NI-9202 Specifications

2022-07-12

Contents

NI-9202 Datasheet

- DSUB or push-in spring terminal connectivity
- 250 V RMS, CAT II, channel-to-earth isolation (spring terminal); 60 V DC, CAT I, channel-to-earth isolation (DSUB)
- -40 °C to 70 °C operating, 5 g vibration, 50 g shock

Note In this document, the NI-9202 with spring terminal and the NI-9202 with DSUB are referred to inclusively as the NI 9202.

The NI-9202 is an analog input module for CompactDAQ and CompactRIO systems. Each channel provides a ±10 V measurement range at a 24-bit resolution. The NI-9202 has a maximum sample rate of 10 kS/s and features programmable hardware filters. By choosing one of the 5 different filter responses, a trade-off of fast settling time for increased noise rejection can be attained.

Kit Contents	• NI 9202 • NI 9202 Getting Started Guide
Accessories	• NI 9940 Backshell Connector Kit (Spring Terminal) • NI 9923 Screw-Terminal Block (DSUB)

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

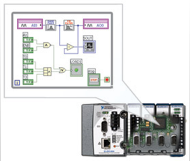
LabVIEW Professional Development System for Windows

- 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

LabVIEW Professional Development System for Windows

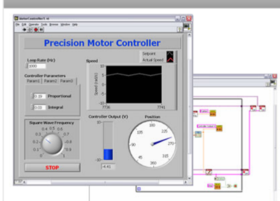
- Take advantage of open connectivity with DLLs, ActiveX, and .NET objects
- Build DLLs, executables, and MSI installers

NI LabVIEW FPGA Module



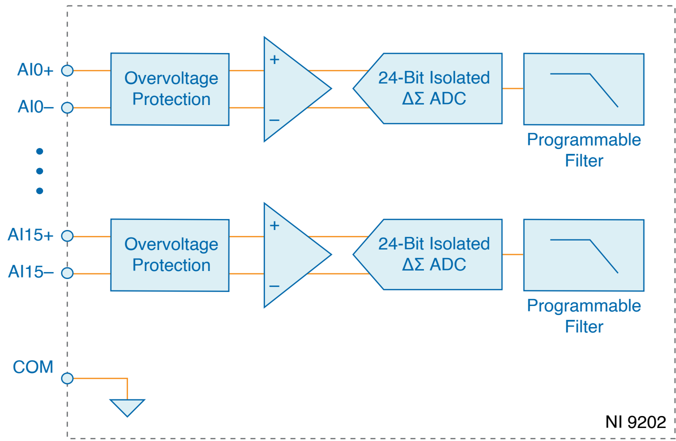
- Design FPGA applications for NI RIO hardware
- Program with the same graphical environment used for desktop and real-time applications
- Execute control algorithms with loop rates up to 300 MHz
- Implement custom timing and triggering logic, digital protocols, and DSP algorithms
- Incorporate existing 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-9202 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.

Filtering

The NI-9202 uses a combination of analog and digital filtering to provide an accurate representation of in-band signals while rejecting out-of-band signals. The filters discriminate between signals based on the frequency range, or bandwidth, of the signal.

The NI-9202 represents signals within the passband, as quantified primarily by passband flatness and phase linearity.

The NI-9202 has a comb frequency response, characterized by deep, evenly spaced notches and an overall roll-off towards higher frequencies. The NI-9202 provides five available filter options for every data rate. 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 sampling frequency. The following figures show the overall filter response with different filter settings.

