DATASHEET

NI 9253

8 AI, ±20 mA, 24 bit, 50 kS/s/ch Simultaneous

- Push-in spring terminal connectivity
- 250 V RMS, CAT II, channel-to-earth isolation
- -40 °C to 70 °C operating, 5 g vibration, 50 g shock

The NI 9253 is an 8-channel analog input module for ComapctDAQ and CompactRIO systems. Each channel provides a ±20 mA input range, 24-bits of resolution at 50 kS/s sample rate. The NI 9253 has several diagnostic features to ensure your system is operating nominally at all times with overcurrent detection, field side power supply detection and configurable thresholds. The NI 9253 has 8 LEDs to show the status of each channel and the power supply so that a user in the field can easily validate the system is operating normally. The NI 9253 also features numerous programmable hardware filters. By choosing the specific Butterworth and comb filters for your application, you can significantly reduce the noise in the system.

Kit Contents	• NI 9253 • NI 9253 Getting Started Guide
Accessories	• NI 9963 Backshell Connector Kit (Spring Terminal)

NI C Series Overview

NI provides more than 100 C Series modules for measurement, control, and communication applications. C Series modules can connect to any sensor or bus and allow for high-accuracy measurements that meet the demands of advanced data acquisition and control applications.

- Measurement-specific signal conditioning that connects to an array of sensors and signals
- Isolation options such as bank-to-bank, channel-to-channel, and channel-to-earth ground
- -40 °C to 70 °C temperature range to meet a variety of application and environmental needs
- Hot-swappable

The majority of C Series modules are supported in both CompactRIO and CompactDAQ platforms and you can move modules from one platform to the other with no modification.

CompactRIO

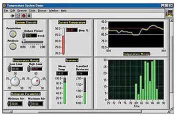
CompactRIO combines an open-embedded architecture with small size, extreme ruggedness, and C Series modules in a platform powered by the NI LabVIEW reconfigurable I/O (RIO) architecture. Each system contains an FPGA for custom timing, triggering, and processing with a wide array of available modular I/O to meet any embedded application requirement.

CompactDAQ

CompactDAQ is a portable, rugged data acquisition platform that integrates connectivity, data acquisition, and signal conditioning into modular I/O for directly interfacing to any sensor or signal. Using CompactDAQ with LabVIEW, you can easily customize how you acquire, analyze, visualize, and manage your measurement data.

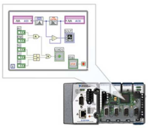
Software

LabVIEW Professional Development System for Windows



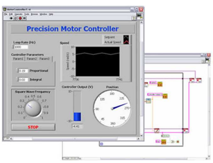
- Use advanced software tools for large project development
- Generate code automatically using DAQ Assistant and Instrument I/O Assistant
- Use advanced measurement analysis and digital signal processing
- Take advantage of open connectivity with DLLs, ActiveX, and .NET objects
- Build DLLs, executables, and MSI installers

NI LabVIEW FPGA Module



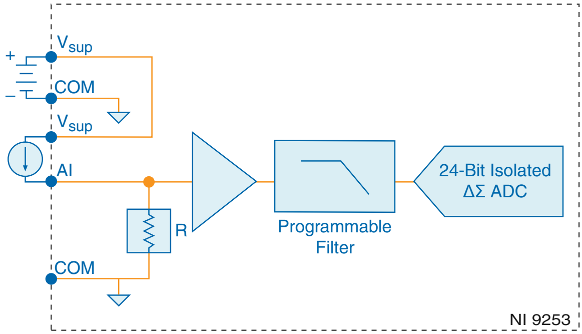
- Design FPGA applications for NI RIO hardware
- Program with the same graphical environment used for desktop and real-time applications
- Execute control algorithms with loop rates up to 300 MHz
- Implement custom timing and triggering logic, digital protocols, and DSP algorithms
- Incorporate existing HDL code and third-party IP including Xilinx IP generator functions
- Purchase as part of the LabVIEW Embedded Control and Monitoring Suite

NI LabVIEW Real-Time Module



- Design deterministic real-time applications with LabVIEW graphical programming
- Download to dedicated NI or third-party hardware for reliable execution and a wide selection of I/O
- Take advantage of built-in PID control, signal processing, and analysis functions
- Automatically take advantage of multicore CPUs or set processor affinity manually
- Take advantage of real-time OS, development and debugging support, and board support
- Purchase individually or as part of a LabVIEW suite

NI 9253 Circuitry



- Input signals on each channel are buffered, conditioned, and then sampled by an ADC.
- Each AI channel provides an independent signal path and ADC, enabling you to sample all channels simultaneously.
- The module protects each channel from overvoltages.

Filtering

The NI 9253 uses programmable hardware filtering to provide an accurate representation of in-band signals and reject out-of-band signals. The filters discriminate between signals based on the frequency range, or bandwidth, of the signal.

The NI 9253 programmable hardware filter supports both Butterworth and comb filter responses.

Butterworth Filter

The NI 9253 has a programmable hardware Butterworth low-pass filter. The Butterworth filter provides two selectable filter orders, each with six selectable cut-off frequencies that are configurable per module. The cut-off frequency (f_c) of the filter is independent of the data rate (f_s). However, using an external master timebase (f_M) will influence both the cut-off frequency (f_c) and data rate (f_s). The following figures show the overall filter response with different filter settings.

