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**FP-DO-400**

# FieldPoint™ Operating Instructions

## FP-DO-400 and cFP-DO-400

### Eight-Channel, 5–30 V Digital Output Module

These operating instructions describe how to install and use the National Instruments FP-DO-400 and cFP-DO-400 digital output modules (referred to inclusively as the [c]FP-DO-400). For information about configuring and accessing the [c]FP-DO-400 over a network, refer to the user manual for the FieldPoint network module you are using.

## Features

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The [c]FP-DO-400 is a FieldPoint digital output module with the following features:

- Eight digital output channels
- Sourcing outputs supply up to 1.5 A per channel, 8 A<sup>2</sup> per module
- Compatible with voltages from 5 to 30 VDC
- On/Off LED indicators
- 2,300 V<sub>rms</sub> transient overvoltage protection
- –40 to 70 °C operation
- Hot swappable
- User-configurable startup states

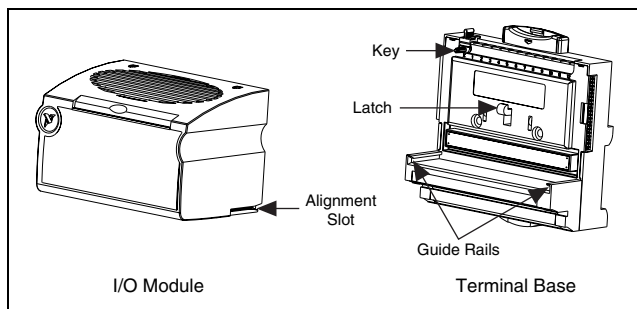
## Installing the FP-DO-400

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The FP-DO-400 mounts on a FieldPoint terminal base (FP-TB-*x*), which provides operating power to the module. Installing the FP-DO-400 onto a powered terminal base does not disrupt the operation of the FieldPoint bank.

To install the FP-DO-400, 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 4, used for the FP-DO-400 module.
2. Align the FP-DO-400 alignment slots with the guide rails on the terminal base.
3. Press firmly to seat the FP-DO-400 on the terminal base. When the module is firmly seated, the terminal base latch locks it into place.



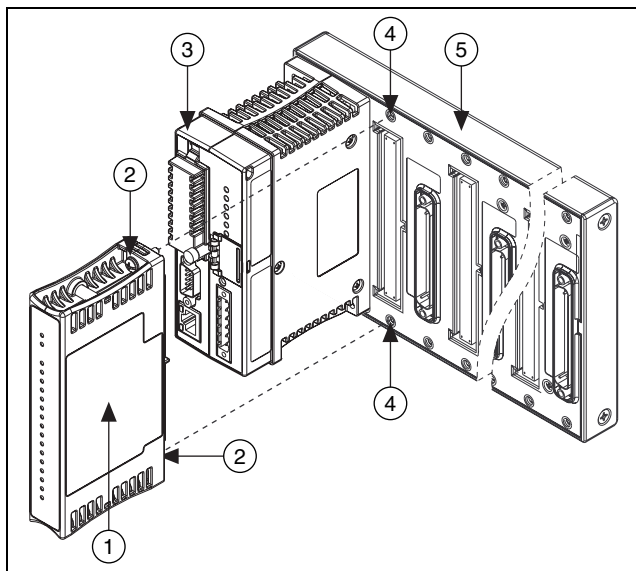
**Figure 1.** Installing the FP-DO-400

## Installing the cFP-DO-400

The cFP-DO-400 mounts on a Compact FieldPoint backplane (cFP-BP-*x*), which provides operating power to the module. Installing the cFP-DO-400 onto a powered backplane does not disrupt the operation of the FieldPoint bank.

To install the cFP-DO-400, refer to Figure 2 and complete the following steps:

1. Align the captive screws on the cFP-DO-400 with the holes on the backplane. The alignment keys on the cFP-DO-400 prevent backward insertion.
2. Press firmly to seat the cFP-DO-400 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 |                 |

