DEVICE SPECIFICATIONS

NI 6353

X Series Data Acquisition: 1.25 MS/s, 32 AI, 48 DIO, 4 AO

The following specifications are typical at 25 °C, unless otherwise noted. For more information about the NI 6353, refer to the *X Series User Manual* available from *ni.com/manuals*.

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	1.25 MS/s
Multichannel maximum (aggregate)	1.00 MS/s
Minimum	No minimum
Timing resolution	10 ns
Timing accuracy	50 ppm of sample rate
Input coupling	DC
Input range	±0.1 V, ±0.2 V, ±0.5 V, ±1 V, ±2 V, ±5 V, ±10 V
Maximum working voltage for analog inputs (signal + common mode)	±11 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	820 Ω
AI- to AI GND	820 Ω
Input bias current	±100 pA
Crosstalk (at 100 kHz)	
Adjacent channels	-75 dB
Non-adjacent channels	-95 dB
Small signal bandwidth (-3 dB)	1.7 MHz
Input FIFO size	2,047 samples
Scan list memory	4,095 entries
Data transfers	
PCIe	DMA (scatter-gather), programmed I/O
USB	USB Signal Stream, programmed I/O
Overvoltage protection for all analog input and sense channels	
Device on	±25 V for up to two AI pins
Device off	±15 V for up to two AI pins
Input current during overvoltage condition	±20 mA max/AI pin

Settling Time for Multichannel Measurements

Range	±60 ppm of Step (±4 LSB for Full-Scale Step)	±15 ppm of Step (±1 LSB for Full-Scale Step)
±10 V, ±5 V, ±2 V, ±1 V	1 µs	1.5 µs
±0.5 V	1.5 µs	2 µs
±0.2 V, ±0.1 V	2 µs	8 µs

