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Find the *National Instruments PXI-7831R* at our website: *Click HERE*

R Series Intelligent DAQ with Onboard Processing

NI R Series

- Onboard FPGA chip, programmable with the LabVIEW FPGA Module
- User-defined triggering, timing, and decision making in hardware with 25 ns resolution
- Up to 8 analog inputs, independent sampling rates up to 750 kHz, 16-bit resolution
- Up to 8 analog outputs, independent update rates up to 1 MHz, 16-bit resolution
- Up to 160 digital lines configurable as inputs, outputs, counters, or custom logic at rates up to 40 MHz
- Direct memory access (DMA) channels for high-speed data streaming
- Implement custom control logic, inline signal processing, and digital communication protocols

Operating Systems

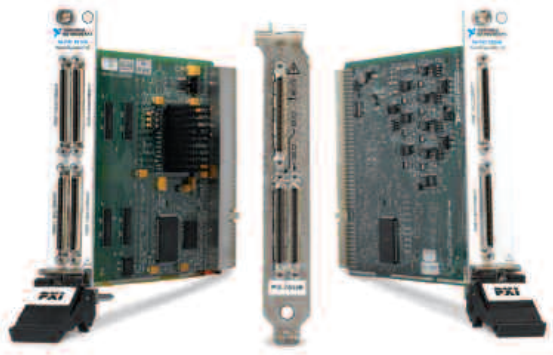
- Windows XP/2000
- LabVIEW Real-Time

Recommended Software

- LabVIEW
- LabVIEW FPGA Module
  - LabVIEW code compiler for FPGAs
  - Emulated debugging mode
- LabVIEW Real-Time Module

Driver Software (included)

- NI-RIO



Calibration Certificate Available

Product	Bus/Form Factor	FPGA	16-Bit Analog Inputs	Max Sampling Rate per Channel (kS/s)	16-Bit Analog Outputs	Max Update Rate per Channel (MS/s)	Digital I/O
Multifunction R Series							
NI 7851R	PXI	Virtex-5 LX30	8	750	8	1	96
NI 7852R	PXI	Virtex-5 LX50	8	750	8	1	96
NI 7841R	PXI	Virtex-5 LX30	8	200	8	1	96
NI 7842R	PXI	Virtex-5 LX50	8	200	8	1	96
NI 7830R	PCI, PXI	Virtex-II 1M gates	4	200	4	1	56
NI 7831R	PCI, PXI	Virtex-II 1M gates	8	200	8	1	96
NI 7833R	PCI, PXI	Virtex-II 3M gates	8	200	8	1	96
Digital R Series							
NI 7811R	PCI, PXI	Virtex-II 1M gates	–	–	–	–	160
NI 7813R	PCI, PXI	Virtex-II 3M gates	–	–	–	–	160

Table 1. R Series Selection Guide

Overview

Intelligent DAQ is multifunction data acquisition that features user-defined onboard processing as well as complete flexibility of I/O timing and triggering. You can configure all device functionality by creating NI LabVIEW block diagrams with the LabVIEW FPGA Module. Your block diagram executes in hardware, giving you direct, immediate control of all I/O signals on the PXI or PCI device. With R Series and LabVIEW FPGA, you can configure user-defined hardware for a wide variety of applications requiring precise timing and control such as:

- Data acquisition with flexible triggering and onboard processing
- High-speed analog and discrete control loops
- Pulse-width modulation (PWM) and encoder interfacing
- User-defined digital communication protocols
- Custom counters with up to 64-bit resolution
- Hardware-timed decision making at 40 MHz

Key Features

Through programming in LabVIEW FPGA, you can control each of the I/O signal lines independently or synchronize a line with other channels. You can configure the digital I/O lines as custom counter/timers, PWM channels, or communication buses for user-defined protocols. All multifunction R Series devices have dedicated analog-to-digital converters/digital-to-analog converters on every analog I/O channel. This offers specialized functionality such as multirate sampling and individual channel triggering, which are beyond the capabilities of typical data acquisition hardware. You can sample every analog input channel on an R Series device simultaneously at rates up to 750 kHz, and you can program every analog output on an R Series device to update simultaneously at rates up to 1 MHz. You can also store your compiled LabVIEW FPGA application in the onboard flash memory of any R Series device and configure it for automatic loading and/or execution at power up.

