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SPECIFICATIONS

# PCI-5105

8-Channel, 12-Bit, 60 MHz PCI Oscilloscope Device

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# Definitions

*Warranted* specifications describe the performance of a model under stated operating conditions and are covered by the model warranty. Warranted specifications account for measurement uncertainties, temperature drift, and aging. Warranted specifications are ensured by design or verified during production and calibration.

*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.
- *Measured* specifications describe the measured performance of a representative model.

Specifications are *Typical* unless otherwise noted.

# Conditions

Specifications are valid under the following conditions unless otherwise noted.

- All filter settings
- All impedance selections
- Sample clock set to 60 MS/s

Warranted specifications are valid under the following conditions unless otherwise noted.

- Temperature range of 0 °C to 45 °C
- The PCI-5105 module is warmed up for 15 minutes at ambient temperature
- Calibration cycle is maintained
- The PCI chassis fan speed is set to HIGH, the foam fan filters are removed if present, and all filler panels are installed. For more information about cooling, refer to the *Maintain Forced-Air Cooling Note to Users* available at *ni.com/manuals*.
- External calibration is performed at 23 °C ± 3 °C

# Vertical

## Analog Input

| | |
|---|---|
| Number of channels | Eight (simultaneously sampled) |
| Input type | Referenced single-ended |
| Connectors | SMB |

## Impedance and Coupling

| | |
|---|---|
| Input impedance | |
| 50 Ω | 50 Ω ±2% |
| 1 MΩ | 1 MΩ ±1% in parallel with a nominal capacitance of 50 pF |
| Input coupling | AC[1], DC |

## Voltage Levels

| | |
|---|---|
| Full-scale (FS) input range | |
| 50 Ω and 1 MΩ | 0.05 V<br>0.2 V<br>1 V<br>6 V |
| 1 MΩ only | 30 V |
| Maximum input overload | |
| 50 Ω | 7 $V_{rms}$ with \|Peaks\| ≤10 V |
| 1 MΩ | \|Peaks\| ≤42 V |

## Accuracy

| | |
|---|---|
| Resolution | 12 bits |

[1] AC coupling available on 1 MΩ input only.

**Table 1.** DC Accuracy[2]

| Input Impedance | Input Range ($V_{pk-pk}$) | DC Accuracy, Warranted |
|---|---|---|
| 50 Ω | All | ±(1% × *Reading* + 0.25% of FS + 1.4 mV) |
| 1 MΩ | 0.05 V | ±(1% × *Reading* + 0.25% of FS + 1.4 mV) |
| | 0.2 V, 1 V, and 6 V | ±(0.65% × *Reading* + 0.25% of FS + 1.4 mV) |
| | 30 V | ±(0.75% × *Reading* + 0.25% of FS + 1.4 mV) |

DC drift ±(0.05% of *Reading* + 0.02% of FS + 20 µV) per °C

**Table 2.** AC Amplitude Accuracy[3]

| Input Impedance | Input Range ($V_{pk-pk}$) | AC Amplitude Accuracy |
|---|---|---|
| 50 Ω | All | ±0.1 dB (±1.2%) of *Reading* |
| 1 MΩ | 0.05 V | ±0.2 dB (±2.3%) of *Reading* |
| | 0.2 V and 1 V | ±0.13 dB (±1.5%) of *Reading* |
| | 6 V and 30 V | ±0.4 dB (±4.7%) of *Reading* |

**Table 3.** Crosstalk[4]

| Input Impedance | Input Range ($V_{pk-pk}$) | Crosstalk |
|---|---|---|
| 50 Ω | All | ≤-80 dB at 1 MHz |
| 1 MΩ | 0.05 V | ≤-75 dB at 1 MHz |
| | 0.2 V, 1 V, 6 V, and 30 V | ≤-80 dB at 1 MHz |

[2] Within ±5 °C of self-calibration temperature.
[3] For a 50 kHz signal with amplitude 90% of full-scale input range measured within ±5 °C of self-calibration temperature.
[4] Measured from one channel to another channel, with same range settings on both channels.