Figure 1. 4th Order Butterworth Filter Response

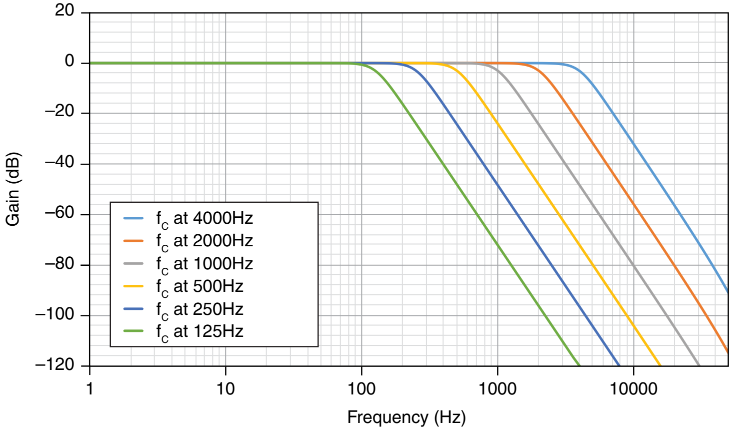
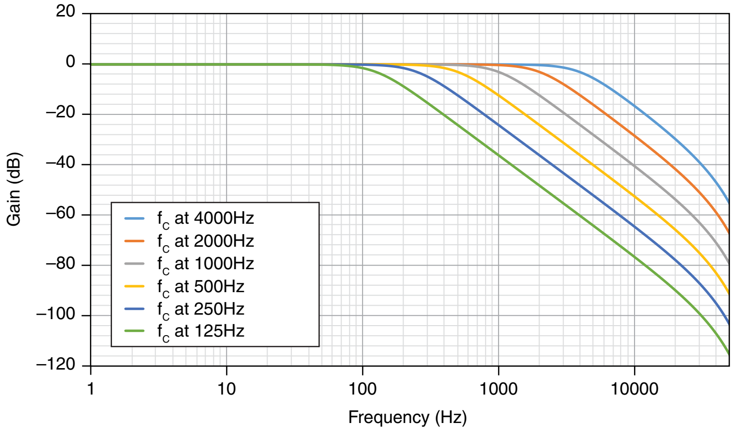


Figure 2. 2nd Order Butterworth Filter Response



Comb Filter

The NI 9253 comb filter frequency response is characterized by deep, evenly spaced notches and an overall roll-off towards higher frequencies. The NI 9253 provides five per module-configurable comb filter settings. The different options provide a trade-off of noise rejection (refer to Idle Channel Noise table) for filter settling time (refer to Settling Time equation) and latency (refer to Input Delay equation). To control the response of the programmable comb filter, you can select to have the first notch at 1, 1/2, 1/4, 1/8 or 1/16 of the data rate. The following figure shows the overall filter response with different filter settings.

Figure 3. Typical Comb Filter Response

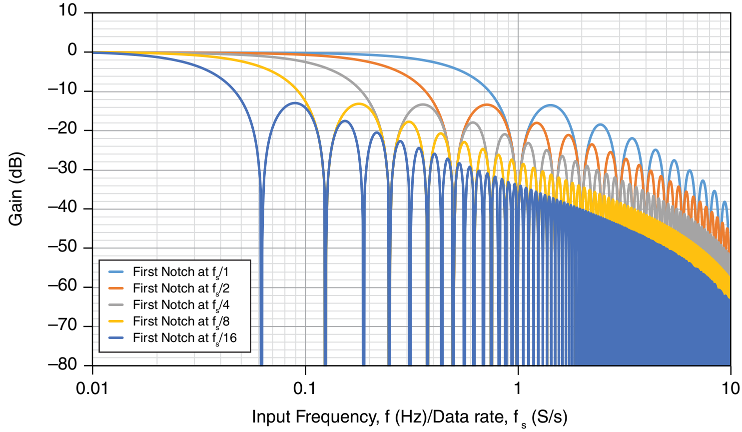
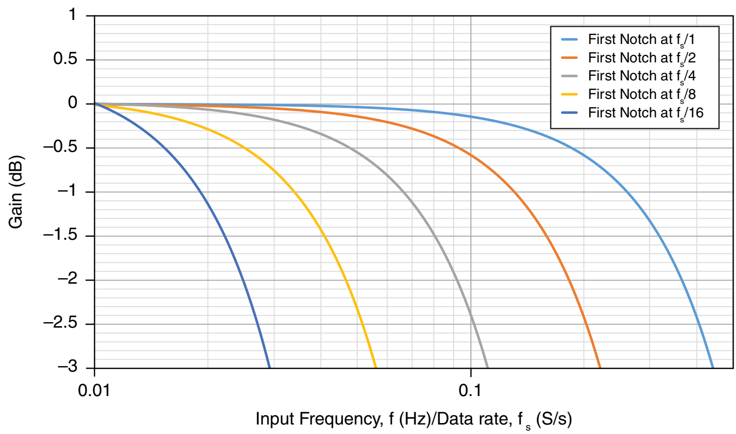


Figure 4. Typical Comb Filter Flatness



Passband

The signals within the passband have frequency-dependent gain or attenuation. The small amount of variation in gain with respect to frequency is called the passband flatness. The hardware filter of the NI 9253 adjust the frequency range of the passband to match the data rate. Therefore, the amount of gain or attenuation at a given frequency depends on the data rate.

