

# R Series Intelligent DAQ with Onboard Processing

## NI R Series *NEW!*

- Intelligent DAQ devices with programmable onboard decision making and digital signal processing
- Precise I/O synchronization, timing, triggering, and control with 25 ns resolution configured with the LabVIEW FPGA Module
- 1M or 3M gate FPGA chips
- Up to 8 analog input channels, 16-bit resolution, 200 kHz simultaneous-sampling rate
- Up to 8 analog output channels, 16-bit resolution, 1 MHz simultaneous update rate,  $\pm 10$  V
- Up to 160 high-speed digital lines configurable at rates up to 40 MHz for input, output, counter, or custom functionality
- Implement custom control logic or digital communication protocols

### Operating Systems

- Windows 2000/XP
- LabVIEW Real-Time (ETS and RTX)

### Recommended Software

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

### Driver Software (included)

- NI-RIO

Calibration Certificate Available



Product	Bus	FPGA Size (gates)	Input/Output Resolution (bits)	Analog Inputs	Max Sampling Rate (kHz/ch)	Analog Input Range (V)	Analog Outputs	Max Update Rate (MHz/ch)	Digital I/O	Triggering (configurable per channel)
<b>Multifunction</b>										
NI 7830R	PCI/PXI	1M	16	4	200	$\pm 10$	4	1	56	Analog/digital
NI 7831R	PCI/PXI	1M	16	8	200	$\pm 10$	8	1	96	Analog/digital
NI 7833R	PCI/PXI	3M	16	8	200	$\pm 10$	8	1	96	Analog/digital
<b>Digital</b>										
NI 7811R	PCI/PXI	1M	–	–	–	–	–	–	160	Digital
NI 7813R	PCI/PXI	3M	–	–	–	–	–	–	160	Digital

Table 1. R Series Selection Guide

## Overview

National Instruments R Series devices are equipped with reconfigurable input/output (RIO) hardware technology featuring onboard digital signal processing. The core of RIO is an FPGA (field-programmable gate array), which is configurable with the National Instruments LabVIEW FPGA Module. These intelligent DAQ devices literally rewire their internal gate array circuitry based on your LabVIEW FPGA program. You can customize the behavior of the device, providing capabilities such as:

- Complete control over synchronization and timing of all operations with 25 ns resolution
- User-defined, onboard decision making and triggering with loop rates up to 40 MHz
- Ability to individually configure digital lines as input, output, counter/timer, pulse-width modulator (PWM), encoder inputs, or user-defined communication protocols
- Simultaneous analog input at up to 200 kHz and simultaneous analog output at up to 1 MHz
- Multirate analog and discrete control

Because of these capabilities, R Series devices and the LabVIEW FPGA Module extend the National Instruments platform and can address applications including:

- High-speed, deterministic analog or discrete control
- Hardware-in-the-loop (HIL) simulation
- Rapid control prototyping (RCP)

## Key Features

Through programming in LabVIEW FPGA, you can control each of the I/O signal lines independently or synchronize a line with other lines. You can configure the digital I/O lines as custom counter/timers, PWM channels, or ports for user-defined protocols. All NI 783x R Series devices have dedicated analog-to-digital converters/digital-to-analog converters on every analog I/O channel, making it possible to sample/update all channels simultaneously or at different rates. You can sample every analog input channel on an R Series device simultaneously at rates up to 200 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 user-defined LabVIEW FPGA configuration in flash memory on any R Series device providing for automatic loading and/or execution of the user program at power up.

# R Series Intelligent DAQ with Onboard Processing

## Signal Conditioning for R Series Devices

The NI cRIO-9151 4-slot CompactRIO R Series expansion chassis connects directly to any digital connector of all PCI/PXI R Series devices and houses up to four CompactRIO I/O modules for high-performance, industrial signal conditioning and screw-terminal, BNC, or D-Sub connectivity.

A variety of I/O modules are available including 24 V industrial digital I/O with up to 32 channels per module, which is ideal for creating industrial counter/timers, electromechanical relays,  $\pm 80$  mV thermocouple inputs,  $\pm 5$  V IEPE accelerometer analog inputs, and simultaneous voltage and current analog outputs. Visit [ni.com/compactrio](http://ni.com/compactrio) for the latest information on module availability.

