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Find the *National Instruments FP-AIO-610* at our website: *Click HERE*

FieldPoint™ Operating Instructions

FP-AIO-610 and cFP-AIO-610

Four-Channel Analog Input, Four-Channel Analog Output, 12-Bit Module

These operating instructions describe how to install and use the National Instruments FP-AIO-610 and cFP-AIO-610 (referred to inclusively as the [c]FP-AIO-610). For information about configuring and accessing the [c]FP-AIO-610 over a network, refer to the user manual for the FieldPoint network module you are using.

Features

The [c]FP-AIO-610 is a FieldPoint analog input and output module with the following features:

- Four analog voltage or current input channels with 11 input ranges up to ±30 V or ±20 mA (±36 V or ±24 mA with 20% overranging)
- Four analog voltage output channels with ±10 or 0–10 V ranges (±10.2 or 0–10.2 V with 2% overranging)
- 1.4 kHz hardware update rate
- 12-bit resolution
- –40 to 70 °C operation
- Voltage outputs sink or source up to 10 mA per channel
- Onboard diagnostics including one out-of-range indicator for all inputs and one overcurrent indicator for each output
- Current inputs protected up to ±10 V
- Voltage outputs short-circuit protected up to ±30 V
- 250 V_{rms} CAT II continuous channel-to-ground isolation, verified by 2,300 V_{rms}, 5 s dielectric withstand test
- Hot swappable

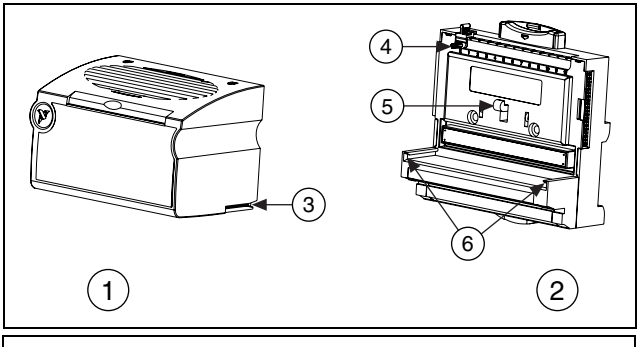
NATIONAL INSTRUMENTS™

Installing the FP-AIO-610

The FP-AIO-610 mounts on a FieldPoint terminal base (FP-TB-*x*), which provides operating power to the module. Installing the FP-AIO-610 onto a powered terminal base does not disrupt the operation of the bank.

To install the FP-AIO-610, refer to Figure 1 and complete the following steps:

1. Slide the terminal base key to position X.
2. Align the FP-AIO-610 alignment slots with the guide rails on the terminal base.
3. Press firmly to seat the FP-AIO-610 on the terminal base. When the module is firmly seated, the terminal base latch locks it into place.



1	I/O Module	4	Key
2	Terminal Base	5	Latch
3	Alignment Slot	6	Guide Rails

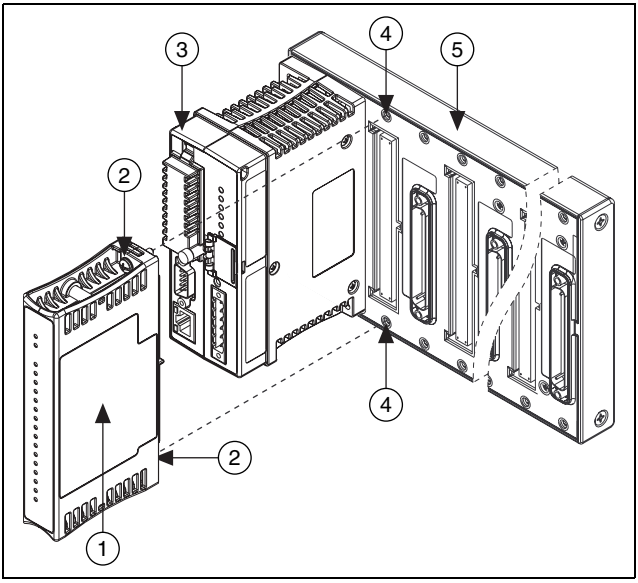
Figure 1. Installing the FP-AIO-610

Installing the cFP-AIO-610

The cFP-AIO-610 mounts on a Compact FieldPoint backplane (cFP-BP-*x*), which provides operating power to the module. Installing the cFP-AIO-610 onto a powered backplane does not disrupt the operation of the bank.

