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# USB-6212 Specifications

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# USB-6212 Specifications

These specifications apply to the USB-6212 BNC, USB-6212 Mass Termination, and USB-6212 Spring Terminal.

## 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.

## Conditions

Specifications are valid at 25 °C unless otherwise noted.

## Analog Input

|                    |                                   |
|--------------------|-----------------------------------|
| Number of channels | 8 differential or 16 single ended |
| ADC resolution     | 16 bits                           |
| DNL                | No missing codes guaranteed       |

|  |  |          |
|--|--|----------|
| INL  | Refer to the <a href="#">AI Absolute Accuracy</a> section                    |          |
| <b>Sample rate</b>   |  |          |
| Single channel maximum   |  | 400 kS/s |
| Multichannel maximum (aggregate)                                 |  | 400 kS/s |
| Minimum  |  | 0 S/s    |
| Timing resolution  | 50 ns  |          |
| Timing accuracy  | 50 ppm of sample rate  |          |
| Input coupling   | DC   |          |
| Input range  | $\pm 0.2\text{ V}$ , $\pm 1\text{ V}$ , $\pm 5\text{ V}$ , $\pm 10\text{ V}$ |          |
| Maximum working voltage for analog inputs (signal + common mode) | $\pm 10.4\text{ V}$ of AI GND  |          |
| CMRR (DC to 60 Hz)   | 100 dB   |          |
| <b>Input impedance</b>   |  |          |
| <b>Device on</b>   |  |          |
| AI+ to AI GND  | $>10\text{ G}\Omega$ in parallel with 100 pF                                 |          |
| AI- to AI GND  | $>10\text{ G}\Omega$ in parallel with 100 pF                                 |          |
| <b>Device off</b>  |  |          |
| AI+ to AI GND  | 1,200 $\Omega$   |          |

|   |                                   |
|---|-----------------------------------|
| AI- to AI GND   | 1,200 $\Omega$                    |
| Input bias current  | $\pm 100$ pA                      |
| <b>Crosstalk (at 100 kHz)</b>   |                                   |
| Adjacent channels   | -75 dB                            |
| Non-adjacent channels   | -90 dB                            |
| Small signal bandwidth (-3 dB)  | 1.5 MHz                           |
| Input FIFO size   | 4,095 samples                     |
| Scan list memory  | 4,095 entries                     |
| Data transfers  | USB Signal Stream, programmed I/O |
| <b>Overvoltage protection for all analog input and sense channels</b> |                                   |
| Device on   | $\pm 30$ V for up to two AI pins  |
| Device off  | $\pm 20$ V for up to two AI pins  |
| Input current during overvoltage condition                            | $\pm 20$ mA maximum/AI pin        |

## Settling Time for Multichannel Measurements

|  |                              |
|--|------------------------------|
| <b>Accuracy, full-scale step, all ranges</b> |                              |
| $\pm 90$ ppm of step ( $\pm 6$ LSB)          | 2.5 $\mu$ s convert interval |
| $\pm 30$ ppm of step ( $\pm 2$ LSB)          | 3.5 $\mu$ s convert interval |

±15 ppm of step (±1 LSB)

5.5 μs convert interval

## Typical Performance Graphs

Figure 3. Settling Error versus Time for Different Source Impedances

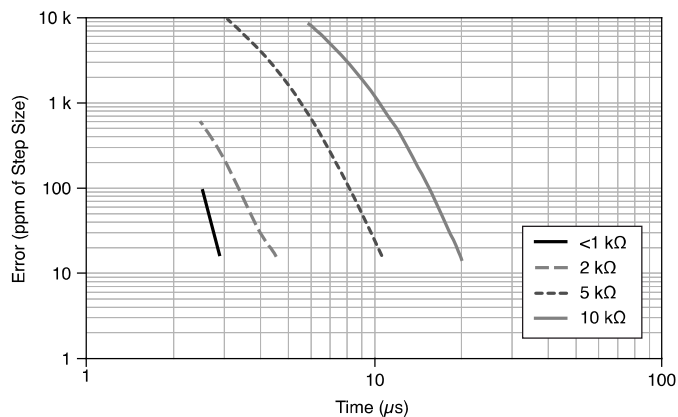
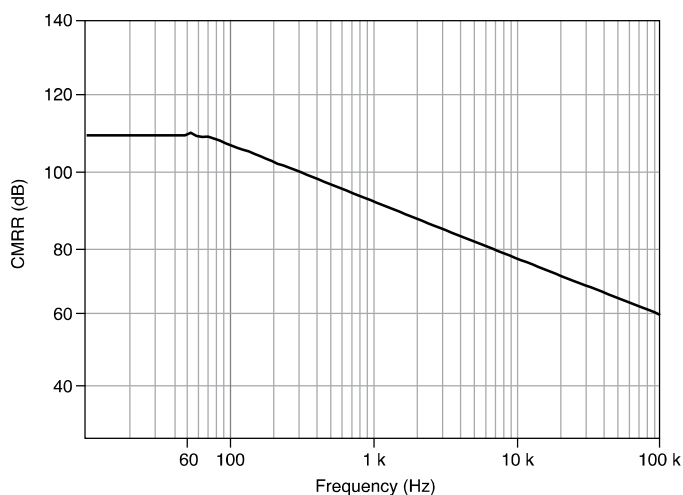


