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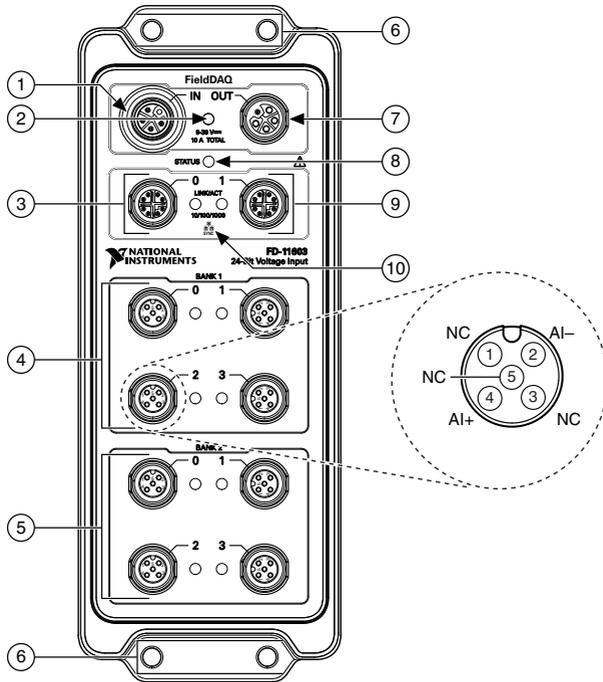
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FD-11603

8-Channel Voltage Input Device for FieldDAQ™

The FieldDAQ FD-11603 is an IP65/IP67-rated eight-channel simultaneous voltage input device that can be networked and synchronized with IEEE 802.1AS devices.

Figure 1. FD-11603 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

Contents

FD-11603 Basic Information

Kit Contents

Items in your FieldDAQ kit:

- FD-11603
- *FD-11603 Quick Start*
- *FD-11603 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* on page 14.
- Ethernet connector pinout: Refer to *Ethernet Ports* on page 21.
- Power connector pinout: Refer to *Power Connectors* on page 11.

Driver Support

Earliest driver support version for your FieldDAQ device:

Table 1. FD-11603 Driver Support

Driver	Earliest Version Support
NI-DAQmx	17.6

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-11603 product page at *ni.com*.

Table 2. FD-11603 Cables and Accessories

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, 2 m lengths)	786173-0R3/01/02
SHM128M-RJ45 Ethernet Cable (1 m, 2 m, 3 m, 10 m lengths)	785944-01/02/03/10

Table 2. FD-11603 Cables and Accessories (Continued)

Cable/Accessory	Part Number
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, I/O and Ethernet	786181-01
M12 Torque Wrench, Power	786181-02
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-11603 Documentation

Documents that contain information about your FieldDAQ device:

- *FD-11603 Specifications*
- *FD-11603 Quick Start*
- *FD-11603 Safety, Environmental, and Regulatory Information*

Safety Guidelines

⚠ **Caution** Do not operate the FD-11603 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 National Instruments for repair.

The FD-11603 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.

Electromagnetic Compatibility 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 or commercial 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 National Instruments could void your authority to operate it under your local regulatory rules.

> (!) **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/certification* and search for the certificate.

> (!) **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-11603 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 *Safety Guidelines* 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 *ni.com/environment/weee*.
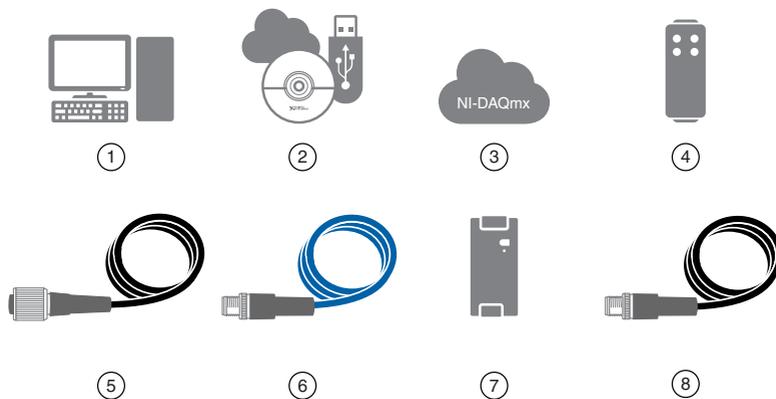
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What You Need to Get Started

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

Figure 2. FD-11603 Installation Supply List

1. Host Computer running Windows
2. Application Software
3. NI-DAQmx Driver
4. FD-11603
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 Voltage Input 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*. Complete the instructions.

3. Register your NI hardware online at *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*.

4. (Optional) Mount the FieldDAQ device to a panel, as described in *Mounting*.

