

FP-QUAD-510 AND cFP-QUAD-510

4-Axis Quadrature Input Module

These operating instructions describe how to install and use the National Instruments FP-QUAD-510 and cFP-QUAD-510 quadrature input modules (referred to inclusively as the [c]FP-QUAD-510). For information about configuring and accessing the [c]FP-QUAD-510 over a network, refer to the user manual for the FieldPoint network module you are using.

Features

The [c]FP-QUAD-510 is a FieldPoint quadrature input module with the following features:

- Four independent 32-bit position counters with individual Phase A, Phase B, and Index input terminals
- Velocity measurement capabilities
- Programmable reset on Index mode
- Sinking inputs, compatible with TTL or differential devices
- Hot plug-and-play
- 2,300 V_{rms} transient overvoltage protection between the inter-module communication bus and the I/O channels
- -40 to 70 °C operation

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Power Requirement

The [c]FP-QUAD-510 is powered by the FieldPoint network module through the backplane bus. The [c]FP-QUAD-510 is a high-power-consumption module and requires more than the nominal power allocated to an I/O module from the network module. In some applications, this could limit the number of I/O modules that you can connect to a single network module.

Before you configure a FieldPoint system that uses a [c]FP-QUAD-510 module, calculate the power consumption of the I/O modules on the FieldPoint bank. You can find the *Power from network modules* specification in the [Power Requirements](#) section of the operating instructions for each I/O module. The maximum power the network module can supply is specified in the network module user manual. Make sure the total power requirements for all of the I/O modules in the bank is less than the maximum power available from the network module.

Suppose you have a bank with an FP-2000 controller module, four FP-QUAD-510 modules, and five FP-DI-301 modules. The FP-2000 can supply up to 9 W. The FP-QUAD-510 requires 1.2 W and the FP-DI-301 requires 0.325 W. The four FP-QUAD-510 and five FP-DI-301 modules require a total of 6.4 W:

$$4 \times 1.2 \text{ W} + 5 \times 0.325 \text{ W} = 6.4 \text{ W}$$

This power requirement is less than the 9 W maximum and the controller meets it.

Installing the FP-QUAD-510

The FP-QUAD-510 mounts on a FieldPoint terminal base (FP-TB-*x*). Hot plug-and-play enables you to install the FP-QUAD-510 onto a powered terminal base without disturbing the operation of other modules or terminal bases. The FP-QUAD-510 receives operating power from the terminal base.

To install the FP-QUAD-510, 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 8, used for the FP-QUAD-510 module.
2. Align the FP-QUAD-510 alignment slots with the guide rails on the terminal base.

3. Press firmly to seat the FP-QUAD-510 on the terminal base. When the module is firmly seated, the terminal base latch locks the FP-QUAD-510 into place.