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New Virtex-5 FPGAs

The new NI PXI-784x and PXI-785x R Series modules use new Virtex-5 field-programmable gate arrays (FPGAs) with improved optimization capabilities that provide faster code execution and increased code capacity. These Virtex-5 FPGAs feature a new six-input look-up table (LUT) architecture for substantially improved resource utilization as well as DSP48 slices that make it possible for you to implement more complex digital signal processing at faster rates. Previous-generation Virtex-II FPGAs use four-input LUTs for up to 16 combinations of digital logic values. The new Virtex-5 FPGAs use six-input LUTs for up to 64 combinations, increasing the amount of logic that you can implement per slice. In addition, the slices themselves are placed in closer proximity to each other to reduce the propagation delay of electrons and increase overall execution rates. The single-cycle timed loop structure in LabVIEW FPGA takes full advantage of six-input LUTs for substantially improved resource utilization. This means you can optimize more LabVIEW FPGA code to fit within Virtex-5 FPGAs and perform more operations per clock cycle.

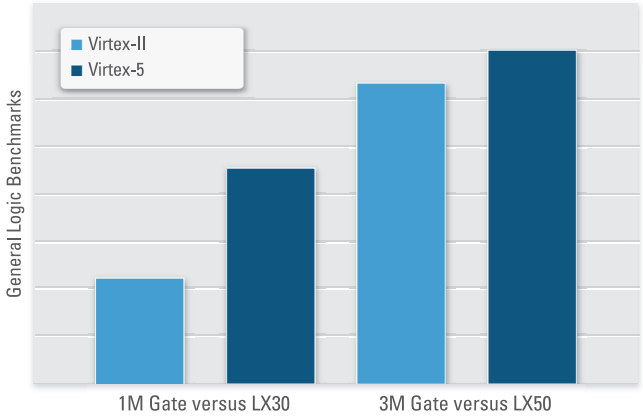


Figure 1. General logic benchmarks show that Virtex-5 FPGAs offer larger sizes when compared to Virtex-II FPGAs.

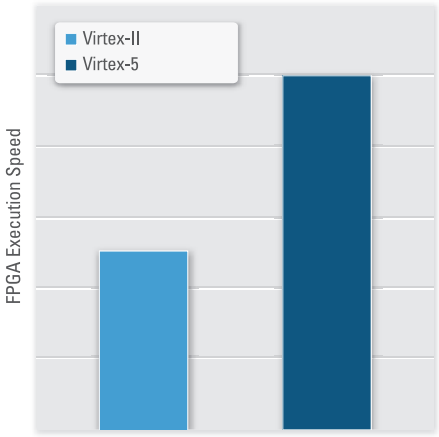


Figure 2. Execution speed benchmarks show that Virtex-5 FPGAs feature faster processing capabilities when compared to Virtex-II FPGAs.

For more information on LabVIEW FPGA benchmarks for Virtex-5 FPGAs, visit **ni.com/info** and enter lvfpgabenchmarks.

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Recommended Accessories

High Performance

SHC68-68-RMIO – High-performance shielded 68-conductor cable terminated with a VHDCI 68-pin male connector at one end and a 68-pin female 0.050 D-type connector at the other end that has been specifically designed for the multifunction I/O connector on R Series intelligent DAQ devices.

1 m 189588-01
2 m 189588-02

SHC68-68-RDIO – High-performance shielded 68-conductor cable terminated with a VHDCI 68-pin male connector at one end and a 68-pin female 0.050 D-type connector at the other end that has been specifically designed for the digital I/O connector on R Series intelligent DAQ devices.

1 m 191667-01

SCB-68 – Shielded I/O connector block for rugged, very low-noise signal termination for connecting to 68-pin devices. The SCB-68 also includes two general-purpose breadboard areas.

Dimensions – 19.5 by 15.2 by 4.5 cm (7.7 by 6.0 by 1.8 in.)

SCB-68 776844-01

Low Cost

SH68-C68-S – General-purpose shielded cable that connects any type of R Series connector to 68-pin connector blocks.

0.5 m.....186381-0R5
1 m 186381-01
2 m 186381-02

Custom Cabling

SHC68-NT-S – Shielded 68-conductor cable terminated with a 68-pin male VHDCI connector at one end and unterminated bare wires at the other. Use this cable, ideal for OEM applications, to create custom cabling solutions for R Series devices.

