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SPECIFICATIONS

USB-6218

Isolated 32 AI (16-Bit, 250 kS/s), 2 AO (250 kS/s), 8 DI, 8 DIO USB Multifunction I/O Device

These specifications apply to the USB-218 BNC and USB-6218 Spring Terminal.

Definitions

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

The following characteristic specifications 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	16 differential or 32 single ended
ADC resolution	16 bits
DNL	No missing codes guaranteed
INL	Refer to the *AI Absolute Accuracy* section
Sample rate	
Single channel maximum	250 kS/s
Multichannel maximum (aggregate)	250 kS/s
Minimum	0 S/s
Timing resolution	50 ns

Timing accuracy	50 ppm of sample rate
Input coupling	DC
Input range	±0.2 V, ±1 V, ±5 V, ±10 V
Maximum working voltage for analog inputs (signal + common mode)	±10.4 V of AI GND
CMRR (DC to 60 Hz)	100 dB
Input impedance	
Device on	
AI+ to AI GND	>10 GΩ in parallel with 100 pF
AI- to AI GND	>10 GΩ in parallel with 100 pF
Device off	
AI+ to AI GND	1,200 Ω
AI- to AI GND	1,200 Ω
Input bias current	±100 pA
Crosstalk (at 100 kHz)	
Adjacent channels	-75 dB
Non-adjacent channels	-90 dB
Small signal bandwidth (-3 dB)	450 kHz
Input FIFO size	4,095 samples
Scan list memory	4,095 entries
USB	USB Signal Stream, programmed I/O
Overvoltage protection for all analog input and sense channels	
Device on	±30 V for up to two AI pins
Device off	±20 V for up to two AI pins
Input current during overvoltage condition	±20 mA maximum/AI pin

Settling Time for Multichannel Measurements

Accuracy, full-scale step, all ranges	
±90 ppm of step (±6 LSB)	4 µs convert interval
±30 ppm of step (±2 LSB)	5 µs convert interval
±15 ppm of step (±1 LSB)	7 µs convert interval

Typical Performance Graphs

Figure 1. Settling Error versus Time for Different Source Impedances

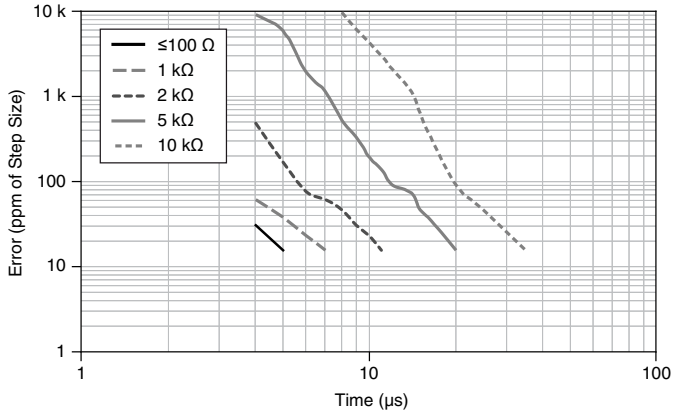
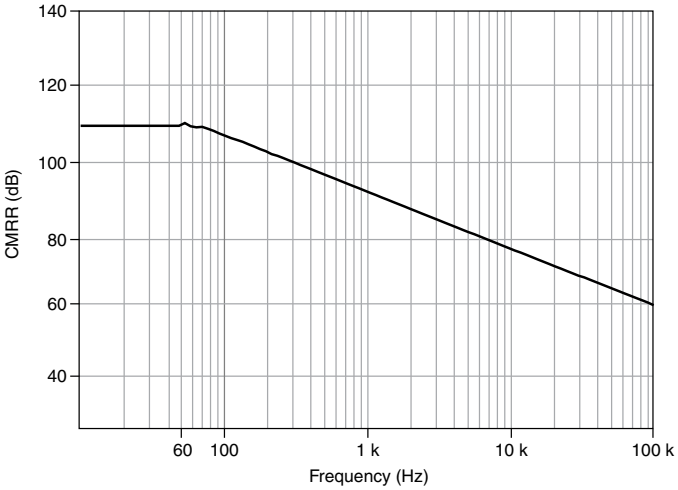


Figure 2. AI CMRR



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.