5. Make voltage input connections. Refer to *Voltage Input Connectors and Measurements* for information about signal connections and guidelines.

6. Carefully 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 carefully aligning and connecting the power IN port on FieldDAQ to an external 9 V DC to 30 V DC power source with the 5-pin L-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-11603 Specifications*.

    The Power LED lights. 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:
            -   Check the box that corresponds to your device in the Hostname column.

Figure 3. Find Network NI-DAQmx Devices
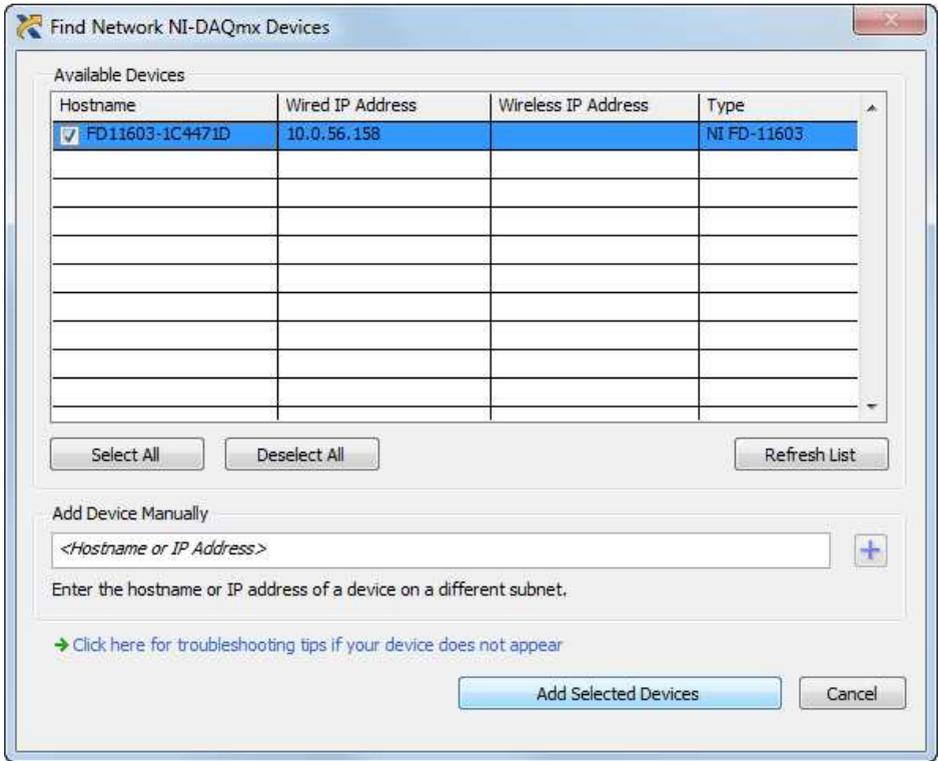
- – If you know the device IP address, such as 192.168.0.2, enter it into the **Add Device Manually** field of the Find Network NI-DAQmx Devices window, and click the + button.
- – Enter the hostname of the device. The default hostname is FD11603-<*serial number*>.

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
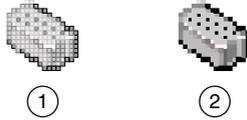
1. Discovered, but Not Added to the Network
2. Recognized, Present, and Reserved on the Network

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

– 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**.

– 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*.

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*. 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-pin L-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
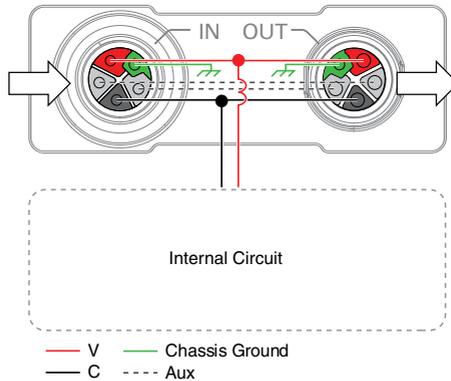
The FieldDAQ device requires an external power source connected between the V and C terminals, as described in *Power Requirements* in the *FD-11603 Specifications*. The FieldDAQ

device internally connects the C terminal to the chassis ground. Recommended NI power supplies are listed in *FD-11603 Basic Information*.

The FD-11603 has a maximum device power consumption of 7.5 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-11603 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
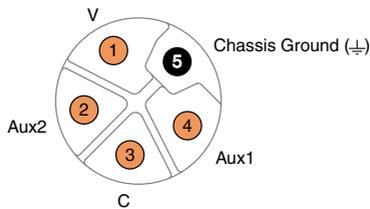
Table 3. Signal Descriptions

Pin Number	Signal	Description
1	V	Positive voltage line
2	Aux2	Optional line for powering non-FieldDAQ devices
3	C	Common. Negative voltage line
4	Aux1	Optional line for powering non-FieldDAQ devices
5	⏚	Chassis Ground. This terminal is internally connected to the C terminal.