Typical Performance Graphs

Figure 1. Settling Error versus Time for Different Source Impedances

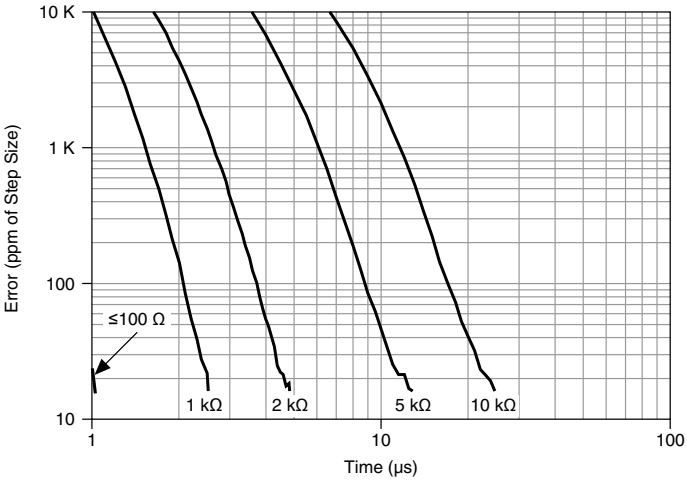


Figure 2. AI <0..31> Small Signal Bandwidth

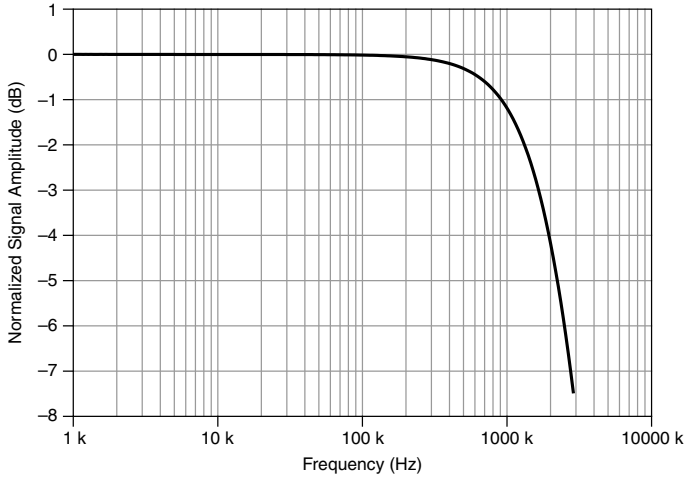
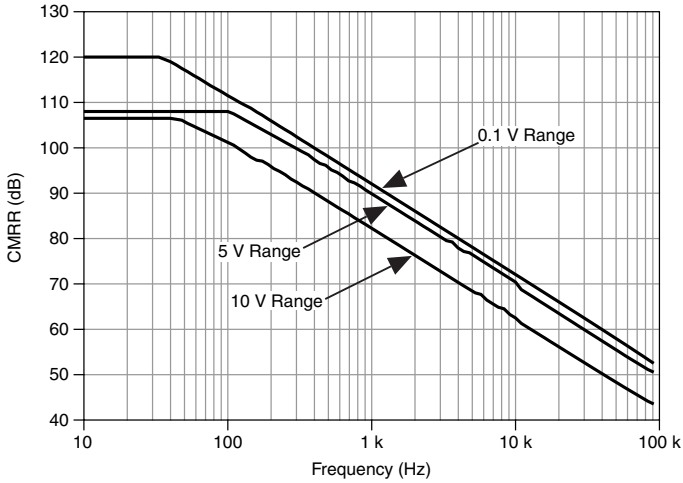


Figure 3. AI <0..31> CMRR



AI Absolute Accuracy

Table 1. AI Absolute Accuracy

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, σ (μVrms)	Absolute Accuracy at Full Scale (μV)
10	-10	48	13	21	281	1,520
5	-5	55	13	21	137	800
2	-2	55	13	24	56	320
1	-1	65	17	27	35	180
0.5	-0.5	68	17	34	26	95
0.2	-0.2	95	27	55	21	50
0.1	-0.1	108	45	90	16	32

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

Gain tempco	13 ppm/°C
Reference tempco	1 ppm/°C
INL error	46 ppm of range

Note Accuracies listed are valid for up to two years from the device external calibration.

AI Absolute Accuracy Equation

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

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

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

NoiseUncertainty = $\frac{\text{Random Noise} \cdot 3}{\sqrt{10,000}}$ 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 °C
- TempChangeFromLastInternalCal = 1 °C
- number_of_readings = 10,000
- CoverageFactor = 3 σ

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

GainError = 48 ppm + 13 ppm · 1 + 1 ppm · 10 = 71 ppm

OffsetError = 13 ppm + 21 ppm · 1 + 46 ppm = 80 ppm

NoiseUncertainty = $\frac{281\ \mu V \cdot 3}{\sqrt{10,000}}$ = 8.4 µV

AbsoluteAccuracy = 10 V · (GainError) + 10 V · (OffsetError) + NoiseUncertainty = 1,520 µV

Analog Triggers

Number of triggers	1
Source	AI <0..31>, APFI <0..1>
Functions	Start Trigger, Reference Trigger, Pause Trigger, Sample Clock, Convert Clock, Sample Clock Timebase
Source level	
AI <0..31>	±Full scale
APFI <0..1>	±10 V
Resolution	16 bits
Modes	Analog edge triggering, analog edge triggering with hysteresis, and analog window triggering
Bandwidth (-3 db)	
AI <0..31>	3.4 MHz
APFI <0..1>	3.9 MHz
Accuracy	±1% of range
APFI <0..1> characteristics	
Input impedance	10 kΩ
Coupling	DC
Protection, power on	±30 V
Protection, power off	±15 V

Analog Output

Number of channels	4
DAC resolution	16 bits
DNL	±1 LSB
Monotonicity	16 bit guaranteed
Accuracy	Refer to the *AO Absolute Accuracy* table.
Maximum update rate	
1 channel	2.86 MS/s
2 channels	2.00 MS/s

