OPERATING INSTRUCTIONS

NATIONAL INSTRUMENTS

FP-CTR-502

8-Channel, 16-Bit Counter Module

FieldPoint

These operating instructions describe the installation, features, and characteristics of the FP-CTR-502. For details on configuring and accessing the FP-CTR-502 over a network, refer to the user manual for the particular FieldPoint network module you are using with the FP-CTR-502.

Features

The FP-CTR-502 is a FieldPoint counter module with the following features:

- Eight 16-bit counters with individual count input terminals
- Internal frequency references of 1 kHz and 32 kHz
- Internally cascadable counters
- Four gate inputs configurable as either gates or discrete inputs
- Four outputs configurable as either counter outputs or discrete outputs
- 5–30 VDC sourcing inputs and sinking outputs, compatible with TTL devices and other 5, 12, or 24 VDC devices.
- Software-enabled, 200 Hz low-pass filters on counter inputs
- On/off LED indicators
- Hot plug and play operation
- 3,000 Vrms input-to-output isolation
- Double insulated for 250 V safe working voltage

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Installation

The FP-CTR-502 mounts on a FieldPoint terminal base (FP-TB-*xx*) unit. Because of its hot plug and play operation, you can install the FP-CTR-502 onto a powered terminal base without disturbing the operation of other modules or terminal bases. The FP-CTR-502 receives operating power from the terminal base.

To install your module, 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-CTR-502 module).
2. Align the FP-CTR-502 alignment slots with the guide rails on the terminal base.
3. Press firmly to seat the FP-CTR-502 on the terminal base. When the module is firmly seated, the terminal base latch locks it into place.

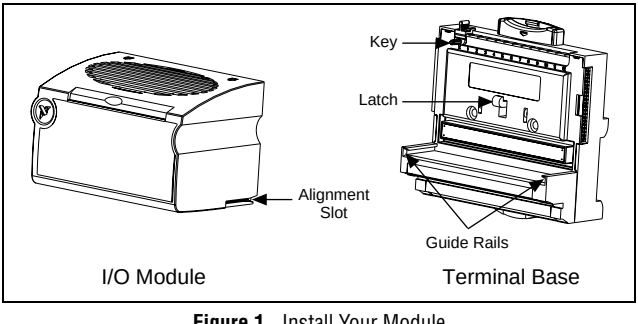

Figure 1. Install Your Module

Field Wiring

The terminal base provides connections for each I/O channel and for an external supply to power the FP-CTR-502 output channels and field devices. Although the module does not need the external supply for its internal operation, the output channels sink current from this external supply and require it to operate.

Each input channel has one input terminal, V_{in}, and each output channel has one output terminal, V_{out}. Each channel also has V_{sup} and COM terminals that can supply field power to devices. You can connect the eight counter inputs and four gate inputs to devices

with sinking outputs. You can connect the four outputs to devices with sourcing inputs. Figure 2 shows an example of these connections for the output channels, and Figure 3 shows two examples for the input channels.

