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# FD-11601

# Feature Usage

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2022-07-11



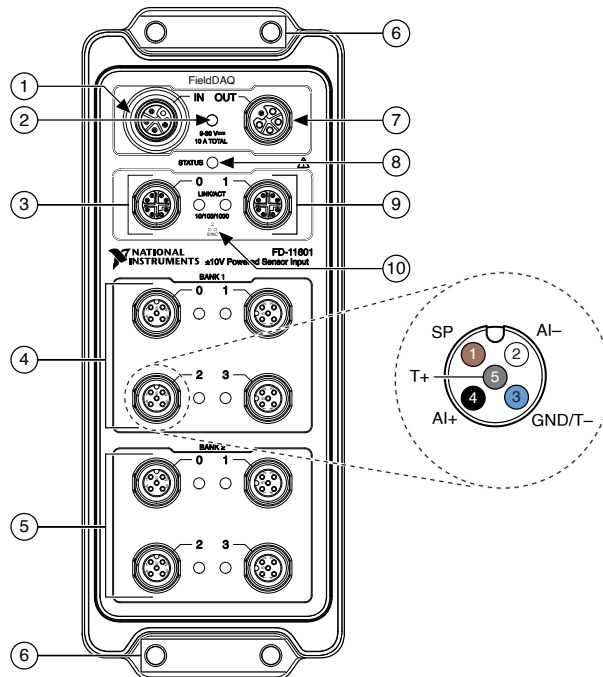
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# FD-11601 User Guide

The FieldDAQ FD-11601 is an IP65/IP67-rated eight-channel simultaneous voltage input device that can be connected to external powered and TEDS sensors. It can be networked and synchronized with IEEE 802.1AS devices.

Figure 1. FD-11601 Front Panel



1. Power IN Connector
2. Power LED
3. Ethernet Port 0 and LED
4. Bank 1 Voltage Input Connectors 0 through 3 and LEDs
5. Bank 2 Voltage Input Connectors 0 through 3 and LEDs
6. Mounting Holes
7. Power OUT Connector
8. STATUS LED
9. Ethernet Port 1 and LED
10. SYNC Logo

## FD-11601 Basic Information

### Kit Contents

Items in your FieldDAQ kit:

- FD-11601
- **FD-11601 Quick Start**
- **FD-11601 Safety, Environmental, and Regulatory Information**
- 1 M12 female cap for power IN connector (connected to device)
- 11 M12 male caps for power OUT, Ethernet, and input connectors (connected to device)

### Pinouts

Refer to the following topics for the connector pinouts on your FieldDAQ device:

- Voltage input connector pinout: Refer to [Voltage Input Connectors](#).
- Ethernet connector pinout: Refer to [Ethernet Ports](#).
- Power connector pinout: Refer to [Power Connectors](#).

### Driver Support

Earliest driver support version for your FieldDAQ device:

Driver	Earliest Version Support
NI-DAQmx	18.5

Table 13. FD-11601 Driver Support

## Cables and Accessories

The following table lists some cables and accessories available for your FieldDAQ device. For a complete list of FieldDAQ accessories and ordering information, refer to the pricing section of the FD-11601 product page at [ni.com](http://ni.com).

Cable/Accessory	Part Number
IP67 Power Supply	147464-01
PS-16 Power Supply	781094-01
M125F-Pigtail Power Cable (1 m, 2 m, 3 m lengths)	786172-01/02/03
M125F-M125M Power Cable (0.3 m, 1 m, 3 m lengths)	786173-0R3/01/03
SHM128M-RJ45 Ethernet Cable (1 m, 2 m, 3 m, 10 m lengths)	785944-01/02/03/10
SHM128M-SH128M Ethernet Cable (0.3 m, 1 m, 3 m lengths)	785946-0R3/01/03
SHM125M-Pigtail I/O Cable (0.3 m, 1 m, 3 m lengths)	785950-0R3/01/03
SHM125M-Pigtail-RA I/O Cable (1 m, 3 m lengths)	785949-01/03
FD-11950, M125F Field-serviceable I/O Connector	785941-01
FD-11951, M125F-RA Field-serviceable I/O Connector	785942-01
M12 Torque Wrench, Ethernet and I/O	786181-01
M12 Torque Wrench, Power	786182-01
Universal M12 Male Cap, Plastic	786177-01
Universal M12 Male Cap, Metal	786178-01
Universal M12 Female Cap, Plastic	786180-01
Universal M12 Female Cap, Metal	786179-01
FD-11960, DIN Rail Mounting Kit	786443-01

Table 2. FD-11601 Cables and Accessories

## Documentation

Documents that contain information about your FieldDAQ device:

- **FD-11601 Specifications**
- **FD-11601 Quick Start**

- **FD-11601 Safety, Environmental, and Regulatory Information**
- **FD-11601 Calibration Procedure**

## Safety Guidelines



**Caution** Do not operate the FD-11601 in a manner not specified in this user guide. Product misuse can result in a hazard. You can compromise the safety protection built into the product if the product is damaged in any way. If the product is damaged, return it to NI for repair.

The FD-11601 is rated for use in DRY or WET LOCATIONS. Hazardous voltages may not be connected to the device. A hazardous voltage is a voltage greater than 42.4 V peak voltage or 60 V DC in DRY LOCATIONS, and 22.6 V peak or 35 V DC in WET LOCATIONS.



**Caution** All wiring must be insulated for the highest voltage used.

## EMC Guidelines

This product was tested and complies with the regulatory requirements and limits for electromagnetic compatibility (EMC) stated in the product specifications. These requirements and limits provide reasonable protection against harmful interference when the product is operated in the intended operational electromagnetic environment.

This product is intended for use in industrial locations. However, harmful interference may occur in some installations, when the product is connected to a peripheral device or test object, or if the product is used in residential areas. To minimize interference with radio and television reception and prevent unacceptable performance degradation, install and use this product in strict accordance with the instructions in the product documentation.

Furthermore, any changes or modifications to the product not expressly approved by NI could void your authority to operate it under your local regulatory rules.

## Electromagnetic Compatibility Notices

Refer to the following notices for cables, accessories, and prevention measures necessary to ensure the specified EMC performance.



**Notice** To ensure the specified EMC performance, operate this product only with shielded cables and accessories.

## Special Conditions for Marine Applications

Some products are approved for marine (shipboard) applications. To verify marine approval certification for a product, visit [ni.com/product-certifications](https://ni.com/product-certifications), search by model number, and click the appropriate link.



**Notice** In order to meet the EMC requirements for marine applications, install the product in a shielded enclosure with shielded and/or filtered power and input/output ports. In addition, take precautions when designing, selecting, and installing measurement probes and cables to ensure that the desired EMC performance is attained.

## Unpacking

The FD-11601 ships in an antistatic package to prevent electrostatic discharge (ESD). ESD can damage several components on the device.



**Notice** Never touch the exposed pins of connectors.

To avoid ESD damage in handling the device, take the following precautions:

- Ground yourself with a grounding strap or by touching a grounded object.
- Touch the antistatic package to a metal part of your computer chassis before removing the device from the package.

Remove the device from the package and inspect it for loose components or any other signs of damage. Notify NI if the device appears damaged in any way. Do not install a damaged device.

Store the device in the antistatic package when the device is not in use.

## Hardware Symbol Definitions

The following symbols are marked on your FieldDAQ device.

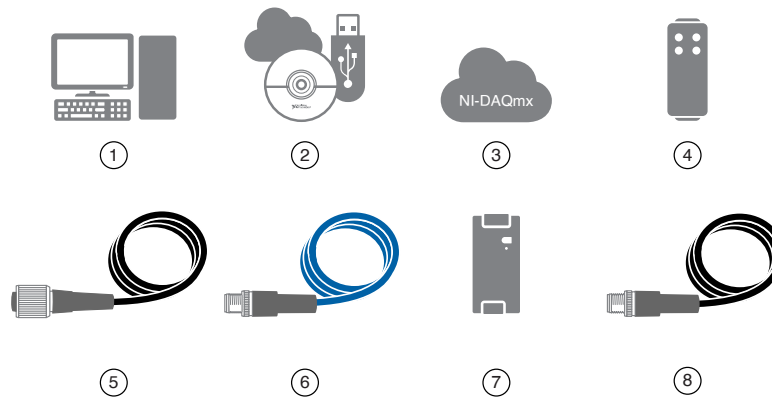
	When this symbol is marked on a product, refer to <a href="#">Safety Guidelines</a> for information about precautions to take.
	At the end of the product life cycle, all NI products must be disposed of according to local laws and regulations. For more information about how to recycle NI products in your region, visit <a href="http://ni.com/environment/weee">ni.com/environment/weee</a> .
	NI 符合中国电子信息产品中限制使用某些有害物质指令(RoHS)。关于 NI 中国 RoHS 合规性信息，请登录 <a href="http://ni.com/environment/rohs_china">ni.com/environment/rohs_china</a> 。(For information about China RoHS compliance, go to <a href="http://ni.com/environment/rohs_china">ni.com/environment/rohs_china</a> .)

## What You Need to Get Started

You will need the following items to set up your FieldDAQ device.



Figure 1. FD-11601 Installation Supply List



1. Host Computer running Windows or NI Linux RT
2. Application Software
3. NI-DAQmx Driver
4. FD-11601
5. 5-pin L-coded M12 Power Input Cable
6. 8-pin X-coded M12 Ethernet Cable
7. External Power Supply
8. 5-pin A-coded M12 I/O Cables and Accessories



**Note** You can either use a shielded straight-through Ethernet cable or an Ethernet crossover cable to connect the FieldDAQ device directly to your computer.

## Setting up the FieldDAQ Device

Complete the following steps.

1. Install the application software (if applicable), as described in the installation instructions that accompany your software. Check your driver and application development environment (ADE) readme files for specific version compatibility.
2. Install NI-DAQmx from [ni.com/downloads/drivers](http://ni.com/downloads/drivers). Complete the instructions.

3. Register your NI hardware online at [ni.com/register](https://ni.com/register) when prompted. The last dialog box opens with the following options:
  - Restart Later to install more NI software or documentation.
  - Shut Down or Restart if you are ready to install your device.

If you have problems installing your software, go to [ni.com/support/daqmx](https://ni.com/support/daqmx).

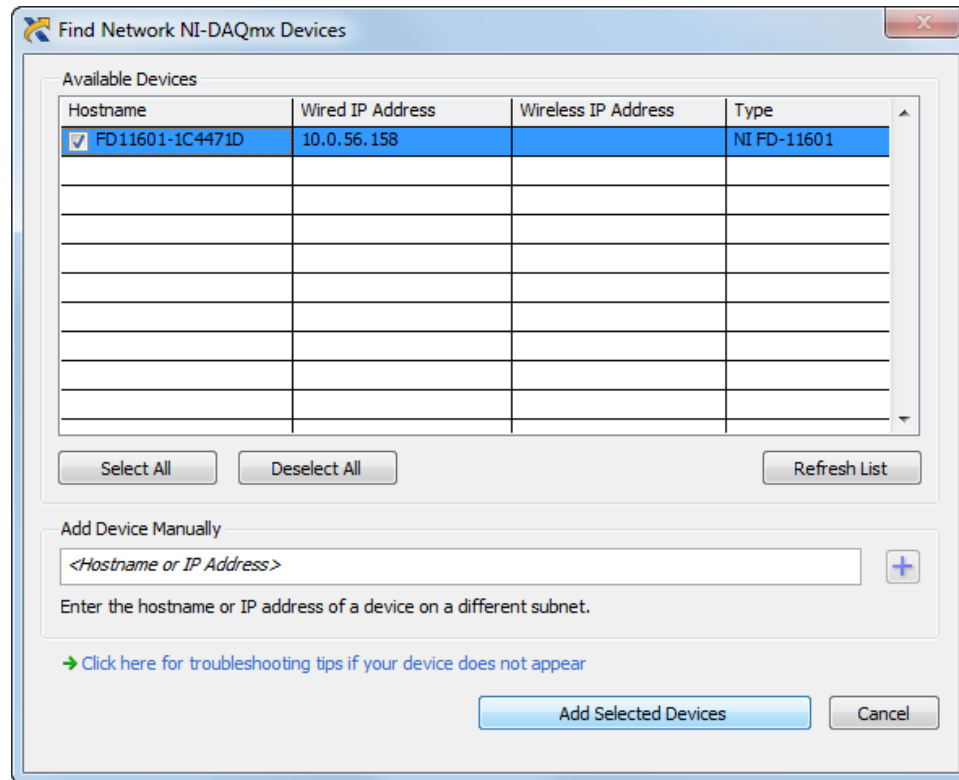
4. (Optional) Mount the FieldDAQ device to a panel or DIN rail, as described in [Mounting](#).
5. Make voltage input connections. Refer to [Voltage Input Connectors and Measurements](#) for information about signal connections and guidelines.
6. Align and connect one end of the Ethernet cable to Ethernet port 0 on the device, and the other end directly to your computer or any network connection on the same subnet as your computer.
7. Power the device by aligning and connecting the power IN port on FieldDAQ to an external 9 V DC to 30 V DC power source with the 5-pinL-coded M12 power cable. For information about wiring your external power source to the power connector, refer to [Wiring External Power to the FieldDAQ Device](#). The FieldDAQ device requires an external power supply that meets the specifications listed in the **FD-11601 Specifications** .

The Power LED turns on. Refer to [Power LED](#) for information about Power LED status.

8. To add the FieldDAQ to your software configuration, open NI MAX on your Windows host computer. Expand **Devices and Interfaces » Network Devices**.
  - If the device is on your local subnet, the device automatically appears in the list of available devices. Right-click the FieldDAQ device and select **Add Device**.
  - If the device is not on your local subnet, right-click **Network Devices** and select **Find Network NI-DAQmx Devices**.
    1. In the **Find Network NI-DAQmx Devices** dialog box that opens, do one of the following:

1. Check the box that corresponds to your device in the Hostname column.

Figure 3. Find Network NI-DAQmx Devices



2. If you know the device IP address, such as 192.168.0.2, enter it into the Add Device Manually field of the Find Network NI-DAQmx Devices window, and click the + button.
  3. Enter the hostname of the device. The default hostname is FD11601-**<serial number>**.
2. Click Add Selected Devices.