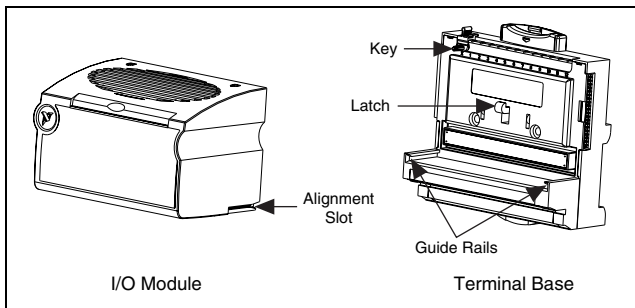


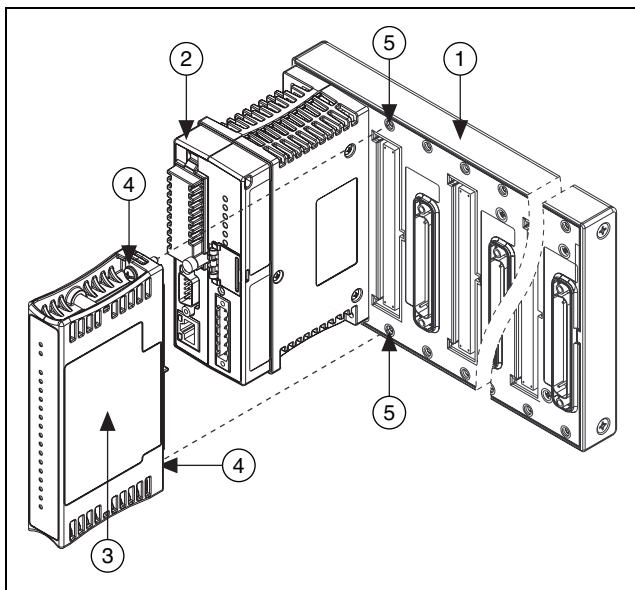
Figure 1. Installing the FP-QUAD-510

Installing the cFP-QUAD-510

The cFP-QUAD-510 mounts on a FieldPoint backplane (cFP-BP-*x*). Hot plug-and-play enables you to install the cFP-QUAD-510 onto a powered backplane without disturbing the operation of other modules or connector blocks. The cFP-QUAD-510 receives operating power from the backplane.

To install the cFP-QUAD-510, refer to Figure 2 and complete the following steps:

1. Align the captive screws on the cFP-QUAD-510 with the holes on the backplane. The alignment keys on the cFP-QUAD-510 prevent backward insertion.
2. Press firmly to seat the cFP-QUAD-510 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 Backplane | 3 cFP I/O Module | 5 Screw Holes |
| 2 cFP Controller Module | 4 Captive Screws | |

Figure 2. Installing the cFP-QUAD-510

Wiring the [c]FP-QUAD-510

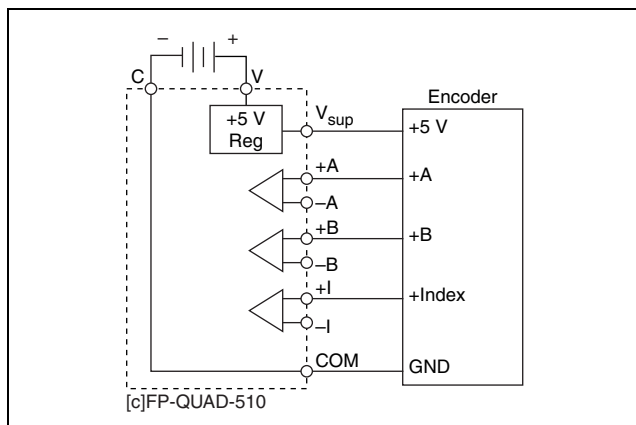
The FP-TB-*x* terminal base provides connections for each axis and for an external supply to power the FP-QUAD-510 input channels and field devices. The cFP-CB-*x* connector block provides the same connections for the cFP-QUAD-510.

Table 1 lists the terminal assignments for the signals of each axis. +A and –A represent the Phase A signals, +B and –B represent the Phase B signals, and +I and –I represent the Index signals. Terminal assignments and wiring diagrams are also listed on the side panel of the cFP-QUAD-510 and under the slide-in card on the front of the FP-QUAD-510 module.

Table 1. Terminal Assignments

Signal	Terminal Numbers			
	Axis 0	Axis 1	Axis 2	Axis 3
+A	1	5	9	13
-A	17	21	25	29
+B	2	6	10	14
-B	18	22	26	30
+I	3	7	11	15
-I	19	23	27	31
V _{sup}	4	8	12	16
COM	20	24	28	32

The [c]FP-QUAD-510 accepts two types of encoder signal inputs: single-ended (TTL) or differential line driver. Figure 3 shows the typical encoder wiring for single-ended signal input. Figure 4 shows the typical encoder wiring for differential signal input. Power for a +5 V encoder is also provided for each axis. If your application requires other encoder power voltages, reference an external supply to either the C terminal or the COM terminal.

**Figure 3.** Basic Field Connections to Single-Ended Encoders

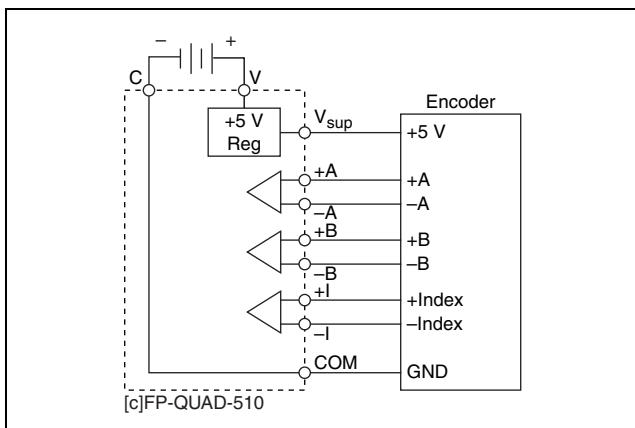


Figure 4. Basic Field Connections to Differential Encoders

The [c]FP-QUAD-510 supports differential inputs for Phase A, Phase B, and Index signals. You can easily accommodate encoders with various phase relationships by swapping the signals and/or connecting them to the inverting inputs as specific applications require. If the index polarity is inverted, try reversing the +Index and -Index signals on differential encoders or using the -Index input on single-ended encoders.