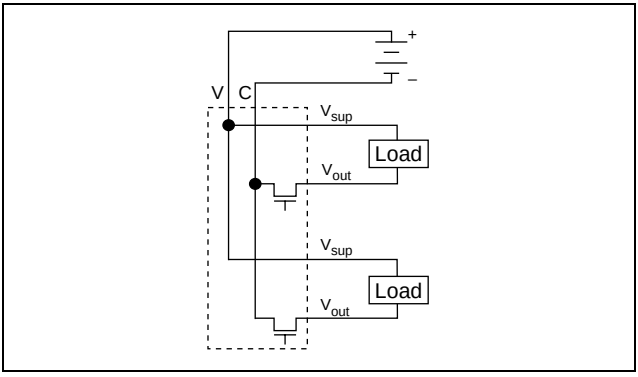

Figure 2. Basic Field Connections to Sinking Output Devices

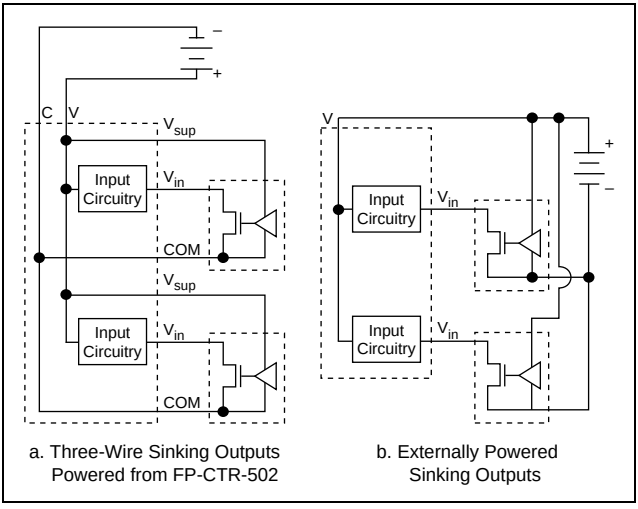

Figure 3. Basic Field Connections to Sourcing Input Devices

Table 1 lists the terminal assignments for the signals of each channel. *C* denotes a count input, *G* a gate input, and *O* an output. Terminal assignments and wiring diagrams are also listed under the slide-in card on the front of the FP-CTR-502 module.

Table 1. Terminal Assignments

Channel	Terminal Numbers		
	V_{in}	V_{sup}	COM
Count Inputs			
C0	1	17	18
C1	2	17	18
C2	3	19	20
C3	4	19	20
C4	5	21	22
C5	6	21	22
C6	7	23	24
C7	8	23	24

Channel	Terminal Numbers		
	V_{in}	V_{sup}	COM
Gate Inputs			
G0	9	25	26
G1	10	25	26
G2	11	27	28
G3	12	27	28
Outputs			
O0	13	29	30
O1	14	29	30
O2	15	31	32
O3	16	31	32

Status Indicators

Figure 4 shows the module label and status indicators. To see wiring diagrams for the input channels, remove the slide-in card.

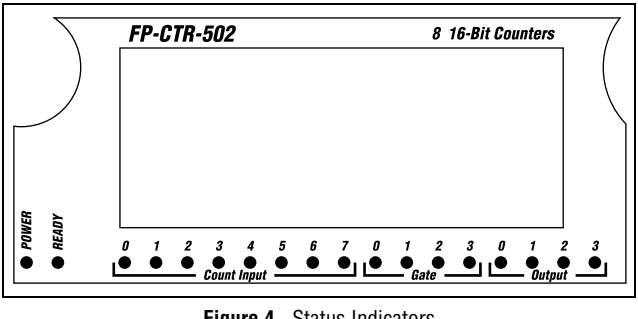

Figure 4. Status Indicators

After you insert the module into a terminal base (and apply power), the green **POWER** indicator lights and the FP-CTR-502 informs the network module of its presence. When the network module recognizes the FP-CTR-502, it sends initial configuration information to the FP-CTR-502. After receiving this initial information, the green **READY** indicator lights and the FP-CTR-502 is in its normal operating mode. In addition to the green **POWER** and **READY** indicators, each channel has a numbered, green status indicator that lights when the channel is in the ON state.

Counter Channel Operation

Each counter channel (channels 0–7) has a 16-bit binary up-counter that you can configure to operate in many different modes. Primarily, the counter channels increment in response to a count trigger event. You can select the source of the trigger from many different sources.

The following sections describe the operation of the counter channels.

Count Input Circuit

The circuit for the count inputs consists of an optoisolator with a current limiting circuit. Each channel has one signal input, V_{in}, which is referenced to the supply terminal (V or V_{sup}). When you apply a voltage above the threshold voltage to the V_{in} terminal of a counter channel, signal current flows through the input and turns on the optoisolator, registering in the ON state. The threshold voltage is typically 2.5 V, but may be as low as 2.0 V, or as high as 3.0 V.

The FP-CTR-502 has sourcing inputs; that is, the inputs source current from the positive external supply terminal (V or V_{sup}) to the V_{in} terminal. Thus, the inputs are compatible with sinking output devices that can sink current from a positive supply voltage to C or COM. The FP-DO-403 is an example of a sinking output device.

