NI-9326 Getting Started

2025-03-13

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NI-9326 Pinout

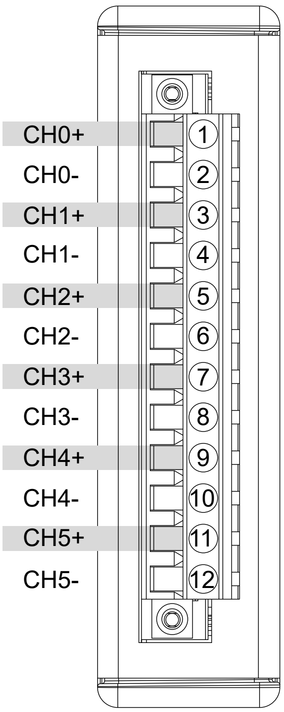
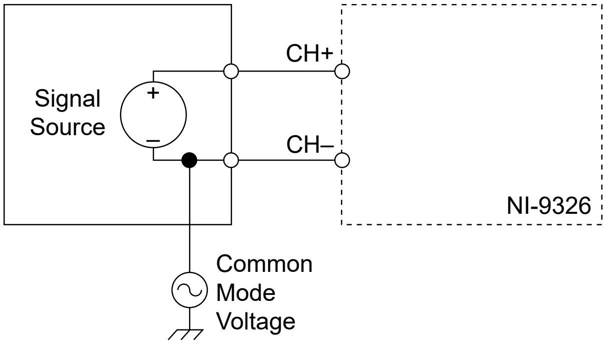


Table 1. Signal Descriptions

Signal	Description
CH+	Positive input signal connection
CH-	Negative input signal connection

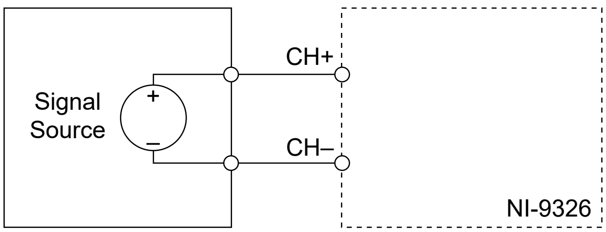
Grounded Differential Connections

Figure 3. NI-9326 Grounded Differential Connections Diagram



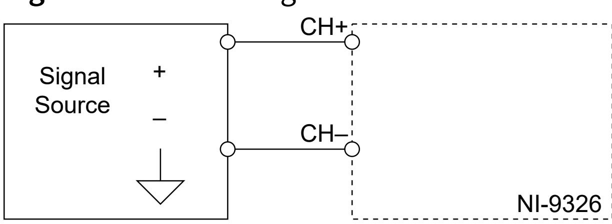
Floating Differential Connections

Figure 3. NI-9326 Floating Differential Connections Diagram



Single-Ended Connections

Figure 3. NI-9326 Single-Ended Connections Diagram



NI-9326 Connection Guidelines

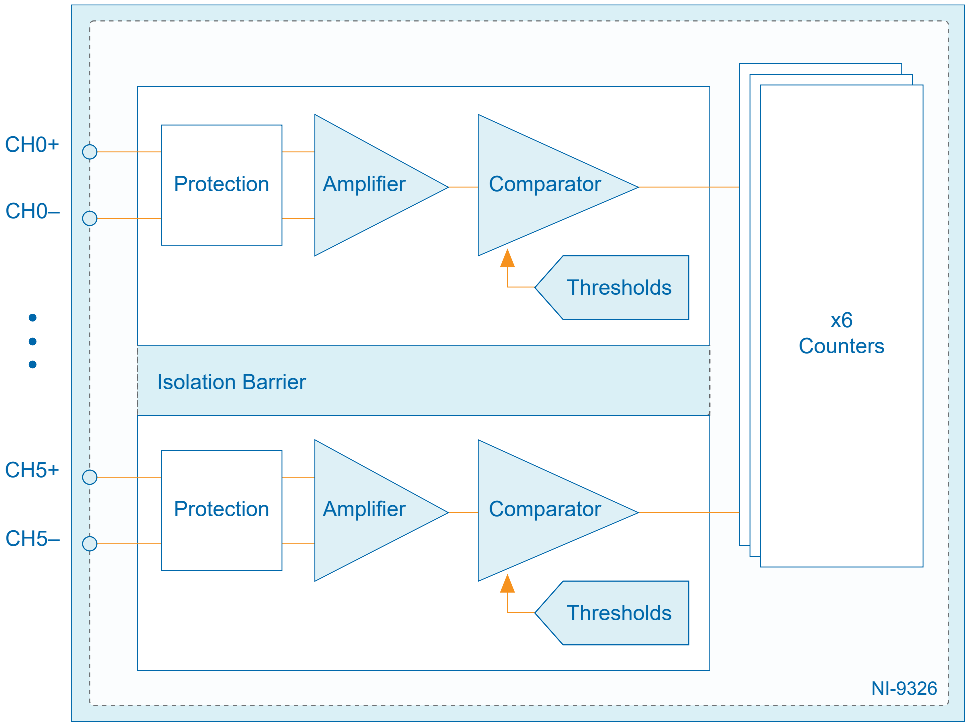
- Make sure that devices you connect to the NI-9326 are compatible with the module specifications.

High-Vibration Application Connections

If your application is subject to high vibration, NI recommends that you follow these guidelines to protect connections to the NI-9326:

- Use ferrules to terminate wires to the detachable connector.
- Use the NI-9929 connector backshell kit.

