

SPECIFICATIONS

PCI-5153

500 MHz Bandwidth, 2 GS/s, 8-Bit PCI Oscilloscope Device

Contents

Definitions.....	2
Conditions.....	2
Vertical.....	3
Analog Input (Channel 0 and Channel 1).....	3
Impedance and Coupling.....	3
Voltage Levels.....	3
Accuracy.....	3
Bandwidth and Transient Response.....	4
Spectral Characteristics.....	6
Noise.....	7
Horizontal.....	7
Sample Clock.....	7
Onboard Clock (Internal VCISO).....	8
External Sample Clock.....	8
Phase-Locked Loop (PLL) Reference Clock.....	8
Sample Clock and Reference Clock Input (PFI 0, Front Panel Connector).....	9
Reference Clock Output (PFI 1, Front Panel Connector).....	9
Trigger.....	9
Analog Trigger.....	10
Digital Trigger.....	11
External Trigger Input (Front Panel Connector).....	11
PFI 0 and PFI 1 (Programmable Function Interface, Front Panel Connectors).....	11
As an Input (Trigger).....	11
As an Output (Event).....	12
Waveform Specifications.....	12
Calibration.....	13
External Calibration.....	13
Self-Calibration.....	13
Calibration Specifications.....	13
Software.....	13
Driver Software.....	13
Application Software.....	13
Interactive Soft Front Panel and Configuration.....	14
TClk Specifications.....	14
Power.....	15

Physical.....	15
Environment.....	15
Operating Environment.....	15
Storage Environment.....	16
Compliance and Certifications.....	16
Safety Compliance Standards.....	16
Electromagnetic Compatibility.....	16
CE Compliance	17
Product Certifications and Declarations.....	17
Environmental Management.....	17

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 1 GS/s.
- Real-Time Interleaved Sampling (TIS) mode provides a 2 GS/s real-time sample rate for a single channel.
- The module is warmed up for 15 minutes at ambient temperature.
- Self-calibration is completed after warm-up period.
- Calibration cycle is maintained.
- The PXI/PCI chassis fan speed is set to HIGH, the foam fan filters are removed if present, and the empty slots contain slot blockers and filler panels. For more information about cooling, refer to the *Maintain Forced-Air Cooling Note to Users*.



Caution If the module has been in use, it may exceed safe handling temperatures and cause burns. Allow the module to cool before removing it from the chassis.

Vertical

Analog Input (Channel 0 and Channel 1)

Number of channels	Two (simultaneously sampled)
Connectors	BNC

Impedance and Coupling

Input impedance	50 $\Omega \pm 2 \Omega$
Voltage Standing Wave Ratio (VSWR)	1.2 DC to 500 MHz
Input coupling	AC, DC, GND

Voltage Levels

Full scale (FS) input ranges (V_{pk-pk})	0.1 V
	0.2 V
	0.5 V
	1 V
	2 V
	5 V
Maximum input overload	7 V RMS with Peaks ≤ 10 V

Accuracy

Resolution	8 bits
DC accuracy ¹	
0.1 V to 1 V input range	$\pm(1.0\%$ of input + 1.3% of FS), typical $\pm(2.2\%$ of input + 1.8% of FS), warranted
2 V to 5 V input range	$\pm(1.4\%$ of input + 1.3% of FS), typical $\pm(2.9\%$ of input + 1.8% of FS), warranted
DC drift ²	$\pm(0.14\%$ of input + 0.05% of FS) per $^{\circ}\text{C}$, nominal

¹ For warranted values: within $\pm 3^{\circ}\text{C}$ of self-calibration temperature.

² At 23°C . 23°C assumed to be room temperature and ambient temperature during external calibration.

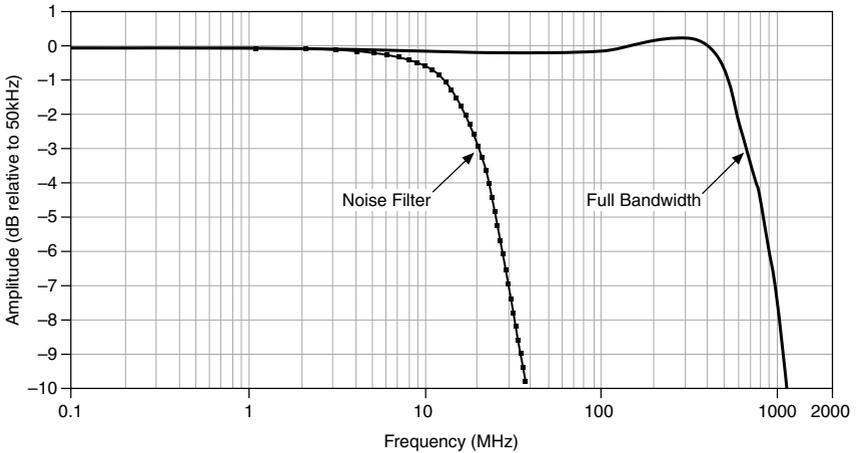
Crosstalk

CH 0 to/from CH 1 ³	<-80 dB at 10 MHz <-60 dB at 100 MHz
External trigger to CH 0 or CH 1 ⁴	<-80 dB at 10 MHz <-70 dB at 100 MHz