Power LED

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

Table 4. LED State/Device Status

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

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.
   a) Connect the positive lead of the primary power source to the V terminal (pin 1) inside the power connector plug.
   b) Connect the negative lead of the primary power source to the C terminal (pin 3) inside the power connector plug.
   c) Connect the Chassis Ground terminal (pin 5) inside the power connector plug to earth ground. This terminal is internally connected to the C terminal.
   d) (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.
   e) 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-11603 Specifications* for information about the power supply input range. Refer to *Safety Voltages* in the *FD-11603 Specifications* for information about the maximum voltage from terminal to chassis ground.

Voltage Input Connectors and Measurements

The following figures show voltage input circuitry and block diagram of the FD-11603.
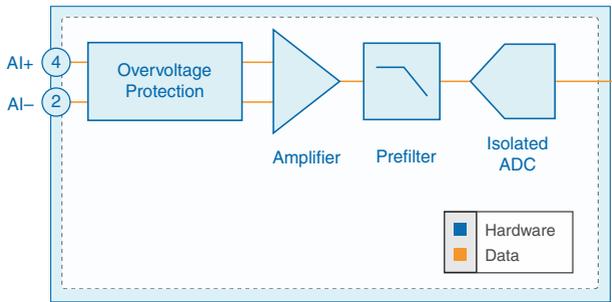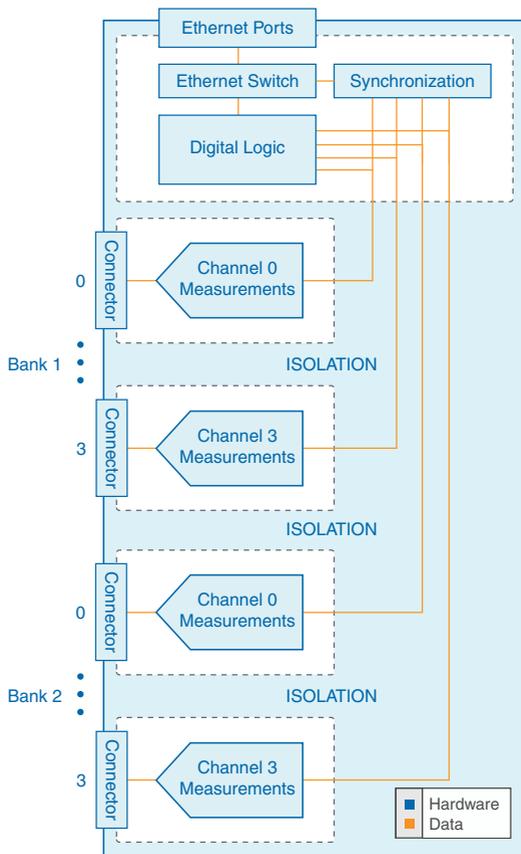
Figure 8. FD-11603 Input Circuitry

Figure 9. FD-11603 Block Diagram

The FD-11603 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-11603 Specifications* for more information about overvoltage protection.

Voltage Input Connectors

The FD-11603 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.
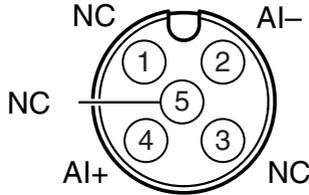
Figure 10. FD-11603 Pinout

Table 5. Signal Descriptions

Pin Number	Signal	Description
1, 3, 5	NC	No connect. Do not connect signals to this terminal.
2	AI-	Negative analog input voltage signal
4	AI+	Positive analog input voltage signal

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 a yellow LED.

Table 6. LED State/Status

| LED State	Connector Status
Off	Normal operation
Blinking	User-defined status. Use MAX to write a state to any LED by expanding **Devices and Interfaces»Network Devices»***your FieldDAQ device***»***bank of connectors in your FieldDAQ device* and configuring the LED settings on the Settings tab.

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 with the *FD-11603 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-11603 Specifications*.