Figure 1. Filter Response for Filter Decimation Rate 2

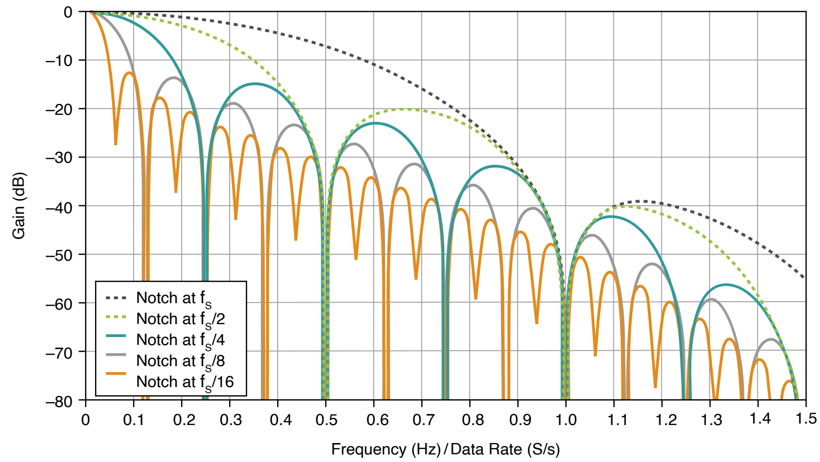


Figure 2. Filter Response for Filter Decimation Rate 4

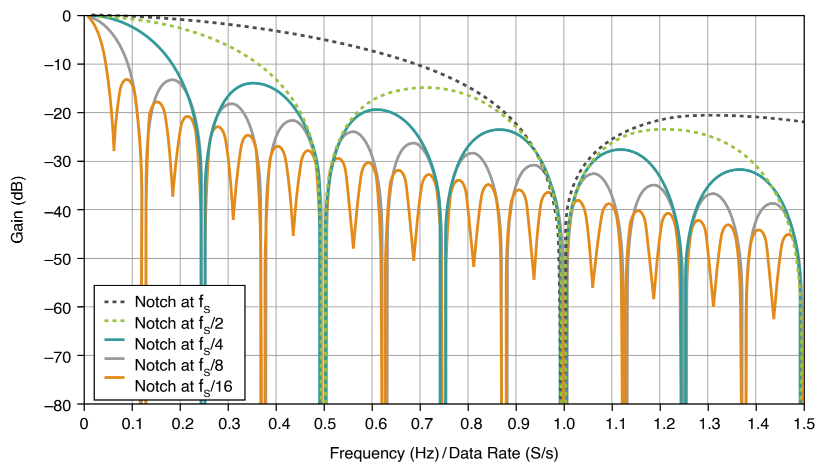


Figure 3. Filter Response for Filter Decimation Rate 5

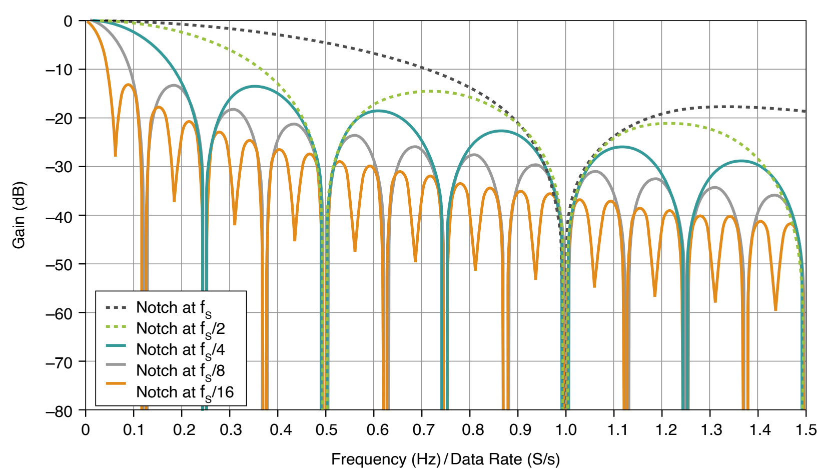
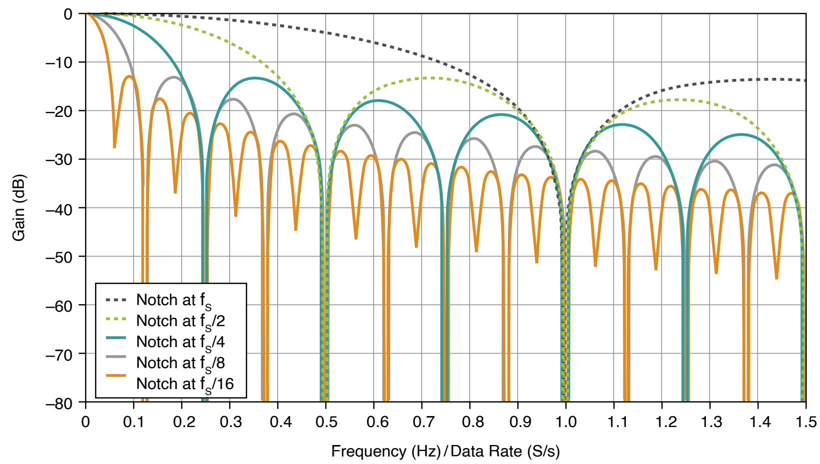