To install the cFP-AIO-610, refer to Figure 2 and complete the following steps:

1. Align the captive screws on the cFP-AIO-610 with the holes on the backplane. The alignment keys on the cFP-AIO-610 prevent backward insertion.
2. Press firmly to seat the cFP-AIO-610 on the backplane.
3. Using a number 2 Phillips screwdriver with a shank of at least 64 mm (2.5 in.) length, tighten the captive screws to 1.1 N · m (10 lb · in.) of torque. The nylon coating on the screws prevents them from loosening.



1	cFP I/O Module	4	Screw Holes
2	Captive Screws	5	cFP Backplane
3	cFP Controller Module		

Figure 2. Installing the cFP-AIO-610

Wiring the [c]FP-AIO-610

The FP-TB-*x* terminal base has connections for each FP-AIO-610 input and output channel, and for an external power supply to power field devices. The cFP-CB-*x* connector block provides the same connections for the cFP-AIO-610. Each input channel has one input terminal for voltage, V_{IN}, and one input terminal for current, I_{IN}. Only one of these input terminals should be connected on each channel. Each output channel has one output terminal, V_{OUT}. All four input channels and all four output channels are referenced to the COM terminals. The V and V_{SUP} terminals are all internally connected, as are the C and COM terminals.

You can use an external power supply to power field devices. Connect the positive lead of the external power supply to both V terminals and the negative lead to both C terminals. Ensure that the current through both V terminals can never exceed 2 A.

Install 2 A maximum, fast-acting fuses between the external power supply and the V terminals. The wiring diagrams in this document show fuses where appropriate.

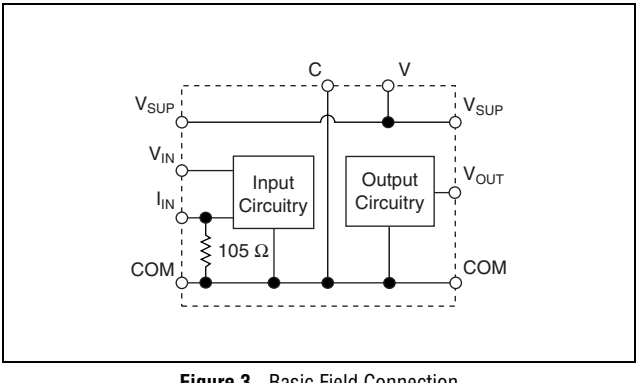


Figure 3. Basic Field Connection

Caution Do *not* connect both current and voltage inputs to the same channel.

Table 1 lists the terminal assignments for the signals of each input channel.

Table 1. Input Terminal Assignments

Channel	Inputs			
	V_{IN}	I_{IN}[1]	V_{SUP}[2]	COM
In 0	1	2	17	18
In 1	3	4	19	20
In 2	5	6	21	22
In 3	7	8	23	24

[1] Install a 63 mA maximum fast-acting fuse on each connected I_{IN} terminal.

[2] Install a 125 mA maximum fast-acting fuse on each connected V_{SUP} terminal.

Table 2 lists the terminal assignments for the signals of each output channel.

Table 2. Output Terminal Assignments

Channel	Outputs		
	V_{OUT}	V_{SUP}[1]	COM
Out 0	9	25	10, 26
Out 1	11	27	12, 28
Out 2	13	29	14, 30
Out 3	15	31	16, 32

[1] Install a 125 mA maximum fast-acting fuse on each connected V_{SUP} terminal.



Caution Cascading power between two modules defeats isolation between those modules.

Connecting Signals to the [c]FP-AIO-610

The [c]FP-AIO-610 has four single-ended input channels. All four input channels share a common ground reference that is isolated from other modules in the FieldPoint system.

Note The input and output channels of the [c]FP-AIO-610 are *not* electrically isolated from each other.

Figure 4 shows the input circuitry on a single input channel.