Choosing the Right Filter for your Application

The NI 9253 Butterworth filter response is a low pass filter that allows signals with frequencies below the filter cutoff frequency to pass through while attenuating signals with frequencies higher than the filter cutoff frequency. This is useful to filter out unwanted high frequency noise in a signal. The Butterworth filter has a better flatness in the passband compared to the comb filter.

The NI 9253 Butterworth filter is a programmable-order filter. The different filter orders are characterized by the steepness of the filter response roll-off. The higher the filter order, the steeper the roll-off is. However, the trade-off of using higher order response is the higher input delay. The NI 9253 Butterworth filter allows user to trade-off between filter roll-off and input delay.

The NI 9253 comb filter frequency response is characterized by deep, evenly spaced notches and an overall roll-off towards higher frequencies. This is useful in rejecting specific frequencies and all its harmonics at a specific data rate. For example, the NI 9253 comb filter rejects powerline frequency of 50 Hz and all its harmonics when running at 50 S/s. The comb filter has lower settling time compared to the Butterworth filter.

For more information about filters, refer to the *Appendix*.

Data Rates

The frequency of a master timebase (f_M) controls the data rate (f_s) of the NI 9253. The NI 9253 includes an internal master timebase with a frequency of 12.8 MHz. Using the internal master timebase of 12.8 MHz results in data rates of 50 kS/s, 33.3333 kS/s, 25 kS/s, 20 kS/s, and so on down to 10 S/s, depending on the decimation rate. However, the data rate must remain within the appropriate data rate range.

The following equation provides the available data rates of the NI 9253:

$$f_s = \frac{f_M}{128 \times a}$$

where a is the decimation rate.

Table 1. Available Data Rates with the Internal Master Timebase

f_s (S/s)	Decimation Rate	f_s (S/s)	Decimation Rate	f_s (S/s)	Decimation Rate
50000.0	2	2272. 7	44	347.2	288
33333.3	3	2083.3	48	312.5	320
25000.0	4	2000.0	50	284.1	352
20000.0	5	1785.7	56	260.4	384
16666.7	6	1562.5	64	250.0	400
14285.7	7	1388.9	72	223.2	448
12500.0	8	1250.0	80	200.0	500

Table 1. Available Data Rates with the Internal Master Timebase (Continued)

f_s (S/s)	Decimation Rate	f_s (S/s)	Decimation Rate	f_s (S/s)	Decimation Rate
11111.1	9	1136.4	88	195.3	512
10000.0	10	1041.7	96	142.1	704
8333.3	12	1000.0	100	125.0	800
7142.9	14	892.9	112	100.0	1000
6250.0	16	781.3	128	97.7	1024
5555.6	18	694.4	144	60.0[1]	1666 or 1706[2]
5000.0	20	625.0	160	50.0[1]	2000 or 2048[2]
4545.5	22	568.2	176	10.0[1]	10000 or 10240[2]
4166.7	24	520.8	192		
3571.4	28	500.0	200		
3125.0	32	446.4	224		
2777.8	36	400.0	250		
2500.0	40	390.6	256		

The NI 9253 can also accept an external master timebase or export its own master timebase. To synchronize the data rate of an NI 9253 with other modules that use master timebases to control sampling, all of the modules must share a single master timebase source. When using an external timebase with a frequency other than 12.8 MHz, the available data rates of the NI 9253 shift by the ratio of the external timebase frequency to the internal timebase frequency. The programmable filter specifications, expressed in Hz, will also scale with the external timebase. Refer to the software help for information about configuring the master timebase source for the NI 9253.

Note The cRIO-9151 R Series Expansion chassis does not support sharing timebases between modules.

Note The cRIO-9151 R Series Expansion chassis has different maximum data rates from the CompactRIO and CompactDAQ chassis. Refer to the *Input Characteristics* section for detailed information.

Diagnostics

The NI 9253 supports the following diagnostics features:

1 When using an external timebase of 13.1072 MHz, this data rate does not change with the ratio of the external to internal clocks.

2 When using an external timebase of 13.1072 MHz.

- **Overcurrent Detection**—NI 9253 has built-in circuitry to detect overcurrent faults on its inputs. If an overcurrent event occurs on any channel, the channel overcurrent status in software returns TRUE and the LED lights up RED. The module uses fold back protection architecture so even under fault conditions the module may still read values between 0 mA to 20 mA. It is recommended to constantly poll the overcurrent status to ensure that the module readings are valid readings instead of fault induced readings.
- **Input Limits Detection**—NI 9253 supports user programmable input limits. These limits can be set to values between 0 mA to 21.9 mA. These values are symmetrical around 0 mA. For example, if the lower limit is set to 4 mA and the upper limit to 20 mA, the channel input limits fault status in software returns FALSE and the LED lights up GREEN when the module readings are between 4 mA to 20 mA or -4 mA to -20 mA. It returns TRUE otherwise. Input Limits Detection can be enabled or disabled via software.
- **Field Side Power Detection**—NI 9253 supports field side power detection. When enabled, this allows the user to detect if any power supply is connected to the V_{sup} pin of the module. If the power supply is below a certain threshold[3], the field side power fault status in the software returns TRUE and all eight LEDs blink. Field Side Power Detection can be enabled or disabled via software. It is recommended that this feature be disabled when the V_{sup} pin is not used.

