kS/s**		**25.6 kS/s**	
	Noise (μVRMS)	Effective Resolution (bits)	Noise(μVRMS)	Effective Resolution (bits)	Noise (μVRMS)	Effective Resolution (bits)
±1 V/V	0.45	24.00	4.96	20.94	33.6	18.17
±0.5V/V	0.31	23.94	3.92	20.28	21.4	17.83
±0.25 V/V	0.15	23.99	1.44	20.72	10.6	17.81
±0.125 V/V	0.056	24	0.73	20.70	4.3	18.14
±62.5 mV/V	0.045	23.72	0.50	20.23	2.77	17.78
±31.25 mV/V	0.028	23.4	0.27	20.10	1.53	17.63
±15.625 mV/V	0.031	22.26	0.24	19.31	1.34	16.83
±7.8125 mV/V	0.022	21.75	0.24	18.3	1.14	16.05

- **Shunt calibration**
  - Resistance: 100 kΩ
  - Resistance accuracy: ±0.1% max.
  - Resistance drift: ±100 ppm/°C max.
- **Over-voltage protection:** ±30 V
- **Acquisition type:** Instant or buffered, software configurable
- **Buffered acquisition**
  - Enabled channel combination: Each channel can be enabled/disabled independently by software
  - Sample clock rate: 25.6 kHz max., for all channels, simultaneous sampling, software configurable
  - Sample clock source: From chassis
  - Allowable internal sample clock rate: 50 MHz/n, where n is an integer larger than 1,953, software configurable
  - Internal data buffer (FIFO) size: 1,024 samples

A.2 Trigger

- **Number of triggers:** 2 max., selectable via software
- **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 Power Consumption

Table A.6: Power Consumption

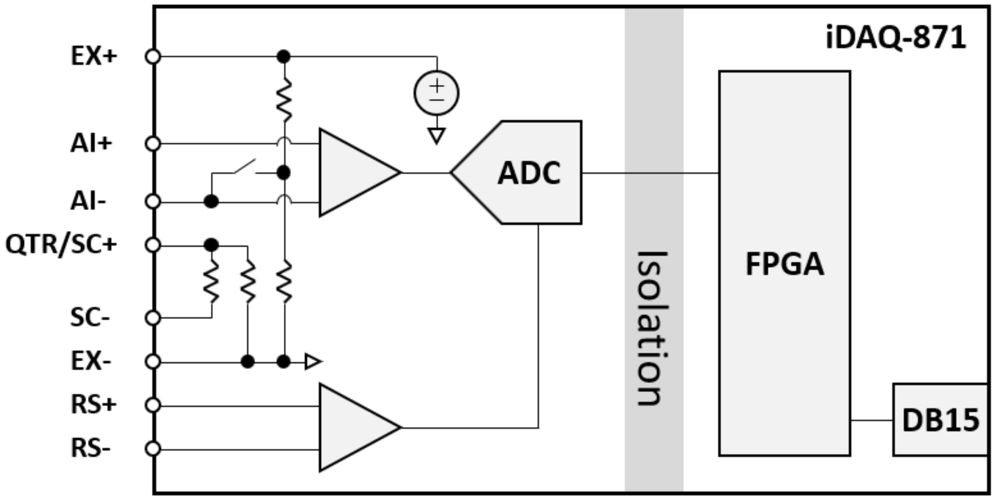
	Typical	Maximum
iDAQ-871	0.8W	2.1W
iDAQ-873	2W	2.6W

A.4 General

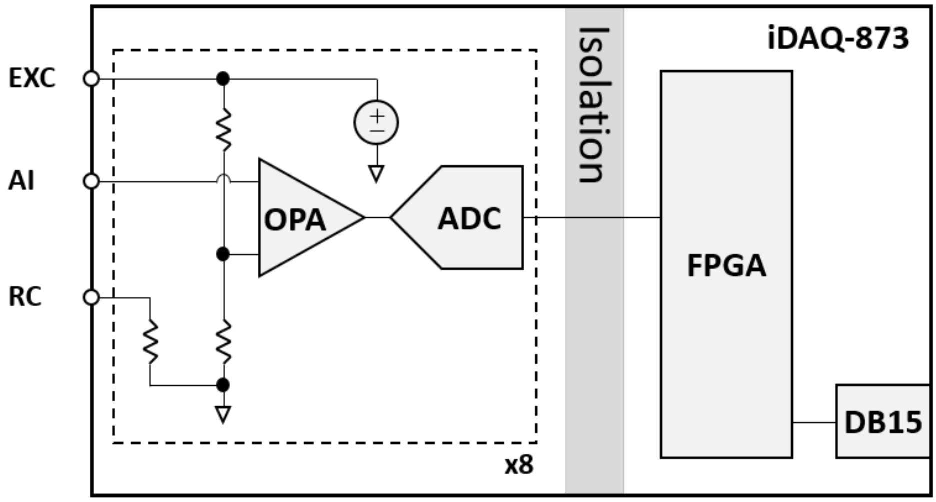
- **Form factor:** iDAQ Module
- **Dimension:** 100 x 80 x 25 mm (3.94 x 3.15 x 0.98 in.)
- **Weight:** 175 g
- **I/O connector:**37-pin D-SUB
- **Operating temperature:**-40 °C to 70 °C (-40 °F to 158 °F)
- **Storage temperature:** -40 °C to 85 °C (-40 °F to 185 °F)
- **Operating humidity:** Up to 90% RH, non-condensing
- **Storage humidity:** Up to 95% RH, non-condensing
- **Vibration:** 5Grms, Random Vibration
- **Shock:** 30G
- Indoor use only