Bandwidth and Transient Response

Bandwidth (-3 dB) ^{5,6}	500 MHz minimum, warranted
Rise/fall time ⁶	600 ps
Bandwidth limit filter	20 MHz noise filter
AC coupling cutoff (-3 dB) ⁷	114 kHz

Figure 1. PCI-5153 Frequency Response, 5 V_{pk-pk} through 0.1 V_{pk-pk} Input Ranges, Measured



³ Measured on one channel with test signal applied to another channel, with same range setting on both channels.

⁴ 10 V signal applied to external trigger channel. Applies to all ranges on CH 0 and CH 1.

⁵ Normalized to 51 kHz.

⁶ Filter off.

⁷ 50 Ω source assumed.

Figure 2. PCI-5153 Frequency Response, $5 V_{pk-pk}$ through $0.1 V_{pk-pk}$ Input Ranges, Measured

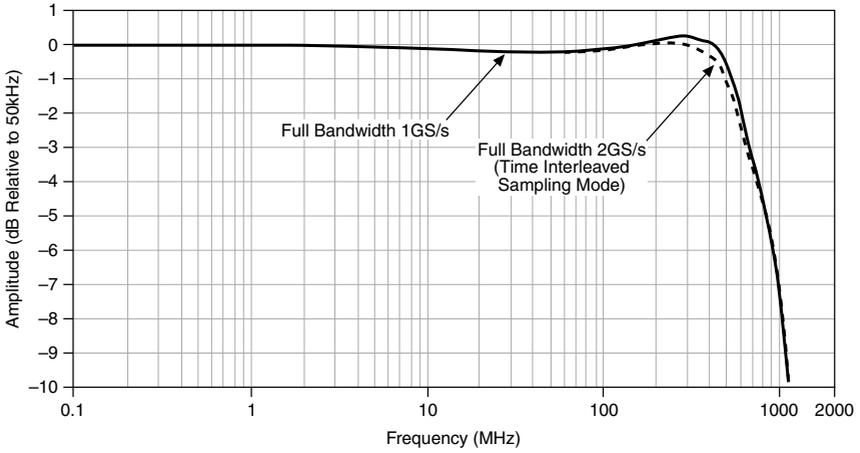
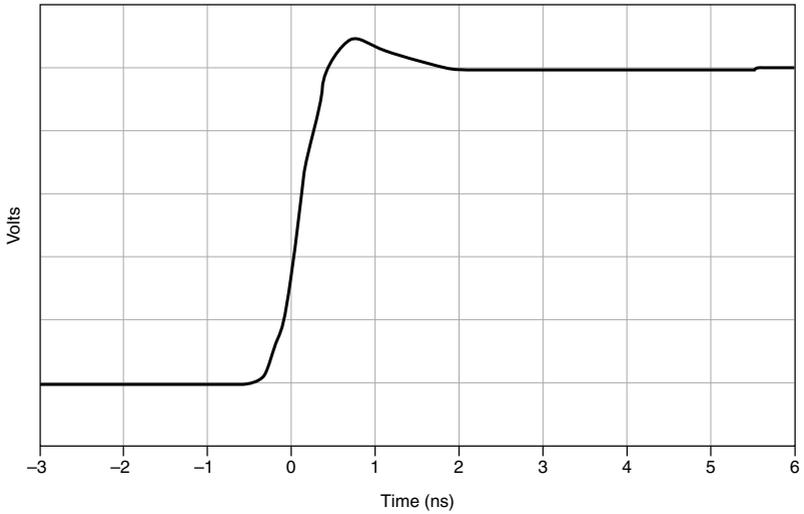


Figure 3. PCI-5153 Step Response, $5 V_{pk-pk}$ through $0.1 V_{pk-pk}$ Input Ranges, Measured