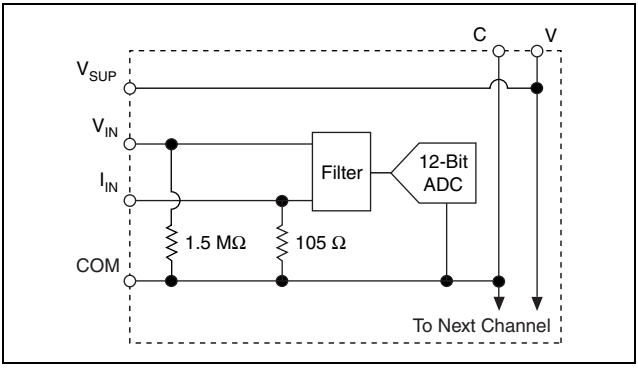


Figure 4. Input Circuitry on One Channel of the [c]FP-AIO-610

Voltage Inputs

The input ranges for voltage signals are ±5, ±10, ±15, ±30, 0–5, 0–10, 0–15, and 0–30 V. FieldPoint software accounts for the 20% overranging feature and shows the ranges accordingly. Figure 5 shows how to connect a voltage source without an external power supply to one input channel of the [c]FP-AIO-610.

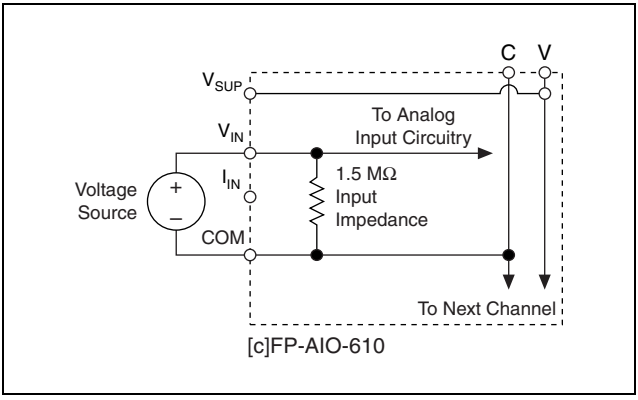


Figure 5. Voltage Input without an External Power Supply

Figure 6 shows how to connect a voltage source with an external power supply to one input channel of the [c]FP-AIO-610.

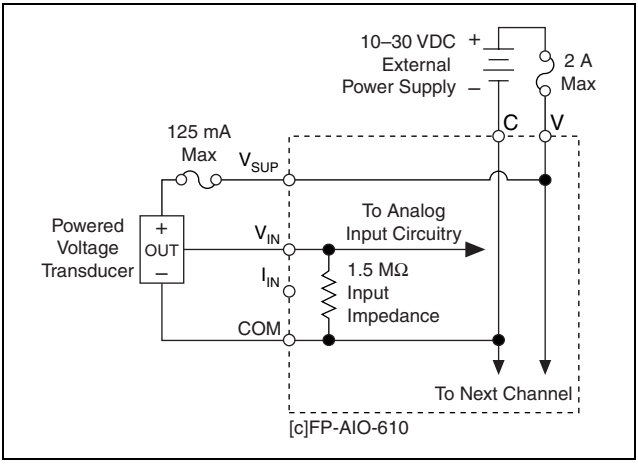


Figure 6. Voltage Input with an External Power Supply

Current Inputs

The input ranges for current sources are ±20, 0–20, and 4–20 mA. FieldPoint software accounts for the 20% overranging feature and shows the ranges accordingly. Figure 7 shows how to connect a current source without an external power supply to one input channel of the [c]FP-AIO-610.

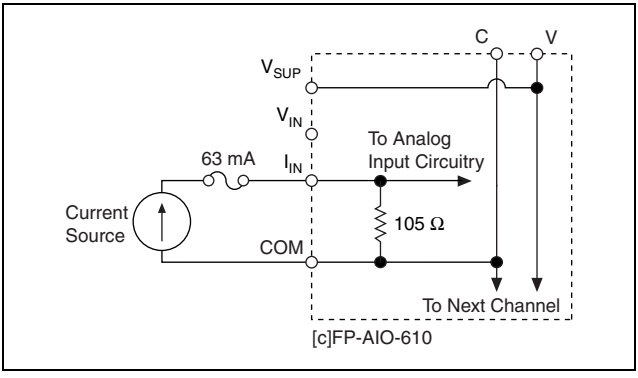


Figure 7. Current Input without an External Power Supply

Figure 8 shows how to connect a current source with an external power supply to one input channel of the [c]FP-AIO-610.