Figure 11. Connecting Grounded Signal Sources to the FieldDAQ Device
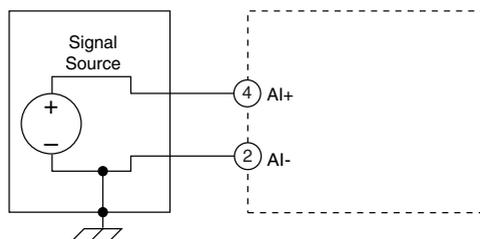
• **Floating Signal Sources**

**Figure 12.** Connecting Floating Signal Sources to the FieldDAQ Device
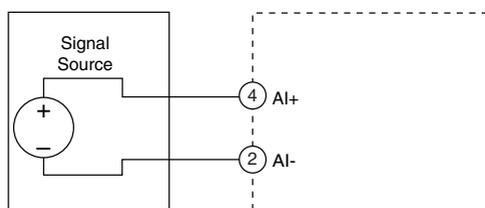
Filtering

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. The three important bandwidths to consider are the passband, transition band, and stopband. The FieldDAQ filters are designed to provide full alias protection from any signal component of more than one-half the sampled data rate. As such, the FieldDAQ filters track the sampled data rate and the frequency range of the passband, transition band, and stopband are all proportional to the sampled data rate.

*   **Passband**—The signals within the passband have frequency-dependent gain or attenuation. The small amount of variation in gain with respect to frequency is called the passband flatness. The following figure shows the typical passband flatness at three different sampled data rates. As the figure indicates, the passband always extends to 0.4 times the sampled data rate before the roll-off of the transition band begins. Refer to the *FD-11603 Specifications* for details on the amount of variation in the passband gain and signal delay you can expect for different frequency ranges.

Figure 13. Typical Passband Flatness
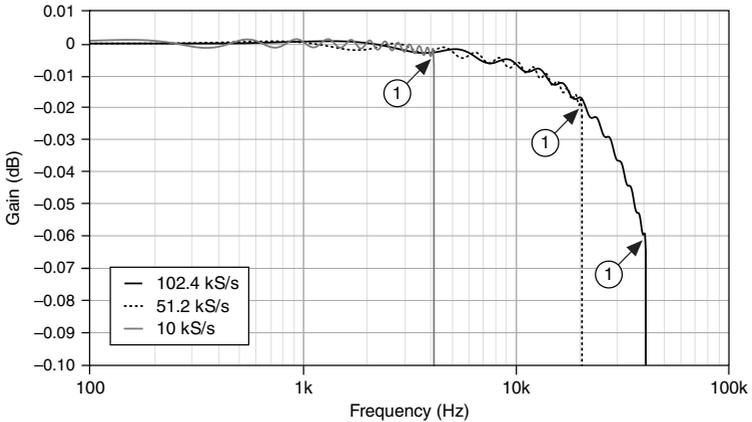
1. Roll-off starts at 0.4 times the data rate

*   **Transition Band**—The transition band spans the frequency range between 0.4 times and 0.5 times the sampled data rate. The transition band scales precisely with sampled data rate. The following figure shows the transition band frequency response and the beginning of the stopband response.

Figure 14. Transition Band and Stopband
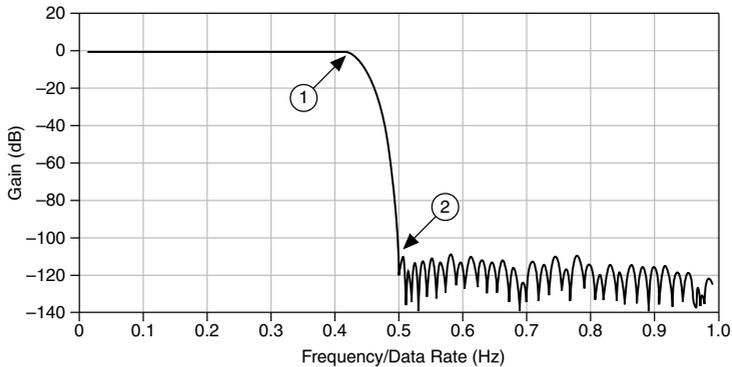
1. Transition band starts at 0.4 times the sampled data rate
2. Stopband starts at 0.5 times the sampled data rate

- **Stopband**—The filter significantly attenuates all signals above the stopband frequency. The primary goal of the filter is to prevent aliasing. Therefore, the stopband frequency scales precisely to equal 0.5 times the sampled data rate. The stopband rejection is the minimum amount of attenuation applied by the filter to all signals with frequencies within the stopband.

Data Rates

You can use the 13.1072 MHz, 12.8 MHz, 12.288 MHz, and 10.24 MHz timebases to generate the measurement signals. The FD-11603 supports data rates (f_s) between 500 Samples/s and 102.4 kSamples/s. Refer to *Timebases* in this guide and the *FD-11603 Specifications* for information about choosing the correct timebase for your data rate.

Programming the FieldDAQ Device

You can use the FieldDAQ device in the following analog input applications:
- Finite acquisition
- Continuous acquisition

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*

For more information about programming analog input applications and triggers in software, refer to the *NI-DAQmx Help* or the *LabVIEW Help* for more information.