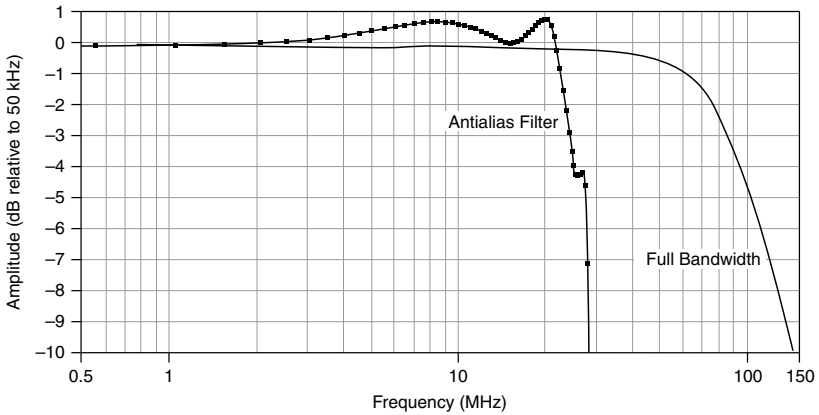
# Bandwidth and Transient Response

**Table 4.** Bandwidth (-3 dB)

| Input Impedance | Input Range ($V_{pk-pk}$) | Bandwidth |
|---|---|---|
| 50 Ω | 0.05 V | 55 MHz |
| | 0.2 V, 1 V, and 6 V | 60 MHz |
| 1 MΩ | 0.05 V | 35 MHz |
| | 0.2 V, 1 V, 6 V, and 30 V | 60 MHz |

| | |
|---|---|
| Bandwidth-limiting filter | 24 MHz anti-alias filter |
| AC-coupling cutoff (-3 dB)[5] | 12 Hz |

**Figure 1.** Frequency Response, 50 Ω, 1 $V_{pk-pk}$ Input Range, Measured




# Spectral Performance

**Note** Due to high spectral noise content below 5 kHz caused by some computer chassis, spectral performance for the PCI-5105 is specified for 5 kHz and above on the indicated ranges. For more information on preventing ground loop noise, refer to the *PCI and PXI Ground Loop Noise* topic available at *ni.com/manuals*.

[5] AC coupling available on 1 MΩ input only.

## 1 MΩ Spectral Performance[6]

**Table 5.** Spurious-Free Dynamic Range (SFDR)

| Input Range ($V_{pk-pk}$) | SFDR |
|---|---|
| 0.2 V | 70 dBc (≥5 kHz) |
| 1 V and 6 V | 65 dBc |

**Table 6.** Total Harmonic Distortion (THD)

| Input Range ($V_{pk-pk}$) | THD |
|---|---|
| 0.05 V | -72 dBc |
| 0.2 V | -75 dBc |
| 1 V | -65 dBc |
| 6 V | -68 dBc |

**Table 7.** Signal to Noise and Distortion (SINAD)

| Input Range ($V_{pk-pk}$) | SINAD |
|---|---|
| 0.05 V | 50 dB (≥5 kHz) |
| 0.2 V | 59 dB (≥5 kHz) |
| 1 V | 61 dB |
| 6 V | 59 dB |

## 1 MΩ Noise

**Table 8.** 1 MΩ RMS Noise[7]

| Input Range ($V_{pk-pk}$) | Full Bandwidth | 24 MHz Filter Enabled |
|---|---|---|
| 0.05 V | 0.18% of FS (90 µV) (≥5 kHz) | 0.12% of FS (60 µV) (≥5 kHz) |
| 0.2 V | 0.060% of FS (120 µV) (≥5 kHz) | 0.036% of FS (72 µV) (≥5 kHz) |
| 1 V | 0.03% of FS (300 µV) | 0.03% of FS (300 µV) |

[6] -1 dBFS input signal. Includes the second through the fifth harmonics. 24 MHz bandwidth filter enabled.

