# NI-9202 Specifications

2024-06-06

# Contents

# NI-9202 Specifications

## 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.

**Related information:**

- Software Support for CompactRIO, CompactDAQ, Single-Board RIO, R Series, and EtherCAT

## Conditions

Specifications are valid for the range -40 °C to 70 °C unless otherwise noted.

## NI-9202 Nomenclature

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

# 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]<br>$\frac{f_M}{b}$<br>needs to stay within 1 MHz and 6.575 MHz. | $f_s = \frac{f_M}{a \times b \times c \times d}$ |
| Overvoltage protection[2] | ±30 V |
| Input resistance (AIx 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]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 |

1. The data rate must remain within the appropriate data rate range and
2. Up to 6 channels simultaneously
3. When using the internal master timebase or an external master timebase of 12.8 MHz

| | | |
|---|---|---|
| All other data rates | | 1,261,244 pV/LSB |
| Maximum input voltage (AIx to COM) | ±10.5 V | |
| Input delay [5] 5 | $\frac{(A + B)}{f_S} + C$ | |
| Settling time [5] | $\frac{2(A + B)}{f_S} + C$ | |

**Table 1.** Input Delay

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

4. When using an external master timebase of 13.1072 MHz
5. Refer to the ***Input Delay*** section 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

**Table 2.** DC Accuracy

| Measurement Conditions | Percent of Reading[8]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% |

| | |
|---|---|
| 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 | $0.24\,^\circ / kHz + 360\,^\circ f_{in} / f_M$ |

8. Includes the expected difference in measurement between using single-ended and differential sources due to finite CMRR
9. Range equals 10.58 V

| 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 |

**Table 3.** Idle Channel Noise

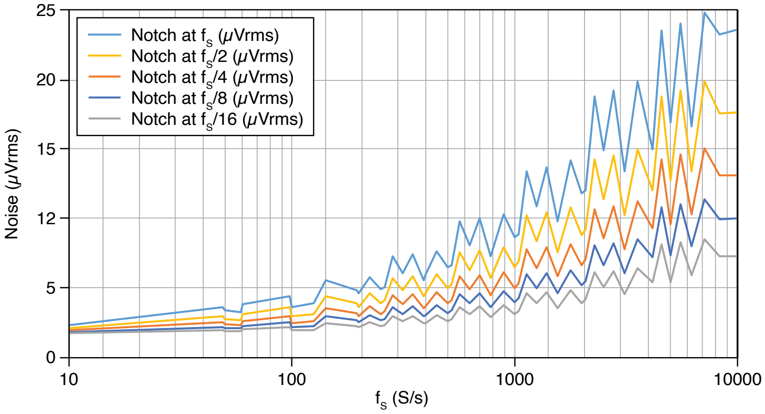
| $f_S$ (S/s) | ADC Decimation Rate | Filter Notch at $f_S$ (µVrms) | Filter Notch at $f_S/2$ (µVrms) | Filter Notch at $f_S/4$ (µVrms) | Filter Notch at $f_S/8$ (µVrms) | Filter Notch at $f_S/16$(µVrms) |
|---|---|---|---|---|---|---|
| 10000.0 | 32 | 23.5 | 17.6 | 13.0 | 9.9 | 7.2 |
| 5000.0 | 64 | 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 |

**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.

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.

**Figure 1.** 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, $f_{in}$ = 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 | 33 dB minimum |

**Related concepts:**

- NI-9202 Filtering

## NI-9202 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 the Idle Channel Noise table) for filter settling time (refer to the Settling Time equation) and latency (refer to the 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 2.** Filter Response for Filter Decimation Rate 2