Figure 4. Filter Response for Filter Decimation Rate ≥ 8



> **Note** Refer to the Data Rates section for more information on the Filter Decimation Rate values.

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 programmable comb filters of the NI-9202 adjust the frequency range of the passband to match the data rate and filter setting. Therefore, the amount of gain or attenuation at a given frequency depends on the data rate and filter setting.

Figure 5. Typical Flatness for Filter Decimation Rate 2

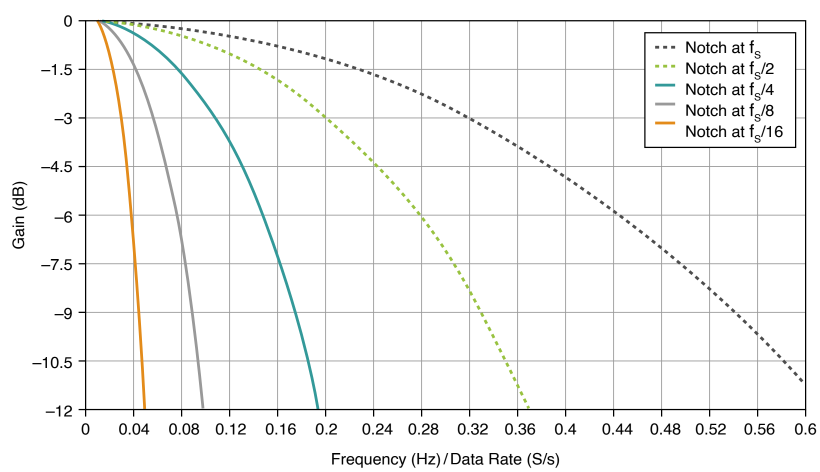


Figure 6. Typical Flatness for Filter Decimation Rate 4

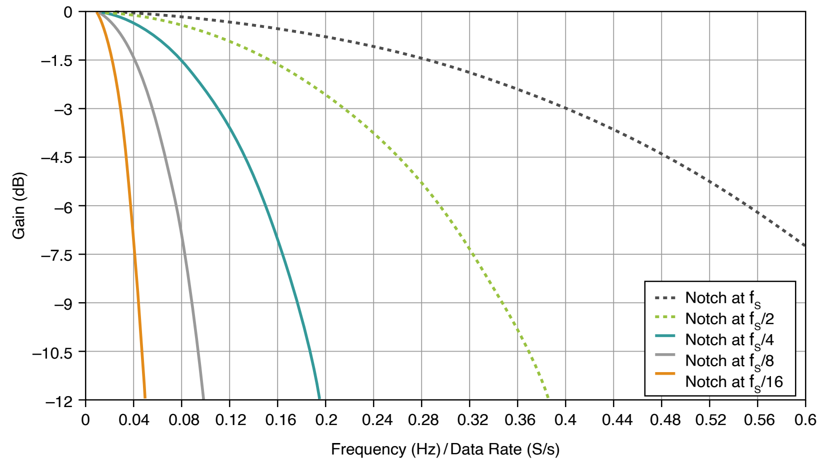