Table 1. AI Absolute Accuracy

Nominal Range Positive Full Scale (V)	Nominal Range Negative Full Scale (V)	Residual Gain Error (ppm of Reading)	Residual Offset Error (ppm of Range)	Offset Tempco (ppm of Range/°C)	Random Noise, σ (µVrms)	Absolute Accuracy at Full Scale (µV)	Sensitivity (µV)
10	-10	75	20	34	229	2,690	91.6
5	-5	85	20	36	118	1,410	47.2
1	-1	95	25	49	26	310	10.4
0.2	-0.2	135	40	116	12	88	4.8

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

$AbsoluteAccuracy = Reading \cdot (GainError) + Range \cdot (OffsetError) + NoiseUncertainty$

$GainError = ResidualAIGainError + GainTempco \cdot (TempChangeFromLastInternalCal) + ReferenceTempco \cdot (TempChangeFromLastExternalCal)$

$OffsetError = ResidualAIOffsetError + OffsetTempco \cdot (TempChangeFromLastInternalCal) + INLError$

$NoiseUncertainty = \frac{\text{Random Noise} \cdot 3}{\sqrt{100}}$ for a coverage factor of 3 σ 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 σ

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 = $\frac{229\ \mu V \cdot 3}{\sqrt{100}}$ = 68.7 µV

AbsoluteAccuracy = 10 V · (GainError) + 10 V · (OffsetError) + NoiseUncertainty = 2,690 µV

Analog Output

Number of channels	2
DAC resolution	16 bits
DNL	±1 LSB
Monotonicity	16 bit guaranteed
Maximum update rate	
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 Ω
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 µs
Slew rate	5 V/µs
Glitch energy	
Magnitude	100 mV
Duration	2.6 µs

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.

Table 2. AO Absolute Accuracy

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

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

AO Absolute Accuracy Equation

AbsoluteAccuracy = *OutputValue* · *(GainError)* + *Range* · *(OffsetError*)

GainError = *ResidualGainError* + *GainTempco* · (*TempChangeFromLastInternalCal*) + *ReferenceTempco* · (*TempChangeFromLastExternalCal*)

OffsetError = *ResidualOffsetError* + *AOOffsetTempco* · *(TempChangeFromLastInternalCal)* + *INLError*

Digital I/O and PFI

Static Digital I/O Characteristics

Number of digital input channels	8 (PFI <0..3>/P0.<0..3>, PFI <8..11>/P0.<4..7>)
Number of digital output channels	8 (PFI <4..7>/P1.<0..3>, PFI <12..15>/P1.<4..7>)
Ground reference	D GND
Pull-down resistor	47 kΩ ±1%
Input voltage protection	±20 V on up to 8 pins[1]

PFI Functionality

PFI <0..3>, PFI <8..11>/Port 0	
Functionality	Static digital input, timing input
Debounce filter settings	125 ns, 6.425 µs, 2.56 ms, disable; high and low transitions; selectable per input
PFI <4..7>, PFI <12..15>/Port 1	
Functionality	Static digital output, timing output
Timing output sources	Many AI, AO, counter timing signals

Maximum Operating Conditions

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

[1] Stresses beyond those listed under *Input voltage protection* may cause permanent damage to the device.

