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USB-6346

SPECIFICATIONS

USB-6346

500 kS/s/ch, 8 Simultaneous AI, 24 DIO, 2 AO Multifunction I/O Device

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 for 25 °C unless otherwise noted.

Analog Input



Note Floating inputs can cause unnecessary power consumption and higher operating temperatures. NI recommends connecting unused analog input channels to AI GND.

| | |
|---|---|
| Number of channels | 8 differential |
| ADC resolution | 16 bits |
| DNL | No missing codes, warranted |
| INL | Refer to the <i>AI Absolute Accuracy</i> section. |
| Sample rate (simultaneous sampling on all channels sampled) | |
| Maximum | 500 kS/s |
| Minimum | No minimum |
| Timing resolution | 10 ns |

| | |
|---|---|
| Timing accuracy | 50 ppm of sample rate |
| Input coupling | DC |
| Input range | ± 1 V, ± 2 V, ± 5 V, ± 10 V |
| Maximum working voltage for all analog inputs (AI \pm) | |
| Ranges ± 10 V, ± 5 V | ± 11 V, Measurement Category I |
| Ranges ± 2 V, ± 1 V | ± 9 V, Measurement Category I |



Caution Do not connect the USB-6346 to signals or use for measurements within Measurement Categories II, III, or IV.



Attention Ne connectez pas le USB-6346 à des signaux et ne l'utilisez pas pour effectuer des mesures dans les catégories de mesure II, III ou IV.

| | |
|---|--|
| CMRR (at 60 Hz) | 80 dB |
| Bandwidth (small signal) | 2.0 MHz at ± 1 V 2.9 MHz at other ranges |
| Input impedance | |
| Device on | |
| AI+ to AI GND | >1 G Ω in parallel with 18 pF |
| AI- to AI GND | >1 G Ω in parallel with 18 pF |
| Device off | |
| AI+ to AI GND | 2.37 k Ω |
| AI- to AI GND | 2.37 k Ω |
| Input bias current | ± 6 nA ± 90 nA, maximum over full temperature range |
| Crosstalk (at 100 kHz) | -80 dB |
| Input FIFO size | 32 MS shared among channels used |
| Data transfers | USB Signal Stream, programmed I/O |
| Overvoltage protection for AI <0..7> | |
| Device on | ± 30 V |
| Device off | ± 15 V |
| Input current during overvoltage conditions | ± 6.3 mA maximum/AI pin |
| Maximum AI channels in overvoltage | 4 |



Notice Exceeding overvoltage specifications may result in data corruption on non-overvoltaged channels.

Analog Triggers

| | |
|------------------------------------|--|
| Number of triggers | 1 |
| Source | AI <0..7>, APFI 0 |
| Functions | Start Trigger, Reference Trigger, Pause Trigger, Sample Clock, Sample Clock Timebase |
| Source level | |
| AI <0..7> | ±Full scale |
| APFI 0 | ±10 V |
| Resolution | 16 bits |
| Modes | Analog edge triggering, analog edge triggering with hysteresis, and analog window triggering |
| Bandwidth (large signal, to -3 dB) | |
| AI <0..7> | 600 kHz |
| APFI 0 | 3.9 MHz |
| Accuracy | ±1% of range |
| APFI 0 characteristics | |
| Input impedance | 10 kΩ |
| Coupling | DC |
| Protection, power on | ±30 V |
| Protection, power off | ±15 V |

AI Absolute Accuracy

Table 1. AI Absolute Accuracy

| Nominal Range Positive Full Scale | Nominal Range Negative Full Scale | Residual Gain Error (ppm of Reading) | Offset Tempco (ppm of Range/°C) | Random Noise, σ (μVrms) | Absolute Accuracy at Full Scale (μV) |
|-----------------------------------|-----------------------------------|--------------------------------------|---------------------------------|---|---|
| 10 | -10 | 115 | 2 | 265 | 3,225 |
| 5 | -5 | 115 | 2 | 148 | 1,613 |

Table 1. AI Absolute Accuracy (Continued)

| Nominal Range Positive Full Scale | Nominal Range Negative Full Scale | Residual Gain Error (ppm of Reading) | Offset Tempco (ppm of Range/°C) | Random Noise, σ (μ Vrms) | Absolute Accuracy at Full Scale (μ V) |
|--------------------------------------|--------------------------------------|---|------------------------------------|---|---|
| 2 | -2 | 117 | 2 | 74 | 650 |
| 1 | -1 | 124 | 3 | 50 | 333 |



Note For more information about absolute accuracy at full scale, refer to the *AI Absolute Accuracy Example* section.