Figure 7. Typical Flatness for Filter Decimation Rate 5

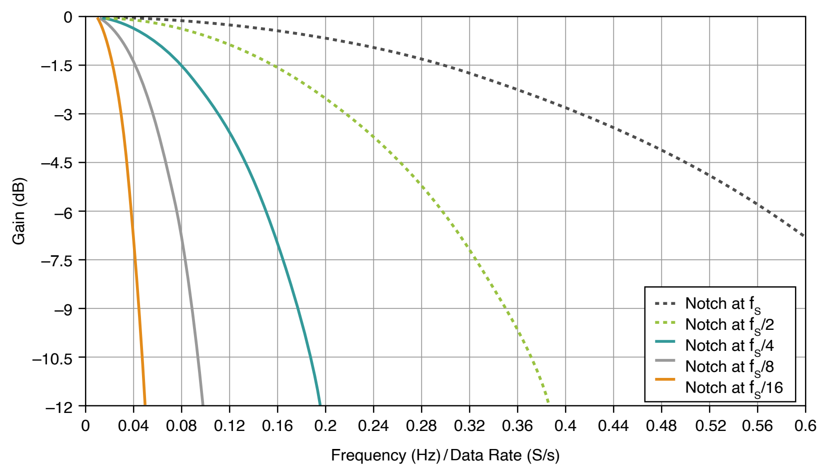
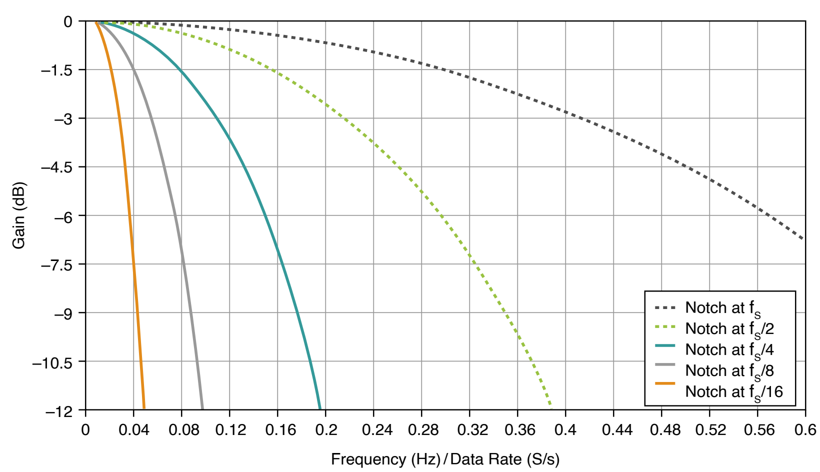
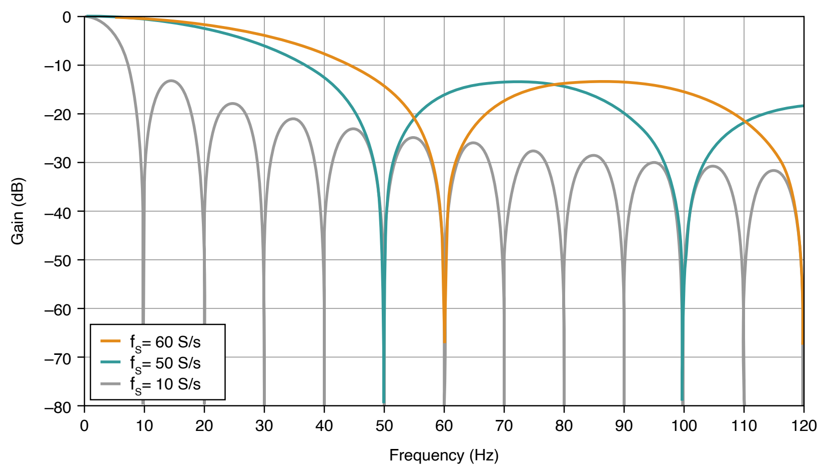


Figure 8. Typical Flatness for Filter Decimation Rate ≥ 8



The NI-9202 also supports power line frequency rejection. The 60 S/s data rate rejects 60 Hz noise and all harmonics of 60 Hz. The 50 S/s data rate rejects 50 Hz noise and all harmonics. The 10 S/s data rate rejects 50 Hz and 60 Hz noise and all harmonics. The following figure shows the typical frequency response for these three data rates. Refer to the Input Characteristics section for the minimum NMRR.