NI cRIO-9151 R Series Expansion Chassis .....779008-01



Figure 1. CompactRIO R Series Expansion System for PXI

R Series Device	Number of Digital Connectors	Max Number of cRIO-9151 Chassis per Device	Max Number of CompactRIO I/O Modules per Device
PCI/PXI-7811R	4	4	16
PCI/PXI-7813R	4	4	16
PCI/PXI-7830R	1	1	4
PCI/PXI-7831R	2	2	8
PCI/PXI-7833R	2	2	8

Table 2. CompactRIO R Series Expansion Chassis Configurations

## Recommended Accessories

### SCB-68 Shielded I/O Connector Block

This is a 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.

SCB-68 .....776844-01

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

### Cables with 68-Pin D-Type Connector

These cables feature a 68-pin VHDCI offset male connector on one end and a 68-pin 0.050 Series D-type female digital connector on the other end.

### SH68-C68-S Cable

The SH68-C68-S cable connects any of the connectors of an NI R Series device to 68-pin connector blocks. The 0.5 m and 1 m SH68-C68-S cables are recommended for use with the cRIO-9151 CompactRIO R Series expansion chassis.

0.5 m .....86381-0R5

1 m .....186381-01

2 m .....186381-02

### SHC68-68-RMIO Cable

The SHC68-68-RMIO cable, with high-noise immunity, is wired specifically for the MIO connector of the NI 7830R, NI 7831R, and NI 7833R devices. Do not use the cRIO-9151 R Series expansion chassis with the SHC68-68-RMIO cable.

1 m .....189588-01

### Custom Cabling Option

The SHC68-NT-S cable is a shielded cable with one 68-pin VHDCI female connector and no connector on the other end of the cable (unterminated). Use the cable, ideal for OEM applications, to create custom cabling solutions for NI R Series devices.

1 m .....189041-02

## 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

Includes NI-RIO driver software.

### 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

Includes NI-RIO driver software.

## BUY NOW!

For complete product specifications, pricing, and accessory information, call (800) 813 3693 (U.S. only) or go to [ni.com/fpga](http://ni.com/fpga).

# R Series Intelligent DAQ with Onboard Processing

## Specifications

### Analog Input (NI 7830R, NI 7831R, NI 7833R)

#### Input Characteristics

Number of channels	
NI 7830R	4
NI 7831R, NI 7833R	8
Input modes	Differential or single-ended (referenced or nonreferenced) software-selectable
Resolution	16 bits, 1 in 65,536
Conversion time	4 $\mu$ s
Maximum sampling rate	200 kS/s (per channel)
Input impedance	
Powered on	10 $\Omega$ , in parallel with 100 pF
Powered off	4 k $\Omega$ , minimum
Overload	4 k $\Omega$ , minimum
Input signal range	$\pm 10$ V
Input bias current	$\pm 2$ nA
Input offset current	$\pm 1$ nA
Input coupling	DC
Maximum working voltage	
(signal + common mode)	Inputs should remain within $\pm 12$ V of ground
Overvoltage protection	$\pm 42$ V
Data transfers	Interrupts, programmed I/O

#### Accuracy Information

Nominal Range (V)	Absolute Accuracy							Relative Accuracy		
	% of Reading		Noise + Quantization			Temp Scale (%/°C)	Absolute Accuracy at Full Scale ( $\pm$ mV)	Resolution ( $\mu$ V)		
	Positive Full Scale	Negative Full Scale	24 Hours	Offset 1 Year	Single Point			Drift Averaged	Point	Averaged
10.0	-10.0	0.0496	0.0507	2.542	1779	165	0.0005	7.78	2170	217

Note: Accuracies are valid for measurements following an internal calibration. Measurement accuracies are listed for operational temperatures within  $\pm 1$  °C of internal calibration temperature and  $\pm 10$  °C of external or factory calibration temperature. Temperature drift applies only if ambient is greater than  $\pm 10$  °C of previous external calibration.