Figure 2 shows example connections to sinking output devices. Make sure these devices have OFF state leakage currents of less than 0.2 mA so they do not send false ON state readings to the FP-CTR-502.

Each external count input has a software-enabled low-pass filter that you can set to reject frequencies above 200 Hz. With the 200 Hz setting, pulses of 2.5 ms or greater activate the count input.

With the filter disabled, pulses 10 µs (50 kHz) or greater activate the count input.

Count Trigger Source

You can configure each counter channel to use one of four different trigger sources: the external count input, internal 1 kHz (1 ms period) reference, internal 32 kHz reference, or the internal output from the previous counter channel. When you select either the external input or one of the internal references, the channel counts off-to-on (low-to-high or rising-edge) transitions of the trigger source.

When you select the internal output from the previous counter channel, the channel counts the number of times that the previous counter channel reaches its terminal value and resets to zero. In effect, you can configure multiple counters to operate as one large counter. The counter channel is slaved to the previous channel in number and increases in numerical value. Channel 1 can be slaved to channel 0, channel 0 to channel 7, channel 7 to channel 6, and so on. If you select this option for all of the channels, no counting occurs.

Terminal Value

The maximum value for each of the FP-CTR-502 counters is 65,535. This is the default terminal count value, but you can set each of the counter channels to use any number between 0 and 65,535 as the terminal value. If a counter is at its terminal value and receives a count trigger, it resets to 0 and triggers any outputs associated with it. It also sends a count trigger to the next counter channel if that channel is set to use the previous channel output as its trigger source.

Gate Input

You can configure each counter channel to use one of the external gate inputs, or no gate. If the counter channel uses no gate, you can set the channel as permanently enabled, or permanently disabled. If the counter channel uses one of the external gate inputs, counting is enabled when the gate input is ON (high) and disabled when it is OFF (low).

Reset on Read Capability

You can configure each counter channel to reset each time the FieldPoint network module reads it. A read-initiated reset also resets any outputs associated with the target channel.

Commands

Each counter channel supports a control command with two actions—increment and reset. The control-increment command increases the target counter channel in value by one. The control-reset command resets the target counter. The control commands ignore the gate source setting and gate input state.

Gate Channel Operation

The four gate inputs (channels 8–11) use an input circuit that is identical to that of the counter channels, except the gate inputs do not have a programmable low-pass filter.

The states of the gate inputs can always be read as simple discrete inputs on channels 8–11.

Output Channel Operation

The FP-CTR-502 includes four outputs (channels 12–15) that you can use either as discrete outputs or associate with any one of the eight counter channels. Several software-programmable attributes control the operation of the output channels.

The following sections describe the operation of the output channels.

Output Circuit

The FP-CTR-502 discrete outputs have optically isolated sinking outputs. In the ON state, a transistor is turned on between the output (V_{out}) terminal and the common terminal (C or COM). In the OFF state, this transistor is turned off, allowing only a small leakage current to flow. Select the impedance of the loads driven by the output channels so that the current supplied by any one channel in the ON state is no more than 1 A.

The output channels need an external power supply of between 5 and 30 VDC connected to the C and V terminals of the module.

In the ON state, the effective resistance between the output and common is 0.12 Ω, which causes a voltage drop. For example, if the external supply voltage is 10 V and the output current is 1 A, the output voltage is 9.88 V: [10 V – (1 A × 0.12 Ω) = 9.88 V].

Figure 5 shows a diagram of the discrete output circuit of one channel.

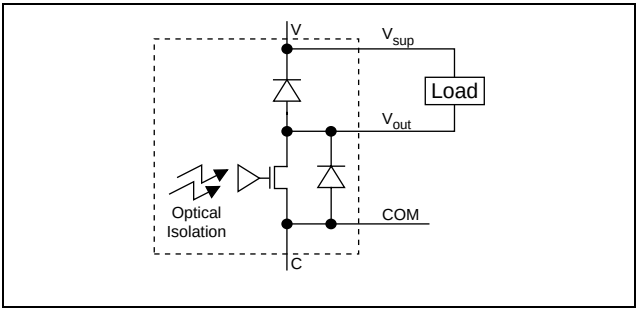

Figure 5. Discrete Output Circuit

Output Source

You can configure each output to operate either as an output for one of the eight counter channels or as a discrete output.