Configuring [c]FP-QUAD-510 Channels

Table 2 summarizes the functionality of each of the [c]FP-QUAD-510 channels as accessed through FieldPoint software.

Table 2. [c]FP-QUAD-510 Channel Operation Summary

Channel Number	Channel Description	Type	Range
0	Axis 0 Position LSB	Count Input	0–65,535
1	Axis 1 Position LSB	Count Input	0–65,535
2	Axis 2 Position LSB	Count Input	0–65,535
3	Axis 3 Position LSB	Count Input	0–65,535
4	Axis 0 Position MSB	Count Input	0–65,535
5	Axis 1 Position MSB	Count Input	0–65,535

Table 2. [c]FP-QUAD-510 Channel Operation Summary (Continued)

Channel Number	Channel Description	Type	Range
6	Axis 2 Position MSB	Count Input	0–65,535
7	Axis 3 Position MSB	Count Input	0–65,535
8	Axis 0 Velocity	Analog Input	8 Ranges
9	Axis 1 Velocity	Analog Input	8 Ranges
10	Axis 2 Velocity	Analog Input	8 Ranges
11	Axis 3 Velocity	Analog Input	8 Ranges
12	Axis 0 Index Active	Discrete Input	Boolean
13	Axis 1 Index Active	Discrete Input	Boolean
14	Axis 2 Index Active	Discrete Input	Boolean
15	Axis 3 Index Active	Discrete Input	Boolean

Configuring Position Counter Channels

Each position counter has a 32-bit binary counter that represents the current position of the shaft connected to the axis. Each 32-bit counter consists of two 16-bit channels. Channels 0 through 3 contain the 16 least significant bits (LSB) of the channel for axes 0 through 3 respectively. Channels 4 through 7 contain the 16 most significant bits (MSB) for axes 0 through 3 respectively. Combine the appropriate channels to create the 32-bit counter.

Primarily, the position counter channels increment or decrement in response to edges encountered at the Phase A and Phase B inputs.

The following sections describe the operation of the counter channels.

Position Counter Input Circuit

The circuit for the position counter inputs consists of a comparator with current-limited inputs to convert signals from differential to single-ended. The output of the comparator drives an optoisolator. When you apply a voltage above the threshold voltage to the input terminal, the comparator turns on the optoisolator, registering in the ON state.

The inputs are designed to be compatible with single-ended TTL encoders or differential encoders supplying a differential voltage of at least ± 0.3 V.

Each encoder input has a lowpass filter that rejects frequencies above 250 kHz to reduce false counts due to high-speed transients. This cut-off point allows encoder frequencies as high as one million counts/second, because there are four counts per period, as shown in Figure 5.

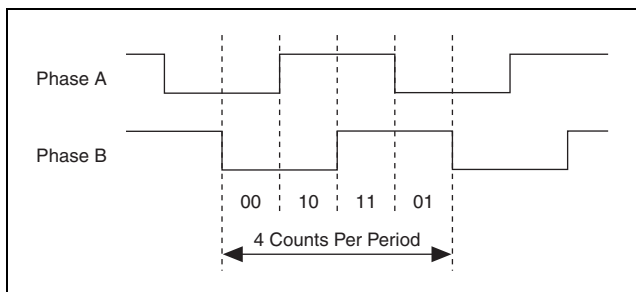


Figure 5. Quadrature Encoder Counts/Period Relationship

Reset on Index Capability

You can configure each position counter to reset each time the index condition is met. An index-initiated reset resets both the upper and lower 16-bit registers associated with that axis. This is useful in applications in which only the position within one rotation of the encoder is important to the user. In this mode of operation, any position count errors that occur are canceled when the index condition is met.