Gain tempco 16.7 ppm/°C

Reference tempco 5 ppm/°C

Residual offset error 12 ppm of range

INL error 126 ppm of range



Note Accuracies listed are warranted for up to one year from the device external calibration when the device is within 10 °C of the external calibration temperature and 1 °C of the last self calibration, when averaging 10,000 DC samples. Other accuracies may be calculated for different temperatures and sample sizes using the given equations.



Notice This product may become more sensitive to electromagnetic disturbances in the operational environment when test leads are attached or when connected to a test object.

AI Absolute Accuracy Equation

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

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

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

$NoiseUncertainty = \frac{Random\ Noise \cdot 3}{\sqrt{10,000}}$ for a coverage factor of 3 σ and averaging 10,000 points.

AI Absolute Accuracy Example

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

- $TempChangeFromLastExternalCal = 10\text{ }^{\circ}\text{C}$
- $TempChangeFromLastInternalCal = 1\text{ }^{\circ}\text{C}$

- $number_of_readings = 10,000$
- $CoverageFactor = 3 \sigma$

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

$$GainError = 115 \text{ ppm} + 16.7 \text{ ppm} \cdot 1 + 5 \text{ ppm} \cdot 10 = 181.7 \text{ ppm}$$

$$OffsetError = 12 \text{ ppm} + 2 \text{ ppm} \cdot 1 + 126 \text{ ppm} = 140 \text{ ppm}$$

$$Noise\ Uncertainty = \frac{265 \mu\text{V} \cdot 3}{\sqrt{10,000}} = 8 \mu\text{V}$$

$$AbsoluteAccuracy = 10 \text{ V} \cdot (GainError) + 10 \text{ V} \cdot (OffsetError) + NoiseUncertainty = 3225 \mu\text{V}$$

Analog Output

| | |
|------------------------------------|---|
| Number of channels | 2 |
| DAC resolution | 16 bits |
| DNL | ±1 LSB, maximum |
| Monotonicity | 16 bit guaranteed |
| Accuracy | Refer to the <i>AO Absolute Accuracy</i> section. |
| Maximum update rate (simultaneous) | |
| 1 channel | 900 kS/s |
| 2 channels | 840 kS/s |
| Minimum update rate | No minimum |
| Timing accuracy | 50 ppm of sample rate |
| Timing resolution | 10 ns |
| Output range | ±10 V |
| Output coupling | DC |
| Output impedance | 0.2 Ω |
| Output current drive | ±5 mA |
| Overdrive protection | ±15 V |
| Overdrive current | 15 mA |
| Power-on state | ±20 mV |
| Power-on/off glitch ¹ | 2 V peak for 1.5 s |
| Output FIFO size | 8,191 samples shared among channels used |
| Data transfers | USB Signal Stream, programmed I/O |

¹ Typical behavior. Time period may be longer due to host system USB performance. Time period will be longer during firmware updates.

| | |
|--|--|
| 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) | 6 μ s |
| Slew rate | 15 V/ μ s |
| Glitch energy at midscale transition | 100 mV \cdot 2.6 μ s |

AO Absolute Accuracy

Accuracies listed are warranted for up to one year from the device external calibration when the device is within 10 °C of the external calibration temperature and 1 °C of the last self calibration.

Table 2. AO Absolute Accuracy

| Nominal Range Positive Full Scale | Nominal Range Negative Full Scale | Residual Gain Error (ppm of Reading) | Gain Tempco (ppm/°C) | Reference Tempco (ppm/°C) | Residual Offset Error (ppm of Range) | Offset Tempco (ppm of Range/°C) | INL Error (ppm of Range) | Absolute Accuracy at Full Scale (μ V) |
|-----------------------------------|-----------------------------------|--------------------------------------|----------------------|---------------------------|--------------------------------------|---------------------------------|--------------------------|--|
| 10 | -10 | 130 | 11.3 | 5 | 52 | 4.8 | 128 | 3,761 |

AO Absolute Accuracy Equation

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

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

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

Digital I/O/PFI

Static Characteristics

| | |
|--------------------|---|
| Number of channels | 24 total 8 (P0.<0..7>) 16 (PFI <0..7>/P1, PFI <8..15>/P2) |
| Ground reference | D GND |

| | |
|--------------------------|--|
| Direction control | Each terminal individually programmable as input or output |
| Pull-down resistor | 50 k Ω , typical 20 k Ω , minimum |
| Input voltage protection | ± 20 V on up to two pins |



Notice Stresses beyond those listed under the *Input voltage protection* specification may cause permanent damage to the device.