The network module can read the state of an output channel at any time. Writing discrete data to an output affects the state of the output only if that output channel is set to act as a discrete output.

Output Mode

You can configure each output to operate either in a pulse or toggle mode and you can specify a reset state of either ON or OFF. If the output channel is configured as a discrete output, the output mode setting has no effect.

In toggle mode, an output changes its state (either ON to OFF or OFF to ON) when the counter channel triggers it. When set to pulse mode, the output toggles from its reset state when the counter channel triggers it and toggles back to its reset state when the counter channel receives its next count trigger, generating either an ON pulse or an OFF pulse.

Application Notes

The following sections describe additional examples of ways you can use the FP-CTR-502 in your applications.

Generating a Continuous Pulse Train

You can use two FP-CTR-502 counter channels and one output channel to generate a continuous pulse train with a controllable duty cycle and period. When you do so, the first counter serves as a clock prescaler and divides your input clock by a fixed value. This generates a slower clock for the second counter and the second counter is used as the pulse counter. One of the FP-CTR-502 outputs uses the pulse counter as its output source.

Figure 6 shows a diagram of a continuous pulse train.

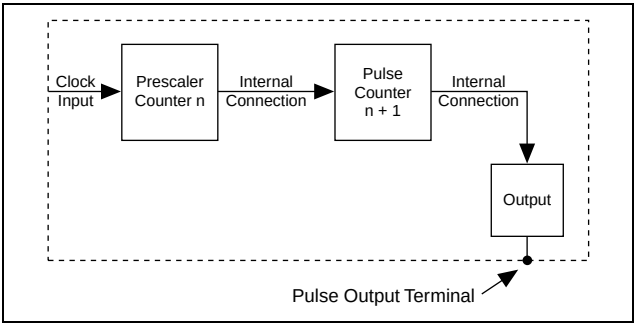

Figure 6. Continuous Pulse Train

Step 1. Set up the Prescaler Counter

To set up the prescaler counter, complete the following steps:

1. If you do not need to scale the frequency of your clock input, you can configure the pulse counter to use the clock input directly and not use the prescaler counter. To set up the pulse counter, skip to *Step 2. Set up the Pulse Counter*.
2. Select two counter channels and an output that you want to use. Select counter channels that are numbered sequentially (for example, channels 1 and 2, 5 and 6, or 7 and 0). The counter with the lower number is the prescaler counter and the counter with the higher number is the pulse counter.
3. Set the Gate Source attribute of the prescaler counter to Always Disabled and set Read Reset Mode to Don't Reset On Read.

4. Set the Count Source of the prescaler counter to the clock that you want to base your pulse train on. This can be the external counter input or one of the FP-CTR-502 internal references.
5. Subtract 1 from the value that you want to divide the input clock by and set the Terminal Count of the prescaler counter to the result. For example, a Terminal Count of 4 divides the input clock by 5. If you use the 1 kHz reference as the prescaler count source, this setting generates a 200 Hz clock for the pulse counter.

To determine the frequency of the prescaler output, use the following formula:

$$f_{pre} = \frac{f_{src}}{term_{pre} + 1}$$

where:

f_{pre} is the frequency of the prescaler counter output,
f_{src} is the count input frequency for the prescaler counter, and
$term_{pre}$ is the Terminal Count value for the prescaler counter.

Step 2. Set up the Pulse Counter

To set up the pulse counter, complete the following steps:

1. Set the Count Source of the pulse counter (the counter with the higher number) to Previous Channel so that it uses the output from the prescaler counter.

Note If you are not using a prescaler counter, set the Count Source to the clock that you want to base your pulse train on.