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 15. AI Sample Clock Timing Options
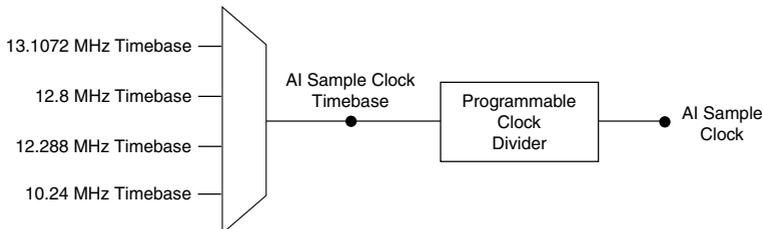
The FD-11603 is considered a Delta-Sigma device; it contains multiple A/D converters that require a high-frequency oversample clock to produce accurate, synchronized data. The FieldDAQ device returns a sample on every Sample Clock pulse.

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, the 12.8 MHz timebase is used.

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-11603 Specifications*.

When using multiple FieldDAQ devices in a task that contains channels for a Delta-Sigma device, such as the FD-11603, ensure that one of those channels is the first in your channel list.

AI Sample Clock Timebase Signal

The AI Sample Clock Timebase signal is divided down to provide a source for Sample Clock.

AI Start Trigger Signal

Use the Start Trigger signal to begin a measurement acquisition. A measurement acquisition consists of one or more samples. If you do not use triggers, begin a measurement with a software command. Once the acquisition begins, configure the acquisition to stop in one of the following ways:

- In finite mode, when a certain number of points has been sampled
- In continuous mode, with a software command

You can specify a default delay from the Start Trigger to the first sample.

Use the Start Trigger signal with a time source, by specifying a specific time in NI-DAQmx. Refer to the *Time Triggering* topic in the *NI-DAQmx Help* for more information on accessing time-based features in the NI-DAQmx API.

Analog Input Sync Pulse

You can use time as a trigger for sync pulses on the FieldDAQ device. To use a sync pulse with a time source, specify a specific time in NI-DAQmx. Refer to the *Time Triggering* topic in the *NI-DAQmx Help* for more information on accessing time-based features in the NI-DAQmx API.

Note To accurately synchronize Delta-Sigma devices in two or more separate tasks, you must specify the same sync pulse. Otherwise, a sync pulse is initiated by software implicitly, even if time start triggers are specified for the tasks. However, for multidevice tasks, the sync pulses and start triggers are automatically synchronized.

Time-Based Triggers

FieldDAQ devices feature automatic network-based synchronization with compatible networks and 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.

FieldDAQ devices can be daisy-chained together or connected to external networks that support 802.1AS synchronization, and all device timebases will be automatically synchronized. Refer to *Synchronization across a Network* for more information about supported topologies and other technical requirements.

Network-synchronized devices can also 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 devices) can help simplify programming for large systems.

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 802.1AS network-synchronized devices on your subnet.
- **Host Time**—The time on your 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-11603 clock routing circuitry and timebases.

Figure 16. Clock Routing Circuitry
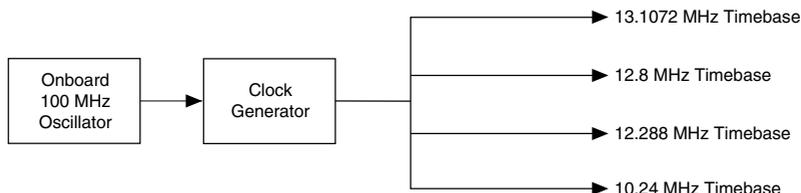
You can use the 13.1072 MHz, 12.8 MHz, 12.288 MHz, and 10.24 MHz timebases to generate the AI Sample Clock signals. These timebases are generated directly from the onboard clock generator. The default timebase is 12.8 MHz.

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

The onboard 100 MHz oscillator automatically synchronizes to other network-synchronized devices that are part of your local 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 802.1AS subnet. This enables measurement signals to be synchronized to other devices across a distributed network.

The FieldDAQ devices use the IEEE 802.1AS protocol over the network to synchronize. These devices cannot synchronize over the network with devices that use protocols or IEEE 1588 profiles other than IEEE 802.1AS.

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* 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* and enter `fdenet`.
- **How to achieve high accuracy measurements**—Visit *ni.com/info* and enter `fdsync`.
- **Synchronization accuracy explained**—Visit *ni.com/info* and enter `syncacc`.