3 channels	1.54 MS/s
4 channels	1.25 MS/s
Timing accuracy	50 ppm of sample rate
Timing resolution	10 ns
Output range	±10 V, ±5 V, ±external reference on APFI <0..1>
Output coupling	DC
Output impedance	0.2 Ω
Output current drive	±5 mA
Overdrive protection	±25 V
Overrdrive current	26 mA
Power-on state	±5 mV
Power on/off glitch	
PCIe	1.5 V peak for 200 ms
USB	1.5 V for 1.2 s[1]
Output FIFO size	8,191 samples shared among channels used
Data transfers	
PCIe	DMA (scatter-gather), programmed I/O
USB	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)	2 µs
Slew rate	20 V/µs
Glitch energy at midscale transition, ±10 V range	10 nV · s

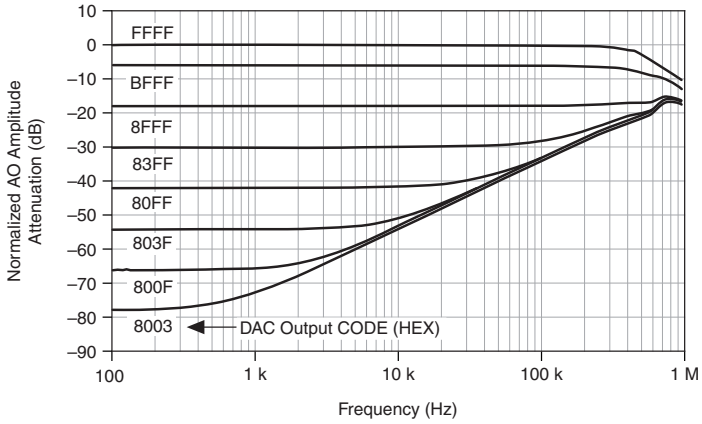
External Reference

APFI <0..1> characteristics	
Input impedance	10 kΩ
Coupling	DC

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

Protection, device on	±30 V
Protection, device off	±15 V
Range	±11 V
Slew rate	20 V/µs

Figure 4. AO External Reference Bandwidth



AO Absolute Accuracy

Absolute accuracy at full-scale numbers is valid immediately following self calibration and assumes the device is operating within 10 °C of the last external 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 (µV)
10	-10	63	17	1	33	2	64	1,890
5	-5	70	8	1	33	2	64	935

Note Accuracies listed are valid for up to two years from the device external calibration.

AO Absolute Accuracy Equation

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

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

OffsetError = ResidualOffsetError + OffsetTempco · (TempChangeFromLastInternalCal) + INLError

Digital I/O/PFI

Static Characteristics

Number of channels	48 total, 32 (P0.<0..31>), 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 kΩ typical, 20 kΩ minimum
Input voltage protection	±20 V on up to two pins

Caution 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..31>)
Port/sample size	Up to 32 bits
Waveform generation (DO) FIFO	2,047 samples
Waveform acquisition (DI) FIFO	255 samples
DI Sample Clock frequency	
PCIe	0 to 10 MHz, system and bus activity dependent
USB	0 to 1 MHz, system and bus activity dependent
DO Sample Clock frequency	
PCIe	
Regenerate from FIFO	0 to 10 MHz
Streaming from memory	0 to 10 MHz, system and bus activity dependent

USB	
Regenerate from FIFO	0 to 10 MHz
Streaming from memory	0 to 1 MHz, system and bus activity dependent
Data transfers	
PCIe	DMA (scatter-gather), programmed I/O
USB	USB Signal Stream, programmed I/O
Digital line filter settings	160 ns, 10.24 µs, 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 µs, 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..31>	-24 mA maximum
PFI <0..15>/P1/P2	-16 mA maximum
Output low current (I_{OL})	
P0.<0..31>	24 mA maximum
PFI <0..15>/P1/P2	16 mA maximum

Digital I/O Characteristics

Positive-going threshold (VT+)	2.2 V maximum
Negative-going threshold (VT-)	0.8 V minimum
Delta VT hysteresis (VT+ - VT-)	0.2 V minimum

I_{IL} input low current (V_{IN} = 0 V)	-10 µA maximum
I_{IH} input high current (V_{IN} = 5 V)	250 µA maximum