#### DC Transfer Characteristics

INL	$\pm 3$ LSB typ, $\pm 6$ LSB maximum
DNL	-1.0 to +2.0 LSB maximum
No missing codes resolution	16 bits typ, 15 bits minimum
CMRR, DC to 60 Hz	86 dB

#### Dynamic Characteristics

Bandwidth	
Small signal (-3 dB)	650 kHz
Large signal (1% THD)	55 kHz
System noise	1.8 LSB <sub>rms</sub> (including quantization)
Settling time	

Step Size	Accuracy		
	16 LSB	4 LSB	2 LSB
$\pm 20.0$ V	7.5 $\mu$ s	10.3 $\mu$ s	40 $\mu$ s
$\pm 2.0$ V	2.7 $\mu$ s	4.1 $\mu$ s	5.1 $\mu$ s
$\pm 0.2$ V	1.7 $\mu$ s	2.9 $\mu$ s	3.6 $\mu$ s

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

### Analog Output (NI 7830R, NI 7831R, NI 7833R)

#### Output Characteristics

Number of channels	
NI 7830R	4 single-ended, voltage output
NI 7831R, NI 7833R	8 single-ended, voltage output
Resolution	16 bits, 1 in 65,536
Update time	1.0 $\mu$ s
Maximum update rate	1 MS/s
Type of DAC	Enhanced R-2R
Data transfers	Interrupts, programmed I/O

#### Accuracy Information

Nominal Range (V)	Absolute Accuracy					Temp Drift (%/°C)	Absolute Accuracy at Full Scale (mV)
	% of Reading		Offset ( $\mu$ V)				
	Positive Full Scale	Negative Full Scale	24 Hours	1 Year	Offset ( $\mu$ V)		
10.0	-10.0	0.0335	0.0351	2366	0.0005	5.88	

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

#### DC Transfer Characteristics

INL	$\pm 0.5$ LSB typ, $\pm 4.0$ LSB maximum
DNL	$\pm 0.5$ to $\pm 1.0$ LSB maximum
No missing codes resolution	16 bits, guaranteed

#### Voltage Output

Range	$\pm 10$ V
Output coupling	DC
Output impedance	1.25 $\Omega$
Current drive	$\pm 2.5$ mA
Protection	Short-circuit to ground
Power-on state	User configurable

#### Dynamic Characteristics

Settling time

Step Size	Accuracy		
	16 LSB	4 LSB	2 LSB
$\pm 20.0$ V	6.0 $\mu$ s	6.2 $\mu$ s	7.2 $\mu$ s
$\pm 2.0$ V	2.2 $\mu$ s	2.9 $\mu$ s	3.8 $\mu$ s
$\pm 0.2$ V	1.5 $\mu$ s	2.6 $\mu$ s	3.6 $\mu$ s

Slow rate	10 V/ $\mu$ s
Noise	150 $\mu$ V <sub>rms</sub> , DC to 1 MHz
Glitch energy at midscale transition	$\pm 100$ mV for 3 $\mu$ s

#### Digital I/O

Number of channels	
NI 7830R	56 input/output
NI 7831R, NI 7833R	96 input/output
NI 7811R, NI 7813R	160 input/output
Compatibility	TTL

#### Digital Logic Levels

Level	Min (V)	Max (V)
Input low voltage ( $V_{IL}$ )	0.0	0.8
Input high voltage ( $V_{IH}$ )	2.0	5.5
Output low voltage ( $V_{OL}$ ), where $I_{OUT} = -I_{max}$ (sink)	—	0.4
Output high voltage ( $V_{OH}$ ), where $I_{OUT} = I_{max}$ (source)	2.4	—

#### Maximum output current

$I_{max}$ (source)	5.0 mA
$I_{min}$ (sink)	5.0 mA
Input leakage current	$\pm 10$ $\mu$ A
Power-on state	Programmable, by line
Data transfers	Interrupts, programmed I/O
Protection	
Input	-0.5 to 7.0 V
Output	Short-circuit (up to eight lines may be shorted at a time)

#### Reconfigurable FPGA

##### NI 7811R, NI 7830R, NI 7831R

System gates	1 M
Number of logic slices	5,120
Equivalent number of logic cells	11,520
Embedded RAM available	81,920 bytes