2. Set the Read Reset Mode of the pulse counter to Don't Reset On Read and set the Gate Source to Always Enabled.
3. Subtract 1 from the value that you want to divide the count input by and set the Terminal Count of the pulse counter to the result.

   The internal output from the pulse counter triggers the output channel that you selected for the pulse train output.

To determine the frequency of the output from the pulse counter, use the following formula:

$$f_{pulse} = \frac{f_{pre}}{term_{pulse} + 1}$$

where:

f_{pulse} is the pulse counter output frequency,
f_{pre} is the prescaler counter output frequency, and
$term_{pulse}$ is the Terminal Count value for the pulse counter.

Step 3. Configure the Pulse Train Output Channel

To configure the pulse train output channel, complete the following steps:

1. Set the Output Source of the output channel that you selected to the pulse counter channel.
2. Set the Output Mode of the output channel. To generate a pulse train with variable duty cycle, use one of the pulse modes—On Pulse or Off Pulse. To generate a 50% duty-cycle pulse train, use one of the toggle modes.

To determine the duty cycle, use the following formulas:

$$d = \frac{1}{term_{pulse} + 1}, \quad \text{for On Pulse mode}$$

$$d = 1 - \left(\frac{1}{term_{pulse} + 1}\right), \quad \text{for Off Pulse mode}$$

where d is the pulse train duty cycle and $term_{pulse}$ is the Terminal Count value for the pulse counter.

When you set the output to one of the pulse modes, the frequency of the pulse train is the same as shown in *Step 2. Set up the Pulse Counter* (f_{pulse}), but the output frequency is half this value when you set the output channel to one of the toggle modes.

Generating a Finite Pulse Train

You can use another FP-CTR-502 counter channel and output to generate a pulse train with a fixed number of pulses. The third counter is a gate control counter that counts the number of pulses generated, and that turns off the pulse counter when the number has reached the appropriate value. You can use the additional output to wire the output from the gate counter to one of the gate inputs.

Figure 7 shows a diagram of a finite pulse train.

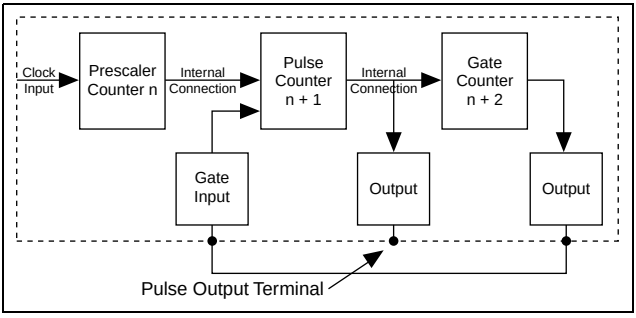

Figure 7. Finite Pulse Train

To set up a finite pulse train, complete the following steps:

1. Refer to the instructions in the previous section to set up a continuous pulse train.
2. Set the gate input of the prescaler channel (or the pulse counter if you are not using a prescaler channel) to Always Disabled.
3. Set the Count Source of the gate counter to Previous Channel. The gate counter must be the channel after the pulse counter. For example, channel 3 if the pulse counter is channel 2 or channel 0 if the pulse counter is channel 7.
4. Configure a second output to use the gate counter channel as its Output Source and set the Output Mode to Toggle, Reset On.
5. If the Output Mode of the pulse train output is set to one of the pulse modes, set the maximum value of the gate counter to the number of pulses that you want to generate. If the pulse output is set to a toggle mode, set the maximum value to twice the number of pulses that you want to generate, because the output toggles twice to generate a single pulse.
6. Wire the output from the gate counter channel to one of the FP-CTR-502 gate inputs and configure the pulse counter channel to use this gate input. When the correct number of pulses is generated, the second output is triggered, which deactivates the gate channel and the pulse counter.
7. To start the first pulse train, send a reset command to all three counter channels, and then set the gate input for the prescaler channel to Always Enabled. The pulse train output stops at its reset value when the correct number of pulses is generated.