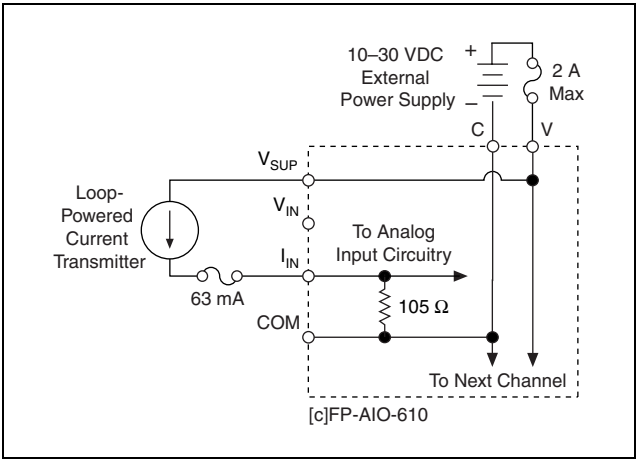


Figure 8. Current Input with an External Power Supply

Input Ranges

To prevent inaccurate readings, select an input range such that the signal you are measuring does not exceed either end of the range.

Overranging

The [c]FP-AIO-610 has an overranging feature that measures 20% beyond the nominal values of each range. For example, the actual measurement limit of the ±5 V range is ±6.0 V. The overranging feature enables the [c]FP-AIO-610 to compensate for field devices with span errors of up to 20% of full scale. Also, the overranging feature helps prevent errors caused by clipping.

Connecting the [c]FP-AIO-610 to a Load

The [c]FP-AIO-610 has four single-ended voltage output channels that *source* or *sink* up to 10 mA. Sourcing current means that current flows out of the V_{OUT} terminal into the load. Sinking current means that current flows out of the load into the V_{OUT} terminal. All four output channels and their common are isolated from the other modules in the FieldPoint system. The four output channels are not isolated from the four input channels.

Note Add a 125 mA max fuse to any V_{SUP} terminal in use.

Figure 9 shows how to connect one output channel of the [c]FP-AIO-610 to a load.

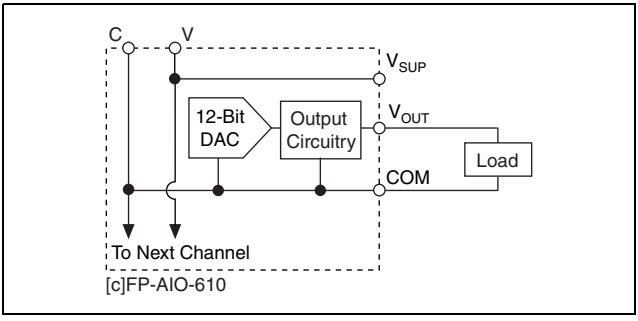


Figure 9. [c]FP-AIO-610 Analog Output Circuit

Output Ranges

You can configure each channel independently for an output range of ±10 or 0–10 V. The default range setting for each channel is 0–10 V, with the power-up output set to 0 V. The [c]FP-AIO-610 has 2% overranging in each of these ranges, so the full-scale ranges available are ±10.2 V and 0–10.2 V. Overranging enables the [c]FP-AIO-610 to compensate for span and offset errors in field devices.

Current Limiting

Each channel has a monitoring circuit that limits the output current to 10 mA. If the [c]FP-AIO-610 cannot maintain the specified output voltage for one or more channels, the monitoring circuits turn on a red **Current Limit** LED for each affected channel and report the error condition to the network module. Generally, the error condition is caused by a low load resistance. Use the following formula to determine the minimum load resistance at any output voltage level:

$$R_{min} = V_{out}/10\ \text{mA}$$

where R_{min} is the minimum load resistance and V_{out} is the specified voltage output level.

Short-Circuit Protection

Each V_{OUT} terminal of the [c]FP-AIO-610 is protected against short circuits. One or more output channels can be short-circuited indefinitely without causing damage or improper operation to the channel, as long as the potential to which each channel is shorted does not exceed ±30 V.