NI-9326 Block Diagram



- Input signals on each channel are filtered and passed through a comparator with configurable threshold and hysteresis.
- Each input channel provides an independent configuration to enable independent data sampling by the counter.
- The module protects each channel from overvoltages.

NI-9326 Front End Control

The NI-9326 has 6 input channels which have independent settings as follows:

- Configurable input signal rising or falling edge detection
- Configurable threshold and hysteresis
- Configurable digital glitch filter

I/O Protection

The voltage input level and the current input level of the digital signals are listed in the specifications of your device. The I/O protection circuitry protects the module in events such as overvoltage, overcurrent, and ESD. Refer to the ***NI-9326 Specifications*** for more information about the protection level supported.

Configurable Threshold and Hysteresis

The NI-9326 provides a configurable threshold and hysteresis on each of the input channels. The use of the hysteresis helps eliminate incorrect triggering caused by a noisy input signal around the threshold level. Input edges are detected when the input signal crosses the threshold in the direction selected. Hysteresis is applied either above or below the threshold depending on the selected direction. The diagrams below illustrate how the direction, threshold, and hysteresis work together to determine the resulting hardware trigger levels.

Figure 1. Input Signal Edge Detection: Rising

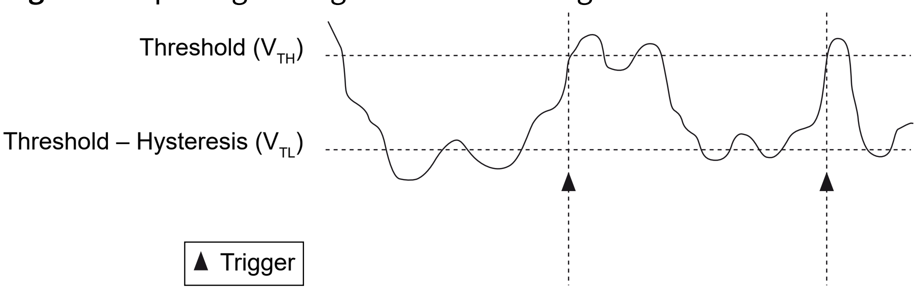
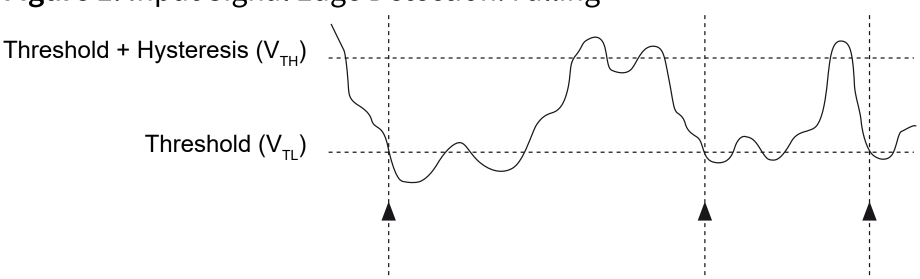


Figure 1. Input Signal Edge Detection: Falling



The upper and lower thresholds achieved from the mathematical operation between the configured threshold and hysteresis values are ultimately still limited by the threshold range supported by the NI-9326. Refer to the ***NI-9326 Specifications*** for more information about the threshold range supported. The following are examples of threshold and hysteresis values with final trigger levels:

- Exceeding upper threshold range
  - Input signal edge detection: Falling
  - Threshold: 8 V
  - Hysteresis: 5 V

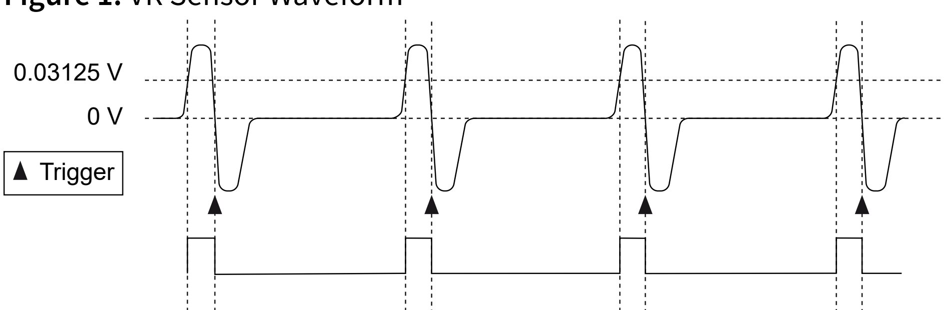
  - Final trigger levels:
    - Threshold + Hysteresis: 9.5 V (limited by the threshold range supported)
    - Threshold: 8 V
- Exceeding lower threshold range
  - Input signal edge detection: Rising
  - Threshold: -8 V
  - Hysteresis: 5 V
  - Final trigger levels:
    - Threshold: -8 V
    - Threshold - Hysteresis: -9.5 V (limited by the threshold range supported)

To get a valid measurement, configure the edge detection and threshold for a point that occurs only once during the signal period. Then configure a hysteresis value large enough to filter out noise around the threshold while still detecting valid transitions. Hysteresis should always be set greater than 0 V.