**Table 8.** 1 MΩ RMS Noise[7] (Continued)

| Input Range ($V_{pk-pk}$) | Full Bandwidth | 24 MHz Filter Enabled |
|---|---|---|
| 6 V | 0.055% of FS (3.3 mV) | 0.036% of FS (2.16 mV) |
| 30 V | 0.03% of FS (9 mV) | 0.03% of FS (9 mV) |

## 50 Ω Spectral Performance

**Table 9.** Spurious-Free Dynamic Range (SFDR)[8]

| Input Range ($V_{pk-pk}$) | SFDR |
|---|---|
| 0.2 V | 72 dBc (≥5 kHz) |
| 1 V and 6 V | 72 dBc |

**Table 10.** Total Harmonic Distortion (THD)[8]

| Input Range ($V_{pk-pk}$) | THD |
|---|---|
| All | -75 dBc |

**Table 11.** Signal to Noise and Distortion (SINAD)[8]

| Input Range ($V_{pk-pk}$) | SINAD |
|---|---|
| 0.05 V | 59 dB (≥5 kHz) |
| 0.2 V to 6 V | 62 dB |

[7] Verified using a 50 Ω terminator connected to input.

[8] -1 dBFS input signal. Includes the second through the fifth harmonics. 24 MHz bandwidth filter enabled.

**Figure 2.** PCI-5105 Dynamic Performance, 50 Ω, 1 $V_{pk-pk}$, with 24 MHz Filter Enabled, Measured

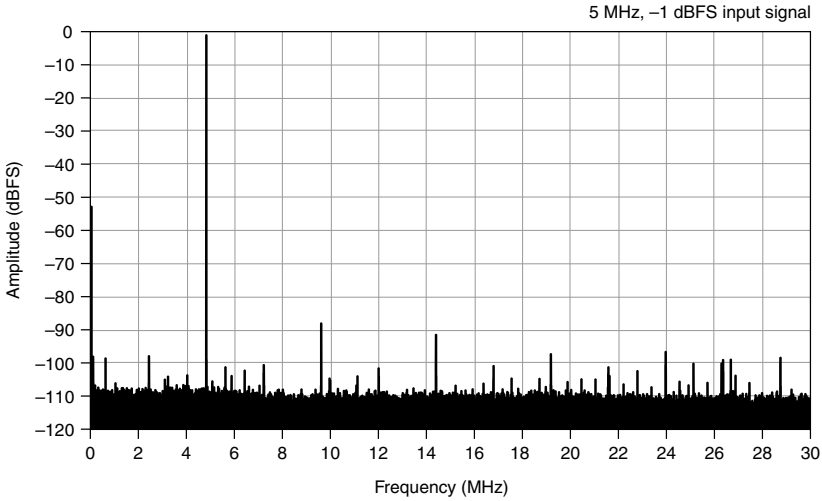
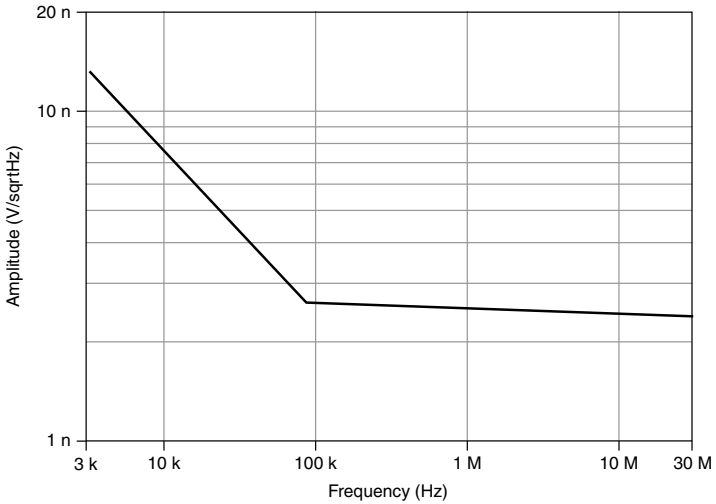