Figure 2. AI CMRR



## AI Absolute Accuracy (Warranted)

**Note** Accuracies listed are valid for up to one year from the device external calibration.

**Note** The input/output channels of this device are not protected for electromagnetic interference due to functional reasons. As a result, this device may experience reduced measurement accuracy or other temporary performance degradation when connected cables are routed in an environment with radiated or conducted radio frequency electromagnetic interference. To ensure that this device functions within specifications in its operational electromagnetic environment and to limit radiated emissions, care should be taken in the selection, design, and installation of measurement probes and cables.

| Nominal Range Positive Full Scale | Nominal Range Negative Full Scale | Residual Gain Error (ppm of Reading) | Residual Offset Error (ppm of Range) | Offset Tempco (ppm of Range/°C) | Random Noise, $\sigma$ ( $\mu\text{Vrms}$ ) | Absolute Accuracy at Full Scale ( $\mu\text{V}$ ) | Sensitivity ( $\mu\text{V}$ ) |
|-----------------------------------|-----------------------------------|--------------------------------------|--------------------------------------|---------------------------------|---|---|-------------------------------|
| 10                                | -10                               | 75                                   | 20                                   | 34                              | 295   | 2,710   | 118.0                         |
| 5                                 | -5                                | 85                                   | 20                                   | 36                              | 149   | 1,420   | 59.6                          |
| 1                                 | -1                                | 95                                   | 25                                   | 49                              | 32  | 310   | 12.8                          |
| 0.2                               | -0.2                              | 135                                  | 40                                   | 116                             | 13  | 89  | 5.2                           |

Table 1. AI Absolute Accuracy

**Note** Sensitivity is the smallest voltage change that can be detected. It is a function of noise.

|                  |                 |
|------------------|-----------------|
| Gain tempco      | 7.3 ppm/°C      |
| Reference tempco | 5 ppm/°C        |
| INL error        | 76 ppm of range |

### AI Absolute Accuracy Equation

**AbsoluteAccuracy = Reading · (GainError) + Range · (OffsetError) + NoiseUncertainty**

- **GainError = ResidualAIGainError + GainTempco · (TempChangeFromLastInternalCal) + ReferenceTempco · (TempChangeFromLastExternalCal)**
- **OffsetError = ResidualAIOffsetError + OffsetTempco · (TempChangeFromLastInternalCal) + INLError**
- **NoiseUncertainty =**  

$$\frac{\text{Random Noise} \cdot 3}{\sqrt{100}}$$
 for a coverage factor of 3  $\sigma$  and averaging 100 points.

## AI Absolute Accuracy Example

Absolute accuracy at full scale on the analog input channels is determined using the following assumptions:

- TempChangeFromLastExternalCal = 10 °C
- TempChangeFromLastInternalCal = 1 °C
- number\_of\_readings = 100
- CoverageFactor = 3  $\sigma$

For example, on the 10 V range, the absolute accuracy at full scale is as follows:

- GainError = 75 ppm + 7.3 ppm · 1 + 5 ppm · 10 = 132 ppm
- OffsetError = 20 ppm + 34 ppm · 1 + 76 ppm = 130 ppm
- NoiseUncertainty =  

$$\frac{295 \mu\text{V} \cdot 3}{\sqrt{100}}$$
 = 88.5  $\mu\text{V}$
- AbsoluteAccuracy = 10 V · (GainError) + 10 V · (OffsetError) +  
 NoiseUncertainty = 2,710  $\mu\text{V}$