Figure 5. P0.<0..31>: I_{OH} versus V_{OH}

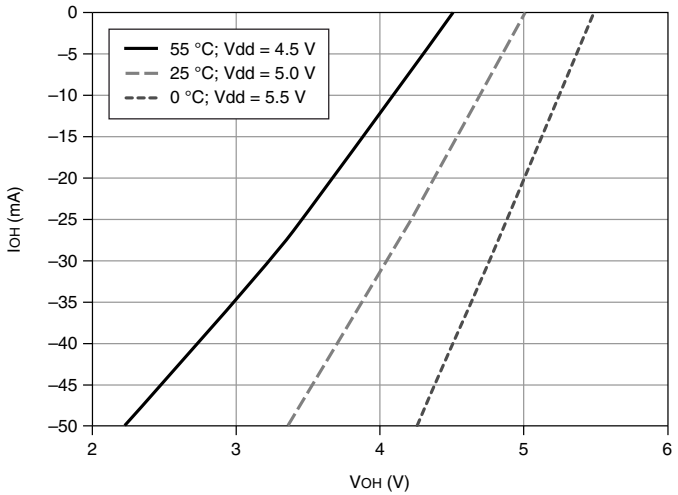


Figure 6. P0.<0..31>: I_{OL} versus V_{OL}

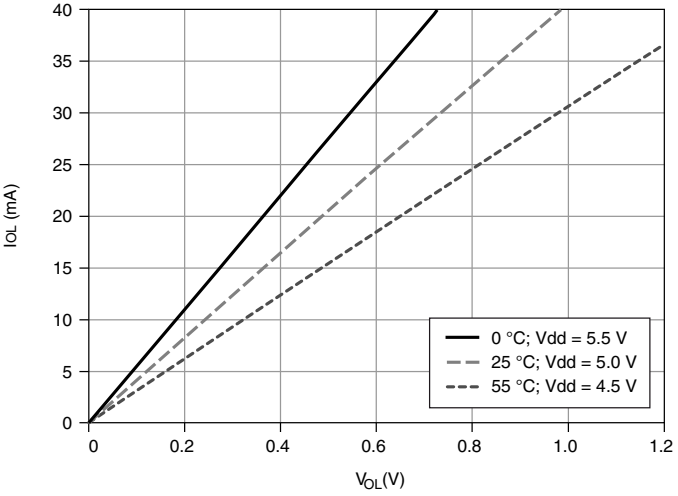


Figure 7. PFI <0..15>/P1/P2: I_{OH} versus V_{OH}

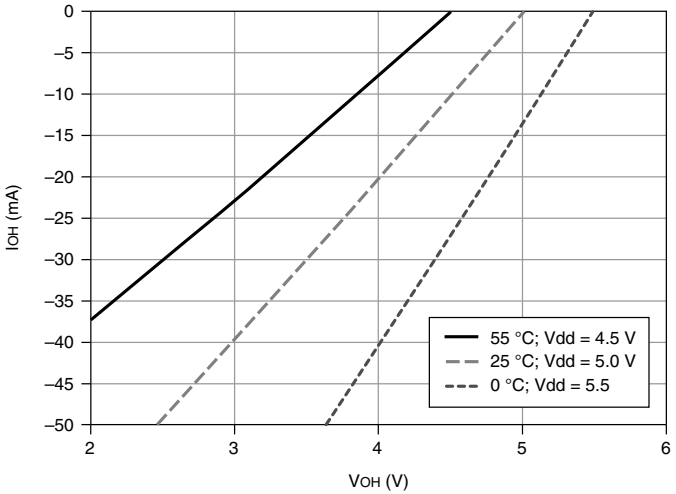
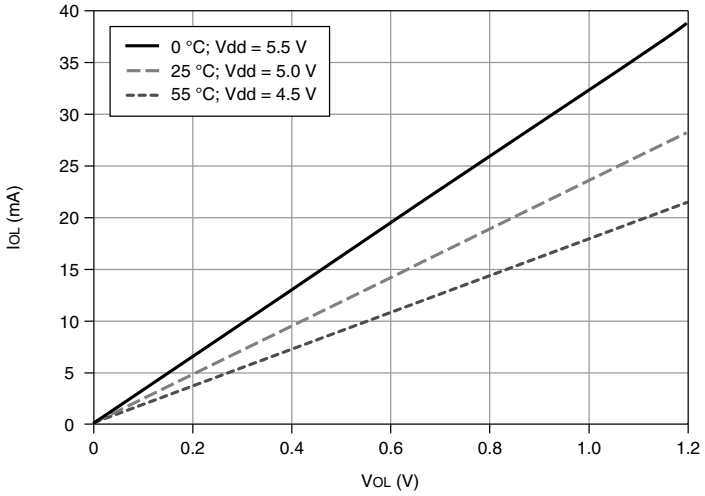