NI 9253 Specifications

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

Caution Observe all instructions and cautions in the user documentation. Using the model in a manner not specified can damage the model and compromise the built-in safety protection. Return damaged models to NI for repair.

Attention Suivez toutes les instructions et respectez toutes les mises en garde de la documentation utilisateur. L'utilisation d'un modèle de toute autre façon que celle spécifiée risque de l'endommager et de compromettre la protection de sécurité intégrée. Renvoyez les modèles endommagés à NI pour réparation.

Input Characteristics

Number of channels	8 analog input channels
ADC resolution	24 bits
Type of ADC	Delta-Sigma with analog prefiltering
Sampling mode	Simultaneous
Internal master timebase (f_M)	
Frequency	12.8 MHz
Accuracy	±50 ppm maximum

3 Refer to the *Field side power detection threshold* for the threshold values.

CompactRIO & CompactDAQ chassis data rate range (f_s)	
Using internal master timebase	
Minimum	10 S/s
Maximum	50 kS/s
Using external master timebase	
Minimum	0.78 S/s
Maximum	51.367 kS/s
R Series Expansion chassis data rate range (f_s)	
Using internal master timebase	
Minimum	10 S/s
Maximum	25 kS/s
Data rate	$f_s = \frac{f_M}{128 \times a}$
Overvoltage protection[4]	±30 V
Input resistance (AI*x* to COM)	79 Ω
Input current range	
Minimum	±21.6 mA
Typical	±21.9 mA
Scaling coefficients	2615 pA/LSB
Butterworth filter	
Filter order	2nd or 4th order
Cut-off frequencies[5]	$\frac{f_c \times f_M}{12.8\,MHz}$
Flatness[6]	$\frac{f_F \times f_M}{12.8\,MHz}$

4 Only 1 channel at a time.

5 Refer to *Table 2.* on page 11 for the values of f_c and f_M.

6 Refer to *Table 2.* on page 11 for the values of f_F and f_M.

Input delay[7]	$\left(t_D - 2.31\ \mu s\right) \times \left(\frac{12.8\ MHz}{f_M}\right) + 2.31\ \mu s$
Input delay tolerance	±200 ns

Table 2. Butterworth Filter Cut-off Frequencies and Flatness

Master Timebase Clock (f_M)	Cut-off Frequencies (f_c)	2nd Order		4th Order	
		0.1% Flatness (f_F) at 0.0087 dB	1% Flatness (f_F) at 0.087 dB	0.1% Flatness (f_F) at 0.0087 dB	1% Flatness (f_F) at 0.087 dB
12.8 MHz	4000 Hz	740 Hz	1445 Hz	1125 Hz	2295 Hz
	2000 Hz	415 Hz	750 Hz	875 Hz	1210 Hz
	1000 Hz	215 Hz	380 Hz	430 Hz	615 Hz
	500 Hz	105 Hz	190 Hz	225 Hz	305 Hz
	250 Hz	55 Hz	95 Hz	115 Hz	155 Hz
	125 Hz	25 Hz	45 Hz	60 Hz	75 Hz

Note The specifications in *Table 2.* on page 11 scale linearly with the master timebase frequency as indicated by the formulas shown in the *Butterworth filter* section. For example, on a 2nd Order Butterworth filter, for a master timebase clock of 13.1072 MHz, the cut-off frequency is 4096 Hz and 757.7 Hz of 0.1% Flatness instead of the cut-off frequency of 4000 Hz and 740 Hz of 0.1% Flatness at the 12.8 MHz default internal master timebase clock.

[7] Refer to *Table 3.* on page 12 for the values of t_D and f_M.

Table 3. Butterworth Filter Input Delay

Master Timebase Clock (f_M)	Cut-off Frequencies (f_c)	2nd Order		4th Order	
		DC Delay (t_D)	Maximum Delay (t_D)	DC Delay (t_D)	Maximum Delay (t_D)
12.8 MHz	4000 Hz	98.1 µs	104.7 µs	136.2 µs	158.1 µs
	2000 Hz	153.7 µs	167.0 µs	238.8 µs	282.7 µs
	1000 Hz	266.3 µs	293.0 µs	449.2 µs	538.9 µs
	500 Hz	491.3 µs	544.5 µs	861.6 µs	1038.1 µs
	250 Hz	941.4 µs	1047.8 µs	1700.3 µs	2059.8 µs
	125 Hz	1841.6 µs	2054.3 µs	3347.0 µs	4055.5 µs

Note The specifications in *Table 3.* on page 12 scale with the master timebase frequency as indicated by the formulas shown in the *Butterworth filter* section. For example, a master timebase clock of 13.1072 MHz, the 2nd order Butterworth filter with a 4096 Hz cut-off will have a 98.855 µs input DC delay.