Status Indicators

The [c]FP-AIO-610 has two green status LEDs, **POWER** and **READY**. After you install the [c]FP-AIO-610 onto a terminal base or backplane and apply power to the connected network module, the green **POWER** indicator lights and the [c]FP-AIO-610 informs the network module of its presence. When the network module recognizes the [c]FP-AIO-610, it sends initial configuration information to the [c]FP-AIO-610. After the [c]FP-AIO-610 receives this initial information, the green **READY** indicator lights and the module is in normal operating mode.

In addition to the green **POWER** and **READY** indicators, the [c]FP-AIO-610 has one **Out of range** indicator for all input channels and one red, numbered error status indicator to indicate current limiting for each output channel. For more information, refer to the *Current Limiting* section.

Upgrading the FieldPoint Firmware

You may need to upgrade the FieldPoint firmware when you add new I/O modules to the FieldPoint system. For information on determining which firmware you need and how to upgrade the firmware, go to `ni.com/info` and enter `fpmatrix`.

Isolation and Safety Guidelines

Caution Read the following information before attempting to connect the [c]FP-AIO-610 to any circuits that may contain hazardous voltages.

This section describes the isolation of the [c]FP-AIO-610 and its compliance with international safety standards. The field wiring connections are isolated from the backplane and the inter-module communication bus. The isolation barriers in the module provide 250 V_{rms} Measurement Category II continuous isolation, verified

by 2,300 V_{rms}, 5 s dielectric withstand test. The [c]FP-AIO-610 provides *double insulation* (compliant with IEC 61010-1) for working voltages of 250 V_{rms}[1]. Safety standards (such as those published by UL and IEC) require the use of double insulation between hazardous voltages and any human-accessible parts or circuits.

Never try to use any isolation product between human-accessible parts (such as DIN rails or monitoring stations) and circuits that can be at hazardous potentials under normal conditions, unless the product is specifically designed for such an application, as is the [c]FP-AIO-610.

Even though the [c]FP-AIO-610 is designed to handle applications with hazardous potentials, follow these guidelines to ensure a safe total system:

- There is no isolation between channels on the [c]FP-AIO-610. If a hazardous voltage is present on any channel, all channels are considered hazardous. Make sure that all other devices and circuits connected to the module are properly insulated from human contact.
- Do *not* share the external supply voltages (the V and C terminals) with other devices (including other FieldPoint devices), unless those devices are isolated from human contact.
- For Compact FieldPoint, you *must* connect the protective earth (PE) ground terminal on the cFP-BP-*x* backplane to the system safety ground. The backplane PE ground terminal has the following symbol stamped beside it: ⏚. Connect the backplane PE ground terminal to the system safety ground using 14 AWG (1.6 mm) wire with a ring lug. Use the 5/16 in. panhead screw shipped with the backplane to secure the ring lug to the backplane PE ground terminal.
- As with any hazardous voltage wiring, make sure that all wiring and connections meet applicable electrical codes and commonsense practices. Mount terminal bases and backplanes in an area, position, or cabinet that prevents accidental or unauthorized access to wiring that carries hazardous voltages.
- Do *not* use the [c]FP-AIO-610 as the only isolating barrier between human contact and working voltages higher than 250 V_{rms}.

[1] *Working voltage* is defined as the signal voltage plus the common-mode voltage. *Common-mode voltage* is the voltage of the module with respect to ground.

- Operate the [c]FP-AIO-610 only at or below Pollution Degree 2. Pollution Degree 2 means that only nonconductive pollution occurs in most cases. Occasionally, however, a temporary conductivity caused by condensation must be expected.
- Do *not* operate FieldPoint products in an explosive atmosphere or where there may be flammable gases or fumes. If you need to operate FieldPoint products in such an environment, the FieldPoint products *must* be in a suitably rated enclosure.
- Operate the [c]FP-AIO-610 at or below Measurement Category II. Measurement Category II is for measurements performed on circuits directly connected to the low-voltage installation. This category refers to local-level distribution, such as that provided by a standard wall outlet.