For example, a VR sensor connected with the proper polarity will idle around 0 V. The sensor output will go positive as a ferrous material approaches the sensor and then swings rapidly back through zero as it moves past the center of the sensor. To get the best measurement, configure the falling edge detection with a 0 V threshold to trigger on this fast falling edge. Configure enough hysteresis to filter out noise that occurs around 0 V while still detecting valid pulses. The following diagram shows an example waveform and configuration for a VR sensor.

- Input signal edge detection: Falling
- Threshold: 0 V
- Hysteresis: 31.25 mV

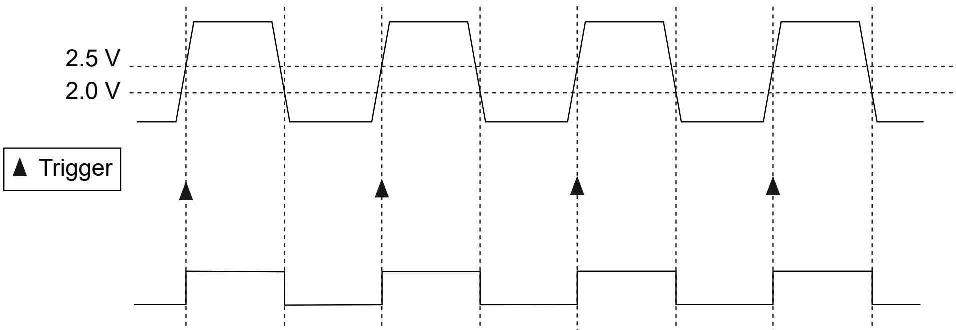
Figure 1. VR Sensor Waveform



The following diagram shows the waveform output from a 5 V CMOS digital IC. This waveform has fast rising and falling edges, so either edge works well for counting. This example shows counting rising edges with the threshold placed in the middle of the signal swing:

- Input signal edge detection: Rising
- Threshold: 2.5 V
- Hysteresis: 0.5 V

Figure 1. 5 V CMOS Digital IC Waveform



Programmable Digital Glitch Filter

The NI-9326 has a digital glitch filter on each of the input lines that are essentially timers to filter unwanted glitches, transitions, or noise on the input signal.

You can configure the following filter properties for each of the input lines:

- Enable or disable the digital glitch filter.
- Minimum pulse width of the input signal that passes through the filter.

The filter time is the minimum pulse width value set by the user. The timer begins at both the rising and falling edge of the unfiltered input signal and the previous value of the input signal is read for the duration of the filter time. After the filter time elapses and no new edges on the input signal have occurred, the new input signal value is read. The filter timer restarts at the next edge of the unfiltered input signal.

Figure 1. Low to High Input Signal Transition

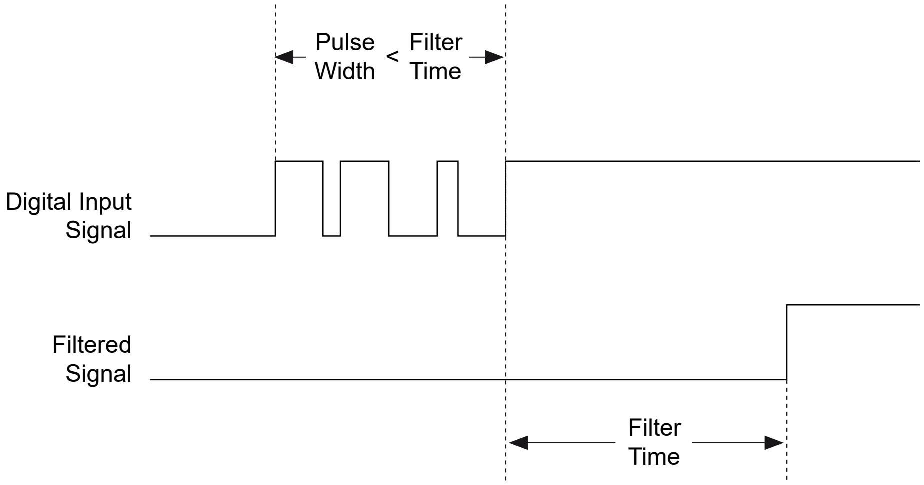
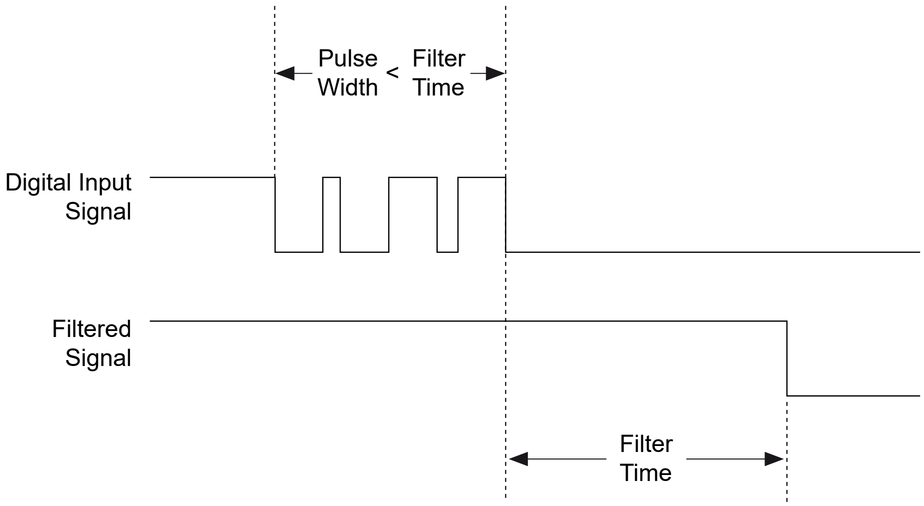