Figure 5. Butterworth Filter Input Delay (4th Order, with 12.8 MHz Timebase, 4000 Hz, 2000 Hz, 1000 Hz)

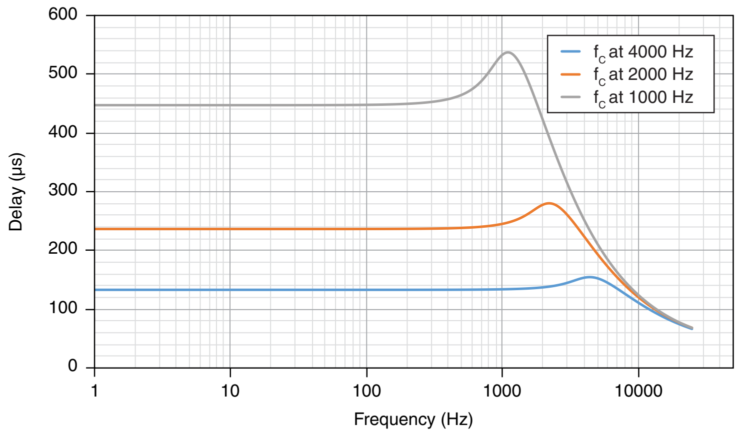


Figure 6. Butterworth Filter Input Delay (4th Order, with 12.8 MHz Timebase, 500 Hz, 250 Hz, 125 Hz)

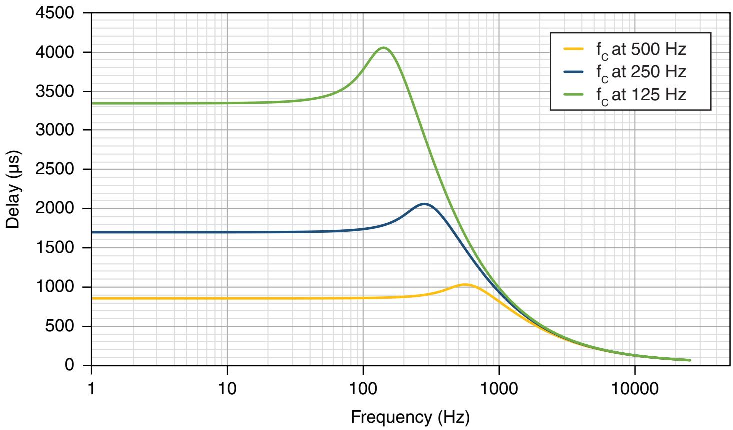


Figure 7. Butterworth Filter Input Delay (2nd Order, with 12.8 MHz Timebase, 4000 Hz, 2000 Hz, 1000 Hz)

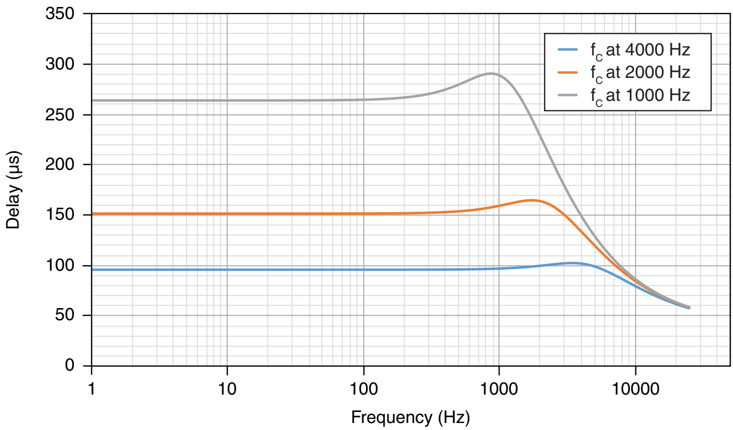
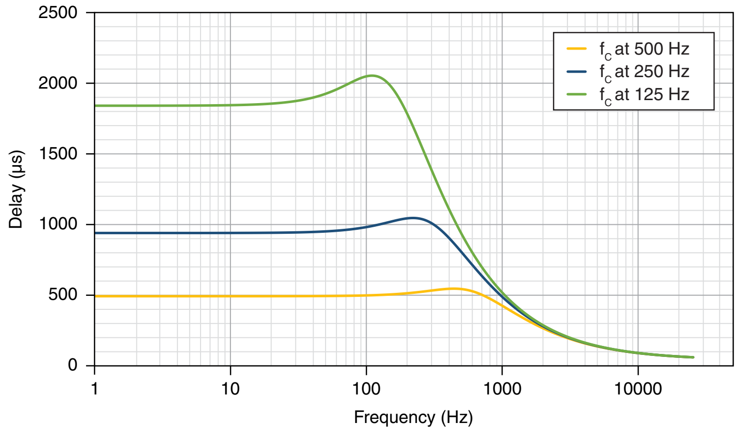


Figure 8. Butterworth Filter Input Delay (2nd Order, with 12.8 MHz Timebase, 500 Hz, 250 Hz, 125 Hz)



Comb filter		
	Programmable first notch	f_s, $f_s/2$, $f_s/4$, $f_s/8$, $f_s/16$
	Input delay with comb filter[8]	$\frac{(A+B)}{f_s} + 2.31\ \mu s$
	Settling time with comb filter[8]	$\frac{2(A+B)}{f_s} + 2.31\ \mu s$

Table 4. Input Delay with Comb Filter

Variable	Value
A	2.4 for f_s = 50000
	1.8 for f_s = 14285.71 to 33333.33
	1 for f_s = 2777.78 to 12500
	0.6 for f_s = all other output data rates

[8] Refer to the *Table 4.* on page 14 table for the values of A and B.