##### NI 7813R, NI 7833R

System gates	3 M
Number of logic slices	14,336
Equivalent number of logic cells	32,256
Embedded RAM available	196,608 bytes

Timebases ..... 40, 80, 120, 160, or 200 MHz

#### Timebase reference sources

PCI R Series	Onboard clock only
PXI R Series	Onboard clock, phase-locked to PXI 10 MHz clock

#### Timebase accuracy

Onboard timebase .....  $\pm 100$  ppm (max)

Frequency dependent jitter	
40 MHz	250 ps
80 MHz	980 ps
120 MHz	970 ps
160 MHz	960 ps
200 MHz	950 ps

#### Phase locked to PXI 10 MHz clock

(PXI R Series only) ..... Adds 350 ps jitter, 300 ps skew

# R Series Intelligent DAQ with Onboard Processing

## Specifications

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### Calibration (NI 7830R, NI 7831R, NI 7833R Only)

Recommended warm-up time.....	15 minutes
Calibration interval.....	1 year
Onboard calibration reference	
DC level .....	5,000 V ( $\pm 3.5$ mV)
	(actual value stored in flash memory)
Temperature coefficient .....	$\pm 5$ ppm/ $^{\circ}$ C maximum
Long-term stability .....	$\pm 20$ ppm/ $\sqrt{1000}$ h

### Physical

Dimensions (not including connectors)	
PXI .....	16 by 10 cm (6.3 by 3.9 in.)
PCI .....	17 by 11 cm (6.7 by 4.3 in.)
I/O connectors	
NI 7831R, NI 7833R.....	Three 68-pin female high-density VHDCI type
NI 7811R, NI 7813R.....	Four 68-pin female high-density VHDCI type
NI 7830R.....	Two 68-pin female high-density VHDCI type

### Environmental

#### Operating Environment

Ambient temperature.....	0 to 55 $^{\circ}$ C, tested in accordance with IEC-60068-2-1 and IEC-60068-2-2
Relative humidity .....	10 to 90%, noncondensing, tested in accordance with IEC-60068-2-56
Altitude .....	2,000 m at 25 $^{\circ}$ C ambient temperature

#### Storage Environment

Ambient temperature.....	-20 to 70 $^{\circ}$ C, tested in accordance with IEC-60068-2-1 and IEC-60068-2-2
Relative humidity .....	5 to 95%, noncondensing, tested in accordance with IEC-60068-2-56

### Shock and Vibration (PXI Only)

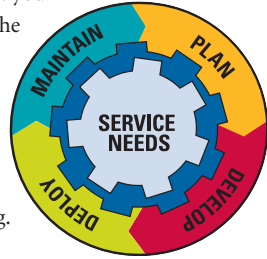
Operational shock .....	30 g peak, half-sine, 11 ms pulse, tested in accordance with IEC-60068-2-27. Test profile developed in accordance with MIL-PRF-28800F.
Random vibration	
Operating.....	5 to 500 Hz, 0.3 $g_{rms}$
Nonoperating.....	5 to 500 Hz, 2.4 $g_{rms}$ , tested in accordance with IEC-60068-2-64.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

### Certifications and Compliances

CE Mark Compliance 

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NI has the services and support to meet your needs around the globe and through the application life cycle – from planning and development through deployment and ongoing maintenance. We offer services and service levels to meet customer requirements in research, design, validation, and manufacturing. Visit [ni.com/services](http://ni.com/services).



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## Hardware Services

### NI Factory Installation Services

NI Factory Installation Services (FIS) is the fastest and easiest way to use your PXI or PXI/SCXI combination systems right out of the box. Trained NI technicians install the software and hardware and configure the system to your specifications. NI extends the standard warranty by one year on hardware components (controllers, chassis, modules) purchased with FIS. To use FIS, simply configure your system online with [ni.com/pxiadvisor](http://ni.com/pxiadvisor).

## Calibration Services

NI recognizes the need to maintain properly calibrated devices for high-accuracy measurements. We provide manual calibration procedures, services to recalibrate your products, and automated calibration software specifically designed for use by metrology laboratories. Visit [ni.com/calibration](http://ni.com/calibration).

## Repair and Extended Warranty

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