Figure 1. High to Low Input Signal Transition



The input signal will have distortion due to the limited bandwidth of the module. The following formula is used to determine the accurate minimum pulse width to be configured for the digital glitch filter of the module, based on the maximum pulse width desired to be filtered and other required parameters:

$$GPW_{Input} = GPW_{Desired} + 0.66\ \mu s \times \ln\left(\frac{V_{IH} - V_{TH}}{V_{TL} - V_{IL}}\right) - 63\text{ns}$$

where

- GPW_{Input} is the glitch pulse width input
- $GPW_{Desired}$ is the desired glitch pulse width
- V_{IH} is input HIGH level of signal
- V_{IL} is input LOW level of signal
- V_{TH} is the upper threshold level
- V_{TL} is the lower threshold level

- $V_{TL} > V_{IL}$
- $V_{TH} < V_{IH}$
- $V_{IH} - V_{IL} < 25\ V_{pp}$
- V_{TH} and V_{TL} must be within 10% to 90% of the square wave amplitude

Note Both V_{TH} and V_{TL} can be determined based on the input signal transition diagrams shown in the ***Configurable Threshold and Hysteresis*** section.

Frequency/Period Measurement

You can take frequency or period measurements with the NI-9326. The counter measures and returns the period information of a signal. The NI-9326 returns the current period measurement values when the counter is read. The raw counter period measurements consist of two different values:

- A — The period measured in ticks of the 100 MHz counter timebase
- B — Scaling factor for the period measured

You can calculate the measured period using the following equation:

$$Measured\ Period = \frac{Number\ \ of\ Ticks \times Timebase}{Scaling\ Factor} = \frac{A \times 10\ \ ns}{B}$$

where

- Number of Ticks (A) and Scaling Factor (B) are the raw values returned by the counter
- 10 ns is the 100 MHz counter timebase period

Example measurement of a 1 kHz input signal:

- A = 3,200,000
- B = 32
- Measured period = (3,200,000 * 10 ns)/32 = 1 ms

You can calculate the frequency using the following equation:

$$Signal\ Frequency = \frac{1}{Signal\ Period}$$

Channel Settings

You can configure the following counter properties:

- Input terminal of the signal-to-measure.
- The active edge, rising or falling, that is counted[1].
- Butterworth filter enabling/disabling
- Butterworth cutoff frequency

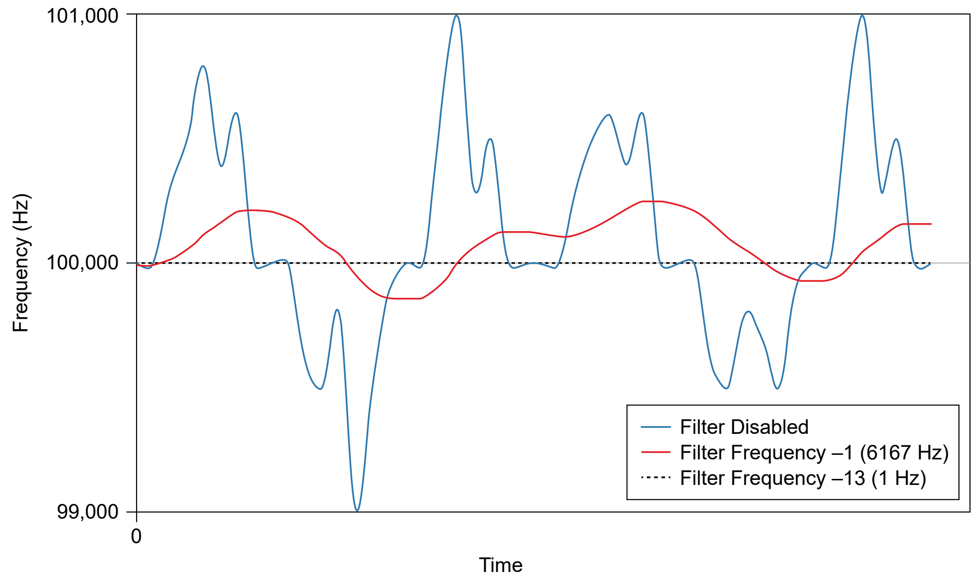
Filter Enabled

You can configure the following properties of the frequency/period measurement method when using the Butterworth filter:

- Enable Butterworth filter
  - Enable Butterworth filter determines whether every single period measurement of the input signal passes through the digital low pass filter or not. Enabling this feature helps in filtering out the variations in the period measured.
- Filter Frequency
  - Filter Frequency specifies the cut-off frequency of the 2nd order Butterworth filter when enabled. The 2nd order Butterworth filter provides thirteen selectable cut-off frequencies that are configurable per channel if enabled.

The Butterworth filter reduces the variations in the measured frequency caused by noise in the system. In the following example, a measurement of a desired 100 kHz signal with an unwanted noise source of 1 kHz superimposed on top of the signal causes the signal measurement to vary between 99 kHz and 101 kHz if filter is not enabled.