Figure 8. PFI <0..15>/P1/P2: I_{OL} versus V_{OL}



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	
PCIe	Any PFI, RTSI, analog trigger, many internal signals
USB	Any PFI, analog trigger, many internal signals
FIFO	127 samples per counter
Data transfers	
PCIe	Dedicated scatter-gather DMA controller for each counter/timer, programmed I/O
USB	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 or RTSI terminal.

Phase-Locked Loop

Number of PLLs	1

Table 3. Reference Clock Locking Frequencies

Reference Signal	PCIe Locking Input Frequency (MHz)	USB Locking Input Frequency (MHz)
RTSI <0..7>	10, 20	—
PFI <0..15>	10, 20	10

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

External Digital Triggers

Source	
PCIe	Any PFI, RTSI
USB	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

Device-to-Device Trigger Bus

Input Source	
PCIe	RTSI <0..7>
USB	None
Output destination	
PCIe	RTSI <0..7>
USB	None
Output selections	10 MHz Clock, frequency generator output, many internal signals
Debounce filter settings	90 ns, 5.12 µs, 2.56 ms, custom interval, disable; programmable high and low transitions; selectable per input

Bus Interface

PCIe	
Form factor	x1 PCI Express, specification v1.1 compliant
Slot compatibility	x1, x4, x8, and x16 PCI Express slots [2]
DMA channels	8, analog input, analog output, digital input, digital output, counter/timer 0, counter/timer 1, counter/timer 2, counter/timer 3
USB	
USB compatibility	USB 2.0 Hi-Speed or full-speed[3]
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

[2] Some motherboards reserve the x16 slot for graphics use. For PCI Express guidelines, refer to *ni.com/pciexpress*.

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

Power Requirements

PCIe	
Without disk drive power connector installed	
+3.3 V	4.6 W
+12 V	5.4 W
With disk drive power connector installed	
+3.3 V	1.6 W
+12 V	5.4 W
+5.0 V	15 W
USB	
Power supply requirements	11 to 30 VDC, 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 NI USB-6353 devices must be powered with an NI offered AC adapter 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.

Current Limits

Caution Exceeding the current limits may cause unpredictable behavior by the device and/or PC.

PCIe	
Without disk drive power connector installed	
P0/PFI/P1/P2 and +5 V terminals combined	0.59 A max
With disk drive power connector installed	
+5 V terminal (connector 0)	1 A max[4]
+5 V terminal (connector 1)	1 A max[4]
P0/PFI/P1/P2 combined	1 A max

[4] Has a self-resetting fuse that opens when current exceeds this specification.

USB	
+5 V terminal	1 A max[4]
P0/PFI/P1/P2 and +5 V terminals combined	2 A max

Physical Characteristics

Printed circuit board dimensions	
PCIe	9.9 × 16.8 cm (3.9 × 6.6 in.) (half-length)
Enclosure dimensions (includes connectors)	
USB	26.4 × 17.3 × 3.6 cm (10.4 × 6.8 × 1.4 in.)
Weight	
PCIe	169 g (5.9 oz)
USB	1.42 kg (3 lb 2 oz)
I/O connector	
PCIe	2 68-pin VHDCI
USB	128 screw terminals