**Figure 3.** PCI-5105 Spectral Noise Density, 50 Ω, 0.05 $V_{pk-pk}$, with Anti-alias Filter Enabled, Nominal



## 50 Ω Noise

**Table 12.** 50 Ω RMS Noise[9]

| Input Range ($V_{pk-pk}$) | Full Bandwidth | 24 MHz Filter Enabled |
|---|---|---|
| 0.05 V | 0.08% of FS (40 µV) (≥5 kHz) | 0.038% of FS (19 µV) (≥5 kHz) |
| 0.2 V | 0.04% of FS (80 µV) (≥5 kHz) | 0.028% of FS (56 µV) (≥5 kHz) |
| 1 V | 0.03% of FS (300 µV) | 0.029% of FS (290 µV) |
| 6 V | 0.03% of FS (1.8 mV) | 0.028% of FS (1.68 mV) |

## Skew

| | |
|---|---|
| Channel-to-channel skew[10] | |
| 24 MHz bandwidth filter disabled | ≤500 ps |
| 24 MHz bandwidth filter enabled | ≤600 ps |

# Horizontal

## Sample Clock

| | |
|---|---|
| Sources | |
| Internal | Onboard clock (internal VCXO)[11] |
| External | PFI 1 |
| External frequency range | 4 MHz to 65 MHz |
| Exporting[12] | |
| Destination | PFI 1 |
| Maximum frequency | 65 MHz |

## Onboard Clock (Internal VCXO)

| | |
|---|---|
| Real-time sample rate range[13] | 915.5 S/s to 60 MS/s |
| Timebase frequency | 60 MHz |

[9] Verified using a 50 Ω terminator connected to input.
[10] 10 MHz sine input signal.
[11] Internal Sample clock is locked to the Reference clock or derived from the onboard VCXO.
[12] You cannot export a decimated Sample clock signal.
[13] Divide by *n* decimation used for all rates less than 60 MS/s. For more information about the Sample clock and decimation, refer to the *NI High-Speed Digitizers Help*.

| | |
|---|---|
| Timebase accuracy | |
| Not phase-locked to Reference clock | ±25 ppm, warranted |
| Phase-locked to Reference clock | Equal to the Reference clock accuracy |
| Sample clock delay range | ±1 Sample clock period |
| Sample clock delay resolution | <10 ps |

### External Sample Clock

| | |
|---|---|
| Source | PFI 1 (front panel SMB connector) |
| Frequency range[14] | 4 MHz to 65 MHz[15] |
| Duty cycle tolerance | 45% to 55% |

## Phase-Locked Loop (PLL) Reference Clock

| | |
|---|---|
| Sources | PFI 1 (front panel SMB connector)<br>RTSI 7 |
| Frequency range[16] | 5 MHz to 20 MHz in 1 MHz increments |
| Duty cycle tolerance | 45% to 55% |
| Exported Reference clock destination | PFI 1 |

# Triggers

## Reference (Stop) Trigger

| | |
|---|---|
| Supported trigger | Reference (stop) trigger |
| Trigger types | Edge<br>Window<br>Hysteresis<br>Digital<br>Immediate<br>Software |
| Trigger sources | CH 0 to CH 7<br>PFI 1<br>RTSI <0..6><br>Software |

[14] Divide by $n$ decimation available where $1 \leq n \leq 65{,}535$. For more information about the Sample clock and decimation, refer to the *NI High-Speed Digitizers Help*.

[15] The PCI-5105, when using NI-SCOPE 3.2, supports a limited frequency range of 8 MHz to 65 MHz.

[16] Default of 10 MHz. The PLL Reference clock frequency must be accurate to ±50 ppm.

| | |
|---|---|
| Time resolution | Sample clock timebase period |
| Minimum rearm time[17] | |
| Internal Onboard clock | 2.4 µs |
| External Sample clock | 144 × External clock period |
| Holdoff | From rearm time up to [($2^{32}$ - 1) × Sample clock timebase period] |
| Delay | From 0 up to [($2^{32}$ - 1) - Requested posttrigger samples] × (1/Actual sample rate), in seconds |

**Related Information**

*Refer to the NI High-Speed Digitizers Help for more information about which trigger sources are available for each trigger type.*

## Analog Trigger

| | |
|---|---|
| Trigger types | Edge<br>Window<br>Hysteresis |
| Sources | CH 0 to CH 7 (front panel SMB connectors) |
| Trigger level range | 100% FS |
| Edge trigger sensitivity | 2% FS |
| Trigger jitter | Sample clock timebase period |

## Digital Trigger

| | |
|---|---|
| Trigger type | Digital |
| Sources | PFI 1 (front panel SMB connector)<br>RTSI <0..6> |

## Programmable Function Interface

| | |
|---|---|
| Connector | PFI 1 (front panel SMB connector) |
| Direction | Bidirectional |
| Coupling | AC<br>DC |

[17] Holdoff set to 0. Onboard Sample clock at maximum rate.