## Analog Output

|                    |   |
|--------------------|---|
| Number of channels | 2 |
|--------------------|---|



|                            |  |
|----------------------------|--|
| DAC resolution             | 16 bits                                  |
| DNL                        | ±1 LSB                                   |
| Monotonicity               | 16 bit guaranteed                        |
| <b>Maximum update rate</b> |  |
| 1 channel                  | 250 kS/s                                 |
| 2 channels                 | 250 kS/s per channel                     |
| Timing accuracy            | 50 ppm of sample rate                    |
| Timing resolution          | 50 ns                                    |
| Output range               | ±10 V                                    |
| Output coupling            | DC                                       |
| Output impedance           | 0.2 $\Omega$                             |
| Output current drive       | ±2 mA                                    |
| Overdrive protection       | ±30 V                                    |
| Overdrive current          | 2.4 mA                                   |
| Power-on state             | ±20 mV                                   |
| Power-on glitch            | ±1 V for 200 ms                          |
| Output FIFO size           | 8,191 samples shared among channels used |

|  |  |
|--|--|
| Data transfers                                 | USB Signal Stream, programmed I/O  |
| AO waveform modes                              | Non-periodic waveform, periodic waveform regeneration mode from onboard FIFO, periodic waveform regeneration from host buffer including dynamic update |
| Settling time, full-scale step, 15 ppm (1 LSB) | 32 $\mu$ s   |
| Slew rate                                      | 5 V/ $\mu$ s   |
| <b>Glitch energy</b>                           |  |
| Magnitude                                      | 100 mV   |
| Duration                                       | 2.6 $\mu$ s  |

## AO Absolute Accuracy (Warranted)

Absolute accuracy at full-scale numbers is valid immediately following internal calibration and assumes the device is operating within 10 °C of the last external calibration.

**Note** Accuracies listed are valid for up to one year from the device external calibration.

**Note** The input/output channels of this device are not protected for electromagnetic interference due to functional reasons. As a result, this device may experience reduced measurement accuracy or other temporary performance degradation when connected cables are routed in an environment with radiated or conducted radio frequency electromagnetic interference. To ensure that this device functions within specifications in its operational electromagnetic environment and to limit

radiated emissions, care should be taken in the selection, design, and installation of measurement probes and cables.

| Nominal Range Positive Full Scale (V) | Nominal Range Negative Full Scale (V) | Residual Gain Error (ppm of Reading) | Gain Tempco (ppm/°C) | Residual Offset Error (ppm of Range) | Offset Tempco (ppm of Range/°C) | Absolute Accuracy at Full Scale (μV) |
|---------------------------------------|---------------------------------------|--------------------------------------|----------------------|--------------------------------------|---------------------------------|--------------------------------------|
| 10                                    | -10                                   | 90                                   | 11                   | 60                                   | 12                              | 3,512                                |

Table 2. AO Absolute Accuracy

|                  |                  |
|------------------|------------------|
| Reference tempco | 5 ppm/°C         |
| INL error        | 128 ppm of range |

## AO Absolute Accuracy Equation

$$\text{AbsoluteAccuracy} = \text{OutputValue} \cdot (\text{GainError}) + \text{Range} \cdot (\text{OffsetError})$$

- **GainError = ResidualGainError + GainTempco · (TempChangeFromLastInternalCal) + ReferenceTempco · (TempChangeFromLastExternalCal)**
- **OffsetError = ResidualOffsetError + AOffsetTempco · (TempChangeFromLastInternalCal) + INLError**

## Digital I/O and PFI

### Static Digital I/O Characteristics

#### Digital input or output

BNC/Mass Termination 24 total, 8 (P0.<0..7>), 16 (PFI <0..7>/P1.<0..7>,PFI <8..15>/P2.<0..7>)

Screw Terminal 32 total, 16 (P0.<0..15>), 16 (PFI <0..7>/P1.<0..7>,PFI <8..15>/P2.<0..7>)

|                          |  |
|--------------------------|--|
| Ground reference         | D GND  |
| Pull-down resistor       | 50 k $\Omega$ typical, 20 k $\Omega$ minimum |
| Input voltage protection | $\pm 20$ V on up to 8 pins <sup>[1]</sup>    |

## PFI Functionality

|                          |   |
|--------------------------|---|
| Functionality            | Static digital input, static digital output, timing input, timing output                |
| Timing output sources    | Many AI, AO, counter timing signals   |
| Debounce filter settings | 125 ns, 6.425 $\mu$ s, 2.56 ms, disable; high and low transitions; selectable per input |

## Maximum Operating Conditions

|                              |                |
|------------------------------|----------------|
| $I_{OL}$ output low current  | 16 mA maximum  |
| $I_{OH}$ output high current | -16 mA maximum |