Table 4. Mating Connectors

Manufacturer, Part Number	Description
MOLEX 71430-0011	68-Pos Right Angle Single Stack PCB-Mount VHDCI (Receptacle)
MOLEX 74337-0016	68-Pos Right Angle Dual Stack PCB-Mount VHDCI (Receptacle)
MOLEX 71425-3001	68-Pos Offset IDC Cable Connector (Plug) (SHC68-*)

PCIe disk drive power connector	Standard ATX peripheral connector (not serial ATA)
USB screw terminal wiring	16-24 AWG

Calibration

Recommended warm-up time	15 minutes
Calibration interval	2 years

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 use for measurements within Categories II, III, or IV.

Environmental

Operating temperature	
PCIe	0 to 50 °C
USB	0 to 45 °C
Storage temperature	-40 to 70 ºC
Operating humidity	10 to 90% RH, noncondensing
Storage humidity	5 to 95% RH, noncondensing
Pollution Degree	2
Maximum altitude	2,000 m

Indoor use only.

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 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:

- 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)

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.

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 *Minimize Our Environmental Impact* 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.

Waste Electrical and Electronic Equipment (WEEE)

EU Customers 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）

中国客户 National Instruments 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 National Instruments 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`.)

Device Pinouts

Figure 9. NI PCIe-6353 Pinout

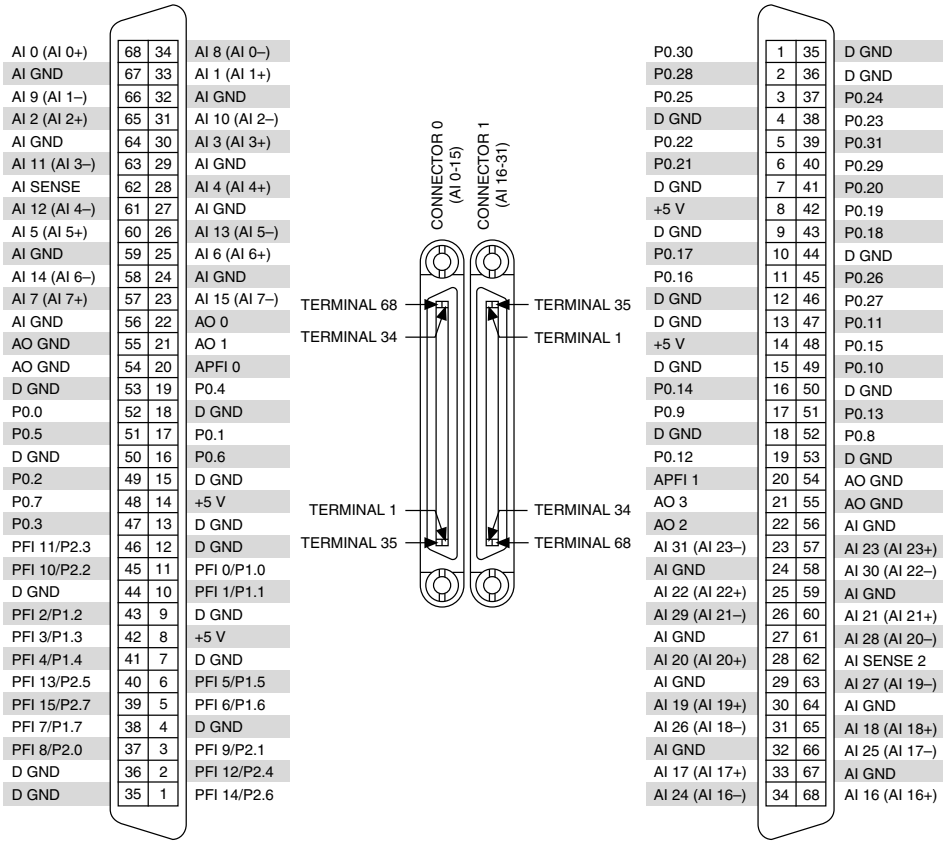


Figure 10. NI USB-6353 Pinout