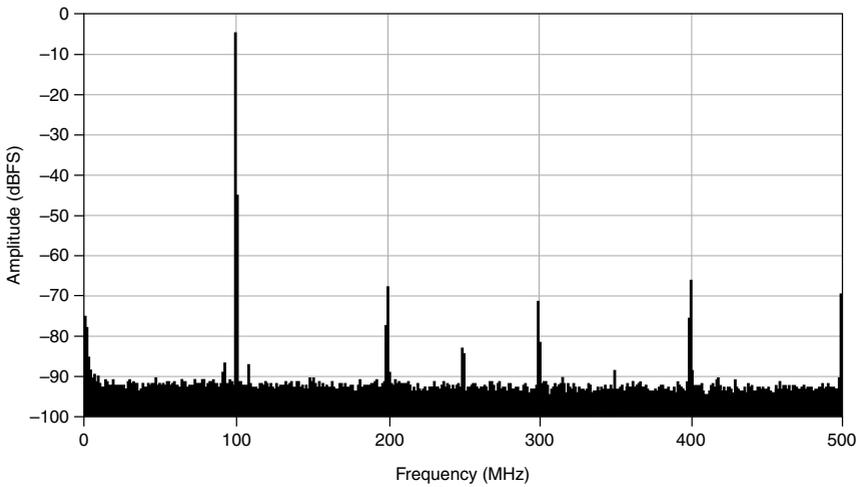


Spectral Characteristics

ENOB⁸

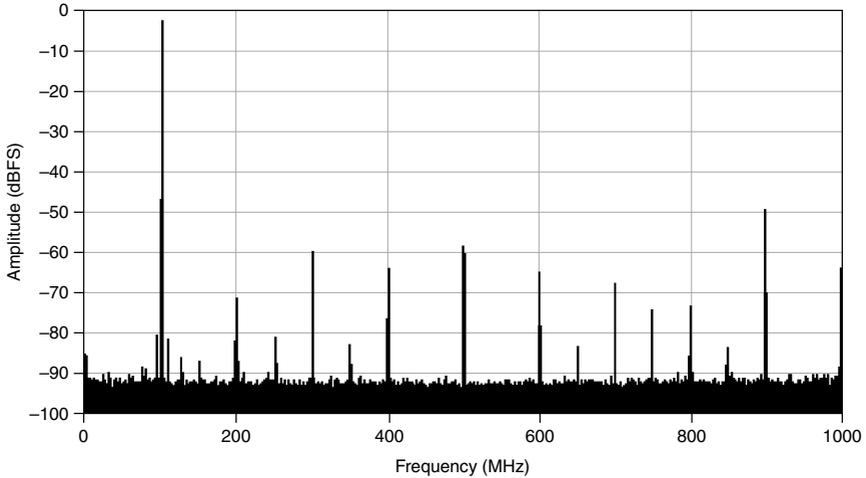
Noise filter on	7.3
Noise filter off	6.7
Signal to noise distortion (SINAD) ⁸	
Noise filter on	45 dB
Noise filter off	41 dB

Figure 4. PCI-5153 Dynamic Performance, 2 V_{pk-pk} Input Range, 100 MHz Input Signal, Measured



⁸ 1 V input range, 10 MHz, -1 dBFS input signal. Includes the 2nd through the 5th harmonics.

Figure 5. PCI-5153 TIS Dynamic Performance, 2 V_{pk-pk} Input Range, 100 MHz Input Signal, Measured



Noise

Table 1. RMS Noise⁹

Range (V _{pk-pk})	Noise Filter On	Noise Filter Off	Noise Filter On TIS Mode	Noise Filter Off TIS Mode
0.1	0.37% FS	0.44% FS	0.41% FS	0.71% FS
0.2 to 5	0.32% FS	0.32% FS	0.41% FS	0.41% FS

Channel-to-channel skew <140 ps

Horizontal

Sample Clock

Sources

Internal	Onboard clock (internal VCSO) ¹⁰
External	PFI 0 (front panel SMB connector)

⁹ 50 Ω terminator connected to input.

¹⁰ Internal Sample clock is locked to the Reference clock or derived from the onboard VCSO.