Table 4. Input Delay with Comb Filter (Continued)

Variable	Value
B	0 for filter first notch at f_s
	0.5 for filter first notch at $f_s/2$
	1.5 for filter first notch at $f_s/4$
	3.5 for filter first notch at $f_s/8$
	7.5 for filter first notch at $f_s/16$

Table 5. DC Accuracy

Measurement Conditions	Percent of Reading (Gain Error)	Percent of Range[9] (Offset Error)
Maximum (-40 °C to 70 °C)	±0.41%	±0.08%
Typical (23 °C, ±5 °C)	±0.14%	±0.02%

Non-linearity	12 ppm
Stability of Accuracy	
Gain drift	12 ppm/°C
Offset drift	81 nA/°C
Passband, -3 dB	Refer to the -3 dB graphs in the *Filtering* section
Delay linearity ($f_{in} \leq 24.9$ kHz)	11.16 ns maximum
Channel-to-channel mismatch ($f_{in} \leq 24.9$ kHz)	
Gain	±0.116 dB maximum
Delay	166.67 ns/kHz maximum
Module-to-module mismatch ($f_{in} \leq 24.9$ kHz)	
Delay	$166.67\ ns/kHz + \frac{1}{f_M}$
Attenuation @ 2 x oversample rate (23° C)	104 dB

[9] Range equals 21.9 mA

Idle Channel Noise	
Comb filter with first notch at f_s	
f_s = 50 kS/s	130 nA
f_s = 10 kS/s	64 nA
$f_s \leq$ 1 kS/s	39 nA
Butterworth filter, f_s = 50 kS/s	
f_c = 4 kHz	68 nA
f_c = 1 kHz	42 nA
f_c = 125 Hz	30 nA

Note The noise specifications assume the NI 9253 is using the internal master timebase frequency of 12.8 MHz.

Crosstalk (CH to CH)	
f_{in} < 100 Hz	100 dB
f_{in} < 15 kHz	90 dB
Normal mode rejection ratio (NMRR) using internal or external master timebase of 12.8 MHz[10]	
60 S/s, f_{in} = 60 Hz ± 1 Hz	35 dB minimum
50 S/s, f_{in} = 50 Hz ± 1 Hz	33 dB minimum
10 S/s, f_{in} = 50 Hz/60 Hz ± 1 Hz	35 dB minimum
Normal mode rejection ratio (NMRR) using external master timebase of 13.1072 MHz[10]	
60 S/s, f_{in} = 60 Hz ± 1 Hz	34 dB minimum
50 S/s, f_{in} = 50 Hz ± 1 Hz	33 dB minimum
10 S/s, f_{in} = 50 Hz/60 Hz ± 1 Hz	35 dB minimum
Common mode sensitivity to earth ground	
$f_{in} \leq$ 60 Hz	0.1 nA/V_{peak}[11]
Field side power detection threshold	
Minimum	7.2 V[12]
Maximum	8.1 V[13]
Input Limit Programming Resolution	30.5176 µA

10 Only applicable for comb filter.

11 This value is how much the module readings change when common mode voltage is applied between the channels and earth ground.

12 Field side power will never be detected if it is below this value.

13 Field side power will always be detected if it is above this value.

Power Requirements

Power consumption from chassis	
Active mode	798 mW maximum
Sleep mode	48 µW maximum
Thermal dissipation (at 70 °C)	
Active mode	1.5 W maximum
Sleep mode	751 mW maximum

Physical Characteristics

Spring terminal wiring	
Gauge	0.14 mm^2 to 1.5 mm^2 (26 AWG to 16 AWG) copper conductor wire
Wire strip length	10 mm (0.394 in.) of insulation stripped from the end
Temperature rating	90 °C, minimum
Wires per spring terminal	One wire per spring terminal; two wires per spring terminal using a 2-wire ferrule
Ferrules	
Single ferrule, uninsulated	0.14 mm^2 to 1.5 mm^2 (26 AWG to 16 AWG) 10 mm barrel length
Single ferrule, insulated	0.14 mm^2 to 1.0 mm^2 (26 AWG to 18 AWG) 12 mm barrel length
Two-wire ferrule, insulated	2x 0.34 mm^2 (2x 22 AWG) 12 mm barrel length
Connector securement	
Securement type	Screw flanges provided
Torque for screw flanges	0.2 N · m (1.80 lb · in.)
Weight	158 g (5.6 oz)

NI 9253 Safety Voltages

Connect only voltages that are within the following limits:

AI-to-COM and V_{sup}-to-COM	±30 V DC maximum
Channel-to-channel isolation	None

Channel-to-earth ground isolation[14]	
Continuous	250 V RMS, Measurement Category II
Withstand	3,000 V RMS, verified by a 5 s dielectric withstand test
Overvoltage protection	±30 V, between any two pins of the connector[15]

Caution Do not connect the NI 9253 to signals or use for measurements within Measurement Categories III or IV.

Attention Ne connectez pas le NI 9253 à des signaux et ne l'utilisez pas pour effectuer des mesures dans les catégories de mesure III ou IV.

Measurement Category II is for measurements performed on circuits directly connected to the electrical distribution system. This category refers to local-level electrical distribution, such as that provided by a standard wall outlet, for example, 115 V for U.S. or 230 V for Europe.