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 devices has two 8-pin X-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.
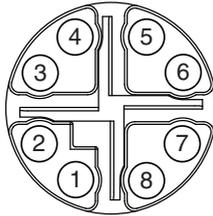
Figure 17. Ethernet Connector Pinout

Table 7. Signal Descriptions

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

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.

Table 8. LED State/Device Status

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.
Off	No Ethernet connection

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 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 802.1AS subnet. It can also serve as a bridge, synchronizing 802.1AS devices that are attached to each of the two ports. Refer to *Synchronization across a Network* for more details.

> **Note** FieldDAQ devices use the IEEE 802.1AS protocol over the network to synchronize. The IEEE 802.1AS protocol is an IEEE 1588 profile, but is incompatible with other IEEE 1588 profiles. These FieldDAQ devices cannot synchronize over the network with devices that use protocols or IEEE 1588 profiles other than IEEE 802.1AS.

IEEE 802.1Q-2014 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-2014 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, 802.1w (RSTP) must be enabled. All external switches must be configured to allow the FieldDAQ device to transmit 802.1w 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.

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.

Table 9. NI MAX Device and Switch MAC Addresses

Device MAC Address	Switch MAC Address
Associated with the device' 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

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

- IEEE 802.1AS-2011 (Precision Time Protocol)
- IEEE 802.1Q-2014 (Rapid Spanning Tree Protocol [RSTP] implemented)

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

For more information about designing Ethernet measurement systems, visit *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 18. Line Topology
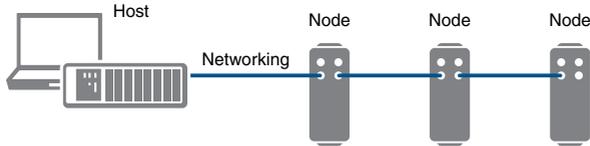
Advantages:
- Simple and inexpensive installation, expansion, and troubleshooting
- Ideal for low number of nodes. NI recommends a maximum of 15 nodes.
- No external switch needed
- Can cover long distances

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 19. Ring Topology
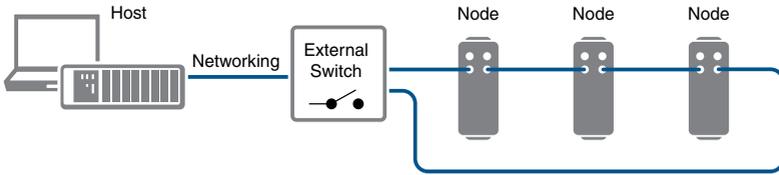
Advantages:

- 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* 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 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 802.1AS switch.

Figure 20. Star Topology
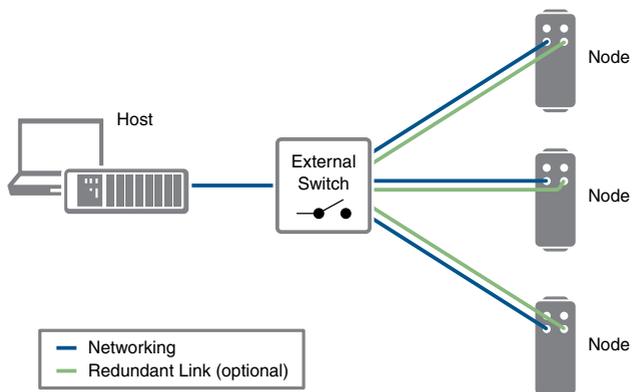
Advantages:

- 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* 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 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* 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-1998 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-2014 (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* 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-317*x*, cRIO-9035/9039 Sync, cRIO-904*x*, and cDAQ-9132/9133/9134/9135/9136/9137 for LabVIEW Real-Time.[1]

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

- Supported Real-Time controller
- LabVIEW software, if not already installed
- LabVIEW Real-Time Module, if not already installed[2]
- Driver for the Real-Time controller, if not already installed
- NI-DAQmx driver, if not already installed
- FieldDAQ device
- 5-pin L-coded M12 power cable
- 8-pin X-coded M12 Ethernet cable[3]
- External power supply

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[1] The cDAQ-9138/9139 for LabVIEW Real-Time controllers will not work in this configuration.
[2] LabVIEW Real-Time 2017 or later required to use the FieldDAQ synchronization features.
[3] 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.

   a. Download NI-DAQmx from *ni.com/downloads/drivers*. Complete the instructions.

   b. Register your NI hardware online at *ni.com/register* when prompted.

   c. 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*.

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. Carefully 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*.