Commands

In FieldPoint software, you can send **Reset** commands to channels 0 through 3. The Reset command resets the target channel and the corresponding upper 16 bits of the channel. For example, sending a reset command to channel 0 resets both channels 0 and 4.

Configuring Velocity Data Channels

The [c]FP-QUAD-510 uses a timebase counter to determine the rate of change of position, the velocity, for each axis. The four velocity data registers, channels 8 through 11, contain 16-bit velocity data for axes 0 through 3 respectively. The data in each register represents the velocity of the axis in number of counts per microsecond. A positive number indicates motion in the forward direction, and a negative number indicates motion in the reverse direction. You can configure each register independently with one

of eight velocity ranges as shown in Table 3. Each range is based on a different timebase length and has a different resolution.

Table 3. Velocity Ranges

Length of Timebase (μs)	Velocity Range (counts/μs)	Velocity Resolution
204.8	±160	4.883 counts/ms
409.6	±80	2.441 counts/ms
819.2	±40	1.221 counts/ms
1,638.4	±20	610.4 counts/s
3,276.8	±10	305.2 counts/s
6,553.6	±5	152.6 counts/s
13,107.2	±2.5	76.29 counts/s
26,214.4	±1.25	38.15 counts/s

The velocity range is the maximum velocity that can be measured for a given timebase. The velocity register uses a 15-bit counter, which gives a maximum number of counts of 2^{15} , or 32,768. Therefore, the velocity range for a given timebase is calculated using the following formula:

$$V_{rng} = \frac{\pm 32768}{T}$$

where V_{rng} is the velocity range in counts per microsecond and T is the timebase in microseconds.

The velocity resolution is the velocity accuracy for a given timebase and is determined using the following formula:

$$V_{res} = \frac{1000}{T}$$

where V_{res} is the velocity resolution in counts per millisecond and T is the timebase in microseconds.

Configuring Index-Status Channels

The [c]FP-QUAD-510 has four channels, 12 through 15, which contain the value of the Index signal for axes 0 through 3, respectively. The value of the status channel is 1 when the condition at the axis inputs is Phase A = 0, Phase B = 0, and Index = 1. The status channel resets to 0 after the user reads the channel in software. The Index signal must occur when both the Phase A and Phase B signals are low, as shown in Figure 6.

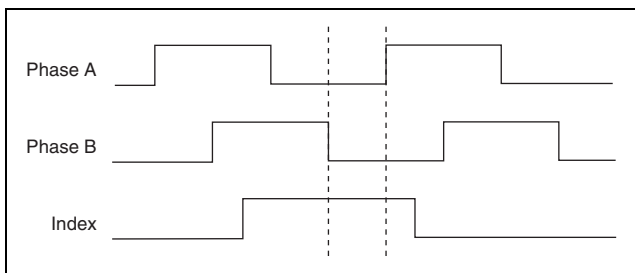


Figure 6. Encoder Signal Phasing



Note If the axis is stopped while the status channel is 1, reading the value of the status channel resets the channel to 0. However, since the index channel is still 1, the status channel immediately returns to 1.

If the Reset on Index attribute (refer to the [Configuring Position Counter Channels](#) section) is selected, then the status channel does not need to be read between successive index pulses in order for the position counters to reset. The position counters respond to index pulses as programmed regardless of the state of the status channel.

Status Indicators

The [c]FP-QUAD-510 has two green status LEDs, **POWER** and **READY**. After you insert the FP-QUAD-510 into a terminal base or the cFP-QUAD-510 into a backplane and apply power to the connected network module, the green **POWER** indicator lights and the [c]FP-QUAD-510 informs the network module of its presence. When the network module recognizes the [c]FP-QUAD-510, it sends initial configuration information to the [c]FP-QUAD-510. After receiving this initial information, the green **READY** indicator lights and the [c]FP-QUAD-510 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, go to ni.com/info and enter `fpmatrix`.


Isolation and Safety Guidelines



Caution Read the following information before attempting to connect the [c]FP-QUAD-510 to any circuits that may contain hazardous voltages.

This section describes the isolation of the [c]FP-QUAD-510 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}.

Follow these guidelines to ensure a safe total system:

- The [c]FP-QUAD-510 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-QUAD-510 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

The following specifications are typical for a range of -40 to 70 °C unless otherwise noted.