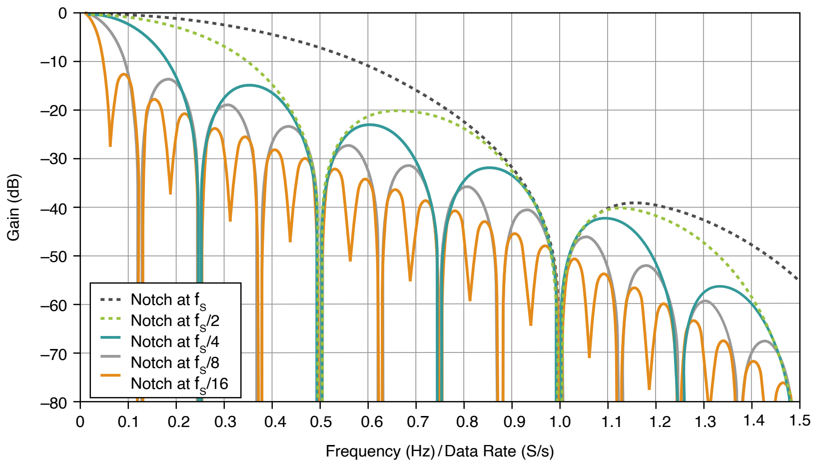



**Figure 3.** Filter Response for Filter Decimation Rate 4

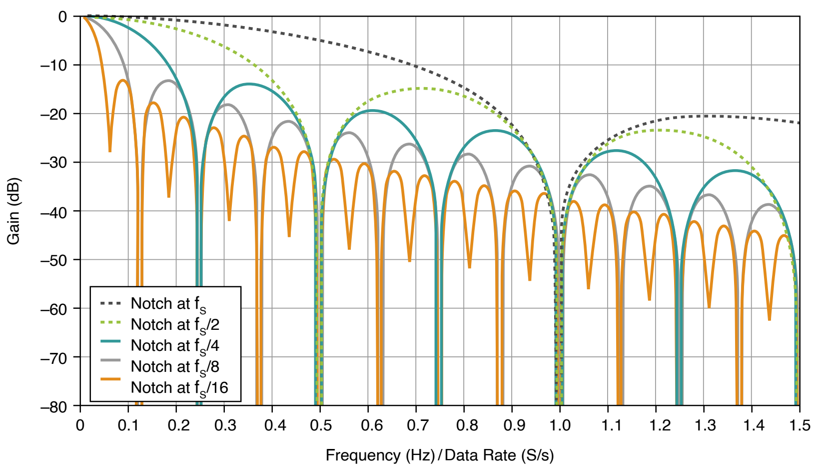


**Figure 4.** Filter Response for Filter Decimation Rate 5

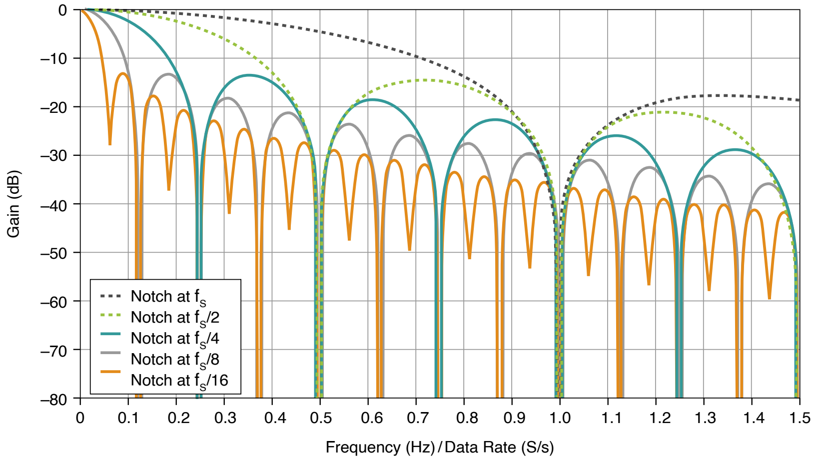
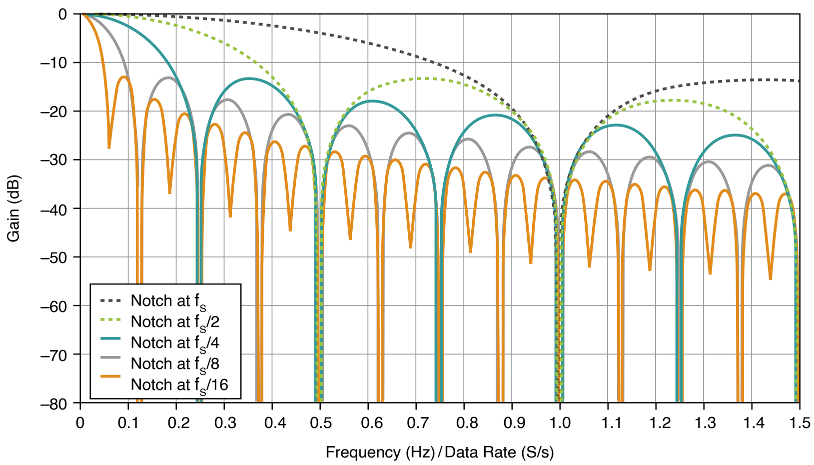