Waveform Characteristics (Port 0 Only)

| | |
|--------------------------------|---|
| Terminals used | Port 0 (P0.<0..7>) |
| Port/sample size | Up to 8 bits |
| Waveform generation (DO) FIFO | 2,047 samples |
| Waveform acquisition (DI) FIFO | 255 samples |
| DI Sample Clock frequency | 0 to 1 MHz, system and bus activity dependent |
| DO Sample Clock frequency | |
| Regenerate from FIFO | 0 to 1 MHz |
| Streaming from memory | 0 to 1 MHz, system and bus activity dependent |
| Data transfers | USB Signal Stream, programmed I/O |
| Digital line filter settings | 160 ns, 10.24 μ s, 5.12 ms, disable |

PFI/Port 1/Port 2 Functionality

| | |
|--------------------------|---|
| Functionality | Static digital input, static digital output, timing input, timing output |
| Timing output sources | Many AI, AO, counter, DI, DO timing signals |
| Debounce filter settings | 90 ns, 5.12 μ s, 2.56 ms, custom interval, disable; programmable high and low transitions; selectable per input |

Recommended Operating Conditions

| | |
|---------------------------------|--------|
| Input high voltage (V_{IH}) | |
| Minimum | 2.2 V |
| Maximum | 5.25 V |
| Input low voltage (V_{IL}) | |
| Minimum | 0 V |
| Maximum | 0.8 V |

Output high current (I_{OH})

| | |
|-------------------|-----------------|
| P0.<0..7> | -24 mA, maximum |
| PFI <0..15>/P1/P2 | -16 mA, maximum |

Output low current (I_{OL})

| | |
|-------------------|----------------|
| P0.<0..7> | 24 mA, maximum |
| PFI <0..15>/P1/P2 | 16 mA, maximum |

Digital I/O Characteristics

| | |
|---|----------------------|
| Positive-going threshold (V_{T+}) | 2.2 V, maximum |
| Negative-going threshold (V_{T-}) | 0.8 V, minimum |
| Delta VT hysteresis ($V_{T+} - V_{T-}$) | 0.2 V, minimum |
| I_{IL} input low current ($V_{IN} = 0$ V) | -10 μ A, maximum |
| I_{IH} input high current ($V_{IN} = 5$ V) | 250 μ A, maximum |