2 m 189041-02

NSC68-262650 – Shielded cable terminated with a VHDCI 68-pin male connector at one end and two 26-pin ribbon connectors and one 50-pin ribbon connector on the other; designed to connect the R Series RMIO connector to standard ribbon cable accessories.

1 m 189151-01

NSC68-5050 – Shielded cable terminated with a VHDCI 68-pin male connector at one end and two 50-pin ribbon connectors on the other; designed to connect R Series RDIO connectors to standard ribbon cable accessories.

1 m 189152-01

Required Software for R Series Intelligent DAQ

- NI 781xR and 783xR devices require the LabVIEW FPGA Module 7.1 or later, and NI-RIO driver software 1.3 or later.
- NI 784xR and 785xR devices require the LabVIEW FPGA Module 8.5.1 or later, and NI-RIO driver software 2.4 or later.

Ordering Information

PCI

NI PCI-7811R.....779363-01
NI PCI-7813R.....779370-01
NI PCI-7830R.....779361-01
NI PCI-7831R.....778797-01
NI PCI-7833R.....779359-01

PXI

NI PXI-7811R.....778800-01
NI PXI-7813R.....779362-01
NI PXI-7830R.....779364-01
NI PXI-7831R.....778668-01
NI PXI-7833R.....779360-01
NI PXI-7841R.....780337-01
NI PXI-7842R.....780338-01
NI PXI-7851R.....780339-01
NI PXI-7852R.....780340-01

Includes NI-RIO driver software.

BUY NOW!

For complete product specifications, pricing, and accessory information, call 800 813 3693 (U.S.) or go to **ni.com/rseries**.

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Specifications

Analog Input (NI 783xR/784xR/785xR Only)

Input Characteristics

Number of channels
- NI 7830R 4
- NI 7831R/7833R/7841R/ 7842R/7851R/7852R 8

Input modes ..... DIFF, RSE, NRSE (software-selectable; selection applies to all channels)
Type of ADC ..... Successive approximation
Resolution ..... 16 bits, 1 in 65,536
Conversion time
- NI 783xR/NI 784xR ..... 4 µs
- NI 785xR ..... 1 µs

Maximum sampling rate
- NI 783xR/NI 784xR ..... 200 kS/s (per channel)
- NI 785xR ..... 750 kS/s (per channel)

Input impedance
- Powered on ..... 10 GΩ in parallel with 100 pF
- Powered off/overload ..... 4.0 kΩ min

Input signal range ..... ±10 V
Input bias current
- NI 783xR ..... ±2 nA
- NI 784xR/785xR ..... ±5 nA

Input offset current
- NI 783xR ..... ±1 nA
- NI 784xR/785xR ..... ±5 nA

Input coupling ..... DC
- Maximum working voltage (signal + common mode) ..... Inputs should remain within ±12 V of ground
- Overvoltage protection
  - Powered on ..... ±42 V
  - Powered off ..... ±35 V

Data transfers ..... DMA, interrupts, programmed I/O

Accuracy Information – NI 783xR

Nominal Range (V)		Absolute Accuracy							Relative Accuracy	
		% of Reading			Noise + Quantization				Resolution (µV)	
Positive Full Scale	Negative Full Scale	24 Hours	1 Year	Offset (µV)	Single Point	Averaged	Temp Drift (%/°C)	Absolute Accuracy at Full Scale (±mV)	Single Point	Averaged
10.0	-10.0	0.0496	0.0507	2,542	1779	165	0.0005	7.78	2,170	217

Note: Accuracies are valid for measurements following an internal calibration. Averaged numbers assume dithering and averaging of 100 single-channel readings. Measurement accuracies are listed for operational temperatures within ±1 °C of internal calibration temperature and ±10 °C of external or factory-calibration temperature.

Accuracy Information – NI 784xR/785xR

Nominal Range (V)		Absolute Accuracy							Relative Accuracy	
		% of Reading			Noise + Quantization				Resolution (µV)	
Positive Full Scale	Negative Full Scale	24 Hours	1 Year	Offset (µV)	Single Point	Averaged	Temp Drift (%/°C)	Absolute Accuracy at Full Scale (±mV)	Single Point	Averaged
10.0	-10.0	0.0186	0.0228	1,591	1,029	91.6	0.0005	3.97	1,205	121

Note: Accuracies are valid for measurements following an internal calibration. Averaged numbers assume dithering and averaging of 100 single-channel readings. Measurement accuracies are listed for operational temperatures within ±1 °C of internal calibration temperature and ±10 °C of external or factory-calibration temperature.