Encoder Input

Number of channels	4
Input type	
Single-ended.....	$V_{IL} = 0.0-0.8$ V $V_{IH} = 2.0-30.0$ V
Differential	± 0.3 V provided one input is between 0.0 and 3.0 V and the other input is between 0.0 and 30.0 V
Input bandwidth.....	250 kHz for each input
Encoder frequency	1 million counts/second
Minimum input pulse width.....	2 μ s
External supply voltage (V).....	8 to 30 VDC, user-provided at 5 W
I/O supply voltage (V_{sup})	5 VDC at 600 mA maximum

Physical Characteristics

Indicators	Green POWER and READY indicators
Weight	
FP-QUAD-510	143 g (5.1 oz)
cFP-QUAD-510.....	113 g (4.0 oz)

Power Requirements

Power from network module 1.2 W maximum

Isolation Voltage

Channel-to-channel isolation No isolation between channels

Transient overvoltage 2,300 V_{rms}

Shock and Vibration

Operating shock (IEC 68-2-27)

cFP-QUAD-510 50 g, 3 ms half sine, 3 shocks;
30 g, 11 ms half sine,
3 shocks

Operating vibration, random (IEC 60068-2-34)

FP-QUAD-510 10–500 Hz, 2.2 g_{rms}

cFP-QUAD-510 10–500 Hz, 5 g_{rms}

Operating vibration, sinusoidal (IEC 60068-2-6)

[c]FP-QUAD-510 10–500 Hz, 5 g

Safety

The [c]FP-QUAD-510 is designed to meet the requirements of the following standards for safety and electrical equipment for measurement, control, and laboratory use.

- EN 61010-1, IEC 61010-1
- UL 3121-1
- CAN/CSA C22.2 No. 1010.1

For certifications under regulatory standards, including hazardous location standards, refer to the product label or to ni.com.

Electromagnetic Compatibility

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

Electromagnetic emissions EN 55011 Class A at 10 m
FCC Part 15A above 1 GHz

Electromagnetic immunity Evaluated to EN 61326:
1997/A1: 1998, Table 1



Note For full EMC compliance, you must operate this device with shielded cabling. Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, click **Declaration of Conformity** at ni.com/hardref.nsf/.

Mechanical Dimensions

Figure 7 shows the mechanical dimensions of the FP-QUAD-510 installed on a terminal base. Dimensions are given in millimeters [inches]. If you are using the cFP-QUAD-510, refer to the Compact FieldPoint controller user manual for the dimensions and cabling clearance requirements of the Compact FieldPoint system.

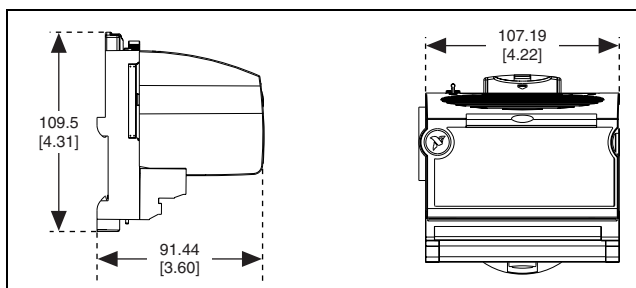


Figure 7. FP-QUAD-510 Mechanical Dimensions

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 operating instructions

Go to 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/ask and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 03 9879 5166, Austria 0662 45 79 90 0,
Belgium 02 757 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, China 86 21 6555 7838,
Czech Republic 02 2423 5774, Denmark 45 76 26 00,
Finland 09 725 725 11, France 01 48 14 24 24,
Germany 089 741 31 30, Greece 01 42 96 427,
Hong Kong 2645 3186, India 91 80 4190000,
Israel 03 6393737, Italy 02 413091, Japan 03 5472 2970,
Korea 02 3451 3400, Malaysia 603 9596711,
Mexico 001 800 010 0793, Netherlands 0348 433466,
New Zealand 09 914 0488, Norway 32 27 73 00,
Poland 22 3390 150, Portugal 210 311 210, Russia 095 238 7139,
Singapore 65 6 226 5886, Slovenia 3 425 4200,
South Africa 11 805 8197, Spain 91 640 0085,
Sweden 08 587 895 00, Switzerland 056 200 51 51,
Taiwan 02 2528 7227, United Kingdom 01635 523545