To initiate subsequent pulse trains, you can either send a reset command to the gate counter channel, or change the polarity of the gate counter output. If the output was set to Reset Off, change it to Reset On, and if it was Reset On, change it to Reset Off.

Isolation and Safety Guidelines

Caution Before you connect *any* circuits that may contain hazardous voltages to the FP-CTR-502, read the following information.

This section describes the isolation of the FP-CTR-502 and its compliance with international safety standards. The field wiring connections are isolated from the backplane provided by the terminal base with an optical and galvanic isolation barrier designed and tested to provide protection against fault voltages of up to 3,000 Vrms. In addition, the FP-CTR-502 provides *double insulation* (compliant with IEC 1010-1) for working common-mode voltages of 250 Vrms. 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 may be at hazardous potentials under normal conditions, unless the product is specifically designed for such an application, as is the FP-CTR-502.

When you use a product like the FP-CTR-502 in applications with hazardous potentials, follow these guidelines to make sure your total system is safe:

- The safety isolation of the FP-CTR-502 is from input to output, *not* between channels on the same module. 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 (V and C on the terminal base) with other devices (including other FieldPoint devices), unless those devices are isolated from human contact.

- As with any hazardous voltage wiring, make sure that all wiring and connections meet applicable electrical codes and common sense practices. Mount terminal bases in an area, position, or cabinet that prevents accidental or unauthorized access to wiring that carries hazardous voltages.
- The isolation of the FP-CTR-502 is certified as double-insulated for normal operating voltages of 250 Vrms. Do *not* use the FP-CTR-502 as the only isolating barrier between human contact and working voltages of more than 250 Vrms.

Specifications

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

Input

Number of channels	12 (eight count, four gate)
Input type	5–30 VDC sourcing, compatible with TTL devices and other 5, 12, or 24 VDC devices
Maximum input voltage	30 VDC
Input threshold level	2.5 V typical 2.0 V minimum 3.0 V maximum
Input current limiting	6 mA
Input bandwidth	
Count inputs	50 kHz or software-enabled 200 Hz low-pass filter
Gate inputs	50 kHz
Minimum input pulse width	10 µs with 50 kHz, 2.5 ms with 200 Hz
Isolation	3,000 Vrms
Safety isolation, working voltage	250 Vrms, designed per IEC 1010 as double insulated

Output

Number of channels 4

Output type ..... 5–30 VDC sinking, compatible with TTL devices and other 5, 12, or 24 VDC devices

Supply voltage ..... 5 to 30 VDC, user-provided

Output current ..... 1 A max per channel

Output impedance ..... 0.12 Ω

Output bandwidth ..... 16 kHz

Physical

Indicators ..... Green **POWER** and **READY** indicators, 16 green input/output state indicators

Weight ..... 130 g (4.5 oz.)

Power Requirements

Power from network module ..... 800 mW maximum

Environment

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

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

Relative humidity ..... 5% to 90%, non-condensing

CE Mark Compliance

This product meets applicable EU directive(s), as follows:

Safety isolation ..... EN 61010 (double insulation for 250 Vrms working isolation, installation category II)

EMC directive

- Immunity ..... EN 50082-1:1994
- Emissions ..... EN 55011:1991 Group I Class A at 10 m

Mechanical Dimensions

Figure 8 shows the mechanical dimensions of the FP-CTR-502 installed on a terminal base. Dimensions are given in inches [millimeters].

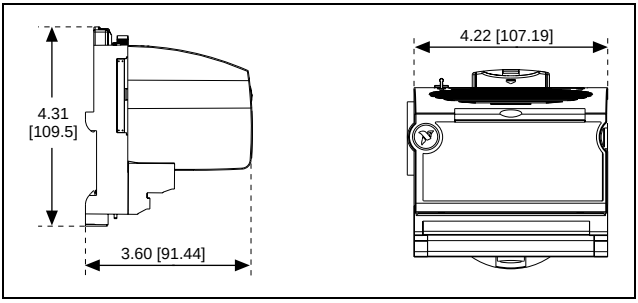

Figure 8. Mechanical Dimensions