Figure 1. P0.<0..7>: I_{OH} versus V_{OH}

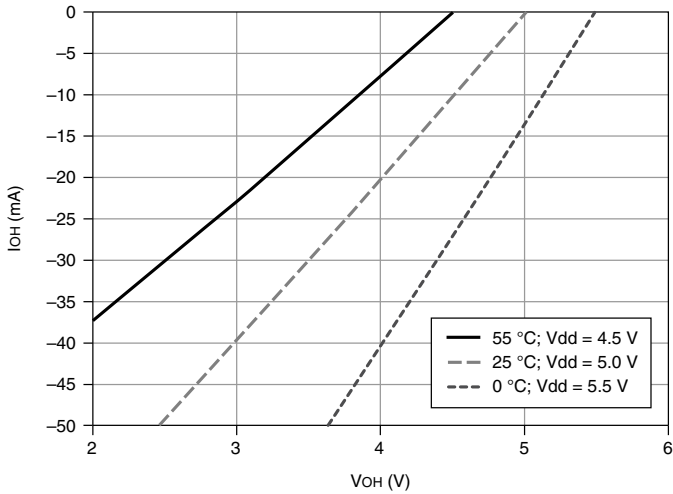


Figure 2. P0.<0..7>: I_{OL} versus V_{OL}

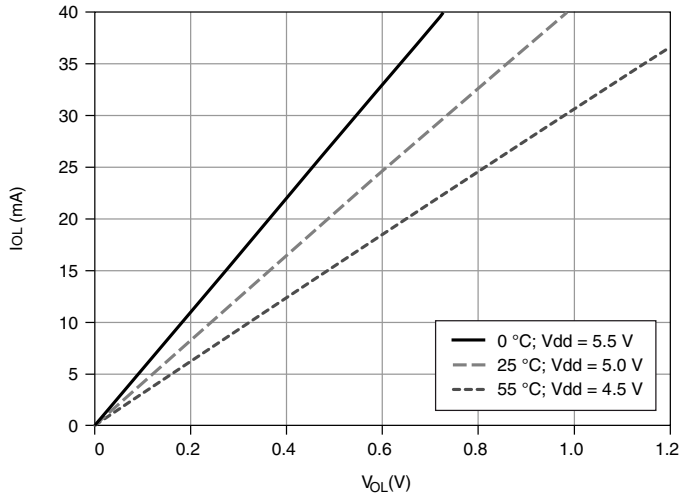


Figure 3. PFI <0..15>/P1/P2: I_{OH} versus V_{OH}

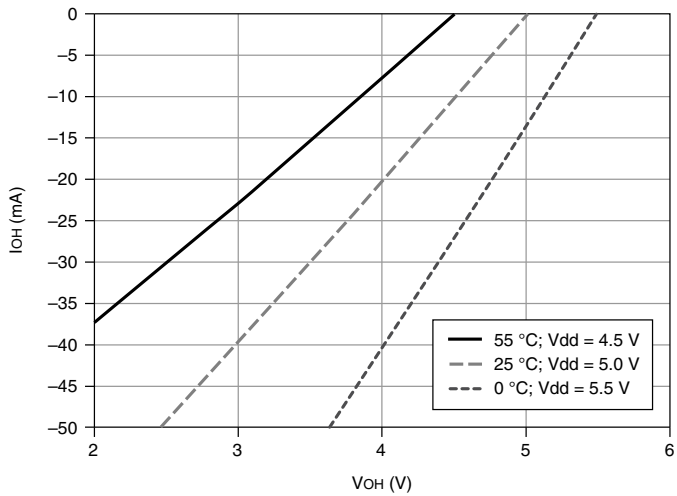
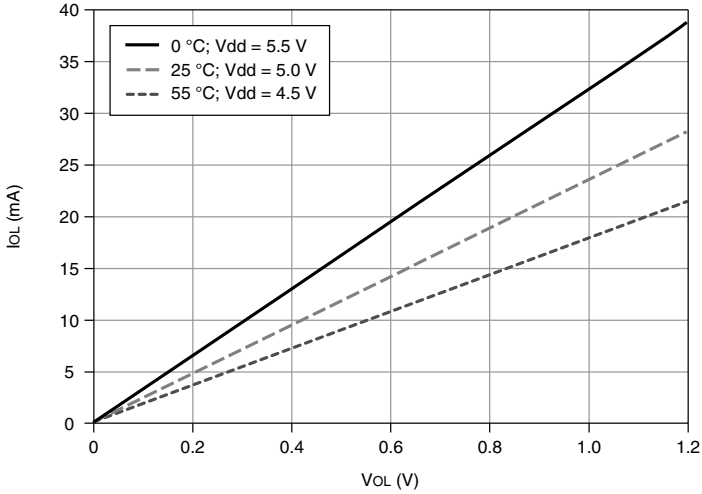


Figure 4. PFI <0..15>/P1/P2: I_{OL} versus V_{OL}



General-Purpose Counters

| | |
|-------------------------------|---|
| Number of counter/timers | 4 |
| Resolution | 32 bits |
| Counter measurements | Edge counting, pulse, pulse width, 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 | 100 MHz, 20 MHz, 100 kHz |
| External base clock frequency | 0 MHz to 25 MHz |
| Base clock accuracy | 50 ppm |
| Inputs | Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down, Sample Clock |
| Routing options for inputs | Any PFI, many internal signals |
| FIFO | 127 samples per counter |
| Data transfers | USB Signal Stream, programmed I/O |

Frequency Generator

| | |
|---------------------|-------------------------|
| Number of channels | 1 |
| Base clocks | 20 MHz, 10 MHz, 100 kHz |
| Divisors | 1 to 16 |
| Base clock accuracy | 50 ppm |

Output can be available on any PFI terminal.