Hazardous Locations

U.S. (UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, AEx nA IIC T4 Gc
Canada (C-UL)	Class I, Division 2, Groups A, B, C, D, T4; Ex nA IIC T4 Gc
Europe (ATEX) and International (IECEx)	Ex nA IIC T4 Gc DEMKO 12 ATEX 1202658X IECEx UL 14.0089X

Safety Compliance and Hazardous Locations Standards

This product is designed to meet the requirements of the following electrical equipment safety standards for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA C22.2 No. 61010-1
- EN 60079-0, EN 60079-15
- IEC 60079-0: Ed 6, IEC 60079-15; Ed 4
- UL 60079-0; Ed 6, UL 60079-15; Ed 4
- CSA C22.2 No. 60079-0, CSA C22.2 No. 60079-15

Note For UL and other safety certifications, refer to the product label or the *Product Certifications and Declarations* section.

[14] Channels include V_{sup} and COM.
[15] Only 1 channel at a time.

Electromagnetic Compatibility Standards

This product meets the requirements of the following EMC standards for sensitive electrical equipment for measurement, control, and laboratory use:

- EN 61326-1 (IEC 61326-1): Class A emissions; Industrial immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- AS/NZS CISPR 11: Group 1, Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions

Note Group 1 equipment (per CISPR 11) is any industrial, scientific, or medical equipment that does not intentionally generate radio frequency energy for the treatment of material or inspection/analysis purposes.

Note In the United States (per FCC 47 CFR), Class A equipment is intended for use in commercial, light-industrial, and heavy-industrial locations. In Europe, Canada, Australia and New Zealand (per CISPR 11) Class A equipment is intended for use only in heavy-industrial locations.

Note For EMC declarations and certifications, and additional information, refer to the *Online Product Certification* section.

Notice Conducted RF interference on the I/O ports of the NI 9253 can adversely affect its measurement accuracy.

CE Compliance CE

This product meets the essential requirements of applicable European Directives, as follows:

- 2014/35/EU; Low-Voltage Directive (safety)
- 2014/30/EU; Electromagnetic Compatibility Directive (EMC)
- 2014/34/EU; Potentially Explosive Atmospheres (ATEX)

Product Certifications and Declarations

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for NI products, visit *ni.com/product-certifications*, search by model number, and click the appropriate link.

Shock and Vibration

To meet these specifications, you must panel mount the system.

Operating vibration	
Random	5 g RMS, 10 Hz to 500 Hz
Sinusoidal	5 g, 10 Hz to 500 Hz

Operating shock	30 g, 11 ms half sine; 50 g, 3 ms half sine; 18 shocks at 6 orientations

Environmental

Refer to the manual for the chassis you are using for more information about meeting these specifications.

Operating temperature (IEC 60068-2-1, IEC 60068-2-2)	-40 °C to 70 °C
Storage temperature (IEC 60068-2-1, IEC 60068-2-2)	-40 °C to 85 °C
Ingress protection	IP40
Operating humidity (IEC 60068-2-30)	10% RH to 90% RH, noncondensing
Storage humidity (IEC 60068-2-30)	5% RH to 95% RH, noncondensing
Pollution Degree	2
Maximum altitude	5,000 m

Indoor use only.

Environmental Management

NI is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial to the environment and to NI customers.

For additional environmental information, refer to the *Commitment to the Environment* web page at *ni.com/environment*. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)

EU Customers At the end of the product life cycle, all NI products must be disposed of according to local laws and regulations. For more information about how to recycle NI products in your region, visit *ni.com/environment/weee*.

电子信息产品污染控制管理办法（中国 RoHS）

中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令(RoHS)。关于 National Instruments 中国 RoHS 合规性信息，请登录 `ni.com/environment/rohs_china`。(For information about China RoHS compliance, go to `ni.com/environment/rohs_china`.)

Calibration

You can obtain the calibration certificate and information about calibration services for the NI 9253 at *ni.com/calibration*.

Calibration interval	2 years

Appendix

NI 9253 Filtering

The NI 9253 supports two types of lowpass filtering:

- Butterworth
- Comb

Table 6. Comparing NI 9253 Filters

Attribute	Butterworth	Comb
Passband	Configurable independent of sample rate	Tracks sample rate
Latency	Medium to high (configuration-dependent)	Low
Phase Delay Variation versus Frequency	Variable input delay	Constant input delay
Flatness	Best	Good
Step Response (Time Domain)	Mid-level delay, overshoot	Short delay, no overshoot/ undershoot
Typical Applications	Filtering out high frequency noise sources Reducing measurement noise	Filtering out specific noise sources Control applications

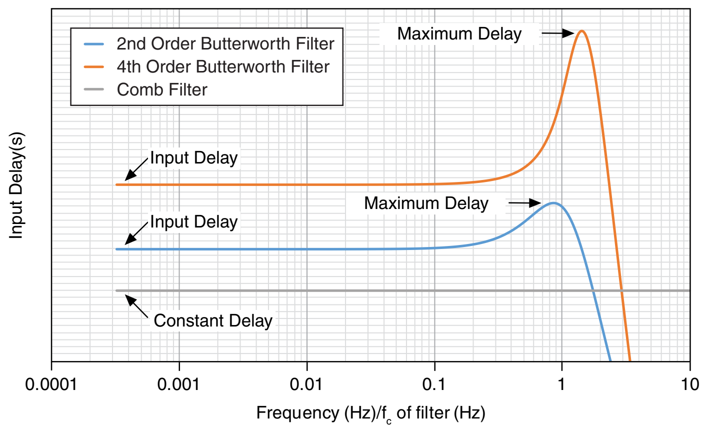
Refer to the specifications for details on the amount of variation in the response you can expect for different input frequency ranges.