6. Power the device by carefully aligning and connecting the power IN port on FieldDAQ to an external 9 V DC to 30 V DC power source with the 5-pin L-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-11603 Specifications*.
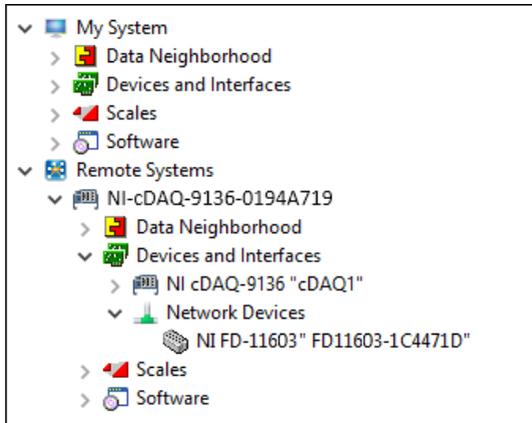
   The Power LED lights. Refer to *Power LED* for information about Power LED status.

7. 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**.

8. Click **Add Network Device**, and then **Find Network NI-DAQmx Devices**.

9. 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 FD11603-<*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*.

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

Figure 21. Adding the FieldDAQ Device to the Real-Time Controller in MAX

11. 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.
12. 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*.
13. 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*. 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 22. MAX Icons and States

1. Recognized, but Disconnected from the Network, Unreserved, or Reserved by Another Host
2. Recognized, Present, and Reserved on the Network

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.
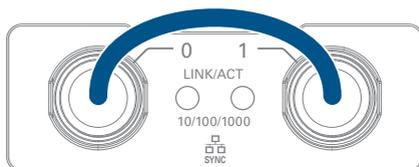
STATUS LED

The FieldDAQ device has a STATUS LED.

Table 10. LED State/Device Status

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 *Resetting the FieldDAQ to Factory-Default Settings*, contact NI for support on corrupted firmware.
Green, solid	Device is reserved and a DAQ task is running.

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 23. 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.

Table 11. Device Default Settings

Attribute	Value
Hostname	FD11603-<*serial number*>
IP	DHCP or Link Local

Table 11. Device Default Settings (Continued)

Attribute	Value
Comment	Empty
Default login	User name = admin Password = no password required

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 24. Reference Mounting Configuration

Up
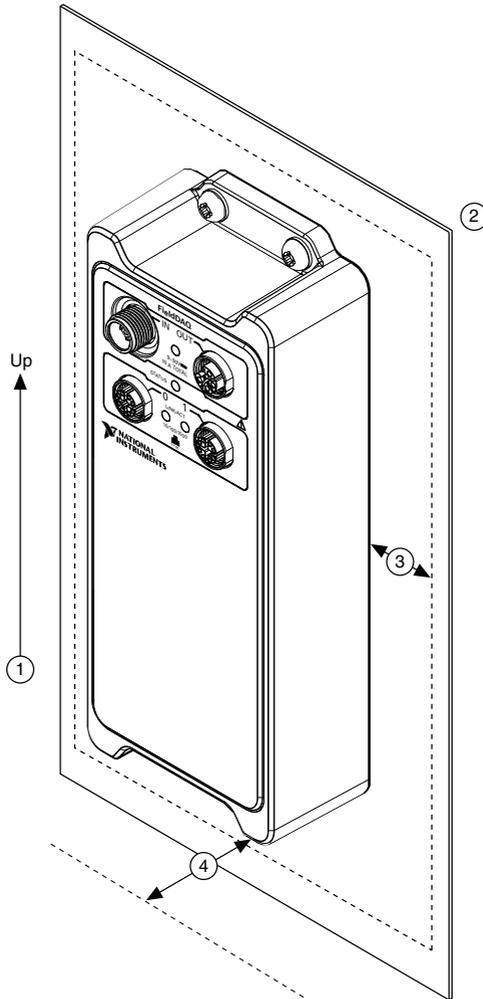
1. Vertical mounting orientation.
2. Mount the FieldDAQ device directly to a metallic surface that is at least 1.6 mm (0.062 in.) thick and extends a minimum of 76.2 mm (3 in.) beyond all edges of the device.
3. Observe the cooling dimensions in Mounting Requirements.
4. Allow space for cabling clearance 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 25. Cooling Dimensions
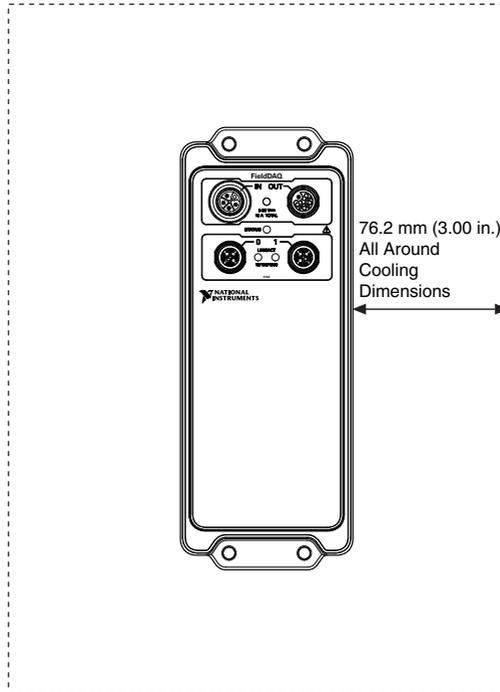
Allow the appropriate space in front of the device for cabling clearance, as shown in the following figure.