Figure 9. Typical Frequency Response at 60 S/s, 50 S/s, and 10 S/s



The -3 dB bandwidth will also be a function of data rate and filter setting, as shown in the following figures.

Figure 10. Typical -3 dB Bandwidth/Data Rate vs Data Rate and Filter Settings

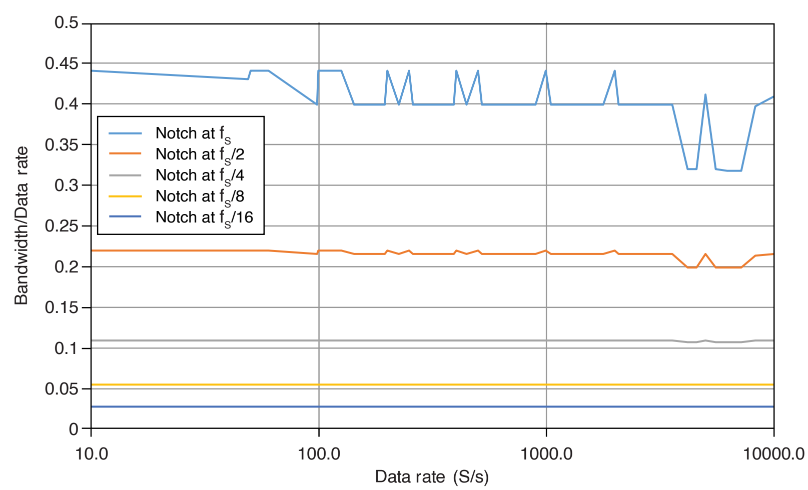
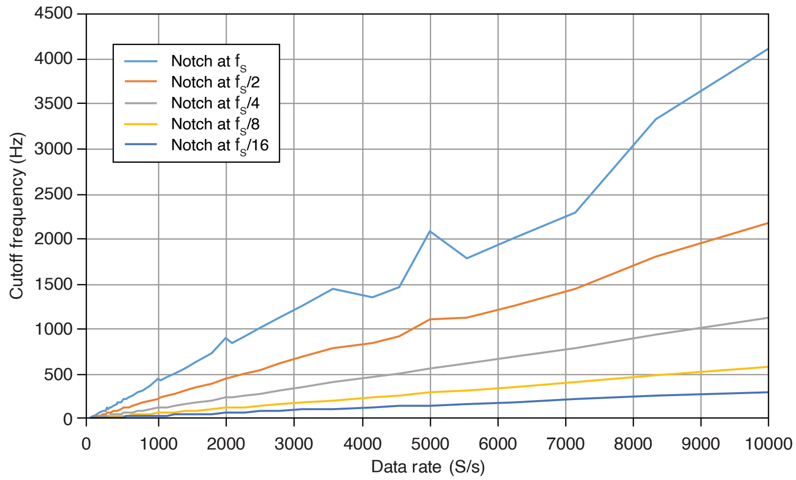


Figure 11. Typical -3 dB Bandwidth vs Data Rate and Filter Settings



Data Rates

The frequency of a master timebase (**f_M**) controls the data rate (**f_s**) of the NI-9202. The NI-9202 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 10 kS/s, 8333.3 S/s, 7142.9 S/s, 6250 S/s, and so on down to 10 S/s, depending on the decimation rates and the values of the clock dividers. However, the data rate must remain within the appropriate data rate range. Power line frequency rejection is supported through the data rates of 60 S/s, 50 S/s and 10 S/s when using the internal master timebase or when using an external master timebase of 13.1072 MHz or 12.8 MHz.

The following equation provides the available data rates of the NI-9202:

$$f_s = \frac{f_M}{a \times b \times c \times d}$$

where **a** is the ADC Decimation Rate (32, 64, 128, 256, 512, 1024), **b** is the Timebase Clock Divider (integer between 1 and 11), **c** is the ADC Clock Divider (4 or 8), and **d** is the Filter Decimation Rate (2, 4, 5, 8, 25, 64, 71, 119, 125).

Note

$\frac{f_M}{b}$

must be greater than or equal to 1 MHz and less than 6.575 MHz.