The FieldDAQ device icon changes from white to dark grey, indicating that it is recognized and present on the network.

Figure 4. MAX Icons and States



1. Discovered, but Not Added to the Network
2. Recognized, Present, and Reserved on the Network
3. Recognized, but Disconnected from the Network, Unreserved, or Reserved by Another Host

If your device does not appear in Available Devices, click Refresh List. If the device still does not appear, try the following:

1. If you connected the FieldDAQ device directly to your computer, ensure your network card is configured to obtain an IP address automatically, then click Refresh List.



**Note** If you connected the FieldDAQ device directly to your computer, the setup time may be longer. Wait 30 to 60 seconds after the STATUS LED turns off, then click Refresh List.

2. Contact your system administrator to confirm that the network is working and that a firewall is not interfering with discovery. For additional troubleshooting resources for the FieldDAQ device, refer to the [Troubleshooting Device Connectivity](#) in this guide and the **Finding a Network DAQ Device in MAX** topic in the **Measurement & Automation Explorer Help for NI-DAQmx**.

Figure 5. Network Devices in MAX



9. If the FieldDAQ device is not reserved automatically, select the device and click the Reserve Network Device button. Refer to [Reserving the Device in MAX](#) for more information.
10. Self-test your device in MAX by expanding Devices and Interfaces » Network Devices, right-clicking your FieldDAQ device, and selecting Self-Test. Self-test performs a brief test to determine successful device installation. When the self-test finishes, a message indicates successful verification or if an error occurred. If an error occurs, refer to [ni.com/support/daqmx](http://ni.com/support/daqmx).
11. Run a test panel in MAX by expanding Devices and Interfaces » Network Devices » **your FieldDAQ device**, right-clicking the bank of connectors in your FieldDAQ device, and selecting Test Panels. If the test panel displays an error message, refer to [ni.com/support](http://ni.com/support). Click Close to exit the test panel.



**Note** When in use, the FieldDAQ device may become warm to the touch. This is normal.



**Note** M12 connectors must be mated to cables or have caps installed on them to meet IP65/IP67 requirements. Cover the unused connectors with the included plastic caps whenever water, dust, or dirt are present.



**Note** Avoid long periods of exposure to sunlight.

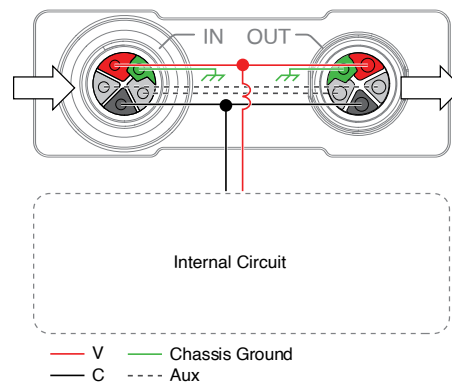
For instructions on networking to a real-time controller, refer to [Connecting to a Real-Time Controller](#).

## Power Connectors and Wiring

The FieldDAQ device has two 5-pinL-coded M12 power connectors, power IN and power OUT. The power connectors provide one voltage line (V), one common line (C), chassis ground, and two lines for optional auxiliary power, Aux1 and Aux2.

The following figure shows the power circuitry on the FieldDAQ device.

Figure 6. Power Circuitry



The FieldDAQ device requires an external power source connected between the V and C terminals, as described in **Power Requirements** in the **FD-11601 Specifications**. The FieldDAQ device internally connects the C terminal to the chassis ground. Recommended NI power supplies are listed in [FD-11601 Basic Information](#).

The FD-11601 has a maximum device power consumption of 16.0 W. Each FieldDAQ filters and regulates the supplied power for its tasks.

When FieldDAQ devices are linked together through the power IN and power OUT connectors, the total current consumption of the chain equals the sum of every linked FieldDAQ device's current consumption. The total current cannot exceed 10 A, and the total supply load of the chain must be less than 300 W.

You can use the optional auxiliary power lines (Aux1 and Aux2) to draw power for non-FieldDAQ devices in your network. The FieldDAQ device does not make use of the auxiliary power itself. If you are connecting power through the auxiliary power lines, ensure that the total combined current between V Input and Aux power lines does not exceed 10 A.

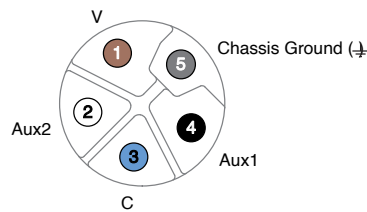
Refer to the **FD-11601 Specifications** for information about the power connectors, power requirements, and current limits of your FieldDAQ device.

Cap the power connectors when not in use.

## Power Connectors

The following figure shows the pinout of the Power IN connector.

Figure 7. Power Connector Pinout



Pin Number	Wire Color*	Signal	Description
1	Brown	V	Positive voltage line
2	White	Aux2	Optional line for powering non-FieldDAQ devices
3	Blue	C	Common. Negative voltage line
4	Black	Aux1	Optional line for powering non-FieldDAQ devices
5	Gray	⊥	Chassis Ground. This terminal is internally connected to the C terminal.

\* Wire color pertains to M125F power cables sold through NI. Other manufacturers' cable wire colors may vary.

Table 3. Signal Descriptions

## Power LED

The green POWER LED on the front panel identifies when the device is powered.

LED State	Device Status
On	Device is receiving adequate power for its tasks.
Off	Device is unpowered or receiving inadequate power.

Table 4. LED State/Device Status

## Wiring External Power to the FieldDAQ Device

Complete the following steps to connect a power source to the FieldDAQ device.

1. Verify the power source is turned off.
2. If you are not using a pre-assembled cable, complete the following steps.
  1. Connect the positive lead of the primary power source to the V terminal (pin 1) inside the power connector plug.
  2. Connect the negative lead of the primary power source to the C terminal (pin 3) inside the power connector plug.
  3. Connect the Chassis Ground terminal (pin 5) inside the power connector plug to earth ground. This terminal is internally connected to the C terminal.
  4. (Optional) To power non-FieldDAQ devices through the power network, connect the leads of an additional auxiliary power source to the Aux1 (pin 4) and Aux2 (pin 2) terminals inside the power connector plug.
  5. Assemble the rest of the plug sleeve.
3. Carefully align and connect the cable to the external power source and the power IN connector on the FieldDAQ device.
4. Turn on the external power source.

If the power source is connected to the power connector using long wiring with high DC resistance, the voltage at the power connector may be significantly lower than the specified voltage of the power source.



Refer to **Power Requirements** in the **FD-11601 Specifications** for information about the power supply input range. Refer to **Safety Voltages** in the **FD-11601 Specifications** for information about the maximum voltage from terminal to chassis ground.

## Voltage Input Connectors and Measurements

The following figures show the voltage input circuitry and block diagram of the FD-11601.

Figure 8. FD-11601 Input Circuitry

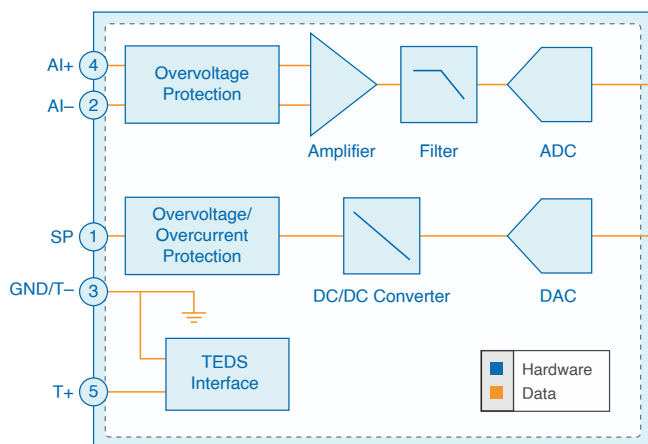
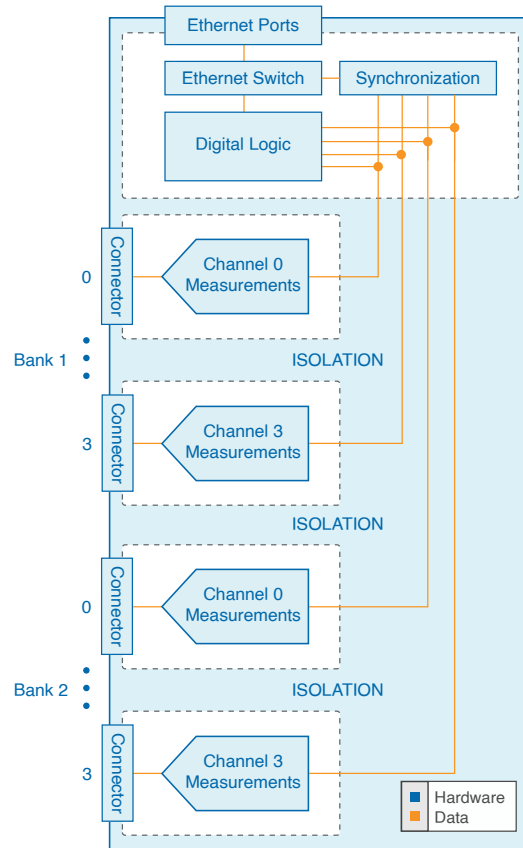


Figure 9. FD-11601 Block Diagram

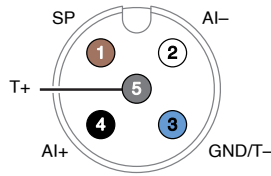


The FD-11601 provides channel-to-channel isolation. Input signals on each channel are conditioned, buffered, and then sampled by an ADC. Each AI channel provides an independent signal path and ADC, enabling you to sample all channels simultaneously. The FieldDAQ device provides overvoltage protection for each channel; refer to the **FD-11601 Specifications** for more information about overvoltage protection.

## Voltage Input Connectors

The FD-11601 features eight 5-pin A-coded M12 connectors: Bank 1 connectors 0 through 3 and Bank 2 connectors 0 through 3. The following figure shows the pinout of a voltage input connector.

Figure 10. FD-11601 Pinout



Pin Number	Wire Color*	Signal	Description
1	Brown	SP	Sensor power
2	White	AI-	Negative analog input voltage signal
3	Blue	GND/T-	Sensor power ground and TEDS return
4	Black	AI+	Positive analog input voltage signal
5	Gray	T+	TEDS data

\* Wire color pertains to SHM125M I/O cables sold through NI. Other manufacturers' cable wire colors may vary.

Table 6. Signal Descriptions



**Note** M12 connectors must be mated to cables or have caps installed on them to meet IP65/IP67 requirements. Cover the unused connectors with the included plastic caps whenever water, dust, or dirt are present.

## Voltage Input LEDs

Each voltage input connector has an LED.

LED Color and State	Connector Status
Off	Normal operation, sensor power output disabled, or sensor not present.
Green, solid	Sensor power output enabled and sensor connected.
Red, solid	Overload. Maximum output current exceeded for the set voltage on sensor power output.
Yellow, blinking/ alternating	User-defined status. Use MAX to write a state to any LED by expanding Devices and Interfaces » Network Devices » <b>your FieldDAQ device</b> » <b>bank</b>

LED Color and State	Connector Status
	<b>of connectors in your FieldDAQ device</b> and configuring the LED settings on the Settings tab.

Table 6. LED State/Status



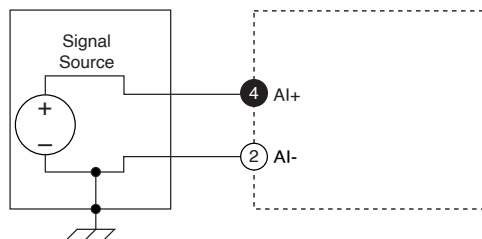
**Note** When you turn off the LEDs in MAX, the FieldDAQ device controls and sets the state of the LED. You cannot configure an LED while a task is running.

## Connecting Voltage Input Signals

You can connect grounded and floating voltage input signals to the FieldDAQ device. Make sure that devices you connect to the FieldDAQ device are compatible, as listed in the **FD-11601 Specifications**.

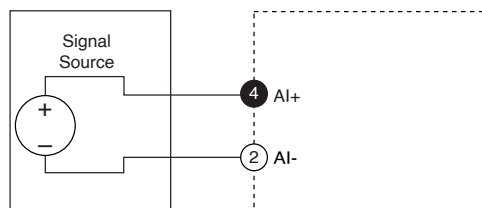
- **Grounded Signal Sources**—To ensure proper operation, make sure the voltage on the AI+ and AI- connections adhere to the channel-to-earth ground safety voltage specifications listed in the **FD-11601 Specifications**.

Figure 11. Connecting Grounded Signal Sources to the FieldDAQ Device



- **Floating Signal Sources**

Figure 12. Connecting Floating Signal Sources to the FieldDAQ Device



## Connecting External Sensors

You can power a 3- or 4-wire external sensor with an output voltage range of 5 V to 24 V by connection through the sensor power (SP) and ground (GND) terminals on the FieldDAQ device. The output voltage level is configurable using a 10-bit resolution for maximum flexibility. Use NI software to configure a sensor to turn on prior to the start of an acquisition.

Figure 13. Powering a 4-Wire External Sensor

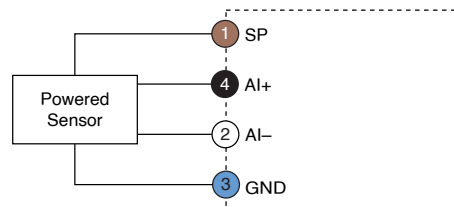
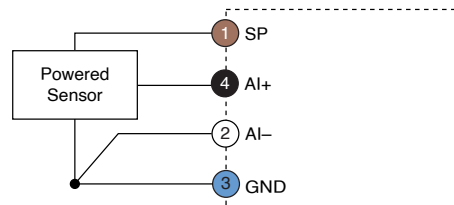


Figure 14. Powering a 3-Wire External Sensor



The FieldDAQ device goes into a current limited voltage fold-back mode to protect the sensor power excitation supply from short circuits or higher current than those listed in the **FD-11601 Specifications**. In this mode, the output voltage folds back to a lower value than the set voltage, the overcurrent status is set in NI-DAQmx, and the voltage input LED lights red. Removing the overload condition automatically triggers the output to return to the desired set voltage, the overcurrent status is cleared in NI-DAQmx, and the voltage input LED returns to normal conditions.