Timebase frequency 1 GHz¹¹

Onboard Clock (Internal VCSCO)

Sample rate range

Real-time sampling (single shot) ¹²	15.26 kS/s to 1 GS/s
TIS ¹³ mode (single shot)	2 GS/s (single channel only)
Random interleaved sampling (RIS) mode ¹⁴	2 GS/s to 20 GS/s in increments of 1 GS/s (repetitive waveforms only)

Timebase accuracy

Not phase-locked to Reference clock	±30 ppm within ±3 °C of external calibration temperature, plus an additional ±7 ppm per °C outside of ±3 °C of external calibration temperature, warranted
Phase-locked to Reference clock	Equal to the Reference clock accuracy ¹⁵

Sample clock delay range ±1 Sample clock period

Sample clock delay/adjustment resolution ≤5 ps

External Sample Clock

Sources PFI 0 (front panel SMB connector)

Frequency range¹⁶ 350 MHz to 1 GHz

Duty cycle tolerance 45% to 55%

Phase-Locked Loop (PLL) Reference Clock

Sources RTSI 7
PFI 0 (front panel SMB connector)

Frequency range¹⁷ 1 MHz to 20 MHz, in 1 MHz increments
Default: 10 MHz

Duty cycle tolerance 45% to 55%

Exported Reference clock destinations RTSI <0..7>
PFI 1 (front panel SMB connector)

¹¹ When not using external Sample clock.

¹² Divide by n decimation used for all rates less than 1 GS/s.

¹³ TIS is a type of real-time sampling that is sometimes called ping-pong.

¹⁴ RIS is a type of equivalent-time sampling.

¹⁵ Refer to your chassis specifications for the Reference clock accuracy.

¹⁶ 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*.

¹⁷ The PLL Reference clock frequency must be accurate to ±50 ppm.

Sample Clock and Reference Clock Input (PFI 0, Front Panel Connector)

Input voltage range	Sine wave: $0.65 V_{pk-pk}$ to $2.8 V_{pk-pk}$ (0 dBm to 13 dBm)
Maximum input overload	7 V RMS with $ Peaks \leq 10$ V
Impedance	50 Ω
Coupling	AC

Reference Clock Output (PFI 1, Front Panel Connector)

Output impedance	50 Ω
Logic type	3.3 V CMOS, except when exporting 5 V
Maximum drive current	± 24 mA

Trigger

Trigger types ¹⁸	Edge Window Hysteresis Video Digital Immediate Software
Trigger sources	CH 0 CH 1 TRIG PFI <0..1> RTSI <0..6> Software
Time resolution	
Onboard clock, time-to-digital conversion circuit (TDC) on	5 ps
Onboard clock, TDC off	1 ns
External clock, TDC off	External clock period

¹⁸ Refer to the following sources and the *NI High-Speed Digitizers Help* for more information about which sources are available for each trigger type.

Minimum rearm time¹⁹

TDC on	8 μ s
TDC off	1 μ s
Holdoff	From rearm time up to $[(2^{32} - 1) \times \text{Sample Clock Period}]$
Trigger delay	From 0 up to $[(2^{35} - 1) - \text{Posttrigger Samples}] \times (1 / \text{Sample Rate})$, in seconds

Analog Trigger

Trigger types	Edge Window Hysteresis
Sources	CH 0 (front panel BNC connector) CH 1 (front panel BNC connector) TRIG (front panel BNC connector)
Trigger level range	
CH 0, CH 1	100% FS
TRIG (External trigger)	± 5 V
Voltage resolution	8 bits (1 in 256)
Edge trigger sensitivity: CH 0, CH 1, TRIG (External trigger)	
DC to 300 MHz	10% FS, warranted
>300 MHz to 500 MHz	10% FS, typical
Trigger level accuracy ²⁰	
CH 0, CH 1	$\pm 5\%$ FS up to 10 MHz, warranted
TRIG (External trigger)	± 1 V ($\pm 10\%$ FS) up to 10 MHz, warranted
Trigger jitter ²⁰	≤ 14 ps RMS, typical 20 ps RMS maximum
Trigger filters	
Low frequency (LF) reject	50 kHz
High frequency (HF) reject	50 kHz

¹⁹ Holdoff set to 0. Onboard Sample clock at maximum rate.

²⁰ Within ± 3 °C of self-calibration temperature.

Digital Trigger

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

External Trigger Input (Front Panel Connector)

Connector	BNC
Impedance	2.25 k Ω
Coupling	DC
Input voltage range	± 5 V
Maximum input overload	Peaks ≤ 10 V

PFI 0 and PFI 1 (Programmable Function Interface, Front Panel Connectors)

Connector	SMB jack
Direction	Bidirectional

As an Input (Trigger)

Destination	Start trigger (acquisition arm) Reference (stop) trigger Arm reference trigger Advance trigger
Input impedance	150 k Ω , nominal
V_{IH}	2.0 V
V_{IL}	0.8 V
Maximum input overload	-0.5 V to 5.5 V
Maximum frequency	25 MHz

As an Output (Event)