The following table lists available data rates with the internal master timebase.

f_s (S/s)	ADC Decimation Rate	Timebase Clock Divider	ADC Clock Divider	Filter Decimation Rate
10000.0	32	2	4	5
8333.3	32	3	4	4
7142.9	32	7	4	2
6250.0	128	1	8	2
5555.6	32	9	4	2
5000.0	64	2	4	5
4545.5	32	11	4	2
4166.7	128	3	4	2
3571.4	32	7	4	4
3125.0	128	1	8	4
2777.8	32	9	4	4
2500.0	64	5	4	4
2272.7	32	11	4	4
2083.3	128	3	4	4
2000.0	32	2	4	25
1785.7	64	7	4	4
1562.5	256	1	8	4
1388.9	64	9	4	4
1250.0	128	5	4	4
1136.4	64	11	4	4
1041.7	256	3	4	4
1000.0	64	2	4	25
892.9	128	7	4	4
781.3	512	1	8	4
694.4	128	9	4	4
625.0	256	5	4	4
568.2	128	11	4	4
520.8	512	3	4	4
500.0	128	2	4	25
446.4	256	7	4	4

f_s (S/s)	ADC Decimation Rate	Timebase Clock Divider	ADC Clock Divider	Filter Decimation Rate
400.0	32	2	4	125
390.6	1024	1	8	4
347.2	256	9	4	4
312.5	512	5	4	4
284.1	256	11	4	4
260.4	1024	3	4	4
250.0	256	2	4	25
223.2	512	7	4	4
200.0	64	2	4	125
195.3	1024	4	4	4
142.0	512	11	4	4
125.0	512	2	4	25
100.0	128	2	4	125
97.7	1024	8	4	4
60.0[1]	64 or 256[2]	7 or 3[2]	4	119 or 71[2]
50.0[1]	512 or 1024[2]	5 or 8[2]	4	25 or 8[2]
10.0[1]	512 or 1024[2]	5	4	125 or 64[2]

Table 1. Available Data Rates with the Internal Master Timebase

The NI-9202 can also accept an external master timebase or export its own master timebase. To synchronize the data rate of an NI-9202 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 (with the exception of 60 S/s, 50 S/s and 10 S/s[1]) of the NI-9202 shift by the ratio of the external timebase frequency to the internal timebase frequency. Refer to the software help for information about configuring the master timebase source for the NI-9202.

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

[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 master timebase of 13.1072 MHz.

NI-9202 Specifications

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

> **Caution** Do not operate the NI-9202 in a manner not specified in this document. Product misuse can result in a hazard. You can compromise the safety protection built into the product if the product is damaged in any way. If the product is damaged, return it to NI for repair.

Definitions

Warranted specifications describe the performance of a model under stated operating conditions and are covered by the model warranty.

Characteristics describe values that are relevant to the use of the model under stated operating conditions but are not covered by the model warranty.

- **Typical** specifications describe the performance met by a majority of models.
- **Nominal** specifications describe an attribute that is based on design, conformance testing, or supplemental testing.

Specifications are **Typical** unless otherwise noted.

Input Characteristics

Number of channels	16 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

Data rate range (f_s)

Using internal master timebase

Minimum	10 S/s
Maximum	10 kS/s

Using external master timebase

Minimum	3.81 S/s
Maximum	10.273 kS/s

Data rate[1]	$f_s = \frac{f_M}{a \times b \times c \times d}$
Overvoltage protection[2]	±30 V
Input resistance (AI**x** to COM)	>10 GΩ

Input voltage range (Differential)

Minimum	10.50 V
Typical	10.58 V

Scaling coefficients	
10 kS/s, 5 kS/s	2,017,990 pV/LSB
60 S/s[3]	1,356,632 pV/LSB
2 kS/s, 1 kS/s, 500 S/s, 250 S/s, 125 S/s, 50 S/s[3]	1,614,392 pV/LSB
400 S/s, 200 S/s, 100 S/s, 10 S/s[3]	1,291,513 pV/LSB
60 S/s[4]	2,273,791 pV/LSB
All other data rates	1,261,244 pV/LSB