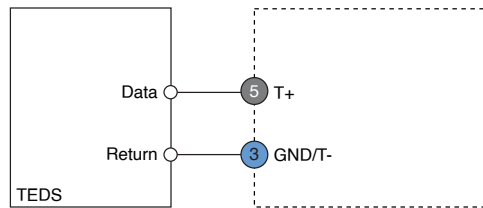
The FieldDAQ device also has an open circuit detection mode to indicate whether a sensor is connected. For any sensor power output voltage, an open circuit is detected when the minimum output current for sensor detection is not drawn, as listed in the **FD-11601 Specifications**. When an open circuit is detected, the Open Channel status is set in NI-DAQmx and the voltage input LED turns off.

If a connected sensor draws a total current below the maximum specifications values, the voltage input LED lights green.

## Connecting TEDS Sensors

You can connect TEDS (Transducer Electronic Data Sheets) sensors to the FieldDAQ device through the T+ and T- pins on each connector.

Figure 15. Connecting TEDS Sensors to the FieldDAQ Device



## Filtering

You can configure a filter for each bank on the FieldDAQ device.<sup>[1]</sup> The FieldDAQ device uses hardware filters that include combinations of analog filters and digital fine tuning to provide highly repeatable responses without the traditional artifacts of software filtering. The filters are lowpass filters meant to reject (attenuate) high frequency signals and noise while passing through lower frequency signals. FieldDAQ supports three types of configurable filter response:

- [Brickwall Filter](#) (default)
- [Butterworth Filter](#) (2nd and 4th order)
- [Comb Filter](#) (5th order)

Each of these three filter responses have different characteristics in how they attenuate and delay signals. A summary of these characteristics is shown in the following table.

Attribute	Brickwall (Default)	Butterworth	Comb
Filter Frequency	Tracks sample rate	Configurable independent of sample rate	Tracks sample rate
Alias Protection	Best—Full protection	Depends on ratio of sample rate to filter frequency	Good—Partial protection

Attribute	Brickwall (Default)	Butterworth	Comb
Input Delay	Constant input delay at all frequencies— Approximately 36 sample periods	Variable input delay— Depends on filter setting (0.4 ms to 5 ms), increases at higher input frequencies	Constant input delay at all frequencies— Approximately 5 sample periods
Step Response (Time Domain)	Exhibits ringing— Overshoot and undershoot	Some overshoot	Fastest settling—No overshoot or undershoot
Flatness (change in gain with input frequency)	Best—Very good flatness up to 40% of sample rate	Best—Exceptionally flat below 1/6 (2nd order) or 1/3 (4th order) the filter frequency	Good—Not Flat
Typical Applications	Analyzing signals in the frequency domain	Analyzing signals in the time domain	Analyzing signals in the time domain
	Analyzing dynamic properties of signals	Reducing measurement noise	Measuring fast edges

Table 7. Comparing FieldDAQ Filters

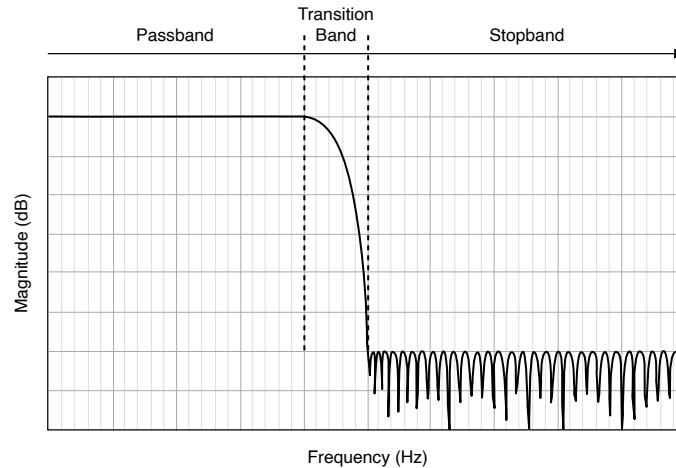
In general, the frequency response of a filter can be described by its attenuation (magnitude response) and delay (phase response or input delay) of signals at different frequencies. The step response can be used to illustrate a filter's resulting behavior in the time domain.

## Frequency Response of FieldDAQ Filters

The FieldDAQ device uses a combination of analog and digital filtering to provide an accurate representation of in-band signals and reject out-of-band signals. The filters discriminate between signals based on the frequency range, or bandwidth, of the signal. How the filter discriminates signals based on their frequency is known as frequency response. In general, the frequency response of a filter is described by a signal attenuation (magnitude response) and an input delay (phase response) for every input frequency.

- **Magnitude Response**—The three important frequency ranges, or bandwidths, to consider for magnitude response are passband, transition band, and stopband:

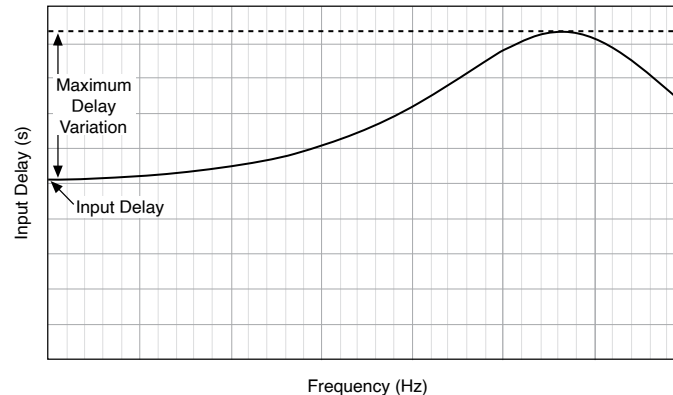
Figure 16. Example Magnitude Response of a Lowpass Filter



- **Passband**—The range of frequencies at which the filter attempts to pass a signal without modifying it. The small amount of variation in magnitude at these frequencies is called passband flatness. This is the frequency range of signals that you want to measure.
- **Transition band**—The range of frequencies in which the filter magnitude response has started to roll-off such that it attenuates signals by some amount, but has not reached the full attenuation amount. The shape of the transition band has an impact on the alias rejection and how signals are represented in the time domain (for example, step response).
- **Stopband**—The range of frequencies at which the filter attenuates input signals to its maximum attenuation level. Ideally, you want to choose a filter with a stopband that covers frequencies of noise sources that you do not want in your measurements.
- **Phase Response (Input Delay)**—Filters delay the input signal by some amount when processing data. In some cases, the delay is a function of the input signal frequency; when this is the case, the phase response plot is useful for knowing the exact delay at different input frequencies and the maximum variation between signals of different frequencies within the passband. Call the `AI.FilterDelay` property in NI-DAQmx to read the input delay.



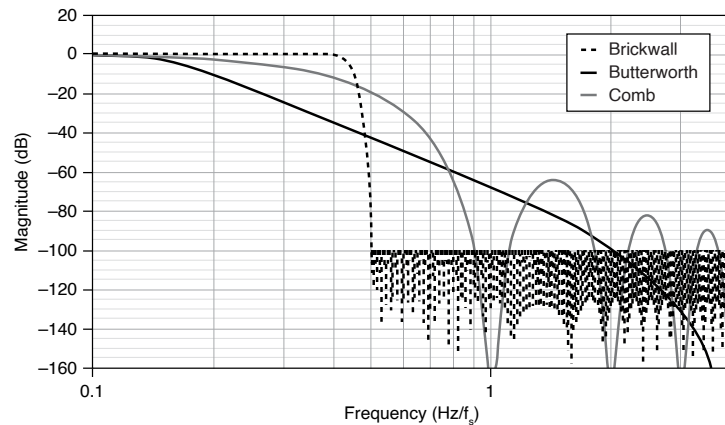
Figure 17. Example Input Delay of a Lowpass Filter



Each FieldDAQ filter has a different frequency response to serve different applications:

- **Brickwall**—Has a passband that extends to approximately 0.4 times the sampled data rate, then drops with a very sharp transition band to reach the stopband and properly reject any alias components or noise that may exist. The brickwall filter is designed to provide full alias protection from any signal component of more than one-half the sampled data rate (Nyquist frequency).
- **Butterworth**—Has a passband independent of the sampling rate (as opposed to the brickwall and comb filters), which offers more flexibility when filtering out noise that is below one-half of the sample rate. However, depending on your settings, you may see alias components of higher frequency signals in your measurement that extend beyond one-half of the sample rate due to the larger transition band.
- **Comb**—Has a smaller passband because its transition band starts early in the frequency range. The comb filter has shorter group delay than other filters and better representation of signals in the time domain (step response). The passband and transition band notches track the data sample rate similar to the brickwall filter. The comb filter's transition band features equally-spaced notches at different frequencies. It is common to use the comb filter with a specific sample rate to align the notches of the transition band thereby removing a specific noise-source frequency from measurements.

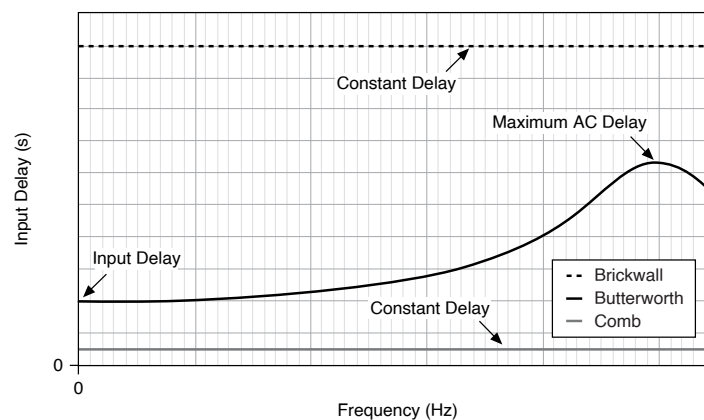
Figure 18. Comparing Typical Magnitude Response of FieldDAQ Filters



The FieldDAQ filters vary between input delay across signals in the passband:

- **Brickwall**—All input frequencies have the same amount of delay when going through the filter. Choose this filter for applications where linear phase is required or applications where data correlation between different devices and configurations is required.
- **Butterworth**—Delays signals by a variable amount depending on their frequency.
- **Comb**—All input frequencies have the same amount of delay when going through the filter. The comb filter has a shorter delay than the brickwall filter. Choose this filter for applications where linear phase, short delay, or data correlation of different devices and configurations is required.

Figure 19. Comparing Typical Input Delay for FieldDAQ Filters



Refer to the **FD-11601 Specifications** for details on the amount of variation in the passband gain and signal delay you can expect for different input frequency ranges.

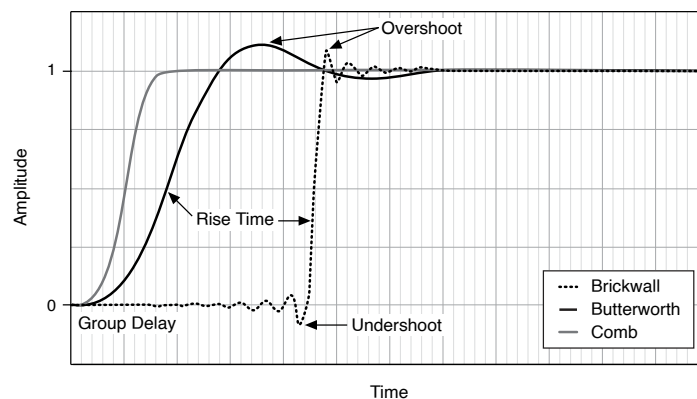
## Step Response of FieldDAQ Filters

The shape of the magnitude and phase responses of a filter impacts how signals look in the time domain. The step response of a filter is typically used to identify the behavior of a filter in the time domain.

Three important factors of the filter step response are group delay, rise time, and overshoot/undershoot. The three filters differ in step response across signals in the transition band:

- **Brickwall**—Has the longest group delay. The output signal shows overshoot and undershoot.
- **Butterworth**—Has a shorter group delay and the longest rise time. The output signal shows overshoot.
- **Comb**—Has the shortest group delay and good rise time. The output signal does not show overshoot or undershoot.

Figure 20. Comparing Typical Step Response of FieldDAQ Filters



Refer to the **FD-11601 Specifications** for details on the amount of variation in the response you can expect for different input frequency ranges.

## Data Rates

You can use the 13.1072 MHz, 12.8 MHz, 12.288 MHz, and 10.24 MHz timebases to generate data rates. The FD-11601 supports data rates ( $f_s$ ) between 500 Samples/s and 102.4 kSamples/s. By default, NI-DAQmx automatically chooses the most suitable timebase for a selected data rate. You can also manually select a timebase through the NI-DAQmx API. Refer to [Timebases](#) in this guide and the **FD-11601 Specifications** for information about choosing the correct timebase for your data rate.

## Programming the FieldDAQ Device

The following topics provide information about programming analog input applications and triggers in software for your FieldDAQ device:

- [Configuring Bridge Input Settings](#)
- [Configuring Filter Settings](#)
- [Using Offset Nulling Functions](#)
- [Using Shunt Calibration Functions](#)
- [Configuring Sample Timing](#)
- [Acquiring with a Single NI-DAQmx Task](#)
- [Synchronizing Multiple NI-DAQmx Tasks](#)
- [Using TEDS](#)
- [Timing and Triggering Signals](#)

## Configuring Bridge Input Settings

You must configure your FD-11601 for the bridge configuration, excitation, and, when using quarter bridge configuration, bridge resistance. Use the following DAQmx properties to configure your bridge sensor.

- AI.Bridge.Cfg (Channel:Analog Input:General Properties:Signal Conditioning:Bridge:Configuration)—Allowed values are Full Bridge, Half Bridge, Quarter Bridge

- `AI.Excit.Val` (Channel:Analog Input:General Properties:Signal Conditioning:Excitation:Value)—Allowed values are 3.0 (Full, Half, and Quarter Bridge), 5.0 (Full, Half, and Quarter Bridge), 10.0 (Full and Half Bridge)
- `AI.Excit.Src` (Channel:Analog Input:General Properties:Signal Conditioning:Excitation:Source)—Allowed vlaue is Internal
- `AI.Bridge.NomResistance` (Channel:Analog Input:General Properties:Signal Conditioning:Bridge:Nominal Resistance)—Allowed values are 120, 350



**Note** You do not need to configure the FD-11601 to use remote sensing. The FieldDAQ device automatically uses remote sense when the RS+ and RS- inputs are connected, and local sensing when the RS+ and RS- inputs are unconnected.

