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FieldPoint Operating Instructions

FP-AI-111 and cFP-AI-111

16-Channel, 16-Bit Analog Milliamp Input Modules

These operating instructions describe how to install and use the National Instruments FP-AI-111 and cFP-AI-111 analog input modules (referred to inclusively as the [c]FP-AI-111). For information about configuring and accessing the [c]FP-AI-111 over a network, refer to the user manual for the FieldPoint network module you are using.

Features

The [c]FP-AI-111 is a FieldPoint analog input module with the following features:

- 16 single-ended analog current input channels
- Three input ranges: ±20, 0–20, and 4–20 mA
- 16-bit resolution
- Three filter settings: 50, 60, and 500 Hz
- Hot swappable
- 2,300 V_{rms} transient overvoltage protection
- –40 to 70 °C operation

Installing the FP-AI-111

The FP-AI-111 mounts on a FieldPoint terminal base (FP-TB-*x*), which provides operating power to the module. Installing the FP-AI-111 onto a powered terminal base does not disrupt the operation of the bank.

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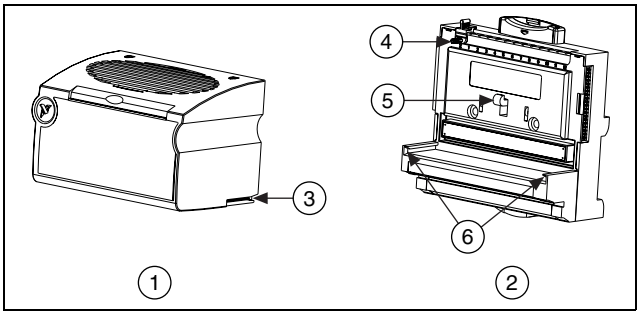
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To install the FP-AI-111, refer to Figure 1 and complete the following steps:

1. Slide the terminal base key to either position X, used for any module, or position 1, used for the FP-AI-111 module.
2. Align the FP-AI-111 alignment slots with the guide rails on the terminal base.
3. Press firmly to seat the FP-AI-111 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-AI-111

Installing the cFP-AI-111

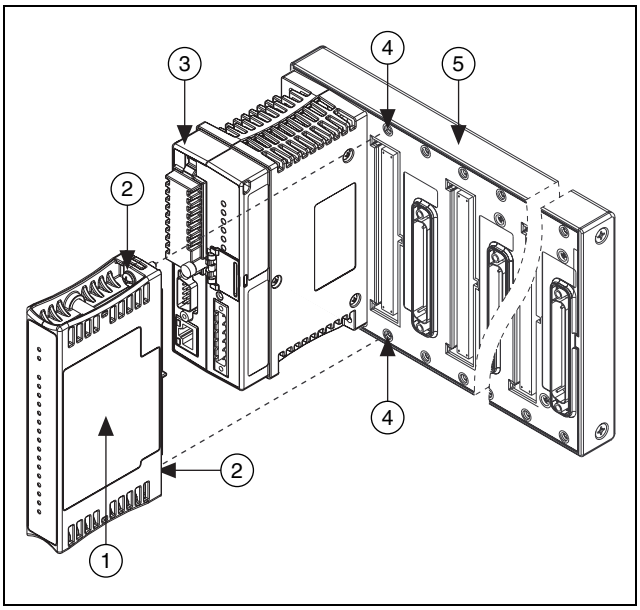
The cFP-AI-111 mounts on a Compact FieldPoint backplane (cFP-BP-*x*), which provides operating power to the module. Installing the cFP-AI-111 onto a powered backplane does not disrupt the operation of the bank.

To install the cFP-AI-111, refer to Figure 2 and complete the following steps:

1. Align the captive screws on the cFP-AI-111 with the holes on the backplane. The alignment keys on the cFP-AI-111 prevent backward insertion.
2. Press firmly to seat the cFP-AI-111 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

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(10 lb · in.) of torque. The nylon coating on the screws prevents them from loosening.



1	cFP-AI-111	4	Screw Holes
2	Captive Screws	5	cFP Backplane
3	cFP Controller Module		

Figure 2. Installing the cFP-AI-111

Wiring the [c]FP-AI-111

The FP-TB-*x* terminal bases have connections for each of the 16 input channels on the FP-AI-111 and for an external supply to power field devices. The cFP-CB-*x* connector blocks provide the same connections for the cFP-AI-111.