Maximum input voltage (AI**x** to COM)	±10.5 V
Input delay [5]	$\frac{(A + B)}{f_S} + C$
Settling time [5]	$\frac{2(A + B)}{f_S} + C$

Variable	Value
A	0.8 for f_S = 10 to 60, 100, 125, 200, 250, 400, 500, 1000, 2000
	1.4 for f_S = 97.7 to 2083.3, 2500, 3125, 5000, 10000[6]
	1.8 for f_S = 2272.7 to 4166.7, 6250, 8333.3[7]
	2.6 for f_S = 4545.5, 5555.6, 7142.9
B	0 for filter notch at f_S
	0.5 for filter notch at $f_S/2$
	1.5 for filter notch at $f_S/4$
	3.5 for filter notch at $f_S/8$

Variable	Value
	7.5 for filter notch at $f_S/16$
C	8.5 µs

Table 2. Input Delay

Measurement Conditions	Percent of Reading[8] (Gain Error)	Percent of Range[9] (Offset Error)
Maximum (-40 °C to 70 °C)	±0.25%	±0.17%
Typical (23 °C, ±5 °C)	±0.06%	±0.04%

Table 3. DC Accuracy

Non-linearity	5 ppm

Stability of Accuracy

Gain drift[8]	5.3 ppm/°C
Offset drift	34.5 µV/°C

Passband, -3 dB	Refer to the -3 dB graphs in the Passband section
Phase linearity (f_{in} ≤ 4.9 kHz)	0.07° maximum

Channel-to-channel mismatch (f_{in} ≤ 4.9 kHz)

Gain	0.2 dB maximum
Phase	0.24°/kHz maximum

Module-to-module mismatch (f_{in} ≤ 4.9 kHz)

Phase

$$0.24°/\text{kHz} + 360° f_{in}/f_M$$

Attenuation @ 2 x oversample rate (23° C)[10]

f_s = 10000.0 S/s	95 dB @ 581.818 kHz
f_s = 4545.5 S/s	85 dB @ 3.2 MHz

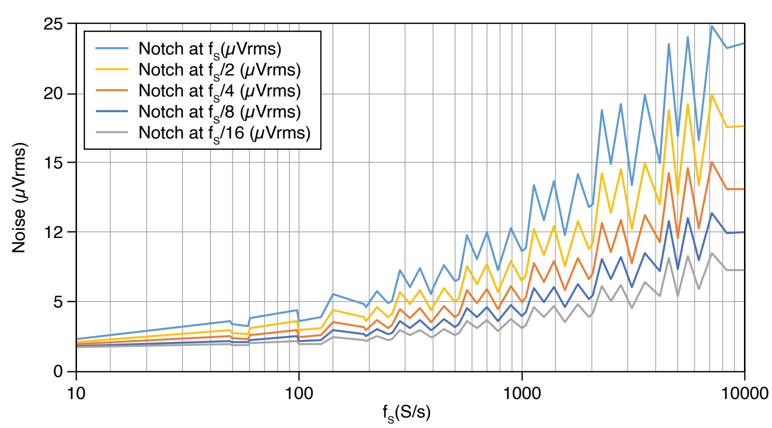
f_S (S/s)	ADC Decimation Rate	Filter Notch at f_S (µVrms)	Filter Notch at $f_S/2$ (µVrms)	Filter Notch at $f_S/4$ (µVrms)	Filter Notch at $f_S/8$ (µVrms)	Filter Notch at $f_S/16$(µVrms)
10000.0	32	23.5	17.6	13.0	9.9	7.2
5000.0	64	16.8	12.7	9.5	7.3	5.4
6250.0	128	16.6	13.3	10.2	7.9	5.8
1562.5	256	9.7	7.5	5.8	4.6	3.5
781.3	512	7.2	5.6	4.4	3.6	2.8
390.6	1,024	5.5	4.3	3.5	2.9	2.4

Table 4. Idle Channel Noise

Note The noise specifications assume the NI-9202 is using the internal master timebase frequency of 12.8 MHz.

Note The noise is dominated by the ADC Decimation Rate.

Figure 12. Idle Channel Noise vs Data Rate and Filter Settings.