**Figure 5.** Filter Response for Filter Decimation Rate ≥ 8




**Related concepts:**

- NI-9202 Data Rates

**Related reference:**

- Input Characteristics

## NI-9202 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 6.** Typical Flatness for Filter Decimation Rate 2

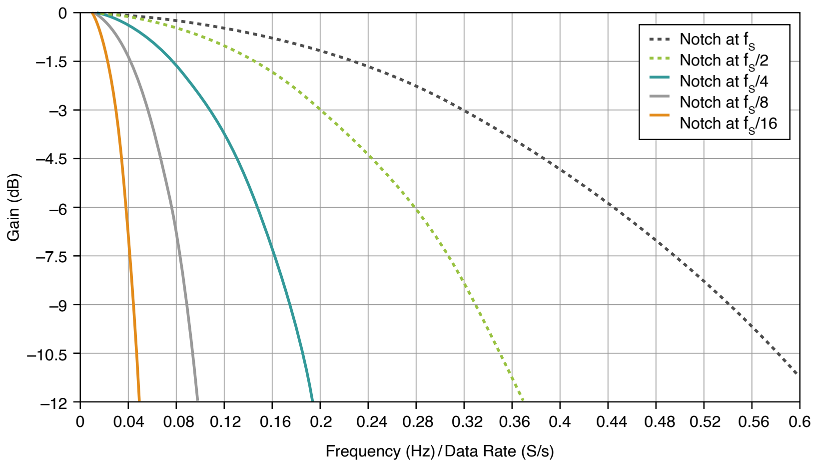



**Figure 7.** Typical Flatness for Filter Decimation Rate 4

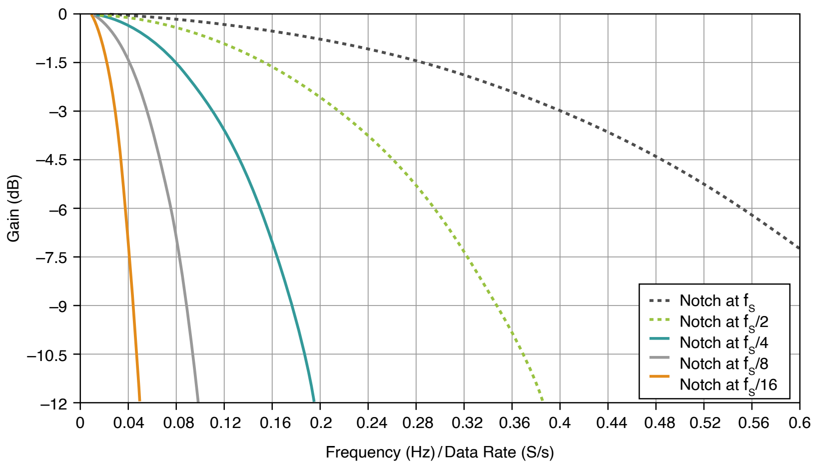