Table 1 lists the terminal assignments for the signals associated with each channel. The terminal assignments are the same for the FP-TB-*x* terminal bases and the cFP-CB-*x* connector blocks.

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Table 1. Terminal Assignments

Channel	Terminal Numbers		
	I_{in}	V_{SUP}	COM
0	1	17	18
1	2	17	18
2	3	19	20
3	4	19	20
4	5	21	22
5	6	21	22
6	7	23	24
7	8	23	24
8	9	25	26
9	10	25	26
10	11	27	28
11	12	27	28
12	13	29	30
13	14	29	30
14	15	31	32
15	16	31	32

Each channel has one input terminal (I_{in}) for current input. All 16 current inputs are referenced to the COM terminals. If you are using an external supply to power field devices, connect the power supply to the V and C terminals of the terminal base or connector block. Field devices source power from the V_{SUP} and COM terminals. Refer to the *Measuring Current with the [c]FP-AI-111* section for detailed wiring diagrams.

Caution Cascading power between two modules defeats isolation between those modules. Cascading power from the network module defeats all isolation between modules in the FieldPoint bank.

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Measuring Current with the [c]FP-AI-111

The [c]FP-AI-111 has 16 single-ended input channels. All 16 channels share a common ground reference that is isolated from other modules in the FieldPoint system. Figure 3 shows the analog input circuitry on one channel.

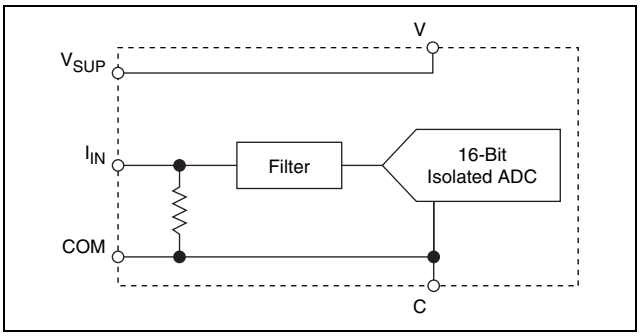


Figure 3. FP-AI-111 Analog Input Circuitry

The current input ranges are ±20, 0–20, and 4–20 mA. The input channels have overcurrent protection up to ±30 mA. The [c]FP-AI-111 reads current flowing into the I_{in} terminal as positive and current flowing out of the terminal as negative. Current flows into the I_{in} terminal, goes through a 100 Ω resistor, and flows out from the COM or C terminal.

Figure 4 shows how to connect a current source without an external power supply to one channel of the [c]FP-AI-111.

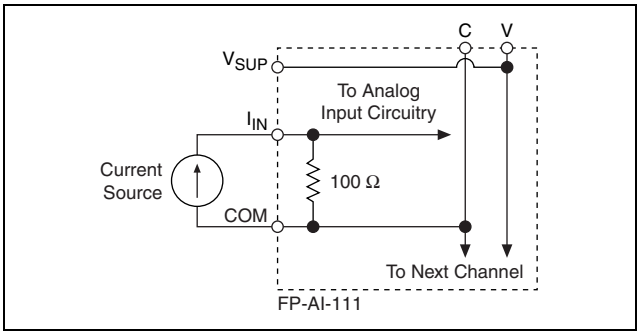


Figure 4. Current Source without External Power Supply

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Figure 5 shows how to connect a loop-powered current transducer to one channel of the [c]FP-AI-111.

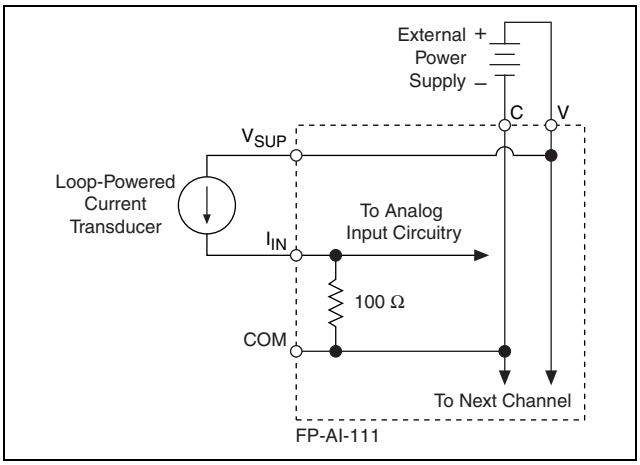


Figure 5. Loop-Powered Current Transducer

Figure 6 shows how to connect a three-wire powered current transducer to one channel of the [c]FP-AI-111.