Crosstalk (CH to CH)

NI-9202 with spring terminal

$f_{in} \leq$ 100 Hz	100 dB
$f_{in} \leq$ 1 kHz	80 dB
$f_{in} \leq$ 3 kHz	70 dB

NI-9202 with DSUB

$f_{in} \leq$ 100 Hz	105 dB
$f_{in} \leq$ 1 kHz	85 dB
$f_{in} \leq$ 3 kHz	75 dB

Common mode rejection ratio (CMRR) to COM

$f_{in} \leq$ 60 Hz	72 dB typical, 67 dB minimum

Common mode rejection ratio (CMRR) to Earth Ground

$f_{in} \leq$ 60 Hz	125 dB minimum

Normal mode rejection ratio (NMRR) using internal or external master timebase of 12.8 MHz

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	34 dB minimum

Normal mode rejection ratio (NMRR) using external master timebase of 13.1072 MHz

60 S/s, $\mathbf{f_{in}}$ = 60 Hz ± 1 Hz	34 dB minimum
50 S/s, $\mathbf{f_{in}}$ = 50 Hz ± 1 Hz	33 dB minimum
10 S/s, $\mathbf{f_{in}}$ = 50 Hz/60 Hz ± 1 Hz	33 dB minimum

Power Requirements

Power consumption from chassis

Active mode	0.95 W maximum
Sleep mode	53 µW maximum

Thermal dissipation

Active mode	1.30 W maximum
Sleep mode	0.64 W 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

Connector securement	
Securement type	Screw flanges provided
Torque for screw flanges	0.2 N · m (1.80 lb · in.)

Safety Voltages

Connect only voltages that are within the following limits:

Maximum voltage[11]	
Channel-to-COM	±30 V DC maximum, up to 6 channels at a time

NI-9202 with Spring Terminal Isolation Voltages

Channel-to-channel	None
Channel-to-earth ground	
Continuous	250 V RMS, Measurement Category II
Withstand (up to 5,000 m)	3,000 V RMS, verified by a 5 s dielectric withstand test

NI-9202 with DSUB Isolation Voltages

Channel-to-channel	None
Channel-to-earth ground	
Continuous	60 V DC, Measurement Category I
Withstand	

up to 2,000 m	1,000 V RMS, verified by a 5 s dielectric withstand test
up to 5,000 m	500 V RMS

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

Safety 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 60079-0:2012, EN 60079-15:2010
- 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 Online Product Certification section.

Electromagnetic Compatibility

This product meets the requirements of the following EMC standards for 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 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 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 For EMC declarations and certifications, and additional information, refer to the Online Product Certification section.

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 (IEC 60068-2-64)	5 g_{rms}, 10 Hz to 500 Hz
Sinusoidal (IEC 60068-2-6)	5 g, 10 Hz to 500 Hz
Operating shock (IEC 60068-2-27)	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 60068-2-78)	10% RH to 90% RH, noncondensing

Storage humidity (IEC 60068-2-78)	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 **Engineering a Healthy Planet** 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.

EU and UK Customers

- Waste Electrical and Electronic Equipment (WEEE)—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 RoHS— NI 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 NI 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-9202 at ni.com/calibration.

Calibration interval	2 years

[1] The data rate must remain within the appropriate data rate range and

$\frac{f_M}{b}$

needs to stay within 1 MHz and 6.575 MHz.

[2] Up to 6 channels simultaneously

[3] When using the internal master timebase or an external master timebase of 12.8 MHz

[4] When using an external master timebase of 13.1072 MHz

[5] Refer to Input Delay for the values of A, B, and C.

[6] Excludes sample rates in the 0.8 category

[7] Excludes sample rates in 1.4 category

[8] Includes the expected difference in measurement between using single-ended and differential sources due to finite CMRR

[9] Range equals 10.58 V

[10] The oversample rate is the timebase divided by Timebase Clock Divider and ADC Clock Divider in Table 1. At odd multiples of the oversample rate, the NI-9202 will have significantly higher rejection.

[11] The maximum voltage that can be applied or output between AI and COM without creating a safety hazard.