Digital Input Characteristics

Level	Minimum	Maximum
V_{IL} input low voltage	0 V	0.8 V
V_{IH} input high voltage	2 V	5.25 V
I_{IL} input low current (V_{in} = 0 V)	-	-10 µA
I_{IH} input high current (V_{in} = 5 V)	-	120 µA

Digital Output Characteristics

Parameter	Voltage Level	Current Level
V_{OL}	0.6 V	6 mA
V_{OH}	2.7 V	-16 mA
V_{OH}	3.8 V	-6 mA

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..3>, PFI <8..11>, 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..3>, PFI <8..11>
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[2]
USB Signal Stream	4, can be used for analog input, analog output, digital input, digital output, counter/timer 0, counter/timer 1

Current Limits

+5 V terminal as output[3]	
Voltage	4.6 V to 5.2 V
Current (internally limited)	50 mA maximum, shared with digital outputs

[2] 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.

[3] These devices have a self-resetting fuse that opens when current exceeds this specification.

+5 V terminal as input[3]	
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
Maximum load	
Typical current	400 mA at 4.5 V
Suspend current	260 µA 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.)
Screw Terminal	16.9 cm × 9.4 cm × 3.1 cm (6.65 in. × 3.70 in. × 1.20 in.)
Weight	
BNC	950 g (33.5 oz)
Screw Terminal	206 g (7.2 oz)
I/O connectors	
BNC	19 BNCs and 26 screw terminals
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 ºC to 45 ºC
Storage temperature	-20 ºC to 70 ºC
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[4]	
Continuous	≤60 VDC Measurement Category I
Withstand	≤1,000 Vrms, verified by a 5 s dielectric withstand test
Analog channel-to-AI GND or AO GND (in the following figure, $\|V_a - V_c\|$)	≤11 V, Measurement Category I
Digital channel-to-D GND (in the following figure, $\|V_b - V_c\|$)	≤5.25 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 This device is rated for Measurement Category I and the voltage across the isolation barrier is limited to no greater than 30 Vrms/60 VDC/42.4 V_{pk}

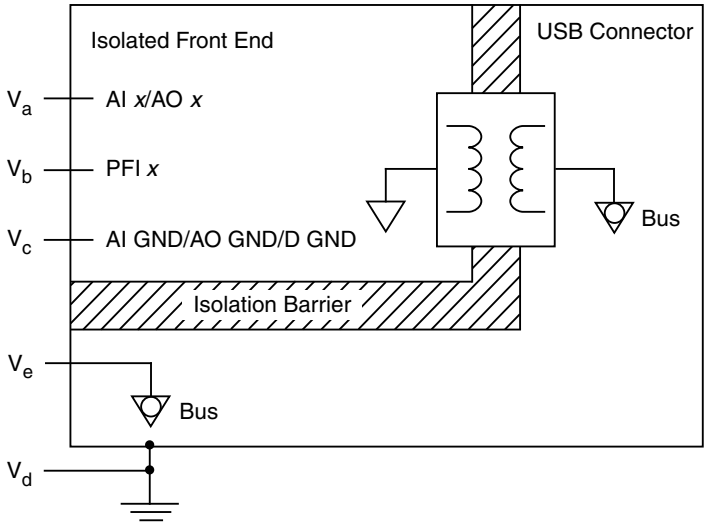
[4] In the figure, $|V_a - V_d|$, $|V_b - V_d|$, and $|V_c - V_d|$.

continuous. Do not use for measurements within Measurement Categories CAT II, CAT III, or CAT 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.

The following figure illustrates the safety voltages specifications.

Figure 3. USB-6218 Safety Voltages



Safety

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 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; for radio equipment; and for telecommunication terminal equipment:

- EN 61326-1 (IEC 61326-1): Class A emissions; Basic immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- EN 55022 (CISPR 22): Class A emissions
- EN 55024 (CISPR 24): Immunity
- AS/NZS CISPR 11: Group 1, Class A emissions
- AS/NZS CISPR 22: 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)
- 2011/65/EU; Restriction of Hazardous Substances (RoHS)

Online Product Certification

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit *ni.com/certification*, search by model number or product line, and click the appropriate link in the Certification column.

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