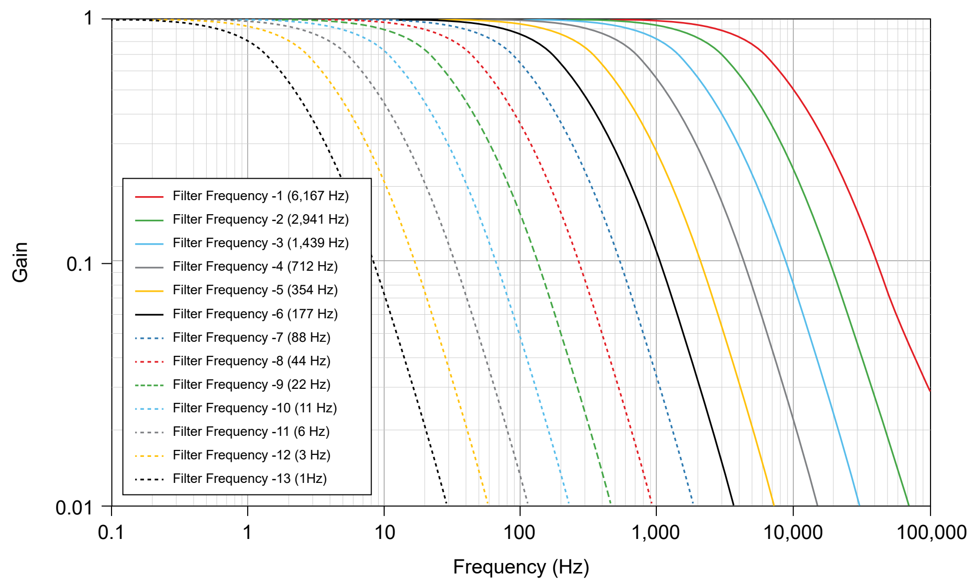
1. The active edge that is counted refers to the input signal rising or falling detection that is selected for the input terminal to the counter.



Enabling the Butterworth filter does not attenuate the fundamental 100 kHz test frequency itself but reduces the spread of the frequency due to the noise. Therefore, the desired 100 kHz signal can still be measured even with the lowest 1 Hz cutoff.

The Butterworth filter is configured by selecting the desired filter cut-off frequency. The following figure shows the response in the frequency domain for each of the available filter frequencies:

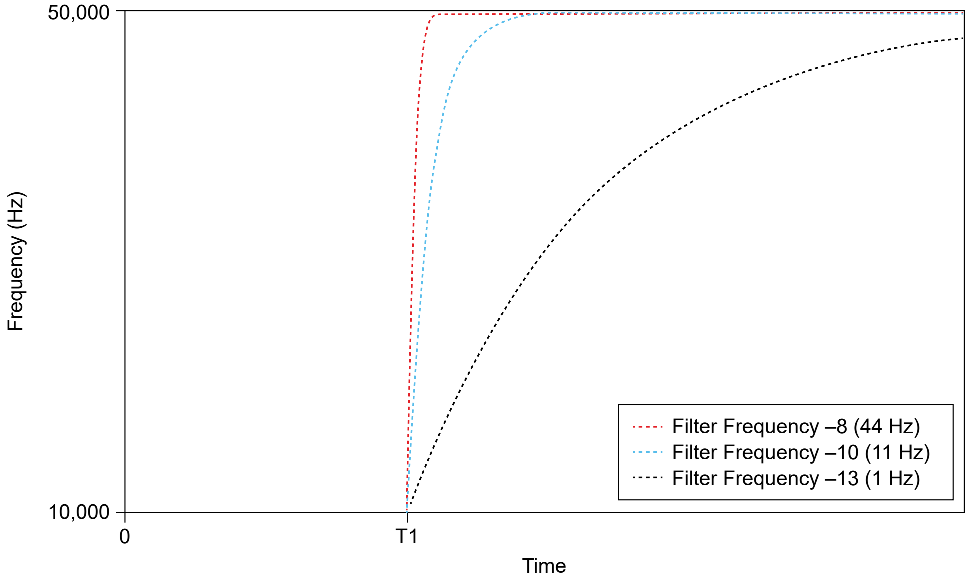
Figure 1. Butterworth Low Pass Filter Response



Selecting a lower filter frequency provides more filtering of the input noise, but it will add longer filter delay and filter settling time. The filter delay represents the processing time added by the filter. The filter settling time shows the time required to reach 99% of the input step. Refer to the ***NI-9326 Specifications*** for the filter delay and settling time.

Any step response change of the test frequency will take longer to settle for filters with a lower cut-off frequency as shown in the following figure, where the frequency measurement changes from 10 kHz to 50 kHz at T1:

Figure 1. Butterworth Low Pass Filter Settling Time



Filter Disabled

You can configure the following properties of the frequency/period measurement method when not using the Butterworth filter:

- Divisor
    - Divisor specifies the number of periods of the input signal to measure to determine the average input signal period.
- Measurement Time
    - Measurement Time specifies the amount of time over which to measure and average multiple periods of the input signal. In this measurement mode, the counter measures however many periods of the input signal fit within the specified Measurement Time.
- Maximum Measurable Period
    - You can set the maximum measurable period of the signal. If the input signal

period is slower than this value, the counter returns a measurement value of zero. Use this property to get updated measurement data when the signal slows down or is stopped instead of previous measurements. To disable this feature, set the maximum measurable period to zero. When this feature is disabled, the counter keeps measuring until a valid measurement is detected, the counter overflows, or the user stops the counter.

> **Note** The measurement time, divisor, and maximum measurable period parameters are ignored when the Butterworth filter is enabled.