**Figure 8.** Typical Flatness for Filter Decimation Rate 5

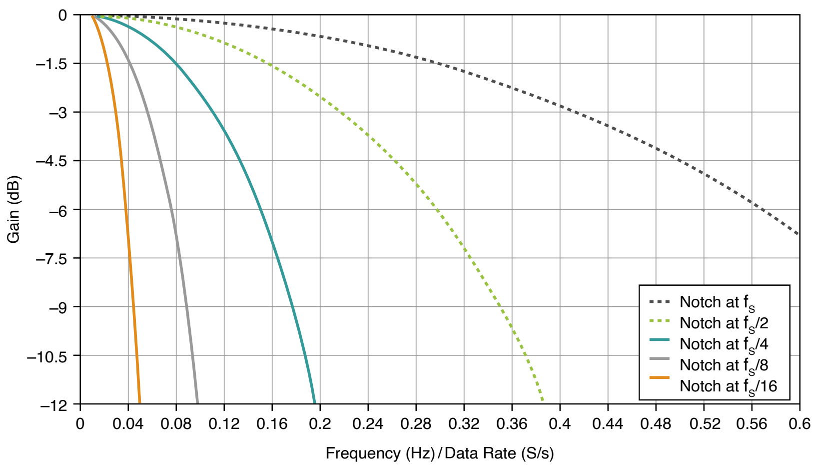
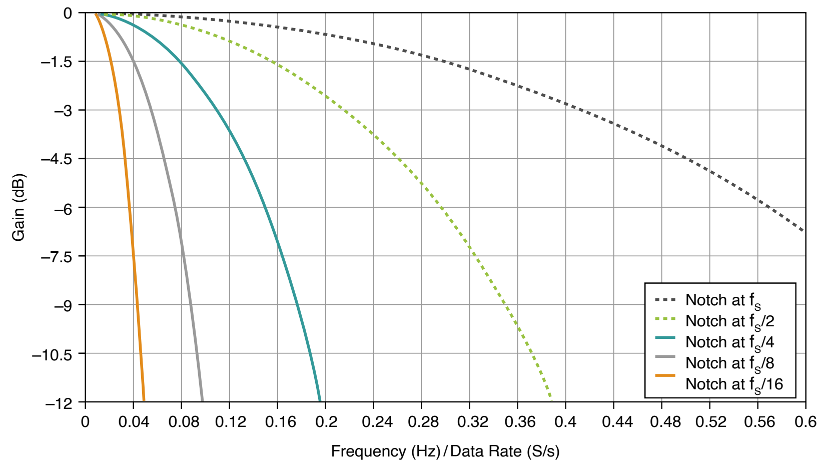
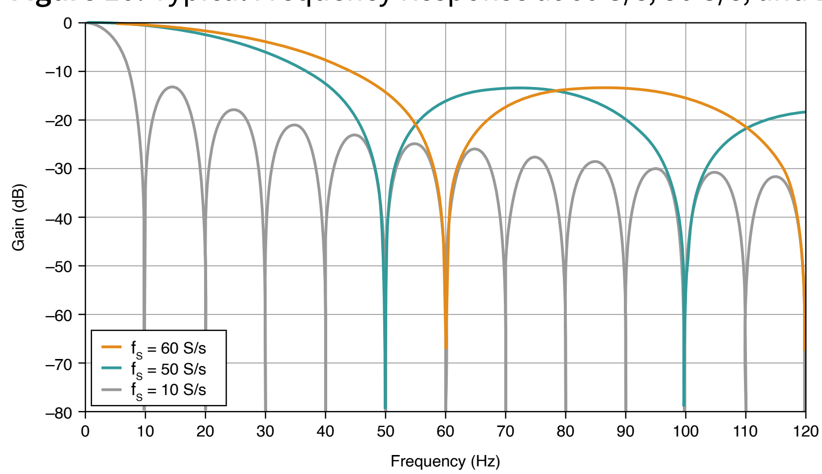


**Figure 9.** Typical Flatness for Filter Decimation Rate ≥ 8




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 ***Input Characteristics*** in the ***NI-9202 Specifications*** for the minimum NMRR.