## Digital Input Characteristics

| Level   | Minimum | Maximum     |
|---|---------|-------------|
| $V_{IL}$ input low voltage                    | 0 V     | 0.8 V       |
| $V_{IH}$ input high voltage                   | 2.2 V   | 5.25 V      |
| $I_{IL}$ input low current ( $V_{in} = 0$ V)  | -       | -10 $\mu$ A |
| $I_{IH}$ input high current ( $V_{in} = 5$ V) | -       | 250 $\mu$ A |
| Positive-going threshold ( $V_{T+}$ )         | -       | 2.2 V       |

| Level                           | Minimum | Maximum |
|---------------------------------|---------|---------|
| Negative-going threshold (VT-)  | 0.8 V   | -       |
| Delta VT hysteresis (VT+ - VT-) | 0.2 V   | -       |

## Digital Output Characteristics

Figure 3. PFI <0..15>/P0.<0..15>: I<sub>oh</sub> versus V<sub>oh</sub>

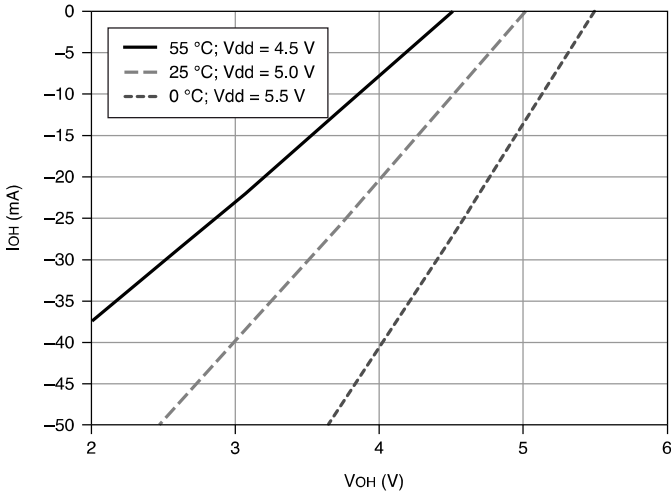
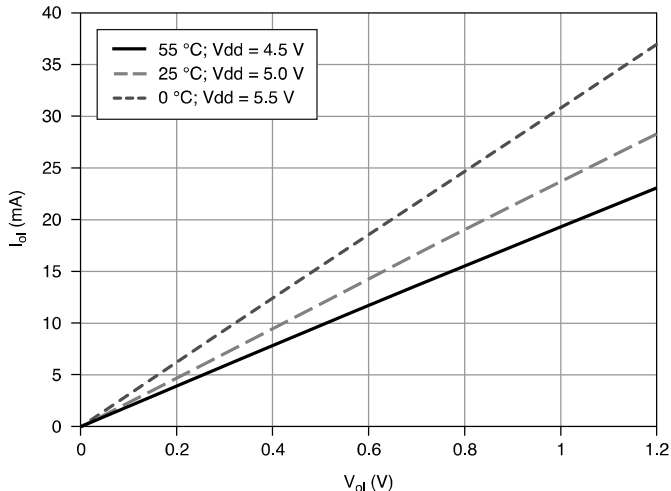


Figure 4. PFI <0..15>/P0.<0..15>: I<sub>ol</sub> versus V<sub>ol</sub>



## General-Purpose Counters/Timers

|                               |   |
|-------------------------------|---|
| Number of counter/timers      | 2   |
| Resolution                    | 32 bits   |
| Counter measurements          | Edge counting, pulse, semi-period, period, two-edge separation                        |
| Position measurements         | X1, X2, X4 quadrature encoding with Channel Z reloading; two-pulse encoding           |
| Output applications           | Pulse, pulse train with dynamic updates, frequency division, equivalent time sampling |
| Internal base clocks          | 80 MHz, 20 MHz, 0.1 MHz   |
| External base clock frequency | 0 MHz to 20 MHz   |
| Base clock accuracy           | 50 ppm  |
| Inputs                        | Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down   |
| Routing options for inputs    | PFI <0..15>, many internal signals  |
| FIFO                          | 1,023 samples   |
| Data transfers                | USB Signal Stream, programmed I/O   |

## Frequency Generator

|                    |   |
|--------------------|---|
| Number of channels | 1 |
|--------------------|---|

|                     |                 |
|---------------------|-----------------|
| Base clocks         | 10 MHz, 100 kHz |
| Divisors            | 1 to 16         |
| Base clock accuracy | 50 ppm          |

Output can be available on any output PFI terminal.