Figure 26. Cabling Clearance
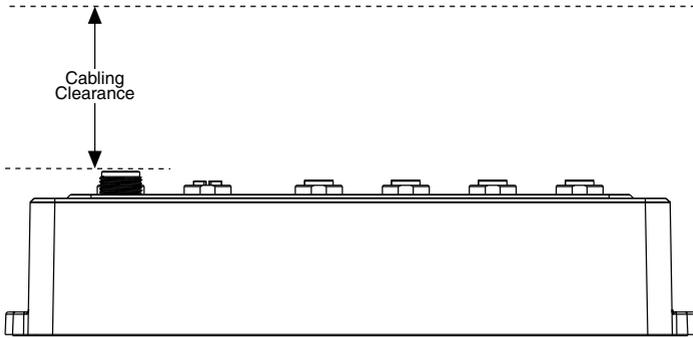
Measure the ambient temperature at each side of the FieldDAQ device, 76.2 mm (3.00 in.) from the side and 25.4 mm (1.00 in.) forward from the rear of the device. Refer to the following figures for ambient temperature locations for horizontal and vertical mounting configurations.

Figure 27. Ambient Temperature Locations, Horizontal Mounting Configuration
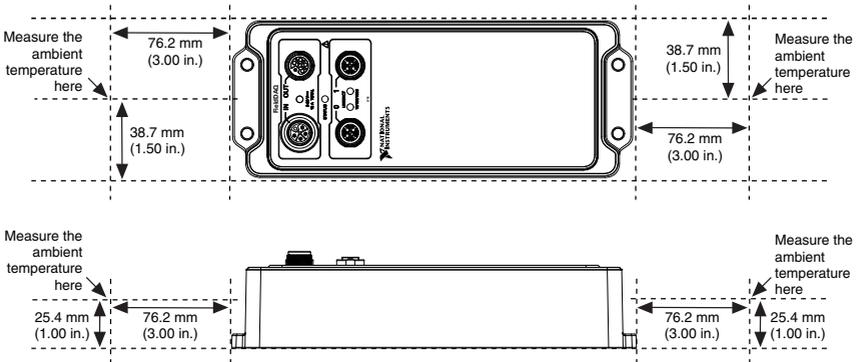
Dimensions

For detailed dimensional drawings and 3D models, visit *ni.com/dimensions* and search for FD-11603.

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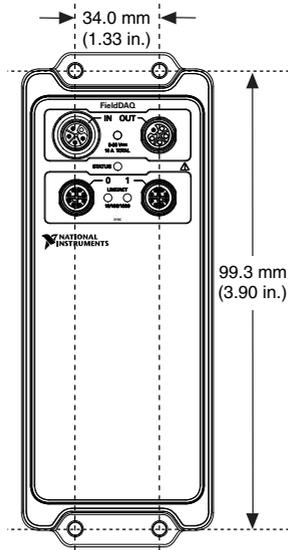
2. Align the device on the surface.
3. Fasten the device to the surface using the M5 or 10-32 screws. Tighten the screws to a maximum torque of 2.5 N · m (25.0 lb · in.).

Figure 30. Fastening the Device to the Surface
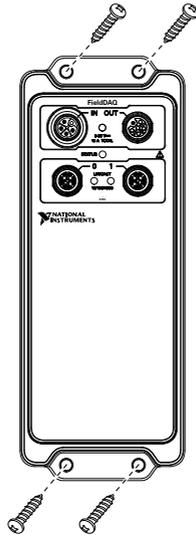
Alternate Mounting Configurations

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.

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* and enter the Info Code `fdfw`.

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* 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 17.6 or later.

FieldDAQ

The *FD-11603 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-11603 Specifications* lists all specifications for your FieldDAQ device. Go to *ni.com/manuals* and search for FD-11603.

The *FD-11603 Safety, Environmental, and Regulatory Information*, packaged with your device, includes important compliance precautions and connection information for your FieldDAQ device.

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.

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*.

Technical Support on the Web

For additional support, refer to *ni.com/support* or *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* to download Adobe Reader. Refer to the National Instruments Product Manuals Library at *ni.com/manuals* for updated documentation resources.