### As a Sample Clock or Reference Clock

| | |
|---|---|
| Input voltage range | |
| Sine wave | 0.65 $V_{pk-pk}$ to 2.8 $V_{pk-pk}$ (0 dBm to 13 dBm) |
| Square wave | 0.2 $V_{pk-pk}$ to 2.8 $V_{pk-pk}$ |
| Maximum input overload | 7 $V_{rms}$ with \|Peaks\| ≤10 V |
| Input impedance | 50 Ω |
| Coupling | AC |

### As an Input (Digital Trigger)

| | |
|---|---|
| Destinations | Start trigger (acquisition arm)<br>Reference (stop) trigger<br>Arm Reference trigger<br>Advance trigger |
| Input impedance | 150 kΩ, nominal |
| $V_{IH}$ | 2.0 V |
| $V_{IL}$ | 0.8 V |
| Maximum input overload | -0.5 V, 5.5 V |
| Maximum frequency | 65 MHz |

### As an Output

| | |
|---|---|
| Sources | Start trigger (acquisition arm)<br>Reference (stop) trigger<br>End of record<br>Done (end of acquisition)<br>Sample clock timebase<br>Reference clock |
| Output impedance | 50 Ω |
| Logic type | 3.3 V CMOS |
| Maximum drive current | ±24 mA |

# Waveform Specifications

| | |
|---|---|
| Onboard memory size options[18] | 16 MB<br>128 MB<br>512 MB |
| Minimum record length | 1 sample |

[18] Onboard memory is shared between all enabled channels.

| | |
|---|---|
| Number of samples[19] | |
| Pretrigger | Zero up to full record length |
| Posttrigger | Zero up to full record length |
| Allocated onboard memory per record[20] | [(Record length in samples × 2 bytes/sample × number of enabled channels) + 480] rounded up to the nearest 128 bytes |

# Calibration

## External Calibration

External calibration calibrates the onboard references used in self-calibration and the external trigger levels. All calibration constants are stored in nonvolatile memory.

## Self-Calibration

Self-calibration is done on software command. The calibration corrects for gain, offset, triggering, and timing errors for all input ranges.

## Calibration Specifications

| | |
|---|---|
| Interval for external calibration | 2 years |
| Warm-up time[21] | 15 minutes |

# Software

## Driver Software

Driver support for this device was first available in NI-SCOPE 3.2.

NI-SCOPE is an IVI-compliant driver that allows you to configure, control, and calibrate the PCI-5105. NI-SCOPE provides application programming interfaces for many development environments.

## Application Software

NI-SCOPE provides programming interfaces, documentation, and examples for the following application development environments:

- LabVIEW
- LabWindows™/CVI™

[19] Single-record and multirecord acquisitions.

[20] The maximum number of records is 100,000.

[21] Warm-up time begins after the NI-SCOPE driver is loaded. Unless manually disabled, the NI-SCOPE driver automatically loads with the operating system and enables the module.

- Measurement Studio
- Microsoft Visual C/C++
- .NET (C# and VB.NET)

# Interactive Soft Front Panel and Configuration

When you install NI-SCOPE on a 64-bit system, you can monitor, control, and record measurements from the PCI-5105 using InstrumentStudio.

InstrumentStudio is a software-based front panel application that allows you to perform interactive measurements on several different device types in a single program.

**Note** InstrumentStudio is supported only on 64-bit systems. If you are using a 32-bit system, use the NI-SCOPE–specific soft front panel instead of InstrumentStudio.