A.5 Function Block

iDAQ-871



iDAQ-873



Appendix B

System Dimensions

B.1 System Dimensions

iDAQ-871

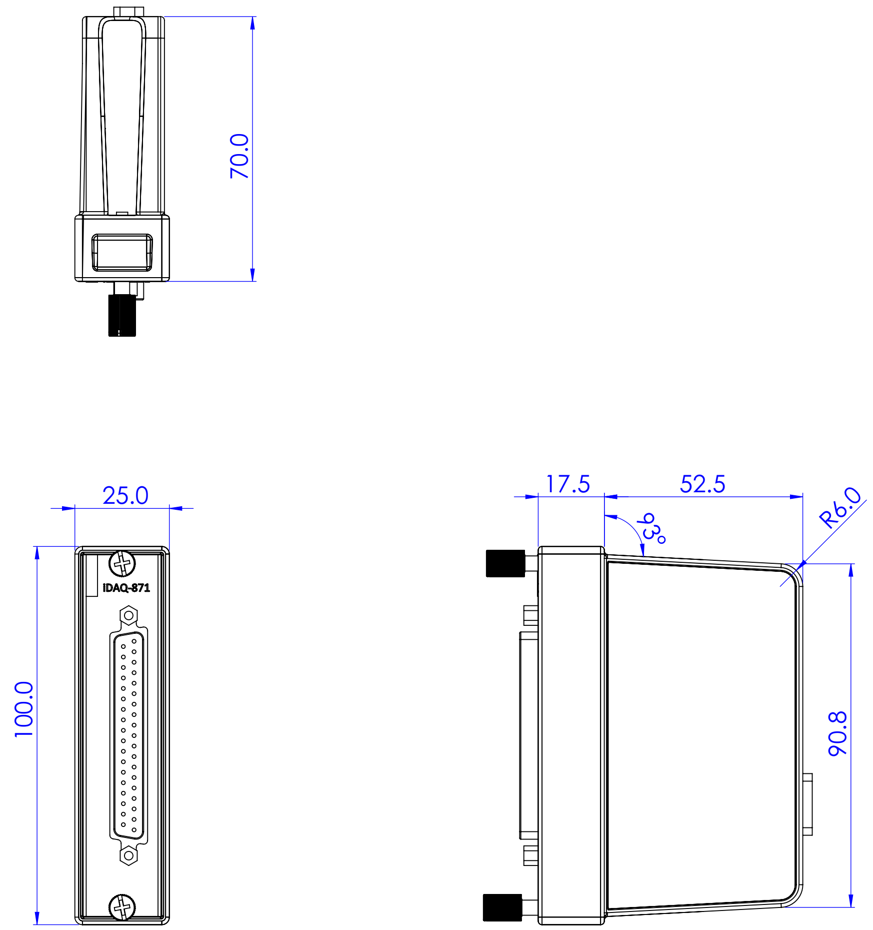


Figure B.1 System Dimensions - iDAQ-871

iDAQ-873

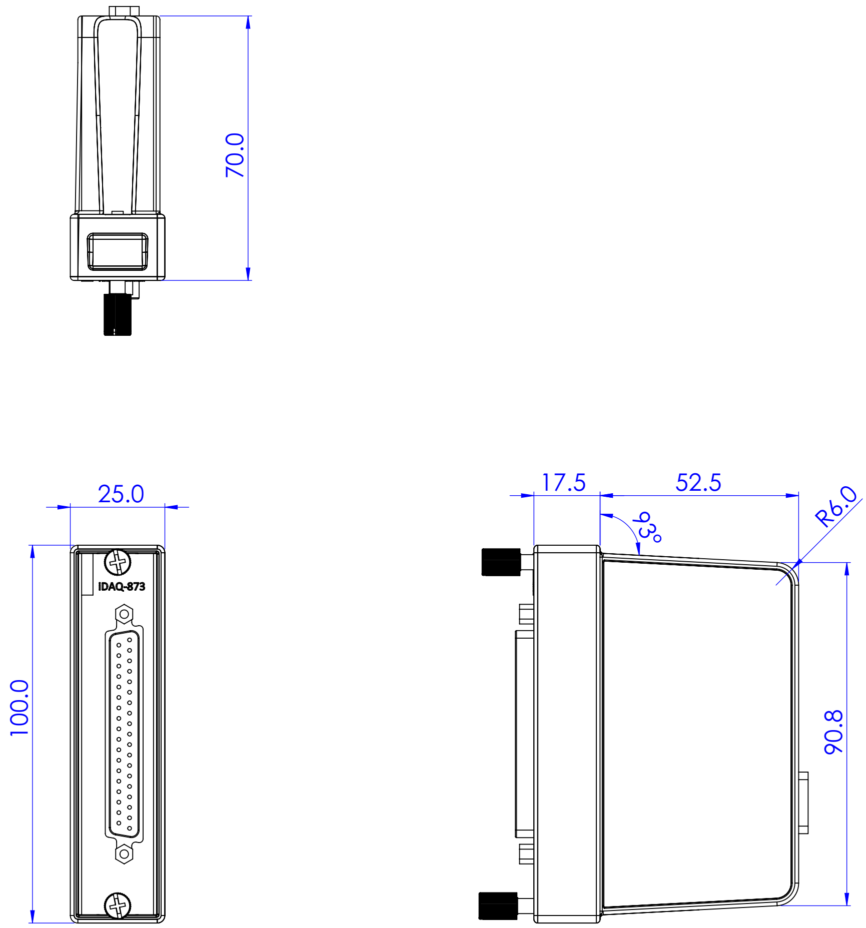


Figure B.2 System Dimensions - iDAQ-873

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

All product specifications are subject to change without notice.