Refer to the **Bridge-Based Sensors** topic in the **NI-DAQmx Help** for more information about configuring and working with bridge-based sensors in NI-DAQmx.

## Configuring Filter Settings

You can configure a filter for each bank on the FieldDAQ device.<sup>[2]</sup> By default, the FD-11601 uses the Brickwall filter. You can specify Comb or Butterworth filter responses), as well as the order and cutoff frequency of Butterworth filters. Use the following DAQmx properties to configure the filters:

- `AI.Filter.Response` (Channel:Analog Input:General Properties:Filter:Response)—Allowed values are Brickwall (default), Butterworth, Comb.
- `AI.Filter.Order` (Channel:Analog Input:General Properties:Filter:Order)—Allowed values are 2 (Butterworth), 4 (Butterworth), 5 (Comb). This setting is ignored for Brickwall response.
- `AI.Filter.Freq` (Channel:Analog Input:General Properties:Filter:Frequency)—Range of values for Butterworth filters are 100 to 4096. NI-DAQmx rounds up to the nearest supported cutoff frequency for the timebase used. Read this property to get the actual cutoff frequency used:

- Brickwall filter—Returns the stopband frequency (one-half the sample rate)
- Comb filter—Returns the first notch frequency (equal to the sample rate)

You do not need to specify the filter frequency with Brickwall or Comb filters. NI-DAQmx returns an error if you specify a frequency higher than the frequency that would otherwise be returned.

## Using Offset Nulling Functions

Use the DAQmx function Perform Bridge Offset Nulling Calibration to perform offset nulling in Full, Half, and Quarter bridge mode. This function performs software compensation by taking a reading from the input and subtracting this reading from all future readings.

The ratiometric reading is stored in the DAQmx property AI.Bridge.InitialRatio (Channel:Analog Input:General Properties:Signal Conditioning:Bridge:Initial Bridge Ratio). You can read this property to see the amount of offset that is being nulled. For best accuracy, ensure that your sensor is in the null or unloaded state and has had time to reach a steady-state temperature while excited at the desired voltage.

Refer to the **Offset Nulling (Bridge Balancing)** topic in the **NI-DAQmx Help** for more information on performing offset nulling.

## Using Shunt Calibration Functions

Use the following DAQmx functions to perform shunt calibration of your sensors:

- Perform Strain Shunt Cal (for strain channel types)
- Perform Bridge Shunt Cal (for bridge channel types)—Refer to the **Bridge Measurement Types** topic in the **NI-DAQmx Help** for more information on measurement types with bridge-based sensors.

Depending on how you configure your channel, you must configure the following:

- Quarter Bridges—DAQmx uses the internal shunt calibration switch and shunt resistors and automatically perform the shunt calibration. Configure the following for your sensor:

- Internal shunt resistance—49900  $\Omega$  for 350  $\Omega$  quarter bridges or 49660  $\Omega$  for 120  $\Omega$  quarter bridges
  - Shunt location—Location of R3
  - Shunt source—Default
  - Shunt—Switch A
- **Half and Full Bridges**—You will generally get better gain accuracy by using Remote Sense than by using Shunt Calibration. Refer to [Remote Sensing and Shunt Calibration](#) for more information.

However, you can use the DAQmx Perform Shunt Cal functions with half bridge and full bridge completion. You must manually apply an external shunt resistor across the desired bridge resistance before calling the shunt calibration function and after calling the offset nulling function. When calling the Perform Strain or Bridge Shunt Cal functions, configure the following for your sensor:

- Shunt source—Default
- Shunt—Switch A
- Bridge resistance—Resistance of your sensor
- Shunt resistance—Resistance of your sensor
- Shunt location—Location of your sensor

Regardless of the bridge configuration used, the DAQmx Perform Shunt Cal functions measure the shunted bridge or gage and compare this measurement to the `AI.Bridge.InitialRatio` value set by the Perform Bridge Offset Nulling Calibration function. The function then calculates the Correction Factor described in [Remote Sensing and Shunt Calibration](#), and applies this factor to all future readings. The correction factor is stored in the NI-DAQmx property `AI.Bridge.ShuntCal.GainAdjust` (Channel:Analog Input:General Properties:Signal Conditioning:Bridge:Shunt Cal:Gain Adjustment). You can read this property to see the amount of correction being applied as a result of the shunt calibration.



**Note** You must use the DAQmx Perform Bridge Offset Nulling Calibration function immediately prior to using the DAQmx Perform Shunt Calibration

function because the Shunt Calibration uses the result of the Offset Nulling calibration as the unshunted value.

## Directly Programming the Shunt Calibration Switch

With quarter bridge configurations, you may also directly control the internal shunt calibration resistor by writing to the NI-DAQmx Channel property `AI.Bridge.ShuntCal.Enable` (Channel:Analog Input:General Properties:Signal Conditioning:Bridge:Shunt Cal:Shunt Cal Enable). Writing to this property simple enables and disables the shunt calibration switch. It does not affect the stored results of previous offset nulling or shunt calibration functions.

## Configuring Sample Timing

You can use the FieldDAQ device in the following analog input applications:

- Finite acquisition
- Continuous acquisition

The FieldDAQ device supports the NI-DAQmx Sample Clock timing type. An onboard clock is dedicated to producing periodic edges to produce each sample. All the channels on the FieldDAQ device are simultaneously sampled on every sample clock edge. Refer to the **Sample Timing Types** topic in the **NI-DAQmx Help** for more information on Sample Clock timing and simultaneous sampling.

## Acquiring with a Single NI-DAQmx Task

The simplest method for synchronously acquiring multiple channels with DAQmx is to create a single DAQmx task containing all the channels to be acquired. You can include channels from multiple FieldDAQ devices in a single task, but they must all be part of the same IEEE 802.1AS subnet so that they will be synchronized with each other. All the channels across all devices within the task are sampled simultaneously with no other programming or trigger necessary.

Even though the channels are sampled simultaneously, the sampled data represents the signal present at the input terminals at an earlier time due to the



input delay of the signal through the filtering of the channel. If the channels in the task have different filter settings or are taken from different FieldDAQ device models, they can have different input delays. In this case, simultaneously sampled channels may represent signals at the input terminals at different points in time. Depending on the needs of your application, you have three options for different input delays:

- Ignore the difference in delays
- Subtract the input delay of each channel from the first sample timestamp (the  $t_0$  component of a waveform) of your acquired waveforms to reflect the timing of the signals at the input terminals
- Separate your acquisition into multiple synchronized tasks, as described in [Synchronizing Multiple NI-DAQmx Tasks](#)



**Note** Refer to [Understanding Phase Response \(Input Delay\)](#) for more information about the input delay with different filter settings.

## Synchronizing Multiple NI-DAQmx Tasks

You can separate your acquisition into multiple NI-DAQmx tasks. All the channels that you acquire from the same FieldDAQ device must be placed in the same task, but each task can include the channels from other FieldDAQ devices. Even when your tasks are running at different sample rates, they all remain synchronized if all the devices are part of the same IEEE 802.1AS subnet. The tasks containing FieldDAQ channels are also synchronized with tasks on other IEEE 802.1AS supported devices, such as TSN-enabled CompactDAQ chassis and CompactRIO with NI-DAQmx controllers.

The automatic IEEE 802.1AS synchronization of multiple devices on the same TSN network ensures that once started, the sample rates of your tasks will not drift relative to each other. To ensure that all the tasks start at the same time, you provide a time-based trigger to all the tasks.

The simplest method for starting all the tasks at the same point in time is to set the NI-DAQmx Timing property `FirstSampClk.When` (Timing:Advanced:First Sample Clock Time:When). NI-DAQmx configures the necessary timing and triggering signals

to ensure that the first sample clock on every device occurs simultaneously at the time you write to this property.

Even though the channels are all sampled simultaneously, the sampled data represents the signal present at the input terminals at an earlier time due to the input delay of the signal through the filtering of the channel. You can adjust the timing of each task to account for a fixed amount of input delay by writing to the NI-DAQmx Timing property `FirstSampClk.Offset` (Timing:Advanced:First Sample Clock Time:Offset). NI-DAQmx configures all devices in a task to delay the sampling by the amount written to this property. If all the channels in a task are configured such that they have the same input delay, writing the value of this delay to the `FirstSampClk.Offset` property ensures that the first sampled data point represents the signal at the input terminals at the precise time specified in the `FirstSampClk.When` property.

Refer to [Understanding Phase Response \(Input Delay\)](#) for more information about the input delay with different filter settings. Refer to [Time-Based Triggers](#) for more information about how TSN devices share a notion of time that can be used for setting trigger events.

## Using TEDS

A TEDS can reside in embedded memory, typically an EEPROM, within the sensor. You can download a TEDS from the sensor with the FieldDAQ device. You can then download the TEDS in MAX to use in your application.

With MAX, you can use the Configure TEDS window to add and remove transducer electronic data sheet (TEDS)-compatible sensors from your FieldDAQ device.

- **Scan for TEDS**—Use to detect TEDS-compatible sensors. For each channel connected to a detected sensor, TEDS Capable Sensor appears in the corresponding TEDS Information column. Select a device channel.
- **Import Virtual TEDS**—Use to select a .ted file. After the file loads, TEDS Capable Sensor appears in the corresponding TEDS Information column.

Use the DAQmx Write TEDS Data (U8 Array) function to write TEDS data from a 1D array of 8-bit unsigned integers to the TEDS sensor connected to the physical

channel you specify. The TEDS data must be in a bitstream constructed according to the IEEE 1451.4 specification.

Some TEDS sensors include a PROM, to which you can write data one time. When you write TEDS data, you can choose to write basic TEDS data to the PROM or to the EEPROM. Basic TEDS data includes the manufacturer ID, model number, serial number, version number, and version letter. If you write basic TEDS data to the PROM, the Write TEDS Data function returns an error if you later attempt to write basic TEDS data to the EEPROM.

## Timing and Triggering Signals

The FieldDAQ device features the following timing and triggering signals:

- [AI Sample Clock Signal](#)
- [AI Sample Clock Timebase Signal](#)
- [AI Start Trigger Signal](#)
- [Analog Input Sync Pulse](#)

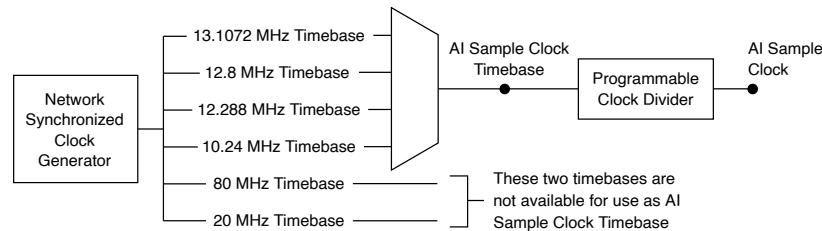
### AI Sample Clock Timebase Signal

The FD-11601 generates four measurement timebases, with frequencies of 13.1072 MHz, 12.8 MHz, 12.288 MHz, and 10.24 MHz. Any of these timebases can be selected as the AI Sample Clock Timebase. The AI Sample Clock Timebase signal is divided down to provide a source for the AI Sample Clock. Refer to the **FD-11601 Specifications** for a table of possible sample rates for each of the four timebases. By default, NI-DAQmx automatically chooses the most suitable timebase for a selected data rate. You can also manually select a timebase through the NI-DAQmx API, using the NI-DAQmx property `SampleClock.Timebase.Source` (Timing:Sample Clock:Timebase:Source).

The 13.1072 MHz, 12.8 MHz, 12.288 MHz, and 10.24 MHz timebases are all synchronized to each other and are automatically synchronized to other network-synchronized devices that are part of your local IEEE 802.1AS subnet. This enables

measurement signals to be synchronized to other devices across a distributed network.

Figure 21. AI Sample Clock Timebase Options

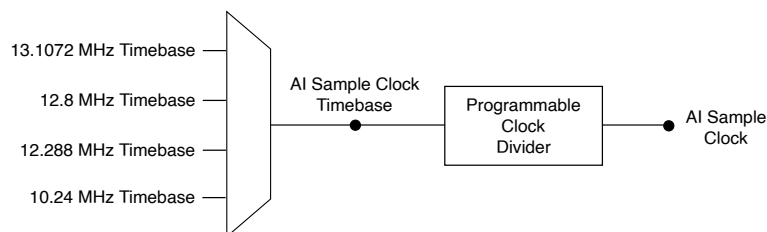


The FD-11601 also generates an 80 MHz and 20 MHz timebase that are used with internal counters in the device. The 80 MHz and 20 MHz timebases are not available for use as the AI Sample Clock Timebase.

## AI Sample Clock Signal

A sample consists of one reading from each channel in the AI task. Sample Clock signals the start of a sample of all analog input channels in the task. Refer to the following figure for sample clock source options.

Figure 22. AI Sample Clock Timing Options



The FD-11601 is considered a Delta-Sigma device; it contains multiple A/D converters that require a high-frequency oversample clock to produce accurate, synchronized data. The FieldDAQ device returns a sample on every Sample Clock pulse.

The oversample clock is used as the AI Sample Clock Timebase. The FieldDAQ device supplies 13.1072 MHz, 12.8 MHz, 12.288 MHz, and 10.24 MHz timebases. By

default, NI-DAQmx automatically chooses the most suitable timebase for a selected data rate.