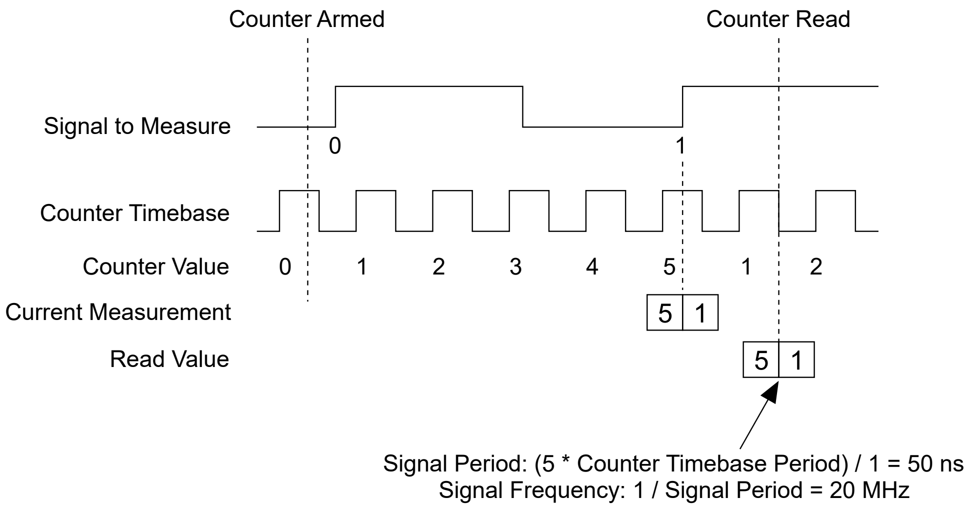
When both the Divisor and the Measurement Time values are set, the counter goes into Dynamic Averaging mode. In this mode, the counter simultaneously performs the measurement based on both the Divisor and Measurement Time settings, and returns whichever measurement completes first. The following table shows the summary of the different setting combinations.

Divisor	Measurement Time	Counter Characteristic
1	0 (Disabled)	Measure 1 period of the input signal.
N	0 (Disabled)	Measure N periods of the input signal.
0 (Disabled)	M	Measures all the period of the input signals that occur within the M measurement time.
N	M	Returns the measurement of N periods of the input signal or the measurement that occurs within the M measurement time, whichever completes first.

The measurement time and divisor settings affect the measurement error and latency. Increasing the divisor or measurement time improves the measurement accuracy but also reduces the measurement rate.

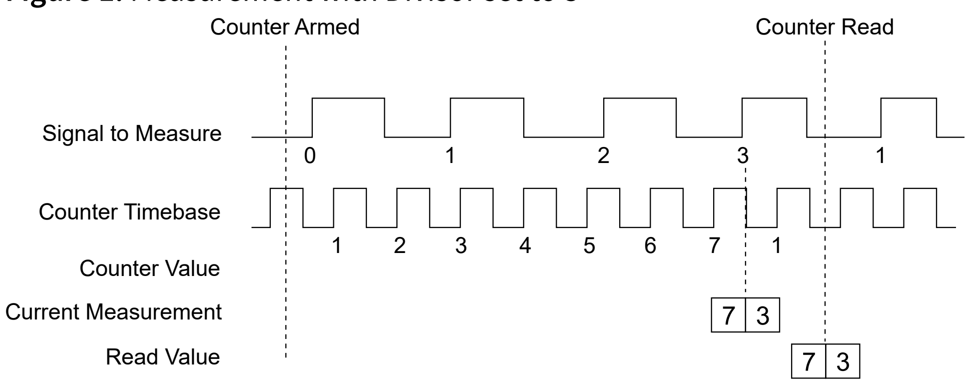
The following figure shows an example of setting the Divisor to 1 for the frequency measurement.

Figure 1. Measurement with Divisor set to 1



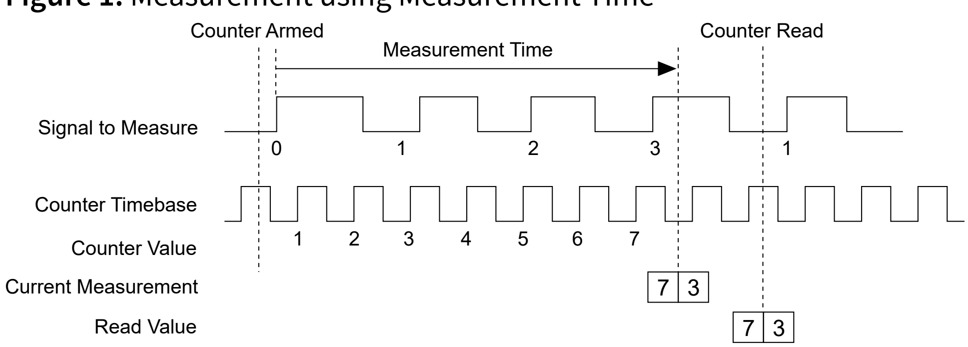
The following figure shows an example of setting the Divisor to 3 for the frequency measurement.

Figure 1. Measurement with Divisor set to 3



The following figure shows an example of Measurement Time.