Frequency Response of NI 9253 Filters

The NI 9253 uses programmable hardware filtering to provide an accurate representation of in-band signals and reject out-of-band signals. The filters discriminate between signals based on the frequency range, or bandwidth, of the signal. How the filter discriminates signals based on their frequency is known as frequency response. In general, the frequency response of a filter is described by a signal attenuation (magnitude response) and a input delay (phase response) for every input frequency.

- **Magnitude Response**—The three important frequency ranges, or bandwidths, to consider for magnitude response are passband, transition band, and stopband:
  - Passband—The range of frequencies at which the filter attempts to pass a signal without modifying it. The small amount of variation in magnitude at these frequencies is called passband flatness. This is the frequency range of signals that you want to measure.
  - Transition band—The range of frequencies in which the filter magnitude response has started to roll-off such that it attenuates signals by some amount, but has not reached the full attenuation amount. The shape of the transition band has an impact on the alias rejection and how signals are represented in the time domain (for example, step response).
  - Stopband—The range of frequencies at which the filter attenuates input signals to its maximum attenuation level. Ideally, you want to choose a filter with a stopband that covers frequencies of noise sources that you do not want in your measurements.
- **Input Delay**—Filters delay the input signal by some amount when processing data. In some cases, the delay is a function of the input signal frequency; when this is the case, the input delay plot is useful for knowing the exact delay at different input frequencies and the maximum variation between signals of different frequencies within the passband.

Figure 9. Comparing Typical Input Delay for NI 9253 Filters

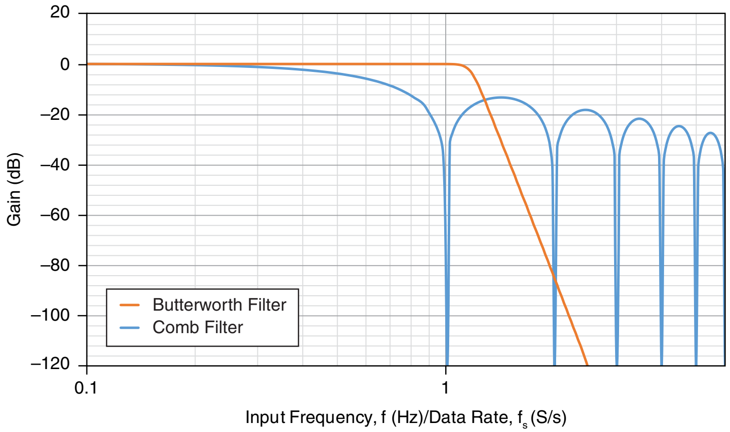


Each NI 9253 filter has a different frequency response to serve different applications:

- **Butterworth**—Has a passband independent of the sampling rate (as opposed to the comb filter), which offers more flexibility when filtering out noise that is below one-half of the sample rate. However, depending on your settings, you may see alias components of higher frequency signals in your measurement that extend beyond one-half of the sample rate due to the larger transition band.

- **Comb**—Has a smaller passband because its transition band starts early in the frequency range. The comb filter has shorter group delay than other filters and better representation of signals in the time domain (step response). The comb filter's transition band features equally-spaced notches at different frequencies. It is common to use the comb filter with a specific sample rate to align the notches of the transition band thereby removing a specific noise-source frequency from measurements.

Figure 10. Comparing Typical Magnitude Response of NI 9253 Filters



The NI 9253 filter delay across signals in the passband varies between filters:

- **Butterworth**—Delays signals by a variable amount depending on their frequency.
- **Comb**—All input frequencies have the same amount of delay when going through the filter. Choose this filter for applications where linear phase, short delay, or data correlation of different devices and configurations is required.

Refer to the specifications for details on the amount of variation in the passband gain and input delay you can expect for different input frequency ranges.

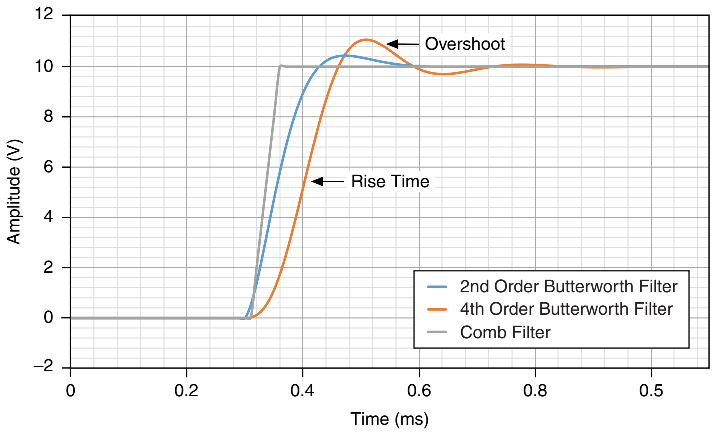
Step Response of NI 9253 Filters

The shape of the magnitude and phase responses of a filter impacts how signals look in the time domain. The step response of a filter is typically used to identify the behavior of a filter in the time domain.

Three important factors of the filter step response are group delay, rise time, and overshoot/undershoot. The three filters differ in step response across signals in the transition band:

- **Butterworth**—Has a short group delay and the longest rise time. The output signal shows overshoot.
- **Comb**—Has the shortest group delay and the shortest rise time. The output signal does not show overshoot or undershoot.

Figure 11. Comparing Typical Step Response of NI 9253 Filters



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