Safety Guidelines for Hazardous Locations

The cFP-AIO-610 is suitable for use in Class I, Division 2, Groups A, B, C, D, T4 hazardous locations; Class I, Zone 2, AEx nA IIC T4 and Ex nA IIC T4 hazardous locations; and nonhazardous locations only. Follow these guidelines if you are installing the cFP-AIO-610 in a potentially explosive environment. Failing to follow these guidelines may result in serious injury or death.

Caution Make sure that all products you use in hazardous locations are certified for such use. Refer to the product label or visit `ni.com/certification`, search by model number or product line, and click the appropriate link in the Certification column.



Caution Do *not* disconnect I/O-side wires or connectors unless power has been switched off or the area is known to be nonhazardous.



Caution Do *not* remove modules unless power has been switched off or the area is known to be nonhazardous.



Caution Substitution of components may impair suitability for Class I, Division 2.



Caution For Zone 2 applications, install the Compact FieldPoint system in an enclosure rated to at least IP 54 as defined by IEC 60529 and EN 60529.

Caution For Zone 2 applications, install a protection device across the external power supply and the COM terminal. The device must prevent the external power supply voltage from exceeding 42 V if there is a transient overvoltage condition.

Special Conditions for Hazardous Locations Use in Europe

The cFP-AIO-610 has been evaluated as EEx nC IIC T4 equipment under DEMKO Certificate No. 03 ATEX 0251502X. Each module is marked ⟨Ex⟩ II 3G and is suitable for use in Zone 2 hazardous locations.

Specifications

The following specifications are maximums for the range –40 to 70 °C unless otherwise noted. Specifications are subject to change without notice.

Input and Output Characteristics

Number of input channels.....4

Number of output channels.....4

ADC resolution.....12 bits

Type of ADC.....Successive approximation

DAC resolution.....12 bits

Type of DAC.....Resistor string

Hardware update rate
(all 8 channels).....1.4 kHz (714 µs period)

Maximum voltage, V_{sup} to COM.....10–30 VDC

Voltage Inputs

Effective resolution.....11.3 bits

Input impedance.....1.5 MΩ

Signal input bandwidth (–3 dB).....350 Hz

Voltage input accuracy by voltage input range

Voltage Input Range (with Overranging)	Accuracy at 15 to 35 °C (% of Reading; % of Full Scale)	Accuracy at –40 to 70 °C (% of Reading; % of Full Scale)
0–6 V	±0.04%; ±0.15%	±0.15%; ±0.25%
0–12 V	±0.04%; ±0.12%	±0.15%; ±0.17%
0–18 V	±0.04%; ±0.1%	±0.15%; ±0.14%
0–36 V	±0.04%; ±0.1%	±0.15%; ±0.11%
±6 V	±0.04%; ±0.12%	±0.2%; ±0.17%
±12 V	±0.04%; ±0.1%	±0.2%; ±0.12%
±18 V	±0.04%; ±0.09%	±0.2%; ±0.11%
±36 V	±0.04%; ±0.08%	±0.2%; ±0.09%

Current Inputs

Effective resolution..... 11.3 bits

Input impedance..... 105 Ω

Overcurrent protection..... ±100 mA

Overvoltage protection ..... ±10 V

Signal input bandwidth (–3 dB)..... 350 Hz

Current input accuracy by current input range

Current Input Range (with Overranging)	Accuracy at 15 to 35 °C (% of Reading; % of Full Scale)	Accuracy at –40 to 70 °C (% of Reading; % of Full Scale)
0–24 mA	±0.07%; ±0.09%	±0.3%; ±0.09%
3.5–24 mA	±0.07%; ±0.09%	±0.3%; ±0.09%
±24 mA	±0.07%; ±0.08%	±0.32%; ±0.08%

Voltage Outputs

Output range ..... ±10 or 0–10 V, programmable (±10.2 or 0–10.2 V with overranging)

Type ..... Voltage source, no external power required

Output current ..... ±10 mA with 20% tolerance

Protection ..... Short-circuit up to ±30 V and current limiting to ±10 mA

Default power-up state ..... 0 V

Voltage output accuracy by voltage output range

Voltage Output Range (with Overranging)	Guaranteed Accuracy at 15 to 35 °C (% of Output Value; % of Full Scale)	Guaranteed Accuracy at –40 to 70 °C (% of Output Value; % of Full Scale)
0–10.2 V	±0.04%; ±0.05%	±0.15%; ±0.25%
±10.2 V	±0.04%; ±0.03%	±0.15%; ±0.15%