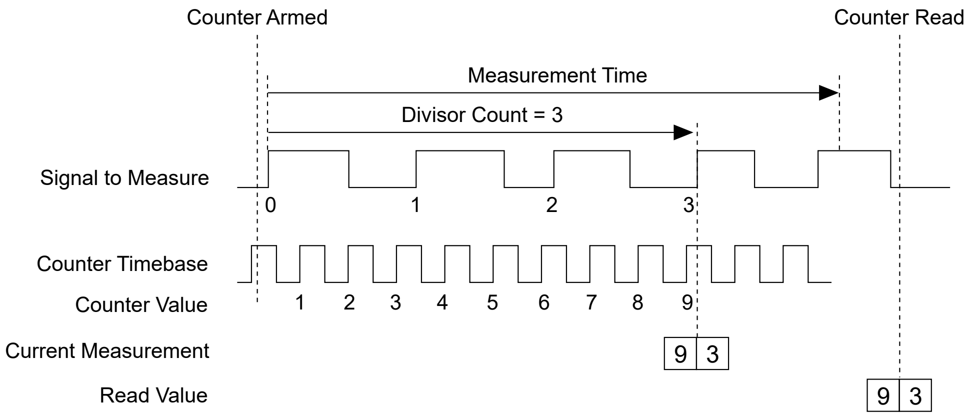
Figure 1. Measurement using Measurement Time



In the following examples, both the Divisor and Measurement Time are set for frequency measurement.

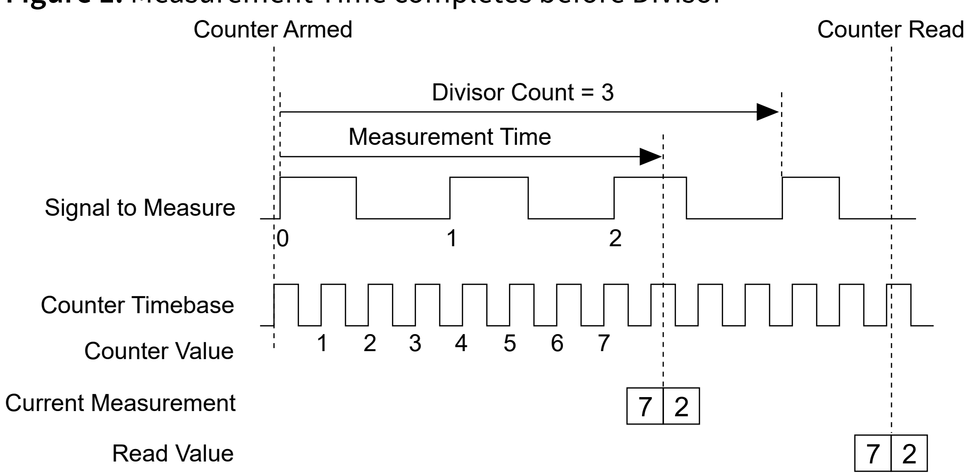
In the following figure, the Divisor period of the input signal, in this case 3, is met before the measurement time elapsed, thus the Divisor setting is used for the frequency measurement.

Figure 1. Divisor completes before Measurement Time



In the following figure, the measurement time elapsed before the 3 divisor periods of the input signal, thus the Measurement Time setting is used for the frequency measurement.

Figure 1. Measurement Time completes before Divisor



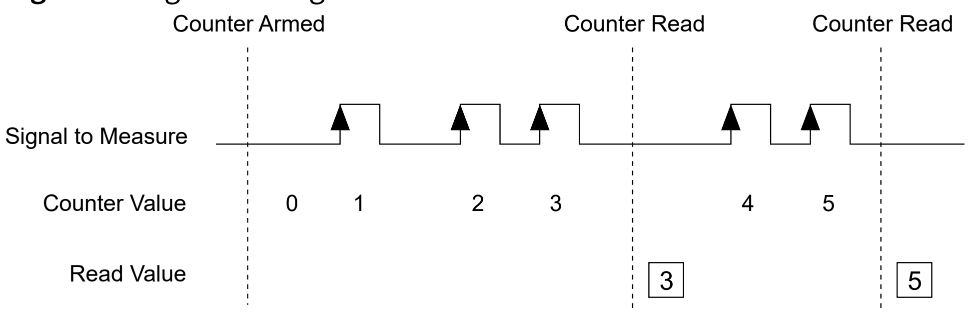
Trigger Settings

Counter Arm—You can control when the counter starts the frequency measurement through the counter arm control. After the counter is armed, it waits for the active edge on the signal-to-measure, and then it begins measuring the signal period. The measurement data is only ready and valid once the counter has finished measuring the first measurement according to the Divisor and Measurement Time settings. The counter returns a value of zero for both the Number of Ticks (A) and Scaling Factor (B) prior to the first measurement becoming ready. Refer to your software documentation for more information on arming the counter.

Edge Counting

You can take edge counting measurements with the NI-9326. The counter counts the number of active edges on a signal. The NI-9326 returns the current count value when the counter is read. The following figure shows an example of edge counting.