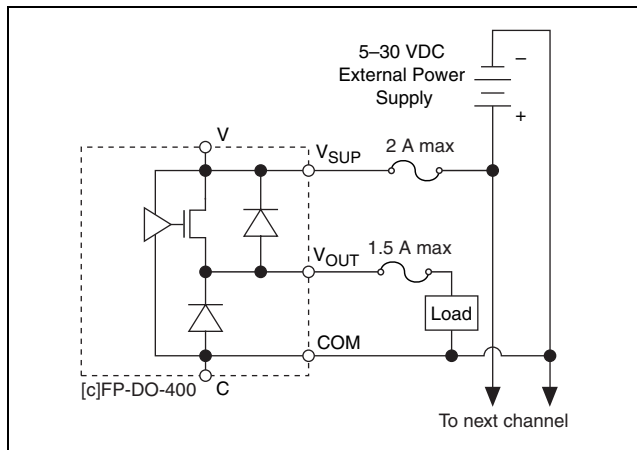
**Figure 2.** Installing the cFP-DO-400

## Wiring the [c]FP-DO-400

The FP-TB-*x* terminal base has connections for each of the eight output channels and for an external power supply to power the output channels and field devices. The cFP-CB-*x* connector block provides the same connections. Each channel has one output terminal ( $V_{OUT}$ ), one supply terminal ( $V_{SUP}$ ), and two common terminals (COM). All eight channels are referenced to the COM terminals. The  $V$  and  $V_{SUP}$  terminals are all internally connected, as are the C and COM terminals.

Use a 5–30 VDC external power supply for the output channels. The power supply must provide enough current to power all of the loads on the output channels, up to 1.5 A per channel.<sup>1</sup> Connect the external power supply to multiple V and V<sub>SUP</sub> terminals and to multiple C and COM terminals as needed to ensure that the maximum current through any terminal is 2 A or less.

Install a 2 A maximum, fast-acting fuse between the external power supply and the V<sub>SUP</sub> terminal on each channel. Install a 1.5 A maximum, fast-acting fuse suitable for the load at the V<sub>OUT</sub> terminal. Figure 3 shows fuses where appropriate.



**Figure 3.** Recommended Field Connections

Table 1 lists the terminal assignments for the signals of each channel. Terminal assignments are also listed on the side panel of the cFP-DO-400 and under the slide-in card on the front of the FP-DO-400.

<sup>1</sup> Refer to the [Digital Output Circuit](#) and [Specifications](#) sections for the maximum output current level on all channels.

**Table 1.** Terminal Assignments

Channel	Terminal Numbers		
	V <sub>OUT</sub> <sup>1</sup>	V <sub>SUP</sub> <sup>2</sup>	COM
0	1	17	2, 18
1	3	19	4, 20
2	5	21	6, 22
3	7	23	8, 24
4	9	25	10, 26
5	11	27	12, 28
6	13	29	14, 30
7	15	31	16, 32

<sup>1</sup> Install a 1.5 A maximum, fast-acting fuse on each V<sub>OUT</sub> terminal.  
<sup>2</sup> Install a 2 A maximum, fast-acting fuse on each V and V<sub>SUP</sub> terminal.

## Digital Output Circuit

The [c]FP-DO-400 digital output channels are optically isolated from the rest of the FieldPoint bank. The channels are *sourcing* outputs, which means that the output terminal provides a path to a voltage supply.

In the ON state, a transistor is turned on between the positive external supply voltage (V and V<sub>SUP</sub>) and the output terminal (V<sub>OUT</sub>). In the OFF state, this transistor is turned off, allowing only a small leakage current to flow.

Ensure that the load on any channel does not draw more than 1.5 A, and the sum of the squares of the total current supplied by all channels at any time is no more than 8 A<sup>2</sup>.

To determine whether the total current is within the limit, square the current on each channel and add the squares together. If the sum of all the squares is less than or equal to 8 A<sup>2</sup>, the total current is within the limit. In the following example, three channels supply 1.5 A each and one channel supplies 1 A:

$$(1.5 \text{ A})^2 + (1.5 \text{ A})^2 + (1.5 \text{ A})^2 + (1 \text{ A})^2 \leq 8 \text{ A}^2$$



**Caution** The outputs must *not* be short-circuited to the potential of the C or COM terminals (the negative voltage of the external supply). Short circuits damage the [c]FP-DO-400 output channels. Check all wiring carefully before applying power.

In the ON state, the effective resistance between the output ( $V_{OUT}$ ) and the supply voltage ( $V$  and  $V_{SUP}$ ) is  $0.3 \Omega$ . This resistance causes a voltage drop between the external supply voltage and the output voltage. Table 2 lists the actual output voltages based on the voltage provided by the external power supply.