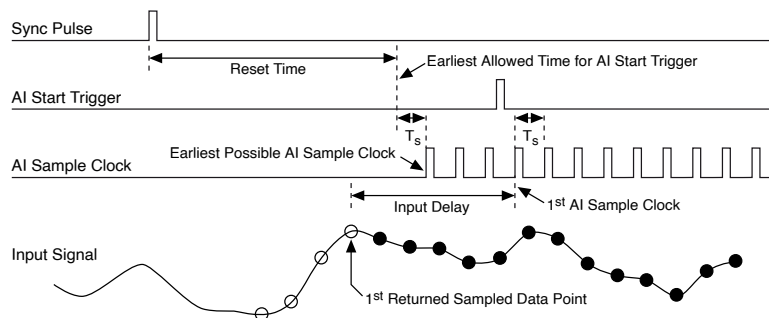
The FieldDAQ device automatically issues a synchronization pulse to each bank that resets their ADCs at the same time. You can also specify a specific time for the synchronization pulse to occur. Because of the filtering used in the Delta-Sigma FieldDAQ device A/D converters, these devices exhibit a fixed input delay relative to non-Delta-Sigma devices in the system. This input delay is specified in the **FD-11601 Specifications**.

When using multiple FieldDAQ devices in a task that contains channels for a Delta-Sigma device, such as the FD-11601, ensure that one of those channels is the first in your channel list.

## AI Start Trigger Signal

Use the Start Trigger signal to begin a measurement acquisition. After the AI Start Trigger signal, the AI Sample Clock begins on the next available time interval according to the equation given above in the description of the Synchronization Pulse. Since the AI Sample Clock occurs at precise timing intervals referenced to the sync pulse and spaced apart by the sample period, the first AI Sample Clock event may occur up to one sample period after the AI Start Trigger. You may not specify an AI Start Trigger to occur more than one sample period before the first available time for an AI Sample Clock; this means that the AI Start Trigger must be configured to occur at least the reset time after the sync pulse.

Figure 23. Relationship of Timing and Triggering Signals



You can configure the Start Trigger signal to occur at a specific time by writing to the DAQmx property Start.Time.When (Trigger:Start:Time:When). Refer to [Time-Based Triggers](#) for more information about specifying time events.

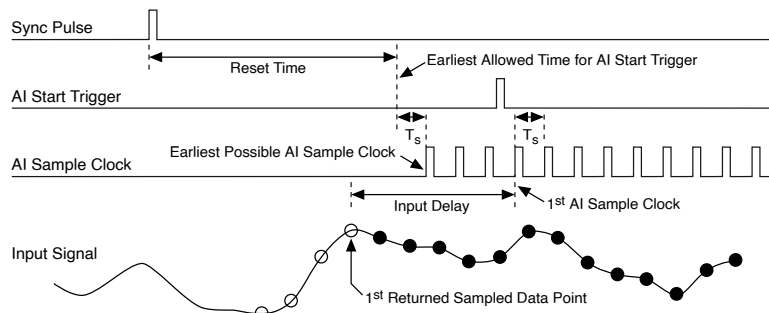
## Analog Input Sync Pulse

The Analog Input Sync Pulse resets the internal generation of the Sample Clock signal. Sample Clocks will be generated after a reset time which depends on the Sample Clock Rate and the filter settings. You can read the value of this reset time with the DAQmx property SyncPulse.ResetTime (Timing:More:Synchronization Pulse:Reset Time). Since the filter delay depends on filter and sample rate settings, you must configure your DAQmx task with the sample rate and filter settings before reading the reset time property.

Sample clocks are available precisely after the analog input synchronization pulse at times equal to **SyncPulse.ResetTime + (n × T<sub>S</sub>)** where **T<sub>S</sub>** is the sample period (1/**Sample Clock Rate**) and **n** is any integer greater than or equal to 1.

The actual time of the first AI Sample Clock is determined by the AI Start Trigger signal. Refer to the following figure for an illustration of the reset time and sync pulse operation.

Figure 24. Relationship of Timing and Triggering Signals



You can configure the synchronization pulse to occur at a specific time by writing to the DAQmx property SyncPulse.Time.When (Timing:More:Synchronization Pulse:Time:When). Refer to [Time-Based Triggers](#) for more information about specifying time events.

## Time-Based Triggers

TSN enabled devices can take advantage of time-based synchronization features in NI-DAQmx. Certain triggers can be specified in terms of time of day. Time-based triggers and multidevice tasks (spanning multiple network-synchronized FieldDAQ and other TSN enabled devices) can help simplify programming for large systems.

The simplest method to trigger a task based on time is to use the NI-DAQmx property `FirstSampClk.When` (Advanced:First Sample Clock Time:When), and optionally the NI-DAQmx property `FirstSampClk.Offset` (Advanced:First Sample Clock Time:Offset). Refer to [Synchronizing Multiple NI-DAQmx Tasks](#) for details on the use of these properties.

You can also directly set the times at which the Analog Input Synchronization Pulse and the AI Start Trigger occur by setting the following NI-DAQmx properties:

- `SyncPulse.Type` (Timing:More:Synchronization Pulse:Type)—Allowed value is Time.
- `SyncPulse.Time.Timescale` (Timing:More:Synchronization Pulse:Time:Timescale)—Set as described below.
- `SyncPulse.Time.When` (Timing:More:Synchronization Pulse:Time:When)—Set to the time you want the Synchronization Pulse to occur.
- `Start.TrigType` (Trigger:Start:Trigger Type)—Allowed value is Time.
- `Start.Time.Timescale` (Trigger:Start:Time:Timescale)—Set as described below.
- `Start.Time.When` (Trigger;Start:Time:When)—Set to the time you want the Start Trigger to occur.

You can also configure the Start Trigger time using the Start Time instance of the DAQmx Trigger node in LabVIEW, or the `DAQmxCfgTimeStartTrig` function in C.



**Note** You must set the start trigger to occur after the synchronization pulse by at least the reset time, as described in [AI Start Trigger Signal](#).

Time triggers can be specified in Host Time or I/O Device Time, depending on the needs of your application.

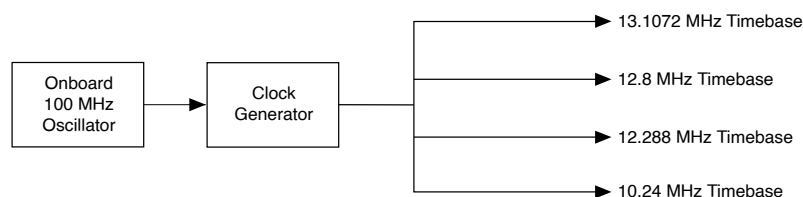
- **I/O Device Time**—The time the FieldDAQ device uses internally. This time is determined by the network configuration and is shared by all IEEE 802.1AS network-synchronized devices on your subnet.
- **Host Time**—The time on your Windows computer or NI Linux Real-Time controller. This is usually the current global time and is provided by a local real-time clock or a network time protocol (NTP) server.

NI-DAQmx automatically translates from Host Time to I/O Device Time as necessary. The accuracy of this translation depends on the relationship between these times and can reduce the relative accuracy of time triggers across multiple devices. For maximum accuracy, use an NI Linux Real-Time controller as the host in a supported topology. However, NI-DAQmx guarantees that two tasks configured to start at the same host time always start at the same I/O Device Time in all scenarios, preserving precise synchronization between chassis in this common use case. Refer to the **Time Triggering** topic in the **NI-DAQmx Help** for more information on accessing time-based features in the NI-DAQmx API.

## Timebases

The following figure shows the FD-11601 clock routing circuitry and timebases.

Figure 1. Clock Routing Circuitry



You can use the 13.1072 MHz, 12.8 MHz, 12.288 MHz, and 10.24 MHz timebases to generate the AI Sample Clock signals. These timebases are generated directly from the onboard clock generator. By default, NI-DAQmx automatically chooses the most suitable timebase for a selected data rate. You can also manually select a timebase through the NI-DAQmx API.



Refer to the **FieldDAQ Timing Considerations** and **Master Timebase Synchronization** topics in the **NI-DAQmx Help** for more information about configuring timing in the NI-DAQmx API.

## Synchronization across a Network

FieldDAQ devices feature automatic network-based synchronization with compatible networks and IEEE 802.1AS-capable NI Linux Real-Time controllers. The SYNC logo on the device front panel indicates that the device is capable of hardware-based synchronization over a network, whether daisy-chained together or connected to external networks that support IEEE 802.1AS synchronization. For more information about supported topologies and other technical requirements, refer to Topology Options.

The clock generator illustrated in [AI Sample Clock Timebase Signal](#) automatically synchronizes to other network-synchronized devices that are part of your local IEEE 802.1AS subnet. The 13.1072 MHz, 12.8 MHz, 12.288 MHz, and 10.24 MHz timebases are derived from the oscillator, and are synchronized to it. Therefore, they are also synchronized to other network-synchronized timebases on your IEEE 802.1AS subnet. This enables measurement signals to be synchronized to other devices across a distributed network.

While the simplest method of synchronizing FieldDAQ devices over a network is to use the default IEEE 802.1AS protocol, the FieldDAQ devices can optionally be configured to use the IEEE 1588 "Delay Request-Response Default PTP" profile instead. The FieldDAQ devices do not support synchronizing with other 1588 profiles. For an example of synchronizing with this IEEE 1588 profile, see the tutorial "Synchronizing FieldDAQ and TSN-Enabled Ethernet cDAQ Chassis to a PXI System" by visiting [ni.com/info](http://ni.com/info) and entering fd1588.

## More Information about Synchronization

The following documents will help you overcome typical hurdles in getting started with synchronized measurements:

- Synchronizing analog input FieldDAQ devices with NI-DAQmx in LabVIEW—Visit [ni.com/info](https://ni.com/info) and enter fdaisync.
- Designing Ethernet measurement systems for synchronization, considering topologies, masters, and third party devices—If topology changes result in a device's master changing, executing tasks may be affected. Visit [ni.com/info](https://ni.com/info) and enter fdenet.
- How to achieve high accuracy measurements—Visit [ni.com/info](https://ni.com/info) and enter fdsync.
- Synchronization accuracy explained—Visit [ni.com/info](https://ni.com/info) and enter syncacc.
- Synchronizing FieldDAQ and TSN-Enabled Ethernet cDAQ Chassis to a PXI System—Visit [ni.com/info](https://ni.com/info) and enter fd1588.

## Ethernet Ports and Networking

The Ethernet Network Interface transfers data between the FieldDAQ device and the network. It gathers the data into TCP/IP packets that can be sent across the network and interpreted by the host.

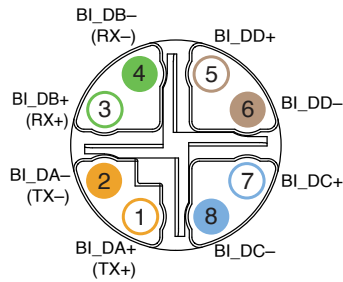


**Note** Refer to [Setting up the FieldDAQ Device](#) or [Connecting to a Real-Time Controller](#) for information about connecting the FieldDAQ device to a host computer or host real-time controller.

## Ethernet Ports

The FieldDAQ device has two 8-pinX-coded M12 Ethernet ports—0 and 1. You can use a shielded straight-through Ethernet or an Ethernet crossover cable with either of the Ethernet ports to network your device to a computer host, NI Linux Real-Time controller, another FieldDAQ device, or any network connection on the same subnet. Refer to [Topology Options](#) for more information about using these ports in various topologies.

Figure 26. Ethernet Connector Pinout



Pin Number	Wire Color	Gigabit Ethernet Signal	Fast Ethernet Signal
1	Orange/White	BI_DA+	TX+
2	Orange	BI_DA-	TX-
3	Green/White	BI_DB+	RX+
4	Green	BI_DB-	RX-
5	Brown/White	BI_DD+	No Connect
6	Brown	BI_DD-	No Connect
7	Blue/White	BI_DC+	No Connect
8	Blue	BI_DC-	No Connect

Table 8. Signal Descriptions

You can use the Ethernet ports to reset the FieldDAQ device to factory-default settings. Refer to [Resetting the FieldDAQ to Factory-Default Settings](#) for more information.

Cap the Ethernet ports when not in use.

## Ethernet LEDs

Each Ethernet port has a green LED that indicates network activity and link speed.

LED State	Device Status
On	Ethernet link
Blinking, fast (12 blinks/s)	Ethernet activity. Connected at 1,000 Mbit/s.
Blinking, moderate (6 blinks/s)	Ethernet activity. Connected at 100 Mbit/s.
Blinking, slow (3 blinks/s)	Ethernet activity. Connected at 10 Mbit/s.

LED State	Device Status
Off	No Ethernet connection

Table 11. LED State/Device Status

## Internal Ethernet Switch

The FieldDAQ device features a full hardware-accelerated internal Ethernet switch for greater performance, wiring flexibility, and compatibility over standard Ethernet ports. The Ethernet switch exposes two Ethernet ports to the user. Either port can be used to connect the device to the network. The two ports can be used to connect multiple devices in a daisy-chain topology. The switch also supports the Rapid Spanning Tree Protocol (RSTP) algorithm, enabling ring topologies. Refer to [Topology Options](#) for more details.

### IEEE 802.1AS-2011 Precision Time Protocol

The internal Ethernet switch is an IEEE 802.1AS time-aware bridge, compatible with the IEEE 802.1AS-2011 Precision Time Protocol. It can synchronize local measurement signals to other devices across an IEEE 802.1AS subnet. It can also serve as a bridge, synchronizing IEEE 802.1AS devices that are attached to each of the two ports. Refer to [Synchronization across a Network](#) for more details.

### IEEE 802.1Q Rapid Spanning Tree Protocol (RSTP)

It is possible to create loops in a network using the FieldDAQ device. To prevent these loops from disrupting the network, the FieldDAQ device implements the IEEE 802.1Q Rapid Spanning Tree Protocol (RSTP). Using this protocol, each FieldDAQ device can find the shortest path for incoming packets to reach the rest of the network. When multiple paths exist, this adds a form of redundancy. If a link fails, the protocol automatically switches to use the redundant link. This process can take several seconds in some cases.

To gain these benefits on external switches connected to the FieldDAQ device, IEEE 802.1Q (RSTP) must be enabled. All external switches must be configured to allow the FieldDAQ device to transmit RSTP packets, known as Bridge Protocol Data

Units (BPDU). If any switch has a feature—such as “BPDU guard”—enabled, the port connected to the FieldDAQ device is disabled and communication is lost. Refer to the documentation for your external switch for information about enabling RSTP and disabling BPDU guards on the switch.