Figure 1. Edge Counting



Channel Settings

You can configure the following counter properties:

- Input terminal of the signal-to-measure.
- The initial value of the count.
- The active edge, rising or falling, that is counted[2].
- Count direction to increment or decrement the counter on each edge. You can set this property to:
    - Count Up
    - Count Down
    - Externally Controlled

> **Note** If you select Externally Controlled, the NI-9326 monitors a

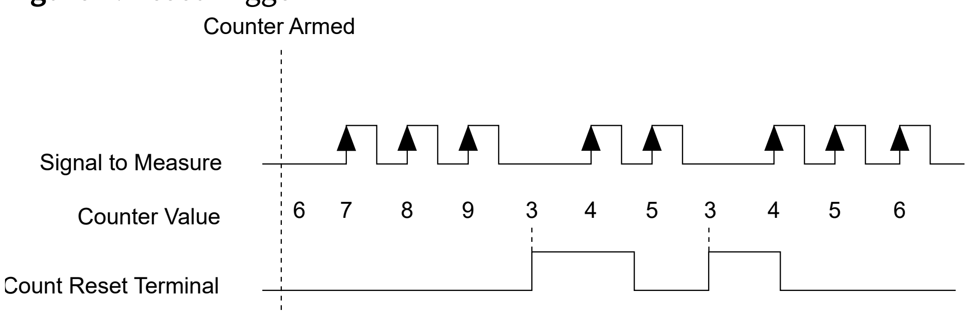
2. The active edge that is counted refers to the input signal rising or falling detection that is selected for the input terminal to the counter.

> hardware signal to determine the count direction. When the signal is high, the counter counts up; when the signal is low, the counter counts down. You can set which signal to monitor.

- Counter Reset
  - You can configure the counter to reset the count to a specific value in response to a hardware signal using the following Reset Trigger properties:
    - Enable or disable the Reset Trigger feature.
    - Input terminal of the signal to be used as the Reset Trigger.
    - The reset value to change the count value to in response to the Reset Trigger.
- Count Edges Pause Trigger
  - You can configure the counter to pause counting based on a hardware signal using the following properties:
    - Enable or disable the Count Edges Pause Trigger feature.
    - Input terminal of the signal to be used as the Count Edges Pause Trigger.

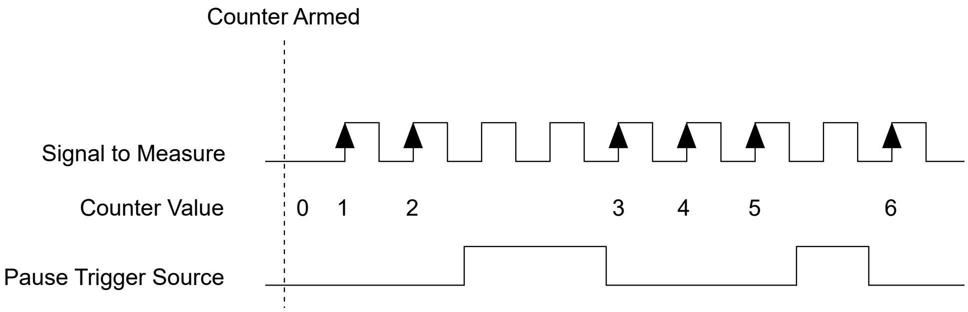
The following figure shows an example of a count edge measurement using the Reset Trigger with the initial value of the count value set to 6, Reset Trigger active edge set to rising edge, and the reset value set to 3.

Figure 1. Reset Trigger



The following figure shows an example of edge counting with Count Edges Pause Trigger level set to high.

Figure 1. Count Edges Pause Trigger



Trigger Settings

Counter Arm—You can control when the counter starts counting through the counter arm control. The counter waits for the active edge on the signal-to-measure after it is armed, and counts on every active edge on the signal-to-measure. Refer to your software documentation for more information on arming the counter.

NI-9326 Parallel DI Measurements

The NI-9326 supports a passthrough DI mode only for CompactRIO systems.

In this measurement mode, the input signal bypasses the counter and its digital input value can be read directly. The counter measurements will not be available when using this passthrough mode. To enable the DI measurement mode, select the module DI mode using the Module Properties page in the LabVIEW project. Refer to the detected signal diagram in the ***Configurable Threshold and Hysteresis*** section for an example of the DI waveform that can be read in this mode.

Channel Settings

You can only configure the following DI properties as a subset of the available settings for the input channel:

- Threshold and hysteresis of the input channel.
- Input signal rising or falling edge detection.

> **Note** The digital glitch filter is not supported in this measurement mode.

Related concepts:

- NI-9326 Front End Control

NI-9326 Counter Signal Routing

The NI-9326 has flexible signal routing features. The input signals to the counters can be routed from any of the six input channels. You can change the signal routing by configuring the counter properties.

The software routes certain input signals to each of the counters by default. The following table shows the default routing for counter signals.

Table 2. Default Routing for Counter Signals

Measurement	Signal	Counter					
		0	1	2	3	4	5
Period/ Frequency	Source	DI0	DI1	DI2	DI3	DI4	DI5
Edge Counting	Source	DI0	DI1	DI2	DI3	DI4	DI5
	Reset	DI3	DI4	DI5	DI0	DI1	DI2
	Count Direction	DI5	DI2	DI4	DI1	DI3	DI0
	Pause Trigger	DI4	DI5	DI1	DI2	DI0	DI3

Conformal Coating

The NI-9326 is available with conformal coating for additional protection in corrosive and condensing environments, including environments with molds and dust.

In addition to the environmental specifications listed in the ***NI-9326 Safety, Environmental, and Regulatory Information***, the NI-9326 with conformal coating meets the following specification for the device temperature range. To meet this specification, you must follow the appropriate setup requirements for condensing environments. Refer to ***Conformal Coating and NI RIO Products*** for more information about conformal coating and the setup requirements for condensing environments.

Operating humidity (IEC 60068-2-30 Test Db)	80 to 100% RH, condensing

Related information:

- Conformal Coating and NI RIO Products