**Figure 10.** 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 11.** Typical -3 dB Bandwidth/Data Rate vs Data Rate and Filter Settings

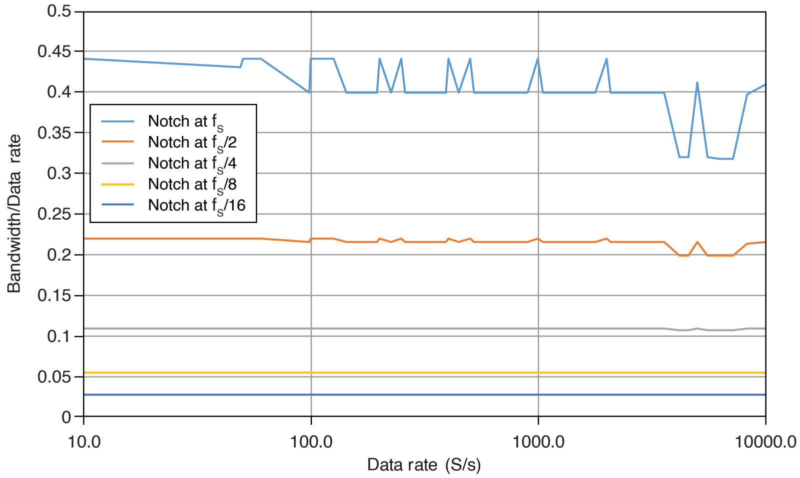
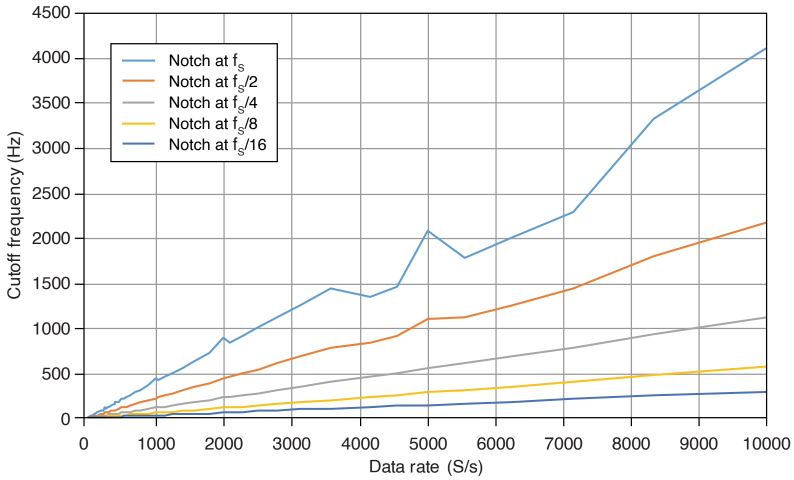



**Figure 12.** Typical -3 dB Bandwidth vs Data Rate and Filter Settings




# NI-9202 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)
- d is the Filter Decimation Rate (2, 4, 5, 8, 25, 64, 71, 119, 125)

**Note** $f_M/b$ 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.

**Table 4.** 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 |

| $f_S$ (S/s) | ADC Decimation Rate | Timebase Clock Divider | ADC Clock Divider | Filter Decimation Rate |
|---|---|---|---|---|
| 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 |
| 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 |

| $f_s$ (S/s) | ADC Decimation Rate | Timebase Clock Divider | ADC Clock Divider | Filter Decimation Rate |
|---|---|---|---|---|
| 97.7 | 1024 | 8 | 4 | 4 |
| 60.0[11]11 | 64 or 256[12]12 | 7 or 3[12] | 4 | 119 or 71[12] |
| 50.0[11] | 512 or 1024[12] | 5 or 8[12] | 4 | 25 or 8[12] |
| 10.0[11] | 512 or 1024[12] | 5 | 4 | 125 or 64[12] |

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[11]) 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.