Phase-Locked Loop (PLL)

| | |
|----------------|---|
| Number of PLLs | 1 |
|----------------|---|

Table 3. Reference Clock Locking Frequencies

| Reference Signal | USB Locking Input Frequency |
|------------------|-----------------------------|
| PFI <0..15> | 10 MHz |

Output of PLL 100 MHz Timebase; other signals derived from 100 MHz Timebase including 20 MHz and 100 kHz Timebases

External Digital Triggers

| | |
|--|---|
| Source | Any PFI |
| 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 functions | Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down, Sample Clock |
| Digital waveform generation (DO) function | Start Trigger, Pause Trigger, Sample Clock, Sample Clock Timebase |
| Digital waveform acquisition (DI) function | Start Trigger, Reference Trigger, Pause Trigger, Sample Clock, Sample Clock Timebase |

Bus Interface

| | |
|--------------------------------|--|
| USB compatibility ² | USB 2.0 Hi-Speed or full-speed |
| USB Signal Stream | 8 (can be used for analog input, analog output, digital input, digital output, counter/timer 0, counter/timer 1, counter/timer 2, counter/timer 3) |

Power Requirements



Caution The protection provided by the USB-6346 can be impaired if it is used in a manner not described in the user documentation.



Attention La protection apportée par le USB-6346 risque d'être endommagée s'il est utilisé d'une autre façon que celle décrite dans la documentation utilisateur.

| | |
|------------------------------|---|
| Power supply requirements | 11 V DC to 30 V DC, 30 W, 2 positions 3.5 mm pitch pluggable screw terminal with screw locks similar to Phoenix Contact MC 1,5/2-STF-3,5 BK |
| Power input mating connector | Phoenix Contact MC 1,5/2-GF-3,5 BK or equivalent |



Caution The USB-6346 must be powered with an AC adapter offered by NI or a National Electric Code (NEC) Class 2 DC source that meets the power requirements for the device and has appropriate safety certification marks for country of use.



Attention Le USB-6346 doit être alimenté par un adaptateur secteur proposé par NI ou une source de courant continu de classe 2, selon la norme NEC (National Electric Code), qui répond aux exigences d'alimentation de l'appareil et possède les marques de certification de sécurité appropriées pour le pays d'utilisation.

Current Limits



Notice Exceeding the current limits may cause unpredictable device behavior.

| | |
|-----------------------------|--------------|
| +5 V terminal (connector 0) | 1 A, maximum |
|-----------------------------|--------------|

² Operating on a full-speed bus results in lower performance, and you might not be able to achieve maximum sampling/update rates.



Note Connector 0 has a self-resetting fuse that opens when current exceeds this specification.

P0/PFI/P1/P2 and +5 V terminals combined 1.2 A, maximum

Physical Characteristics

Screw terminal

| | |
|--|---|
| Enclosure dimensions (includes connectors) | 26.4 cm × 17.3 cm × 3.6 cm (10.39 in. × 6.81 in. × 1.42 in.) |
| Weight | 1.45 kg (3 lb 3 oz) |
| I/O connectors | 64 screw terminals |

BNC

| | |
|--|--|
| Enclosure dimensions (includes connectors) | 20.3 cm × 18.5 cm × 6.8 cm (7.99 in. × 7.28 in. × 2.68 in.) |
| Weight | 1.80 kg (4 lb 0 oz) |
| I/O connectors | 20 BNC terminals 30 screw terminals |

Screw terminal wire gauge 0.2 mm² to 1.3 mm² (24 AWG to 16 AWG)

Calibration

Recommended warm-up time 15 minutes

Calibration interval 1 year

Maximum Working Voltage

Maximum working voltage refers to the signal voltage plus the common-mode voltage.

Channel to earth 11 V, Measurement Category I



Caution Do not connect the USB-6346 to signals or use for measurements within Measurement Categories II, III, or IV.



Attention Ne connectez pas le USB-6346 à des signaux et ne l'utilisez pas pour effectuer des mesures dans les catégories de mesure II, III ou IV.

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 Guidelines



Notice This model is intended for use in indoor applications only.

Environmental Characteristics

Temperature

| | |
|-----------|---------------|
| Operating | 0 °C to 45 °C |
|-----------|---------------|

| | |
|---------|-----------------|
| Storage | -40 °C to 70 °C |
|---------|-----------------|

Humidity

| | |
|-----------|------------------------------|
| Operating | 10% to 90% RH, noncondensing |
|-----------|------------------------------|

| | |
|---------|-----------------------------|
| Storage | 5% to 95% RH, noncondensing |
|---------|-----------------------------|

Pollution Degree

2

Maximum altitude

2,000 m (800 mbar) (at 25 °C ambient temperature)

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