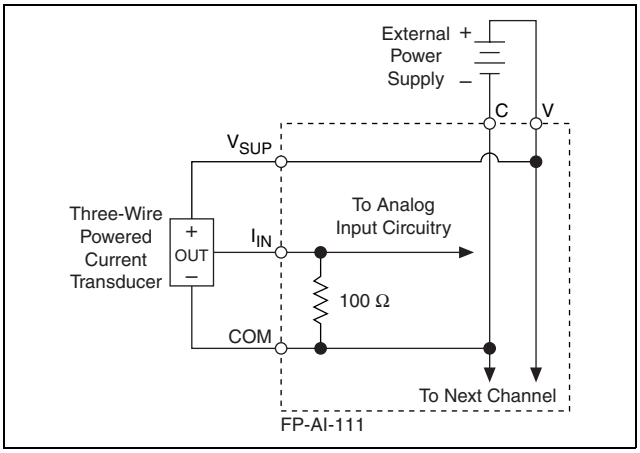


Figure 6. Three-Wire Powered Current Transducer

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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-AI-111 has an overranging feature that measures 5% beyond the nominal values of each range. For example, the actual measurement limit of the ±20 mA range is ±21 mA. The overranging feature enables the [c]FP-AI-111 to compensate for field devices with span errors of up to 5% of full scale. Also, with the overranging feature, a noisy signal near full scale does not create rectification errors. FieldPoint software accounts for the 5% overranging feature and shows the ranges accordingly. For example, the ±20 mA range appears in FieldPoint software as ±21 mA.

Filter Settings

Three filter settings are available for each channel. The filters on the [c]FP-AI-111 input channels are comb filters that provide notches of rejection at multiples, or harmonics, of a fundamental frequency. You can select a fundamental frequency of 50, 60, or 500 Hz. The [c]FP-AI-111 applies 95 dB of rejection at the fundamental frequency and at least 60 dB of rejection at each of the harmonics. In many cases, most of the noise components of input signals are related to the local AC power line frequency, so a filter setting of either 50 or 60 Hz is best.

Update Rate

The rate at which the [c]FP-AI-111 samples current inputs is determined by the ranges and filter settings you select. When all channels are set to the same range and to 50 or 60 Hz filters, the module samples each channel every 1.23 s or every 1.05 s, respectively. When all channels are set to 500 Hz filters, the module samples each channel every 0.29 s. If you select different filter settings or ranges for the different channels, you can use the following formula to determine the sampling rate:

(*number of channels with 50 Hz filters*) × 70 ms +
(number of ranges used with these channels) × 113 ms +
(*number of channels with 60 Hz filters*) × 60 ms +
(number of ranges used with these channels) × 93 ms +
(*number of channels with 500 Hz filters*) × 18 ms +
(number of ranges used with these channels) × 3 ms =
Update Rate

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Therefore, setting any unused channels to the 500 Hz filter setting improves the sampling rate of the module. For example, if one channel is set for a 60 Hz filter, and the other 15 channels are set for 500 Hz, each channel is sampled every 0.42 s (2.5 times faster than if all 16 channels are set for 60 Hz filtering).

The sampling rate does not affect the rate at which the network module reads the data. The [c]FP-AI-111 always has data available for the network module to read; the sampling rate is the rate at which this data is updated. Set up your application so that the sampling rate is faster than the rate at which the network module polls the [c]FP-AI-111 for data.

Status Indicators

The [c]FP-AI-111 has two green status LEDs, **POWER** and **READY**. After you insert the [c]FP-AI-111 into a terminal base or backplane and apply power to the connected network module, the green **POWER** indicator lights and the [c]FP-AI-111 informs the network module of its presence. When the network module recognizes the [c]FP-AI-111, it sends initial configuration information to the [c]FP-AI-111. After the [c]FP-AI-111 receives this initial information, the green **READY** indicator lights and the module is in normal operating mode.

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-AI-111 to any circuits that may contain hazardous voltages.

This section describes the isolation of the [c]FP-AI-111 and its compliance with international safety standards. The field wiring connections are isolated from the backplane and the inter-module communication bus. The isolation is provided by the module, which has optical and galvanic isolation barriers designed and tested to protect against transient fault voltages of up to 2,300 V_{rms}.