**Table 2.** [c]FP-DO-400 Output Voltages for a 0.5 A Current Flow

V	$V_{OUT}$
5	4.85
10	9.85
12	11.85
24	23.85
30	29.85

If the external power supply you are using does not provide one of the voltages in Table 2, use the following equation to calculate the actual voltage output.

$$ActualOutput = V_{ext} - (I_{flow} \times 0.3 \Omega)$$

where  $ActualOutput$  is the voltage sourced by  $V_{OUT}$

$V_{ext}$  is the voltage provided by the external power supply

$I_{flow}$  is the current flow through the  $V_{OUT}$  terminal



**Note** Using a 5–10 V external supply increases the output impedance to  $2 \Omega$ . This increase limits the amount of current each channel can supply. Refer to the [Specifications](#) section for more information.

Table 3 shows some common combinations of output current levels on several channels. Combinations are valid from  $-40$  to  $50 \text{ }^\circ\text{C}$  for the cFP-DO-400 and from  $-40$  to  $70 \text{ }^\circ\text{C}$  for the FP-DO-400.

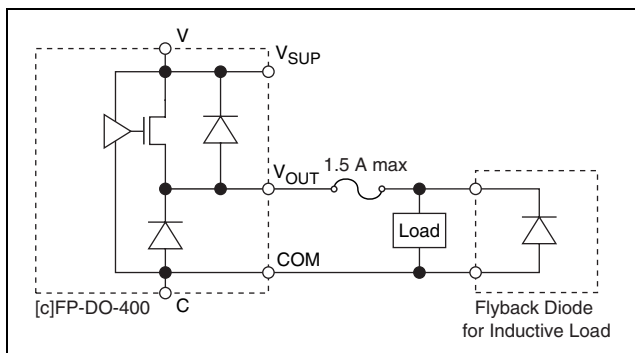
**Table 3.** Common Output Configurations

Channel Subset	Channel Subset	Total A <sup>2</sup>
8 channels @ 1 A	—	8 A <sup>2</sup>
5 channels @ 1.25 A	—	7.81 A <sup>2</sup>
4 channels @ 1.25 A	3 channels @ 0.75 A	7.94 A <sup>2</sup>
3 channels at 1.5 A	1 channel @ 1 A	7.75 A <sup>2</sup>

## Protection for Inductive Loads

When an inductive load, such as a motor or relay, is connected to an output, a large counter-electromotive force may occur at switching time because of the energy stored in the inductive load. This *flyback voltage* can damage the output and the power supply.

It is best to limit flyback voltages by installing a flyback diode across an inductive load. Typically, you should mount the flyback diode within 18 in. of the load. Figure 4 shows one channel connected to an inductive load with a flyback diode.



**Figure 4.** Digital Output Circuit (External Power Supply Not Shown)

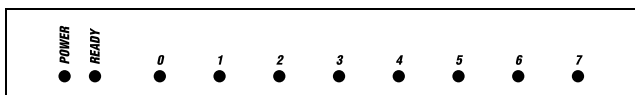
The [c]FP-DO-400 contains flyback diodes to prevent excessively high voltage from damaging the module. National Instruments still recommends using an external protection circuit across any inductive load.



# Status Indicators

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Figure 5 shows the status indicator LEDs on the [c]FP-DO-400.



**Figure 5.** Status Indicators

The [c]FP-DO-400 has two green status LEDs, **POWER** and **READY**. After you install the FP-DO-400 onto a terminal base or the cFP-DO-400 onto a backplane and apply power to the connected network module, the green **POWER** indicator lights and the [c]FP-DO-400 informs the network module of its presence. When the network module recognizes the [c]FP-DO-400, it sends initial configuration information to the [c]FP-DO-400. After the [c]FP-DO-400 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, each channel has a numbered, green output state indicator that lights when the channel is in the ON state.

## Upgrading Your FieldPoint Firmware

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

## Isolation and Safety Guidelines


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**Caution** Read the following information before attempting to connect the [c]FP-DO-400 to any circuits that may contain hazardous voltages.

This section describes the isolation of the [c]FP-DO-400 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<sub>rms</sub>.

Follow these guidelines to ensure a safe total system:

- The [c]FP-DO-400 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-DO-400 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.

# Specifications

These specifications are typical for the range  $-40$  to  $70$  °C unless otherwise noted.