## IEEE 1588-2008 Protocol

The internal Ethernet switch can be configured to act as a 1588 "boundary clock" implementing the IEEE 1588 delay request-response default PTP profile (sometimes referred to as "default profile"). When so configured, it can synchronize local measurement signals to other devices across an IP subnetwork and can serve as a bridge, synchronizing 1588 devices that are attached to each of the two ports. Refer to [Synchronization across a Network](#) for more details.



**Note** The IEEE 802.1AS protocol is an IEEE 1588 profile, but is incompatible with other IEEE 1588 profiles. When FieldDAQ devices are using the IEEE 802.1AS protocol to synchronize they cannot synchronize with devices that use other protocols or IEEE 1588 profiles and vice versa.

## FieldDAQ MAC Addresses

The FieldDAQ device is associated with two MAC addresses—both of which are labeled on the device—device and switch. These MAC addresses are not associated with a particular Ethernet port, but both addresses can appear on both ports as necessary.

Device MAC Address	Switch MAC Address
Associated with the device's IP address	Associated with the internal Ethernet switch—not associated with the device's IP address
Used by normal device traffic	Used for Ethernet protocols for network configuration and synchronization
Listed in MAX	Not listed in MAX

Table 10. NI MAX Device and Switch MAC Addresses

The switch MAC address is used to implement the following switch protocols:

- IEEE 802.1AS-2011 (Precision Time Protocol)
- IEEE 802.1Q (Rapid Spanning Tree Protocol [RSTP])
- IEEE 1588-2008 (Precision Time Protocol)

The switch MAC address only appears in packets exchanged between the switch embedded in the FieldDAQ device and the next Ethernet device. It will not propagate further in a properly configured network. For more information about the recommended configurations for networking the FieldDAQ device, refer to [Topology Options](#).

## Topology Options

Recommended networking topologies are described in this section.

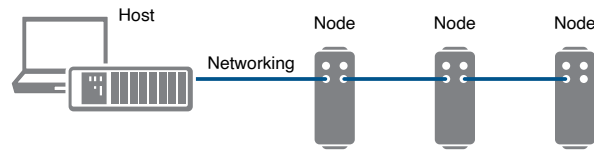
- **Host**—Can be a Windows computer or a real-time controller with the NI Linux Real-Time operating system, such as the IC-317x, cRIO-9035/9039 Sync, cRIO-904x/905x, or cDAQ-9132/9133/9134/9135/9136/9137 for LabVIEW Real-Time
- **Node**—Can be any FieldDAQ device or IEEE 802.1AS-compliant CompactDAQ chassis, such as the cDAQ-9185/9189

For more information about designing Ethernet measurement systems, visit [ni.com/info](http://ni.com/info) and enter fdenet.

### Line Topology

In a line topology—also known as daisy-chaining or bus topology—the host communicates directly with all nodes through one bus line. A standard Ethernet device or switch can be added to the end of the chain if desired and used as normal. Be aware that these devices will compete for network bandwidth with the FieldDAQ device. Reliable system design requires awareness of the bandwidth consumed by each device during operations. This topology offers no redundant links.

Figure 27. Line Topology



### Advantages:

- Simple and inexpensive installation, expansion, and troubleshooting
- Ideal for low number of nodes. NI recommends a maximum of 15 nodes.
- No external switch needed
- Can cover long distances

### Disadvantages:

- Any unpowered nodes and/or node failure disrupts network communication
- Addition or removal of any node disrupts network communication
- Failure of any Ethernet cable and/or improper cable termination disrupts network communication
- Network performance and synchronization affected when node count exceeds 15. Consider the [Star Topology](#) for systems that require a greater number of nodes.

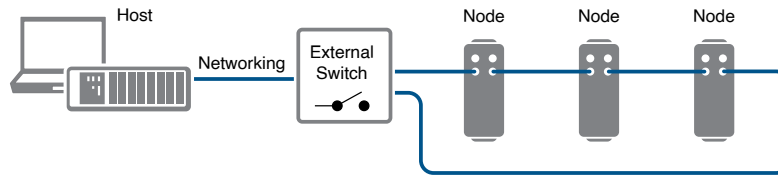


**Note** For information about daisy-chaining power, refer to [Power Connectors and Wiring](#).

## Ring Topology

In a ring topology, the host communicates with all nodes through the most effective path. You must use an external switch in a ring topology. You must configure the network properly with a recommended external switch before creating redundant links in the network. Refer to [External Switch Requirements](#) for information about what to look for in an external switch.

Figure 28. Ring Topology



### Advantages:

- Failure of any single Ethernet cable does not disrupt network communication
- Additional nodes or heavier network traffic affects network performance less than the line topology
- Simple installation
- Ideal for a local networking solution



**Note** Network configuration and programming require careful consideration. Visit [ni.com/info](http://ni.com/info) and enter fdenet for information about exploiting link redundancy and automatically improving reliability.

### Disadvantages:

- Network traffic patterns can make troubleshooting difficult
- Requires an external switch



**Note** For information about daisy-chaining power, refer to [Power Connectors and Wiring](#).

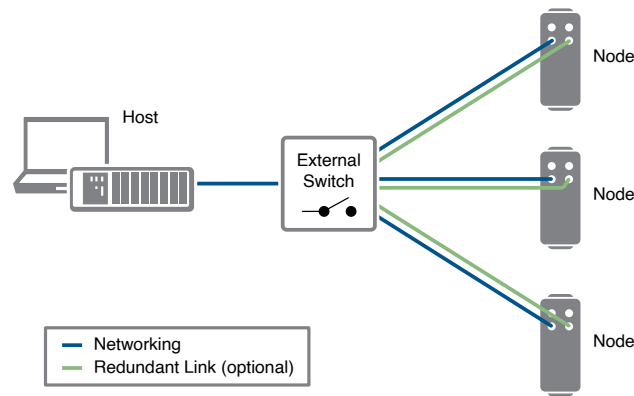
## Star Topology

In a star topology, the host communicates directly with each node through the external switch. You must use an external switch in a star topology; for network synchronization, you must use an external IEEE 802.1AS switch. Redundant links are recommended, but optional, in this topology. You must configure the network properly with a recommended external switch before creating redundant links in



the network. Refer to [External Switch Requirements](#) for information about what to look for in an external IEEE 802.1AS switch.

Figure 29. Star Topology



#### Advantages:

- Unpowered nodes and/or node failure does not disrupt network communication with other nodes
- Failure of any single Ethernet cable does not disrupt network communication when you have a redundant link
- Additional nodes or heavier network traffic affects network performance less than the other topologies
- Simple installation, expansion, and troubleshooting



**Note** Network configuration and programming require careful consideration. Visit [ni.com/info](http://ni.com/info) and enter fdenet for information about exploiting link redundancy and automatically improving reliability.

#### Disadvantages:

- Most costly of the recommended topologies
- Requires an external switch (external IEEE 802.1AS switch for network synchronization)
- Covers the least distance



**Note** For information about daisy-chaining power, refer to [Power Connectors and Wiring](#).

## Other Topologies

For information about designing Ethernet measurement systems for synchronization, visit [ni.com/info](http://ni.com/info) and enter fdenet.

## External Switch Requirements

To meet the minimum requirements for successful operation with FieldDAQ devices, any switch directly connected to the FieldDAQ device should be compliant with IEEE 802.1Q bridges and bridged networks.

To take advantage of the network synchronization and network redundancy features of the FieldDAQ device, ensure that your network infrastructure meets certain requirements:

- IEEE 802.1AS–2011 time-based synchronization support—Automatically synchronizes timebases and enables the use of time-based triggers and multi-device tasks between device across the network.
- IEEE 802.1Q (Rapid Spanning Tree Protocol) support—Supports network redundancy functionality in ring and star topologies
  - Rapid Spanning Tree Protocol (RSTP) enabled
  - Bridge Protocol Data Units (BPDU) Guard disabled

To learn more about recommended network switches and other network configuration best practices and requirements, visit [ni.com/info](http://ni.com/info) and enter fdenet.

## Connecting to a Real-Time Controller

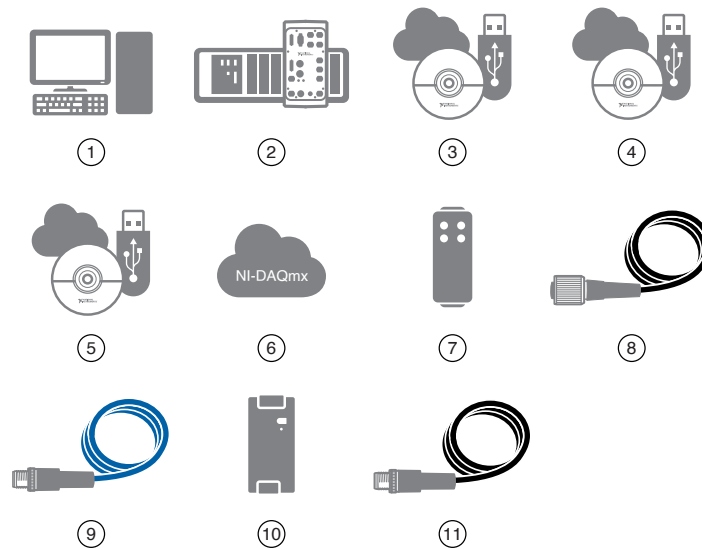
You can use the FieldDAQ device as expansion I/O from certain NI Linux Real-Time controllers. Discover and configure the NI Linux Real-Time controller in NI MAX, then discover and configure the FieldDAQ device.



**Note** When using an NI Real-Time controller as the host, you can only use select controllers with the NI Linux Real-Time operating system that support NI-DAQmx. Supported NI Linux Real-Time controllers include the IC-317x, cRIO-9035/9039 Sync, cRIO-904x/905x, and cDAQ-9132/9133/9134/9135/9136/9137 for LabVIEW Real-Time.<sup>[3]</sup>

To network the FieldDAQ device to a Real-Time controller, you need the following items.

Figure 1. FieldDAQ Installation Supply List



1. Host Computer
2. Supported Real-Time Controller
3. LabVIEW Software, if not already installed
4. LabVIEW Real-Time Module, if not already installed
5. Driver for the Real-Time Controller, if not already installed
6. NI-DAQmx Driver, if not already installed
7. FieldDAQ Device
8. 5-pin L-coded M12 Power Input Cable
9. 8-pin X-coded M12 Ethernet Cable
10. External Power Supply
11. 5-pin A-coded M12 I/O Cables and Accessories



**Note** LabVIEW Real-Time 2017 or later required to use the FieldDAQ synchronization features.



**Note** You can either use a shielded straight-through Ethernet cable or an Ethernet crossover cable to connect the FieldDAQ device directly to your computer.

Complete the following steps.

1. Install the LabVIEW, LabVIEW Real-Time Module, and controller driver software on the host machine as instructed in the getting started or quick start document for the Real-Time controller.
2. Install NI-DAQmx on the host machine if the driver was not installed in step 1.
  1. Download NI-DAQmx from [ni.com/downloads/drivers](http://ni.com/downloads/drivers). Complete the instructions.
  2. Register your NI hardware online at [ni.com/register](http://ni.com/register) when prompted.
  3. Download NI-DAQmx to the target using MAX. Refer to the **MAX Remote Systems Help** by selecting Help » Help Topics » Remote Systems in MAX.  
If you have problems installing your software, go to [ni.com/support/daqmx](http://ni.com/support/daqmx).
3. Set up your Real-Time controller hardware and install software to it as instructed in the getting started or quick start document for the Real-Time controller.
4. For CompactRIO and IC controllers, perform a custom installation of the NI-DAQmx feature to the controller. In MAX, expand Remote Systems » **your Real-Time Controller**, and use the Add/Remove Software option. Select the custom installation option and the NI-DAQmx feature, then follow the prompts to complete the installation.
5. Make signal connections for your application.
6. Align and connect one end of the Ethernet cable to Ethernet port 0 on the FieldDAQ device, and the other end to a switch or network connection on the same subnet as your Real-Time controller, or directly to an open network port on your Real-Time controller. For more information about the recommended configurations for networking the FieldDAQ device in a Real-Time system, refer to [Topology Options](#).
7. Power the device by aligning and connecting the power IN port on FieldDAQ to an external 9 V DC to 30 V DC power source with the 5-pinL-coded M12 power cable. For information about wiring your external power source to

the power connector, refer to [Wiring External Power to the FieldDAQ Device](#). The FieldDAQ device requires an external power supply that meets the specifications listed in the **FD-11601 Specifications** .

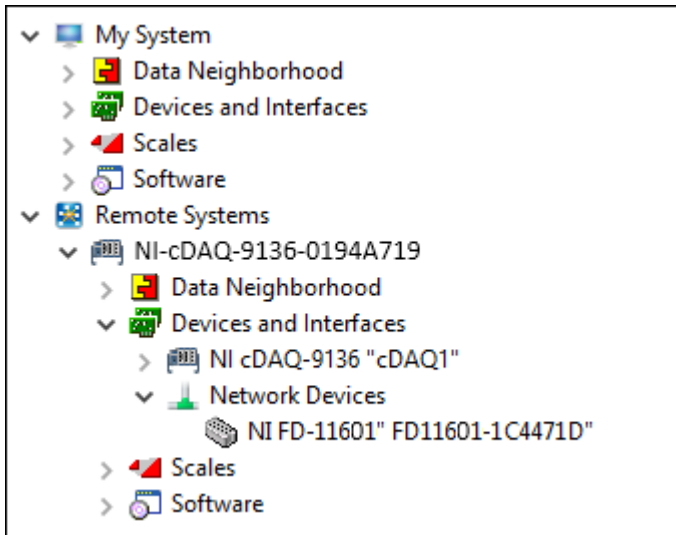
The Power LED turns on. Refer to [Power LED](#) for information about Power LED status.