DC Transfer Characteristics

INL
- NI 783xR ..... ±3 LSB typ, ±6 LSB max
- NI 784xR/785xR ..... ±1 LSB typ, ±3 LSB max

DNL
- NI 783xR ..... -1.0 to +2.0 LSB max
- NI 784xR/785xR ..... ±0.4 LSB typ, ±0.9 LSB max

No missing codes
- NI 783xR ..... 16 bits typ, 15 bits min
- NI 784xR/785xR ..... 16 bits guaranteed

CMRR, DC to 60 Hz ..... -86 dB

Settling Time

Device	Step Size	Accuracy		
		16 LSB	4 LSB	2 LSB
NI 783xR	±20.0 V	7.5 µs	10.3 µs	40 µs
	±2.0 V	2.7 µs	4.1 µs	5.1 µs
	±0.2 V	1.7 µs	2.9 µs	3.6 µs
NI 784xR/ 785xR	±20.0 V	2.1 µs	4.2 µs	8 µs
	±2.0 V	1.3 µs	1.6 µs	1.8 µs
	±0.2 V	0.8 µs	1.1 µs	1.2 µs

Crosstalk ..... -80 dB, DC to 100 kHz

Dynamic Characteristics

Bandwidth
- NI 783xR
  - Small signal (-3 dB) ..... 650 kHz
  - Large signal (1% THD) ..... 55 kHz
- NI 784xR/785xR
  - Small signal (-3 dB) ..... 1 MHz
  - Large signal (1% THD) ..... 500 kHz

Analog Output (NI 783xR/784xR/785xR Only)

Output Characteristics

Output type ..... Single-ended, voltage output
Number of channels
- NI 7830R 4
- NI 7831R/7833R/7841R/ 7842R/7851R/7852R 8

Resolution ..... 16 bits, 1 in 65,536
Update time ..... 1.0 µs
Maximum update rate ..... 1 MS/s
Type of DAC ..... Enhanced R-2R
Data transfers ..... DMA, interrupts, programmed I/O

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Voltage Output

Range ..... ±10 V
Output coupling ..... DC
Output impedance
  NI 783xR ..... 1.25 Ω
  NI 784xR/785xR ..... 0.5 Ω
Current drive ..... ±2.5 mA
Protection ..... Short-circuit to ground
Power-on state ..... User configurable

Accuracy Information

Absolute Accuracy						
Nominal Range (V)		% of Reading		Offset (µv)	Temp Drift (%/°C)	Absolute Accuracy at Full Scale (mV)
Positive Full Scale	Negative Full Scale	24 Hours	1 Year			
10.0	-10.0	0.0335	0.0351	2,366	0.0005	5.88

Note: Accuracies are valid for analog output following an internal calibration. Analog output accuracies are listed for operation temperatures within ±1 °C of internal calibration temperature and ±10 °C of external or factory calibration temperature. Temperature drift applies only if ambient is greater than ±10 °C of previous external calibration.

DC Transfer Characteristics

INL ..... ±0.5 LSB typ, ±4.0 LSB max
DNL ..... ±0.5 LSB typ, ±1 LSB max
Monotonicity ..... 16 bits, guaranteed

Settling Time

Step Size	Accuracy		
	16 LSB	4 LSB	2 LSB
±20.0 V	6.0 µs	6.2 µs	7.2 µs
±2.0 V	2.2 µs	2.9 µs	3.8 µs
±0.2 V	1.5 µs	2.6 µs	3.6 µs

Dynamic Characteristics

Slew rate ..... 10 V/µs
Noise ..... 150 μV_{rms}, DC to 1 MHz
Glitch energy at midscale transition .. ±200 mV for 3 µs

Digital I/O

Number of channels
  NI 7811R/7813R 160
  NI 7830R 56
  NI 7831R/7833R/7841R/
  7842R/7851R/7852R 96
Digital logic levels ..... 3.3 V TTL, 5 V TTL Compatible