## Output Characteristics

Number of channels ..... 8  
Output type ..... Sourcing  
Voltage range ..... 5–30 VDC  
Output impedance at 10–30 V .....  $0.3 \Omega$   
(0.3 V drop at 1 A)  
Maximum output current at 10–30 V  
Per channel

Module	Temperature Ranges		
	$-40$ to $50$ °C	$50$ to $60$ °C	$60$ to $70$ °C
cFP-DO-400	1.5 A	1.0 A	1.0 A
FP-DO-400	1.5 A	1.5 A	1.5 A

All channels<sup>1</sup>

Module	Temperature Ranges		
	$-40$ to $50$ °C	$50$ to $60$ °C	$60$ to $70$ °C
cFP-DO-400	$8 \text{ A}^2$	$8 \text{ A}^2$	$4 \text{ A}^2$
FP-DO-400	$8 \text{ A}^2$	$8 \text{ A}^2$	$8 \text{ A}^2$

Output impedance at 5–10 V .....  $2 \Omega$   
Maximum output current at 5–10 V  
Per channel ..... 0.67 A  
All channels .....  $1.35 \text{ A}^2$

## Physical Characteristics

Indicators ..... Green **POWER** and **READY** indicators, eight green output state indicators

<sup>1</sup> Refer to the *Digital Output Circuit* section for more information about the maximum current across all channels.

## Weight

FP-DO-400 .....	136 g (4.8 oz)
cFP-DO-400 .....	106 g (3.7 oz)

## Power Requirements

Power from network module .....	365 mW
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## Isolation Voltage

Channel-to-channel isolation .....	No isolation between channels
Transient overvoltage.....	2,300 V <sub>rms</sub>

## 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-DO-400. 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 <sub>rms</sub>
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](http://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, you *must* operate this device with shielded cabling.

## CE Compliance

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

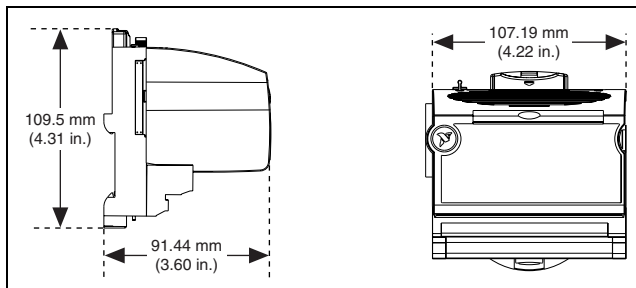
Low-Voltage Directive (safety).....	73/23/EEC
Electromagnetic Compatibility Directive (EMC) .....	89/336/EEC



**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/](http://ni.com/hardref.nsf/).

## Mechanical Dimensions

Figure 6 shows the mechanical dimensions of the FP-DO-400 installed on a terminal base. If you are using the cFP-DO-400, refer to the Compact FieldPoint controller user manual for the dimensions and cabling clearance requirements of the Compact FieldPoint system.



**Figure 6.** FP-DO-400 Mechanical Dimensions

# Where to Go for Support

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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](http://ni.com/support) for the most current manuals, examples, and troubleshooting information.

For telephone support in the United States, create your service request at [ni.com/support](http://ni.com/support) and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 1800 300 800, Austria 43 0 662 45 79 90 0,  
Belgium 32 0 2 757 00 20, Brazil 55 11 3262 3599,  
Canada (Calgary) 403 274 9391,  
Canada (Montreal) 514 288 5722,  
Canada (Ottawa) 613 233 5949, Canada (Québec) 514 694 8521,  
Canada (Toronto) 905 785 0085,  
Canada (Vancouver) 514 685 7530, China 86 21 6555 7838,  
Czech Republic 420 2 2423 5774, Denmark 45 45 76 26 00,  
Finland 385 0 9 725 725 11, France 33 0 1 48 14 24 24,  
Germany 49 0 89 741 31 30, Greece 30 2 10 42 96 427,  
India 91 80 51190000, Israel 972 0 3 6393737,  
Italy 39 02 413091, Japan 81 3 5472 2970,  
Korea 82 02 3451 3400, Malaysia 603 9131 0918,  
Mexico 001 800 010 0793, Netherlands 31 0 348 433 466,  
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Poland 48 0 22 3390 150, Portugal 351 210 311 210,  
Russia 7 095 238 7139, Singapore 65 6226 5886,  
Slovenia 386 3 425 4200, South Africa 27 0 11 805 8197,  
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