8. To add the FieldDAQ to the software configuration on the Real-Time target, open NI MAX on the host computer. In the MAX configuration tree, expand Remote Systems » **your Real-Time Controller** » Devices and Interfaces » Network Devices.
9. Click Add Network Device, and then Find Network NI-DAQmx Devices.
10. In the Find Network NI-DAQmx Devices dialog box that opens, do one of the following:
  - Check the box that corresponds to your device in the Hostname column.
  - If you know the device IP address, such as 192.168.0.2, enter it into the Add Device Manually field of the Find Network NI-DAQmx Devices window, and click the + button.
  - Enter the hostname of the device. The default hostname is FD11601-**<serial number>**.

If your FieldDAQ device does not appear in Available Devices, click Refresh List. If the device still does not appear, contact your system administrator to confirm that the network is working and that a firewall is not interfering with discovery. For additional troubleshooting resources for the FieldDAQ device, refer to [Troubleshooting Device Connectivity](#) in this guide and the **Finding a Network DAQ Device in MAX** topic in the **Measurement & Automation Explorer Help for NI-DAQmx**.

11. Click Add Selected Devices. The FieldDAQ device is added under the Real-Time controller in the MAX configuration tree.

Figure 31. Adding the FieldDAQ Device to the Real-Time Controller in MAX



12. If the FieldDAQ device is not reserved automatically, select the device and click the Reserve Network Device button. Refer to [Reserving the Device in MAX](#) for more information.
13. Self-test your device in MAX by expanding Devices and Interfaces » Network Devices, right-clicking your FieldDAQ device, and selecting Self-Test. Self-test performs a brief test to determine successful device installation. When the self-test finishes, a message indicates successful verification or if an error occurred. If an error occurs, refer to [ni.com/support/daqmx](http://ni.com/support/daqmx).
14. Run a Test Panel in MAX by expanding Devices and Interfaces » Network Devices » **your FieldDAQ device**, right-clicking the bank of connectors in your FieldDAQ device, and selecting Test Panels. If the test panel displays an error message, refer to [ni.com/support](http://ni.com/support). Click Close to exit the test panel.



**Note** When in use, the FieldDAQ device may become warm to the touch. This is normal.



**Note** M12 connectors must be mated to cables or have caps installed on them to meet IP65/IP67 requirements. Cover the unused connectors with the included plastic caps whenever water, dust, or dirt are present.



**Note** Avoid long periods of exposure to sunlight.

## Troubleshooting Device Connectivity

If your FieldDAQ device becomes disconnected from the network, open MAX and try the following:

- After moving the device to a new network, NI-DAQmx may lose connection to the device. In this case, click **Reconnect** to provide NI-DAQmx with the new hostname or IP address.
- The FieldDAQ device icon indicates whether it is recognized and present on the network. If a connected device appears as disconnected in the configuration tree in MAX, select **Self-Test** or **Reset**. If successful, the device icon changes to dark grey.

Figure 32. MAX Icons and States



1. Discovered, but Not Added to the Network
2. Recognized, Present, and Reserved on the Network
3. Recognized, but Disconnected from the Network, Unreserved, or Reserved by Another Host

For additional troubleshooting resources for the FieldDAQ device, refer to the **Finding a Network DAQ Device in MAX** topic in the **Measurement & Automation Explorer Help for NI-DAQmx**.

## Reserving the Device in MAX

When the FieldDAQ device is connected to a network, multiple users can access the device. To perform any DAQ functionality on the device, including reset and self-test, you must reserve the device in MAX. In MAX, an unreserved device or device



reserved by another host appears with an X and a reserved device appears as dark grey. Only one user at a time can reserve the FieldDAQ device.

If the device was not reserved automatically after it was added (Add Device), you can reserve the device in MAX by expanding Devices and Interfaces » Network Devices, selecting the device, and clicking the Reserve Network Device button. The Override Reservation dialog box opens when you attempt to explicitly reserve a device. Agreeing to override the reservation forces the FieldDAQ device to be reserved by the current user.

## STATUS LED

The FieldDAQ device has a STATUS LED.

LED Color and State	Device Status
Off	Device is reserved by NI-DAQmx but there is no activity, the device is not powered, or the device is not reserved by NI-DAQmx.
Yellow, solid	Device firmware is booting or updating.
Red, blinking	Device has reset to factory default or the firmware image is corrupted. If you are not performing a factory default reset, as listed in <a href="#">Resetting the FieldDAQ to Factory-Default Settings</a> , contact NI for support on corrupted firmware.
Green, solid	Device is reserved and an NI-DAQmx task is running.

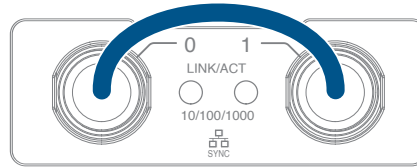
Table 11. LED State/Device Status

## Resetting the FieldDAQ to Factory-Default Settings

To reset your FieldDAQ device to factory-default settings, complete the following steps.

1. Verify the power source is turned off.
2. Connect Ethernet port 0 and port 1 with an Ethernet cable.

Figure 33. Connecting Port 0 and Port 1



3. Turn on the power source to the device. After about 15 seconds, the STATUS LED blinks red indicating that the device has been restored to factory-default settings.
4. Reconnect the Ethernet port 0 to the host.
5. Turn off and then turn on the power source to the device.

The FieldDAQ device factory-set defaults are listed in the following table.

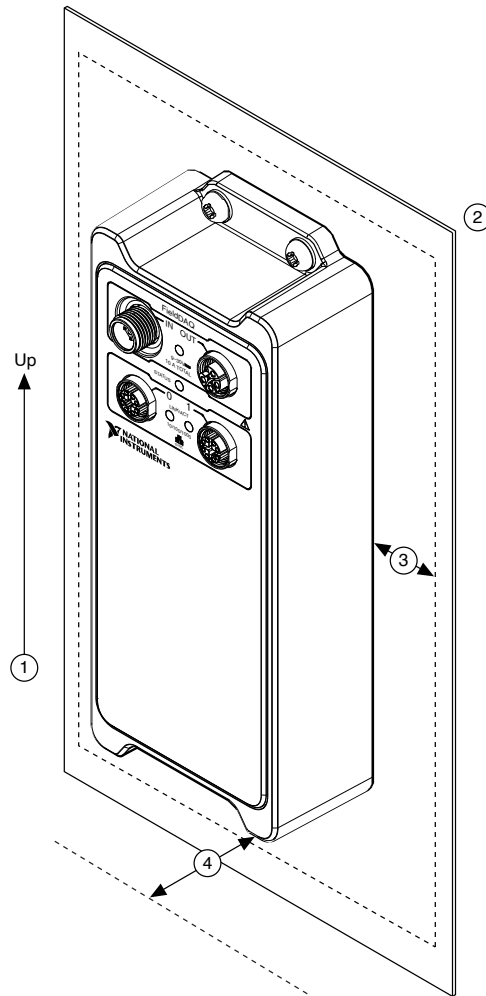
Attribute	Value
Hostname	FD11601-< <b>serial number</b> >
IP	DHCP or Link Local
Comment	Empty
Default login	User name = admin Password = no password required

Table 12. Device Default Settings

## Mounting

FieldDAQ can be mounted on any substrate in any orientation if the ambient temperature is 75 °C or less. However, to ensure proper functionality during use above 75 °C, you must mount the FieldDAQ device in the reference mounting configuration shown in the following figure. Observe the following guidelines to mount the FieldDAQ device in the reference mounting configuration.

Figure 34. Reference Mounting Configuration



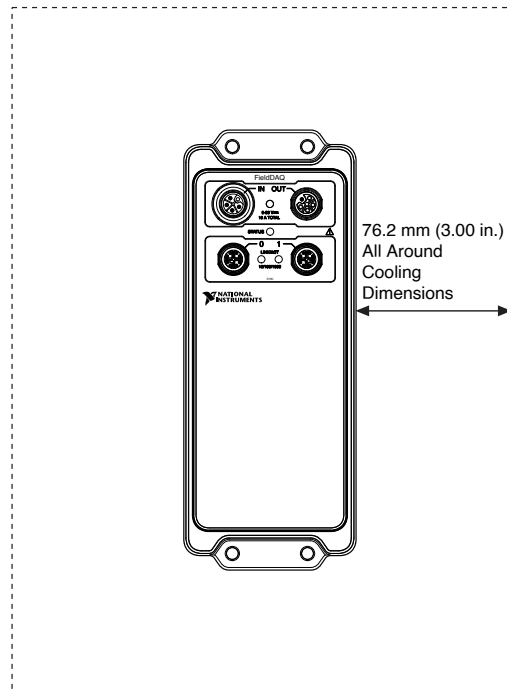
1. Vertical mounting orientation.
2. Mount the FieldDAQ device directly to a metallic surface that is at least 1.6 mm (0.062 in.) thick and extends a minimum of 76.2 mm (3 in.) beyond all edges of the device.
3. Observe the cooling dimensions in Mounting Requirements.
4. Allow space for cabling clearance according to the Mounting Requirements.

Before using any mounting methods, record the serial number from the back of the FieldDAQ device so that you can identify it in MAX. You will be unable to read the serial number after you mount the device.

## Mounting Requirements

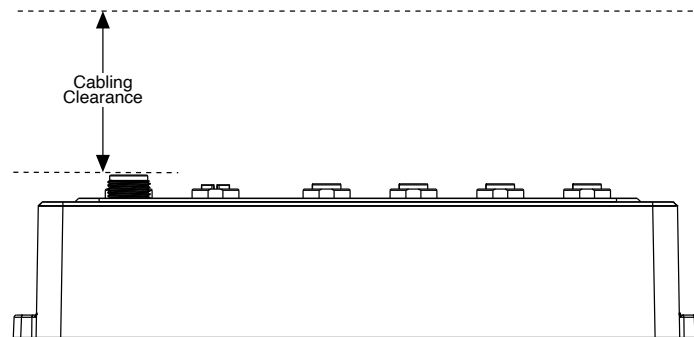
Your installation must meet the following requirements for cooling and cabling clearance. Allow 76.2 mm (3.00 in.) on all sides of the device for air circulation, as shown in the following figure.

Figure 35. Cooling Dimensions



Allow the appropriate space in front of the device for cabling clearance, as shown in the following figure.

Figure 36. Cabling Clearance



Measure the ambient temperature at each side of the FieldDAQ device, 76.2 mm (3.00 in.) from the side and 25.4 mm (1.00 in.) forward from the rear of the device. Refer to the following figures for ambient temperature locations for horizontal and vertical mounting configurations.

Figure 37. Ambient Temperature Locations, Horizontal Mounting Configuration

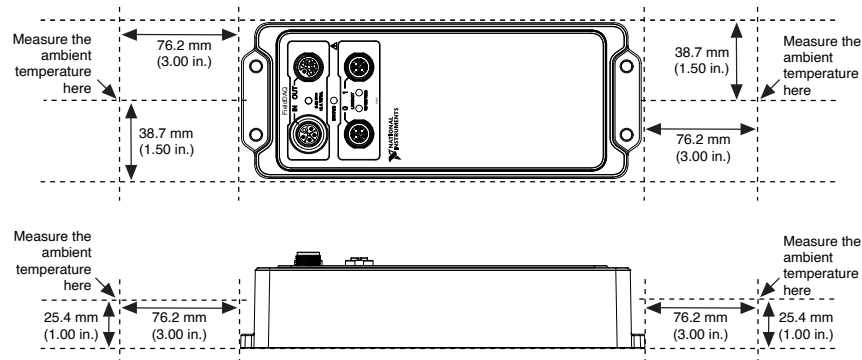
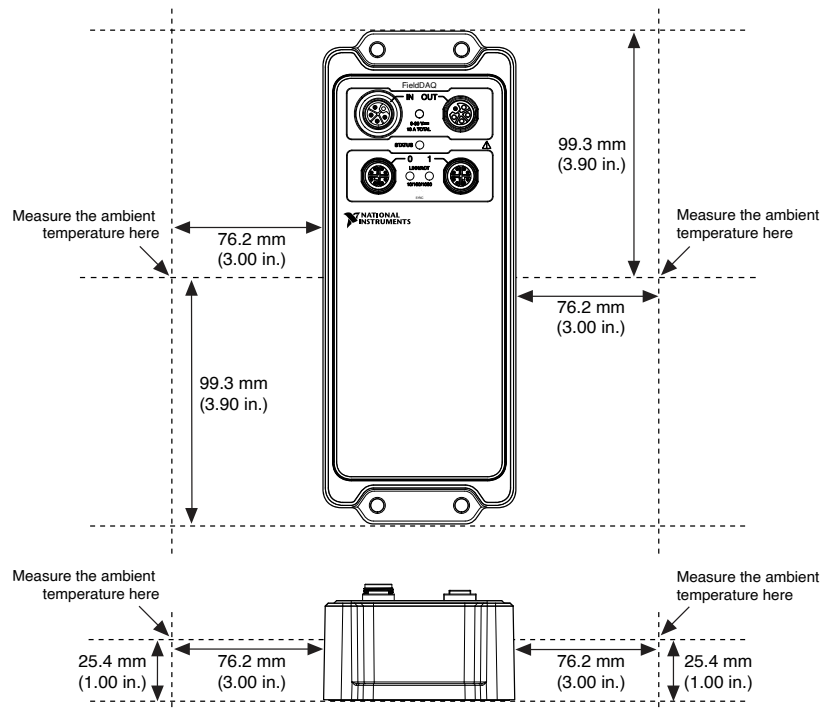


Figure 38. Ambient Temperature Locations, Vertical Mounting Configuration



## Dimensions

For detailed dimensional drawings and 3D models, visit [ni.com/dimensions](https://ni.com/dimensions) and search for FD-11601.

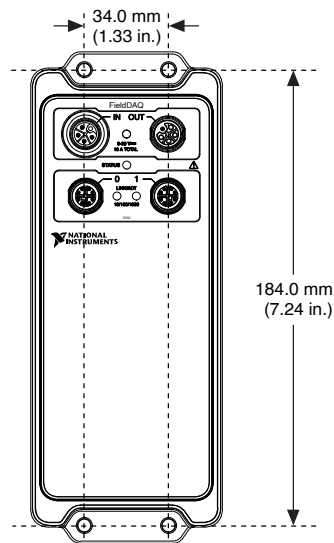
## Mounting the Device Directly on a Flat Surface

For environments with high shock and vibration, NI recommends mounting the FieldDAQ device directly on a flat, rigid surface using the mounting holes on the device. This mounting technique requires four M5 or 10-32 panhead or sockethead cap screws appropriate for the surface.