**Related concepts:**

- NI-9202 Filtering

# Safety Voltages

Connect only voltages that are within the following limits:

| **Maximum voltage**[13] | |
|---|---|
| Channel-to-COM | ±30 V DC maximum, up to 6 channels at a time |

11. When using an external timebase of 13.1072 MHz, this data rate does not change with the ratio of the external to internal clocks.
12. When using an external master timebase of 13.1072 MHz.
13. The maximum voltage that can be applied or output between AI and COM without creating a safety

## 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 |

Measurement Category II

> **Caution** Do not connect the product to signals or use for measurements within Measurement Categories III or IV.

> **Attention** Ne pas connecter le produit à des signaux dans les catégories de mesure III ou IV et ne pas l'utiliser pour effectuer des mesures dans ces catégories.

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.

## NI-9202 with DSUB Isolation Voltages

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

hazard.

| 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 |

Measurement Category I

**Warning** Do not connect the product to signals or use for measurements within Measurement Categories II, III, or IV, or for measurements on MAINs circuits or on circuits derived from Overvoltage Category II, III, or IV which may have transient overvoltages above what the product can withstand. The product must not be connected to circuits that have a maximum voltage above the continuous working voltage, relative to earth or to other channels, or this could damage and defeat the insulation. The product can only withstand transients up to the transient overvoltage rating without breakdown or damage to the insulation. An analysis of the working voltages, loop impedances, temporary overvoltages, and transient overvoltages in the system must be conducted prior to making measurements.

**Mise en garde** Ne pas connecter le produit à des signaux dans les catégories de mesure II, III ou IV et ne pas l'utiliser pour des mesures dans ces catégories, ou des mesures sur secteur ou sur des circuits dérivés de surtensions de catégorie II, III ou IV pouvant présenter des surtensions transitoires supérieures à ce que le produit peut supporter. Le produit ne doit pas être raccordé à des circuits ayant une tension maximale supérieure à la tension de fonctionnement continu, par rapport à la terre ou à d'autres voies, sous peine d'endommager et de compromettre l'isolation. Le produit peut tomber en panne et son isolation risque d'être endommagée si les tensions transitoires dépassent la surtension transitoire nominale. Une analyse des tensions de fonctionnement, des impédances de boucle, des surtensions temporaires et des surtensions transitoires dans le système doit être effectuée avant de procéder à des mesures.

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as ***MAINS*** voltage. MAINS is a hazardous live electrical supply system that powers equipment. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.

**Note** Measurement Categories CAT I and CAT O are equivalent. These test and measurement circuits are for other circuits not intended for direct connection to the MAINS building installations of Measurement Categories CAT II, CAT III, or CAT IV.

## Environmental Characteristics

| | |
|---|---|
| **Temperature** | |
| Operating | -40 °C to 70 °C |
| Storage | -40 °C to 85 °C |
| **Humidity** | |
| Operating | 10% RH to 90% RH, noncondensing |
| Storage | 5% RH to 95% RH, noncondensing |
| Ingress protection | IP40 |
| Pollution Degree | 2 |
| Maximum altitude | 5,000 m |

| Shock and Vibration | |
|---|---|
| **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 |

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

## 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 |

**Ferrules**

| | |
|---|---|
| Single ferrule, uninsulated | 0.14 mm$^2$ to 1.5 mm$^2$ (26 AWG to 16 AWG)<br>10 mm barrel length |
| Single ferrule, insulated | 0.14 mm$^2$ to 1.0 mm$^2$ (26 AWG to 18 AWG)<br>12 mm barrel length |
| Two-wire ferrule, insulated | 2× 0.34 mm$^2$ (2× 22 AWG)<br>12 mm barrel length |

**Connector securement**

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

| | |
|---|---|
| Dimensions | Visit ni.com/dimensions and search by module number. |

| Weight | |
|---|---|
| NI-9202 with spring terminal | 138.6 g (4.9 oz) |
| NI-9202 with DSUB | 149.0 g (5.3 oz) |