## External Digital Triggers

|                        |   |
|------------------------|---|
| Source                 | PFI <0..15>   |
| Polarity               | Software-selectable for most signals  |
| Analog input function  | Start Trigger, Reference Trigger, Pause Trigger, Sample Clock, Convert Clock, Sample Clock Timebase |
| Analog output function | Start Trigger, Pause Trigger, Sample Clock, Sample Clock Timebase                                   |
| Counter/timer function | Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down   |

## Bus Interface

|                   |  |
|-------------------|--|
| USB               | USB 2.0 Hi-Speed or full-speed <sup>[2]</sup>                                    |
| USB Signal Stream | 4, can be used for analog input, analog output, counter/timer 0, counter/timer 1 |

## Current Limits

**+5 V terminal as output<sup>[3]</sup>**

|   |  |
|---|--|
| Voltage                                     | 4.6 V to 5.2 V                             |
| Current (internally limited)                | 50 mA maximum, shared with digital outputs |
| <b>+5 V terminal as input<sup>[3]</sup></b> |  |
| Voltage                                     | 4.75 V to 5.35 V                           |
| Current                                     | 350 mA maximum, self-resetting fuse        |

**Caution** Do **not** exceed 16 mA per DIO pin.

|            |       |
|------------|-------|
| Protection | ±10 V |
|------------|-------|

## Power Requirements

|                           |                                     |
|---------------------------|-------------------------------------|
| Input voltage on USB port | 4.5 V to 5.25 V in configured state |
| Maximum inrush current    | 500 mA                              |
| No load typical current   | 320 mA at 4.5 V                     |
| <b>Maximum load</b>       |                                     |
| Typical current           | 400 mA at 4.5 V                     |
| Suspend current           | 260 $\mu$ A typical                 |

## Physical Characteristics

**Dimensions (includes connectors)**



|                            |  |
|----------------------------|--|
| BNC                        | 23.5 cm × 11.2 cm × 6.4 cm(9.25 in. × 4.40 in. × 2.50 in.) |
| Mass Termination           | 19.3 cm × 9.4 cm × 3.1 cm(7.61 in. × 3.68 in. × 1.20 in.)  |
| Screw Terminal             | 16.9 cm × 9.4 cm × 3.1 cm(6.65 in. × 3.70 in. × 1.20 in.)  |
| <b>Weight</b>              |  |
| BNC                        | 950 g (33.5 oz)  |
| Mass Termination           | 227 g (8.0 oz)   |
| Screw Terminal             | 206 g (7.2 oz)   |
| <b>I/O connectors</b>      |  |
| BNC                        | 19 BNCs and 26 screw terminals                             |
| Mass Termination           | 1 68-pin SCSI  |
| Screw Terminal             | 4 16-position combicon                                     |
| Screw terminal wiring      | 16 AWG to 28 AWG   |
| Torque for screw terminals | 0.22 N · m to 0.25 N · m(2.0 lb · in. to 2.2 lb · in.)     |
| USB connector              | Series B receptacle  |

To clean the device, wipe with a dry towel.

## Calibration

|                          |            |
|--------------------------|------------|
| Recommended warm-up time | 15 minutes |
|--------------------------|------------|

|                      |        |
|----------------------|--------|
| Calibration interval | 1 year |
|----------------------|--------|

## Environmental

|                       |                                 |
|-----------------------|---------------------------------|
| Operating temperature | 0 °C to 45 °C                   |
| Storage temperature   | -20 °C to 70 °C                 |
| Humidity              | 10% RH to 90% RH, noncondensing |
| Maximum altitude      | 2,000 m                         |
| Pollution Degree      | 2                               |

Indoor use only.

## Safety Voltages

Connect only voltages that are below these limits.

|                         |                              |
|-------------------------|------------------------------|
| Channel-to-earth ground | 11 V, Measurement Category I |
|-------------------------|------------------------------|

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.

**Caution** Do not use for measurements within Categories II, III, or IV.

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

## Safety Compliance 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

**Note** For safety certifications, refer to the product label or the [Product Certifications and Declarations](#) section.

## Electromagnetic Compatibility

## CE Compliance

- 2011/65/EU; Restriction of Hazardous Substances (RoHS)

## 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](https://ni.com/product-certifications), search by model number, and click the appropriate link.

## 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](http://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](http://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](http://ni.com/environment/rohs_china)。(For information about China RoHS compliance, go to [ni.com/environment/rohs\\_china](http://ni.com/environment/rohs_china).)

<sup>1</sup> Stresses beyond those listed under **Input voltage protection** may cause permanent damage to the device.

<sup>2</sup> If you are using an USB M Series device in full-speed mode, device performance will be lower and you will not be able to achieve maximum sample/update rates.

<sup>3</sup> USB Screw Terminal/BNC devices have a self-resetting fuse that opens when current exceeds this specification. USB Mass Termination devices have a user-

replaceable socketed fuse that opens when current exceeds this specification. Refer to the **NI USB-621x User Manual** for information about fuse replacement.