Complete the following steps to mount the FieldDAQ device directly on a flat surface.

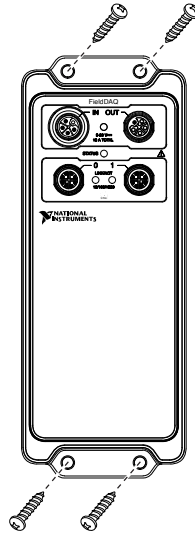
1. Prepare the surface for mounting the device using the surface mounting dimensions.

Figure 39. Surface Mounting Dimensions



2. Align the device on the surface.
3. Fasten the device to the surface using the M5 or 10-32 screws. Tighten the screws to a maximum torque of 2.5 N · m (25.0 lb · in.).

Figure 40. Fastening the Device to the Surface



## Alternate Mounting Configurations

The maximum operating temperature of 85 °C may be reduced for any mounting configuration other than the reference mounting configuration. A 10 °C (18 °F) reduction in maximum operating temperature is sufficient for most alternate mounting configurations. Follow the mounting requirements for all mounting configurations.

The published accuracy specifications, although not guaranteed for alternate mounting configurations, may be met depending on the system power and the thermal performance of the alternate mounting configuration.

Contact NI for further details regarding the impact of common alternate mounting configurations on maximum operating temperature and accuracy.

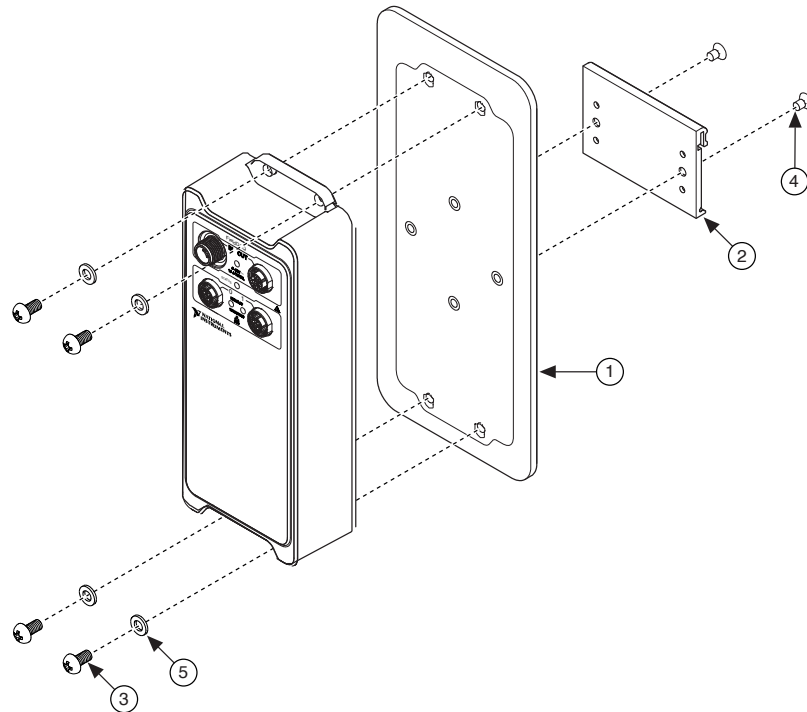
## Mounting the Device on a DIN Rail

The FD-11960 DIN rail mounting kit is an accessory you can use to mount a FieldDAQ device to a DIN rail. The hardware in the FD-11960 DIN rail mounting kit includes a bracket panel, a DIN rail clip, four M5 x 10 mm screws, four M5 washers, and two 8-32 x 1/4 in. screws.

Complete the following steps to install a FieldDAQ device onto a DIN rail using the FD-11960 DIN rail mounting kit.

1. Attach the FieldDAQ device to the bracket panel using the included M5 x 10 mm screws and M5 washers. The front of the bracket panel, which includes an outline of the FieldDAQ device, should be attached to the back of the FieldDAQ device.
2. Attach the DIN rail clip to the FieldDAQ device and bracket panel using the 8-32 x 1/4 in. screws included in the kit. Tighten the screws to a maximum torque of 1.3 N · m (11.5 lb · in.).

Figure 41. Attaching a FieldDAQ Device to the Bracket and DIN Rail Clip



1. Bracket panel
2. DIN rail clip
3. M5 x 10 mm screw
4. 8-32 x 1/4 in. screw
5. M5 washers

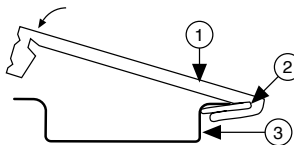




**Note** You can also horizontally mount the FieldDAQ device to the DIN rail.

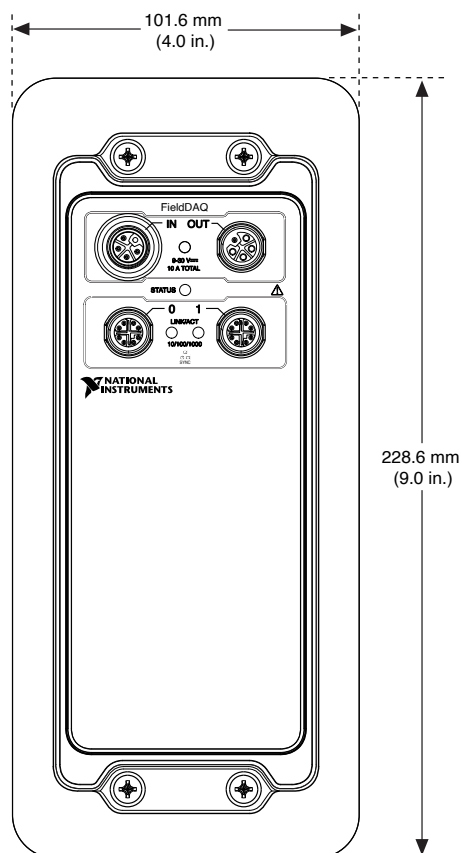
### 3. Clip the device onto the DIN rail.

Figure 42. DIN Rail Clip Parts Locator



1. DIN rail clip
2. DIN rail spring
3. DIN rail

Figure 43. FD-11960 Dimensions



## Calibration

The FD-11601 can be verified and adjusted. Refer to the **FD-11601 Calibration Procedure** for a detailed calibration procedure. Ensure that your driver software is updated to a version that supports calibration for your FieldDAQ device.

Driver	Earliest Version Support
NI-DAQmx	19.0

Table 13. FD-11601 Calibration Driver Support

## Firmware

Firmware can be updated through NI MAX or the web interface to the device. For FieldDAQ firmware information and updates, visit [ni.com/info](http://ni.com/info) and enter the Info Code dfw.

## Maintenance

If you need to clean your device, wipe it with a dry towel.



**Note** M12 connectors must be mated to cables or have caps installed on them to meet IP65/IP67 requirements. Cover the unused connectors with the included plastic caps whenever water, dust, or dirt are present.



**Note** Avoid long periods of exposure to sunlight.

## Where to Go from Here

This section lists where you can find example programs for the FieldDAQ device and relevant documentation.

## Example Programs

NI-DAQmx software includes example programs to help you get started programming with the FieldDAQ device. Modify example code and save it in an

application, or use examples to develop a new application, or add example code to an existing application.

To locate NI software examples, go to [ni.com/info](http://ni.com/info) and enter the Info Code daqmxexp.

To run examples without the device installed, use an NI-DAQmx simulated device. For more information, in Measurement & Automation Explorer (MAX), select Help » Help Topics » NI-DAQmx » MAX Help for NI-DAQmx and search for simulated devices.

## Related Documentation

Each application software package and driver includes information about writing applications for taking measurements and controlling measurement devices. The following references to documents assume you have NI-DAQmx 18.5 or later.

## FieldDAQ

The **FD-11601 Quick Start**, packaged with your device, describes how to install your NI-DAQmx for Windows software, how to set up your FieldDAQ device, and confirm that your device is operating properly.

The **FD-11601 Specifications** lists all specifications for your FieldDAQ device. Go to [ni.com/manuals](http://ni.com/manuals) and search for FD-11601.

The **FD-11601 Safety, Environmental, and Regulatory Information**, packaged with your device, includes important compliance precautions and connection information for your FieldDAQ device.

The **FD-11601 Calibration Procedure** contains information for calibrating your FieldDAQ device. Go to [ni.com/manuals](http://ni.com/manuals) and search for FD-11601.

## NI-DAQmx

The **NI-DAQmx Readme** lists which devices, ADEs, and NI application software are supported by this version of NI-DAQmx. Select Start » All Programs » National Instruments » NI-DAQmx » NI-DAQmx Readme.

The **NI-DAQmx Help** contains API overviews, general information about measurement concepts, key NI-DAQmx concepts, and common applications that are applicable to all programming environments. Select Start » All Programs » National Instruments » NI-DAQmx » NI-DAQmx Help.

## LabVIEW NXG

Refer to the **Taking NI-DAQmx Measurements** lessons to assist in getting started in LabVIEW NXG, beginning with **NI-DAQmx API Basics**. To access these lessons, enter taking NI-DAQmx measurements in the Search bar in LabVIEW NXG.

## Flexlogger

**Configuring I/O Channels** in the **Flexlogger Manual** presents information for configuring channels and logging data in FlexLogger. Go to [ni.com/info](http://ni.com/info) and enter the Info Code flexloggeriochannels.

## LabVIEW

Use the **LabVIEW Help**, available by selecting Help » LabVIEW Help in LabVIEW, to access information about LabVIEW programming concepts, step-by-step instructions for using LabVIEW, and reference information about LabVIEW VIs, functions, palettes, menus, and tools. Refer to the following locations on the Contents tab of the **LabVIEW Help** for information about NI-DAQmx:

- VI and Function Reference » Measurement I/O VIs and Functions » DAQmx – Data Acquisition VIs and Functions—Describes the LabVIEW NI-DAQmx VIs and functions.
- Property and Method Reference » NI-DAQmx Properties—Contains the property reference.
- Taking Measurements—Contains the conceptual and how-to information you need to acquire and analyze measurement data in LabVIEW, including common measurements, measurement fundamentals, NI-DAQmx key concepts, and device considerations.

## LabVIEW Real-Time

The **Real-Time Module Concepts** book of the **LabVIEW Real-Time Module Help** includes conceptual information about real-time programming techniques, application architectures, and Real-Time Module features you can use to create real-time applications. Refer to the **Real-Time Module Concepts** before attempting to create a deterministic real-time application.

## LabWindows/CVI

The Data Acquisition book of the **LabWindows/CVI Help** contains **Taking an NI-DAQmx Measurement in LabWindows/CVI**, which includes step-by-step instructions about creating a measurement task using the DAQ Assistant. In LabWindows™/CVI™, select Help » Contents, then select Using LabWindows/CVI » Data Acquisition. This book also contains information about accessing detailed information through the **NI-DAQmx Help**.

The NI-DAQmx Library book of the **LabWindows/CVI Help** contains API overviews and function reference for NI-DAQmx. Select Library Reference » NI-DAQmx Library in the **LabWindows/CVI Help**.

## Microsoft Visual Studio Support

You can use the NI-DAQmx .NET class library to communicate with and control an NI data acquisition (DAQ) device. Documentation for the NI-DAQmx .NET class library is available by selecting Start » All Programs » National Instruments » NI-DAQmx » NI-DAQmx Documentation and then opening the NINETDAQmxFxXX.chm help file corresponding to the version of NI-DAQmx .NET Framework language support you have installed.

- **Measurement Studio Support for NI-DAQmx**—If you program your NI-DAQmx-supported device in Visual Studio using Visual C# or Visual Basic .NET, you can interactively create channels and tasks using Measurement Studio and the DAQ Assistant. Additionally, you can use Measurement Studio to generate the configuration code based on your task or channel. Refer to the **DAQ Assistant Help** for additional information about generating code.

To create an NI-DAQmx application using Visual Basic .NET or Visual C#, follow these general steps:

1. In Visual Studio, select File » New » Project to launch the New Project dialog box.
  2. Choose a programming language (Visual C# or Visual Basic .NET), and then select Measurement Studio to see a list of project templates.
  3. Select NI DAQ Windows Application. Choose a project type. You add DAQ tasks as a part of this step.
- **.NET Languages without NI Application Software**—With the Microsoft .NET Framework, you can use the NI-DAQmx .NET class library to create applications using Visual C# and Visual Basic .NET without Measurement Studio. Refer to the **NI-DAQmx Readme** for specific versions supported.

## ANSI C without NI Application Software

The **NI-DAQmx Help** contains API overviews and general information about measurement concepts. Select Start » All Programs » National Instruments » NI-DAQmx » NI-DAQmx Help.

The **NI-DAQmx C Reference Help** describes the NI-DAQmx Library functions, which you can use with National Instruments data acquisition devices to develop instrumentation, acquisition, and control applications. Select Start » All Programs » National Instruments » NI-DAQmx » Text-Based Code Support » NI-DAQmx C Reference Help.

### Training Courses

If you need more help getting started developing an application with NI products, NI offers training courses. To enroll in a course or obtain a detailed course outline, refer to [ni.com/training](http://ni.com/training).

### Technical Support on the Web

For additional support, refer to [ni.com/support](http://ni.com/support) or [ni.com/examples](http://ni.com/examples).

Many DAQ specifications and user guides and manuals are available as PDFs. You must have Adobe Reader 7.0 or later (PDF 1.6 or later) installed to view the PDFs. Refer to the Adobe Systems Incorporated website at [www.adobe.com](http://www.adobe.com) to download Adobe Reader. Refer to the National Instruments Product Manuals Library at [ni.com/manuals](http://ni.com/manuals) for updated documentation resources.

<sup>1</sup> Configurable filtering is supported in NI-DAQmx 18.6 and later. Previous versions of NI-DAQmx support only brickwall filtering.

<sup>2</sup> Configurable filtering is supported in NI-DAQmx 18.6 and later. Previous versions of NI-DAQmx support only brickwall filtering.

<sup>3</sup> The cDAQ-9138/9139 for LabVIEW Real-Time controllers will not work in this configuration.