Slew rate ..... 2 V/µs min, 4 V/µs typ

Settling time to within 0.001% of new output value ..... 15 µs typ with 2 kΩ load

Nonlinearity ..... ±3 LSB peak

Physical Characteristics

Indicators ..... Green **POWER** and **READY** indicators, 1 **Out of range** input indicator, and 4 red output indicators

Weight

FP-AIO-610 ..... 147 g (5.19 oz)

cFP-AIO-610 ..... 115 g (4.06 oz)

Power Requirements

Power from network module

No or high-impedance load ..... 600 mW

All channels sourcing or sinking maximum current ..... 1.5 W

Isolation Voltage

Channel-to-ground isolation

- Continuous ..... 250 V_{rms}, Measurement Category II
- Dielectric withstand..... 2,300 V_{rms}, 5 s

Channel-to-channel isolation ..... None

Environmental

FieldPoint modules are intended for indoor use only. For outdoor use, they must be mounted inside a sealed enclosure.

Operating temperature ..... –40 to 70 °C

Storage temperature ..... –55 to 85 °C

Humidity ..... 10 to 90% RH, noncondensing

Maximum altitude..... 2,000 m; at higher altitudes the isolation voltage ratings must be lowered

Pollution Degree 2

Shock and Vibration

These specifications apply only to the cFP-AIO-610.
NI recommends Compact FieldPoint if your application is subject to shock and vibration.

Operating vibration, random (IEC 60068-2-64)..... 10–500 Hz, 5 g_{rms}

Operating vibration, sinusoidal (IEC 60068-2-6)..... 10–500 Hz, 5 g

Operating shock (IEC 60068-2-27)..... 50 g, 3 ms half sine, 18 shocks at 6 orientations; 30 g, 11 ms half sine, 18 shocks at 6 orientations

Safety

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN-61010-1
- UL 61010-1, CAN/CSA-C22.2 No. 61010-1

Note For UL and other safety certifications, refer to the product label or visit `ni.com/certification`, search by model number or product line, and click the appropriate link in the Certification column.

Electromagnetic Compatibility

This product is designed to meet the requirements of the following standards of EMC for electrical equipment for measurement, control, and laboratory use:

- EN 61326 EMC requirements; Industrial Immunity
- EN 55011 Emissions; Group 1, Class A
- CE, C-Tick, ICES, and FCC Part 15 Emissions; Class A

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

- 73/23/EEC; Low-Voltage Directive (safety)
- 89/336/EEC; Electromagnetic Compatibility Directive (EMC)

Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit `ni.com/certification`, search by model number or product line, and click the appropriate link in the Certification column.

Waste Electrical and Electronic Equipment (WEEE)

EU Customers At the end of their life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit `ni.com/environment/weee.htm`.

Mechanical Dimensions

Figure 10 shows the mechanical dimensions of the FP-AIO-610 installed on a terminal base. If you are using the cFP-AIO-610, refer to your Compact FieldPoint controller user manual for the dimensions and cabling clearance requirements of the Compact FieldPoint system.

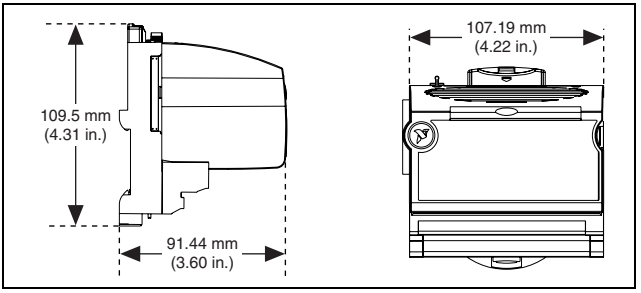


Figure 10. FP-AIO-610 Mechanical Dimensions

Where to Go for Support

For more information about setting up the FieldPoint system, refer to these National Instruments documents:

- FieldPoint network module user manual
- Other FieldPoint I/O module operating instructions
- FieldPoint terminal base and connector block operating instructions

Go to `ni.com/support` for the most current manuals, examples, and troubleshooting information.

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