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Follow these guidelines to ensure a safe total system:

- The [c]FP-AI-111 has a safety isolation barrier between the I/O channels and the inter-module communication bus. There is no isolation between channels unless otherwise noted. If any of the channels on a module are wired at a hazardous potential, make sure that all other devices or circuits connected to that 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.
- Operate the [c]FP-AI-111 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.
- Refer to the FieldPoint product label for regulatory certification under hazardous location standards. If the FieldPoint product is not certified for operation in hazardous locations, do not operate it in an explosive atmosphere or where there may be flammable gases or fumes.

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Specifications

The following specifications are typical for the range –40 to 70 °C unless otherwise noted. Gain error is calculated as a percentage of input signal value.

Input Characteristics

Number of channels 16

ADC resolution ..... 16 bits at 50 or 60 Hz;
12 bits at 500 Hz

Type of ADC ..... Delta-sigma

Input impedance ..... 100 Ω

Overcurrent protection ..... ±30 mA

Input noise (50 or 60 Hz filter) ..... 0.3 μA_{rms}

Input signal ranges (FieldPoint software shows the ranges with 5% overranging.)

Nominal Input Range		With Overranging	Effective Resolution*
Current	4–20 mA 0–20 mA ±20 mA	3.5–21 mA 0–21 mA ±21 mA	0.5 µA 0.5 µA 0.7 µA
* Includes quantization errors and rms noise with the filter set to 50 or 60 Hz.			

Filter settings (software selectable by channel)

Characteristic	Filter Settings		
	50 Hz	60 Hz	500 Hz
Update time*	1.23 s	1.05 s	0.29 s
Input bandwidth (–3 dB)	13 Hz	16 Hz	130 Hz
* Applies when all 16 channels are set to the same filter setting and range.			

Normal-mode rejection
(at 50/60 Hz) ..... 95 dB (with 50/60 Hz filter)

Nonlinearity 0.0015%

Offset error ..... ±0.1 µA

Offset error drift ..... ±20 nA/°C

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Gain error

25 °C ..... ±0.03%

–40 to 70 °C ..... ±0.2%

Gain error drift ..... ±40 ppm/°C

Physical Characteristics

Indicators ..... Green **POWER** and **READY** indicators

Weight

FP-AI-111 ..... 140 g (4.8 oz)

cFP-AI-111 ..... 110 g (3.7 oz)

Power Requirements

Power from network module ..... 350 mW

Isolation Voltage

Channel-to-channel isolation ..... No isolation between channels

Transient overvoltage ..... 2,300 V_{rms}

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

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Shock and Vibration

These specifications apply only to the cFP-AI-111.
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 3121-1, UL 61010C-1
- CAN/CSA C22.2 No. 1010.1

For UL, hazardous location, and other safety certifications, refer to the product label or to `ni.com`.

Electromagnetic Compatibility

CE, C-Tick, and FCC Part 15 (Class A) Compliant

Emissions..... EN 55011 Class A at 10 m
FCC Part 15A above 1 GHz

Immunity..... EN 61326:1997 + A2:2001,
Table 1

Note For EMC compliance, operate this device with shielded cabling.

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CE Compliance

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

Low-Voltage Directive (safety)..... 73/23/EEC

Electromagnetic Compatibility
Directive (EMC) 89/336/EEC

Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, click **Declarations of Conformity Information** at `ni.com/hardref.nsf/`.

Mechanical Dimensions

Figure 7 shows the mechanical dimensions of the FP-AI-111 installed on a terminal base. If you are using the cFP-AI-111, refer to the Compact FieldPoint controller user manual for the dimensions and cabling clearance requirements of the Compact FieldPoint system.

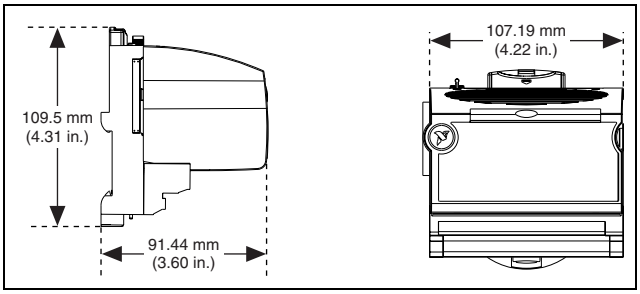


Figure 7. FP-AI-111 Mechanical Dimensions

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

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

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