Sources	Ready for Start Start trigger (acquisition arm) Ready for Reference Reference (stop) trigger End of Record Ready for Advance Advance trigger Done (end of acquisition) Probe Compensation ²¹
Output impedance	50 Ω
Logic type	3.3 V CMOS
Maximum drive current	± 24 mA
Maximum frequency	25 MHz

Waveform Specifications

Table 2. Onboard Memory Size

Real-Time and RIS Modes	Real-Time TIS Mode
8 MB standard (8 MS per channel)	8 MB standard (8 MS)
64 MB option (64 MS per channel)	64 MB option (64 MS)
256 MB option (256 MS per channel)	256 MB option (256 MS)

Minimum record length	1 sample
Number of pretrigger samples ²²	Zero up to full record length
Number of posttrigger samples ²²	Zero up to full record length

²¹ 1 kHz, 50% duty cycle square wave. PFI 1 only.

²² Single-record mode and multiple-record mode.

Maximum number of records in onboard memory²³

8 MB per channel	32,768
64 MB per channel	100,000
256 MB per channel	100,000
Allocated onboard memory per record	$[(Record\ Length \times 1\ \text{byte/sample}) + 400\ \text{bytes}]$ rounded up to next multiple of 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, excluding External Trigger input channel.

Calibration Specifications

Interval for external calibration	2 years
Warm-up time ²⁴	15 minutes

Software

Driver Software

Driver support for this device was first available in NI-SCOPE 3.5.

NI-SCOPE is an IIVI-compliant driver that allows you to configure, control, and calibrate the PCI-5153. 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
- LabWindowsTM/CVITM
- Measurement Studio

²³ It is possible to exceed these numbers if you fetch records while acquiring data. For more information, refer to the *High-Speed Digitizers Help*.

²⁴ Warm-up begins after the NI-SCOPE driver is loaded.

- 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-5153 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-5153 was first available via InstrumentStudio in NI-SCOPE 18.1 and via the NI-SCOPE SFP in NI-SCOPE 3.5. 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-5153. 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

Synchronization specifications are valid under the following conditions:

- All modules are installed in one NI PXI-1042 chassis
- The NI-TClk driver is used to align the Sample clocks of each module
- All parameters are set to identical values for each module
- Modules are synchronized without using an external Sample clock
- Sample clock set to 1 GS/s and all filters are disabled



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

Skew	500 ps
Skew after manual adjustment	≤5 ps
Sample clock delay/adjustment resolution	≤5 ps

Power

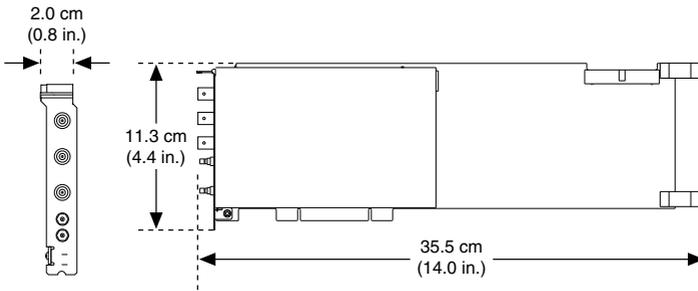
Current draw

+3.3 V DC	2.5 A
+5 V DC	2.4 A
+12 V DC	250 mA
Total power	23.25 W

Physical

Dimensions	35.5 cm × 2.0 cm × 11.3 cm (14.0 in × 0.8 in × 4.4 in)
Weight	439 g (15.5 oz)

Figure 6. PCI-5153 Dimensions



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

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)

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.

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.)

Information is subject to change without notice. Refer to the *NI Trademarks and Logo Guidelines* at ni.com/trademarks for information on NI trademarks. Other product and company names mentioned herein are trademarks or trade names of their respective companies. For patents covering NI products/technology, refer to the appropriate location: **Help»Patents** in your software, the `patents.txt` file on your media, or the *National Instruments Patent Notice* at ni.com/patents. You can find information about end-user license agreements (EULAs) and third-party legal notices in the `readme` file for your NI product. Refer to the *Export Compliance Information* at ni.com/legal/export-compliance for the NI global trade compliance policy and how to obtain relevant HTS codes, ECCNs, and other import/export data. NI MAKES NO EXPRESS OR IMPLIED WARRANTIES AS TO THE ACCURACY OF THE INFORMATION CONTAINED HEREIN AND SHALL NOT BE LIABLE FOR ANY ERRORS. U.S. Government Customers: The data contained in this manual was developed at private expense and is subject to the applicable limited rights and restricted data rights as set forth in FAR 52.227-14, DFAR 252.227-7014, and DFAR 252.227-7015.

© 2008—2019 National Instruments. All rights reserved.

376975D-01 August 15, 2019