Interactive control of the PCI-5105 was first available via InstrumentStudio in NI-SCOPE 18.1 and via the NI-SCOPE SFP in NI-SCOPE 14.1. InstrumentStudio and the NI-SCOPE SFP are included on the NI-SCOPE media.

NI Measurement & Automation Explorer (MAX) also provides interactive configuration and test tools for the PCI-5105. MAX is included on the driver media.

# TClk Specifications

You can use the NI TClk synchronization method and the NI-TClk driver to align the Sample clocks on any number of supported devices, in one or more chassis. For more information about TClk synchronization, refer to the *NI-TClk Synchronization Help*, which is located within the *NI High-Speed Digitizers Help*. For other configurations, including multichassis systems, contact NI Technical Support at *ni.com/support*.

## Intermodule SMC Synchronization Using NI-TClk for Identical Modules

Specifications are valid for modules installed in one NI PXI-1042 chassis. These specifications do not apply to PCI modules. Specifications are valid under the following conditions:

- All parameters are set to identical values for each SMC-based module.
- Sample clock set to 60 MS/s.
- All filters are disabled.

**Note** Although you can use NI-TClk to synchronize non-identical modules, these specifications apply only to synchronizing identical modules.

| | |
|---|---|
| Skew[22] | 500 ps |
| Average skew after manual adjustment[23] | <10 ps |
| Sample clock adjustment resolution | <10 ps |

[22] Caused by clock and analog path delay differences. No manual adjustment performed.

[23] For more information about manual adjustment, refer to the *Synchronization Repeatability Optimization* topic in the *NI-TClk Synchronization Help*.

# Power

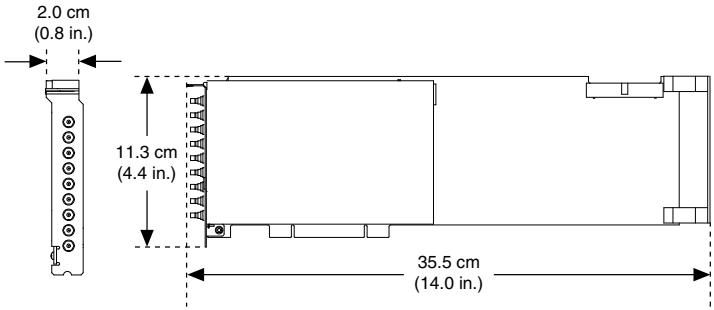
| | |
|---|---|
| Current draw | |
| +3.3 V DC | 1.7 A |
| +5 V DC | 2 A |
| +12 V DC | 20 mA |
| -12 V DC | 0 A |
| Total power | 15.85 W |

# Physical

## Dimensions and Weight

| | |
|---|---|
| Dimensions | 35.5 cm × 2.0 cm × 11.3 cm<br>(14.0 in. × 0.8 in. × 4.4 in.) |
| Weight | 433 g (15.2 oz) |

**Figure 4.** PCI-5105




## Front Panel Connectors

**Table 13.** PCI-5105 Front Panel Connectors

| Label | Connector Type | Description |
|---|---|---|
| CH 0—CH 7 | SMB jack | Analog input connection; digitizes data and triggers acquisitions. |
| PFI 1 | | PFI line for trigger input/output, External clock in, Reference clock input/output, and timebase out. |

# Environment

| | |
|---|---|
| Maximum altitude | 2,000 m (at 25 °C ambient temperature) |
| Pollution Degree | 2 |

Indoor use only.

## Operating Environment

| | |
|---|---|
| Ambient temperature range | 0 °C to 45 °C (Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2.) |
| Relative humidity range | 10% to 90%, noncondensing (Tested in accordance with IEC 60068-2-56.) |

## Storage Environment

| | |
|---|---|
| Ambient temperature range | -40 °C to 71 °C (Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2.) |
| Relative humidity range | 5% to 95%, noncondensing (Tested in accordance with IEC 60068-2-56.) |

# Compliance and Certifications

## 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 UL and other safety certifications, refer to the product label or the *Product Certifications and Declarations* 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, certifications, and additional information, refer to the *Product Certifications and Declarations* 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)

## 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*, 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 *Commitment to the Environment* 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*.

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