Level	Min (V)	Max (V)
Input low voltage (V_{IL})	0.0 V	0.8 V
Input high voltage (V_{IH})	2.0 V	5.5 V
Output low voltage (V_{OL}), where I_{OUT} = -4 mA	–	0.4 V
Output high voltage (V_{OH}), where I_{OUT} = 4 mA	2.4 V	3.3 V

Output current
  Source ..... 4.0 mA
  Sink ..... 4.0 mA
Input leakage current ..... ±10 µA
Power-on state ..... Programmable, by line
Data transfers ..... DMA, interrupts, programmed I/O

Protection
  Input
    NI 781xR/783xR ..... -0.5 to 7.0 V, single line
    NI 784xR/785xR ..... -20.0 to 20.0 V, single line
  Output ..... Short-circuit (up to eight lines may be shorted at a time)

Minimum pulse width
  Input ..... 25 ns
  Output ..... 12.5 ns
Minimum sampling period
  NI 781xR/783xR ..... 5 ns
  NI 784xR/785xR ..... 8.33 ns

Reconfigurable FPGA

NI 7811R/7830R/7831R

FPGA type ..... Virtex-II 1000
Number of flip-flops 10,240
Number of 4-input LUTs 10,240
Number of 18x18 multipliers 40
Embedded block RAM ..... 720 kb

NI 7813R/7833R

FPGA type ..... Virtex-II 3000
Number of flip-flops 28,672
Number of 4-input LUTs 28,672
Number of 18x18 multipliers 96
Embedded block RAM ..... 1,728 kb

NI 7841R/7851R

FPGA type Virtex-5 LX30
Number of flip-flops 19,200
Number of 6-input LUTs 19,200
Number of DSP48
  slices (25x18 multipliers) 32
Embedded block RAM ..... 1,152 kb

NI 7842R/7852R

FPGA type Virtex-5 LX50
Number of flip-flops 28,800
Number of 6-input LUTs 28,800
Number of DSP48
  slices (25x18 multipliers) 48
Embedded block RAM ..... 1,728 kb

Timebases

NI 781xR/783xR ..... 40, 80, 120, 160, or 200 MHz
NI 784xR/785xR ..... 40, 80, or 120 MHz
Timebase reference sources
  NI PCI-781xR/783xR ..... Onboard clock only
  NI PXI-78xxR ..... Onboard clock, phase-locked to PXI 10 MHz clock
Timebase accuracy, onboard clock ..... ±100 ppm, 250 ps peak-to-peak jitter
Phase-locked to PXI 10 MHz clock (NI PXI-78xxR only) ..... Adds 350 ps peak-to-peak jitter

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Additional frequency-dependent peak-to-peak jitter

NI 781xR/783xR	
40 MHz	None
80 MHz	400 ps
120 MHz	720 ps
160 MHz	710 ps
200 MHz	700 ps
NI 784xR/785xR	
40 MHz	None
80 MHz	460 ps
120 MHz	172 ps

Calibration (NI 783xR/784xR/785xR Only)

Recommended warm-up time	15 minutes
Calibration interval	1 year
Onboard calibration reference	
DC level	5.000 V (±3.5 mV) (actual value stored in flash memory)
Temperature coefficient	±5 ppm/°C max
Long-term stability	±20 ppm/$\sqrt{1{,}000\ h}$

Note: Refer to Calibration Certificates at **ni.com/calibration** to generate a calibration certificate for the NI 783xR.

Bus Interface

PXI (NI PXI-78xxR only)	Master, slave
PCI (NI PCI-781xR/783xR only)	Master, slave

Physical

Dimensions (not including connectors)	
NI PCI-781xR/783xR	17 by 11 cm (6.7 by 4.3 in.)
NI PXI-78xxR	16 by 10 cm (6.3 by 3.9 in.)
Weight	
NI PCI-781xR/783xR	112 g
NI PXI-78xxR	152 g
I/O connectors	
NI 781xR	Four 68-pin female high-density VHDCI type
NI 783xR/784xR/785xR	Three 68-pin female high-density VHDCI type

Maximum Working Voltage

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

Channel-to-earth	±12 V, Measurement Category I
Channel-to-channel	±24 V, Measurement Category I

Caution: Do not use the NI 783xR/784xR/785xR for connection to signals in Measurement Category II, III, or IV.

Power Requirement

+5 VDC (±5%)[1]	
NI 781xR	9 mA (typ), 50 mA (max)
NI 7830R/7831R	330 mA (typ), 355 mA (max)
NI 7833R	364 mA (typ), 586 mA (max)
NI 7841R/7851R	125 mA (typ), 252 mA (max)
NI 7842R/7852R	136 mA (typ), 291 mA (max)
+3.3 VDC (±5%)[2]	
NI 7811R	650 mA (typ), 1,000 mA (max)
NI 7813R	850 mA (typ), 1,350 mA (max)
NI 7830R/7831R	462 mA (typ), 660 mA (max)
NI 7833R	727 mA (typ), 1,148 mA (max)
NI 7841R/7851R	525 mA (typ), 1,244 mA (max)
NI 7842R/7852R	604 mA (typ), 1,484 mA (max)
+12 V	
NI 784xR/785xR	0.5 A
-12 V	
NI 784xR/785xR	0.25 A
+5 V terminal	
Connector 0	0.5 A max
Connector 1	0.5 A max
Connector 2	0.5 A max
All connectors	1.5 A max[3]

To calculate the total current sourced by the digital outputs use the following equation:

$$\sum_{i=1}^{j} \text{current sourced on channel } i$$

Power available at I/O connectors	4.50 to 5.25 VDC at 1 A total, 250 mA per I/O connector pin

[1] Does not include current drawn from the +5 V line on the I/O connectors.

[2] Does not include current sourced by the digital outputs.

[3] The NI 784xR/785xR devices have a user-replaceable socketed fuse that opens when current exceeds the current specification. Refer to the R Series Intelligent DAQ User Manual, *available at ni.com/manuals, for information about fuse replacement.*

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Environmental

NI 78xxR devices are intended for indoor use only.

Operating Environment

NI 781xR	0 to 55 °C (tested in accordance with IEC-60068-2-1 and IEC-60068-2-2)
NI 7830R, NI 7831R	
40 or 80 MHz timebase	0 to 55 °C (tested in accordance with IEC-60068-2-1 and IEC-60068-2-2)
NI 7833R/7841R/7842R/7851R/7852R	
40 MHz timebase	0 to 55 °C (tested in accordance with IEC-60068-2-1 and IEC-60068-2-2)
80 MHz timebase	0 to 55 °C except the following: 0 to 45 °C when installed in an NI PXI-1000/B or NI PXI-101x (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)
Altitude	2,000 m at 25 °C ambient temperature

Storage Environment

Ambient temperature range	-20 to 70 °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)

Note: Clean the device with a soft, nonmetallic brush. Make sure that the device is completely dry and free from contaminants before returning it to service.

Shock and Vibration (for NI PXI-78xxR Only)

Operational Shock	30 g peak, half-sine, 11 ms pulse (tested in accordance with IEC-60068-2-27; test profile developed in accordance with MIL-PRF-28800F)
Random Vibration	
Operating	5 to 500 Hz, 0.3 g_{rms}
Nonoperating	5 to 500 Hz, 2.4 g_{rms} (tested in accordance with IEC-60068-2-64; nonoperating test profile exceeds the requirements of MIL-PRF-28800F, Class 3)

Safety and Compliance

Safety

NI 78xxR devices are designed to meet the requirements of the following standards of safety for electrical equipment 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 visit **ni.com/certification**, search by model number or product line, and click the appropriate link in the Certification column.

Electromagnetic Compatibility

This product is designed to meet the requirements of the following standards of EMC for electrical equipment for measurement, control, and laboratory use:

- EN 61326 EMC requirements; Minimum Immunity
- EN 55011 Emissions; Group 1, Class A
- CE, C-Tick, ICES, and FCC Part 15 Emissions; Class A

Note: For EMC compliance, operate this device according to product documentation.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Note: Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain 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

National Instruments is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial not only to the environment but also to NI customers.

For additional environmental information, refer to the NI and 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 their life cycle, all products must be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit **ni.com/environment/weee.htm**.



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Training and Certification

NI training is the fastest, most certain route to productivity with our products. NI training can shorten your learning curve, save development time, and reduce maintenance costs over the application life cycle. We schedule instructor-led courses in cities worldwide, or we can hold a course at your facility. We also offer a professional certification program that identifies individuals who have high levels of skill and knowledge on using NI products. Visit **ni.com/training**.

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