

# USER GUIDE AND SPECIFICATIONS

## NI myRIO-1950

The National Instruments myRIO-1950 is a portable reconfigurable I/O (RIO) device that students can use to design control, robotics, and mechatronics systems. This document contains pinouts, connectivity information, dimensions, mounting instructions, and specifications for the NI myRIO-1950.

## Safety Information

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**Caution** Do not operate the hardware in a manner not specified in this document and in the user documentation. Misuse of the hardware can result in a hazard. You can compromise the safety protection if the hardware is damaged in any way. If the hardware is damaged, return it to National Instruments for repair.

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

## Electromagnetic Compatibility Guidelines

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This product was tested and complies with the regulatory requirements and limits for electromagnetic compatibility (EMC) stated in the product specifications. These requirements and limits provide reasonable protection against harmful interference when the product is operated in the intended operational electromagnetic environment.

This product is intended for use in commercial locations. There is no guarantee that harmful interference will not occur in a particular installation or when the product is connected to a test object. To minimize interference with radio and television reception and prevent unacceptable performance degradation, install and use this product in strict accordance with the instructions in the product documentation.

Furthermore, any modifications to the product not expressly approved by National Instruments could void your authority to operate it under your local regulatory rules.



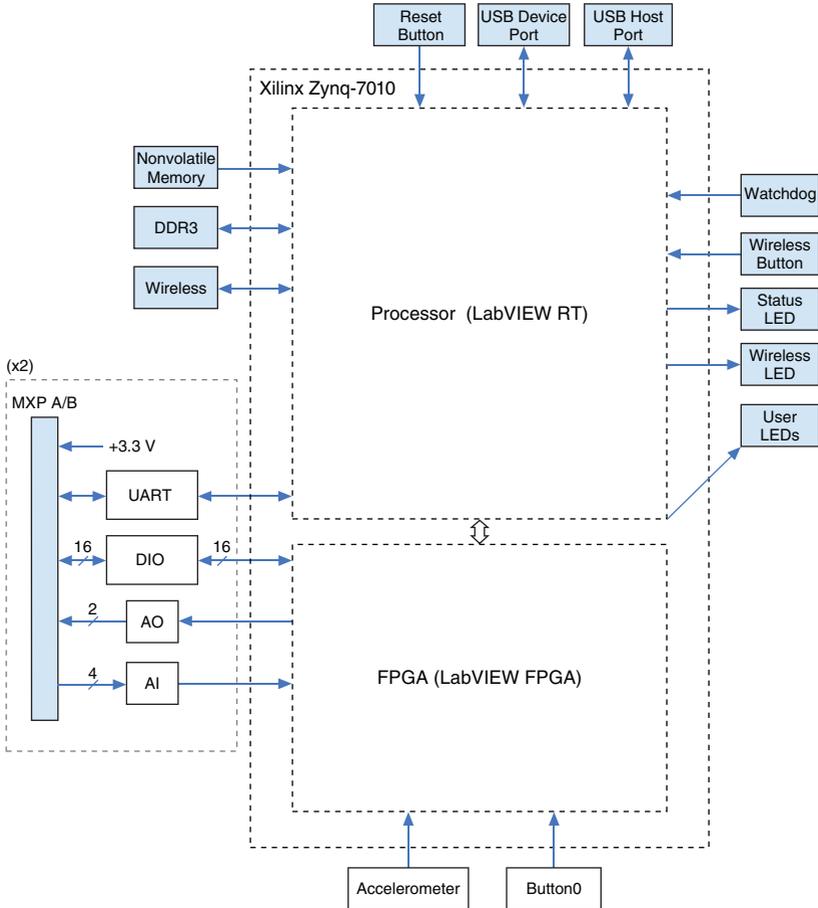
**Caution** This product was tested for EMC compliance using myRIO application software. The maximum length for USB cables is 2.0 m (6.6 ft), and the maximum length for signal wires is 30.0 cm (11.8 in.).

# Hardware Overview

The NI myRIO-1950 provides analog input (AI), analog output (AO), digital input and output (DIO), audio, and power output in a compact embedded device. The NI myRIO-1950 connects to a host computer over USB and wireless 802.11b,g,n.

The following figure shows the arrangement and functions of NI myRIO-1950 components.

**Figure 1. NI myRIO-1950 Hardware Block Diagram**





**Table 1.** Descriptions of Signals on MXP Connectors A and B

Signal Name	Reference	Direction	Description
AGND	N/A	N/A	Reference for analog input and output.
+3.3V	DGND	Output	+3.3 V power output.
DIO <0..15>	DGND	Input or Output	General-purpose digital lines with 3.3 V output, 3.3 V/5 V-compatible input. Refer to the <i>DIO Lines</i> section for more information.
UART.RX	DGND	Input	UART receive input. UART lines are electrically identical to DIO lines.
UART.TX	DGND	Output	UART transmit output. UART lines are electrically identical to DIO lines.
DGND	N/A	N/A	Reference for digital signals, +5 V, and +3.3 V.

## Analog Input Channels

The NI myRIO-1950 has analog input channels on myRIO Expansion Port (MXP) connectors A and B. The analog inputs are multiplexed to a single analog-to-digital converter (ADC) that samples all channels.

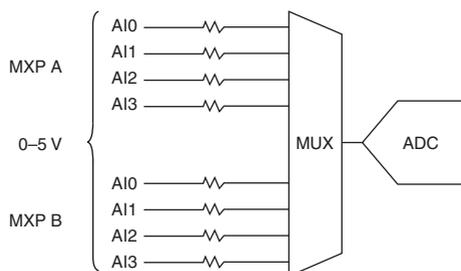
MXP connectors A and B have four single-ended analog input channels per connector, AI0–AI3, which you can use to measure 0–5 V signals.



**Note** For important information about improving measurement accuracy by reducing noise, go to [ni.com/info](http://ni.com/info) and enter the Info Code *analogwiring*.

Figure 3 shows the analog input topology of the NI myRIO-1950.

**Figure 3.** NI myRIO-1950 Analog Input Topology



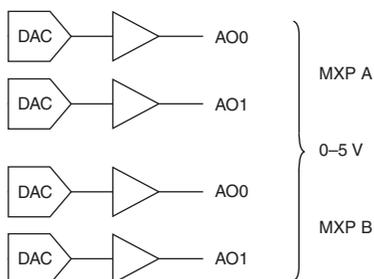
# Analog Output Channels

The NI myRIO-1950 has analog output channels on myRIO Expansion Port (MXP) connectors A and B. Each analog output channel has a dedicated digital-to-analog converter (DAC), so they can all update simultaneously. The DACs for the analog output channels are controlled by two serial communication buses from the FPGA. MXP connectors A and B share one bus. Therefore, the maximum update rate is specified as an aggregate figure in the *Analog Output* section of the specifications.

MXP connectors A and B have two analog output channels per connector, AO0 and AO1, which you can use to generate 0–5 V signals.

Figure 4 shows the analog output topology of the NI myRIO-1950.

**Figure 4.** NI myRIO-1950 Analog Output Topology



## Accelerometer

The NI myRIO-1950 contains a three-axis accelerometer. The accelerometer samples each axis continuously and updates a readable register with the result. Refer to the *Accelerometer* section of the specifications for the accelerometer sample rates.

## Converting Raw Data Values to Voltage

You can use the following equations to convert raw data values to volts:

$$V = \text{Raw Data Value} * \text{LSB Weight}$$

$$\text{LSB Weight} = \text{Nominal Range} \div 2^{\text{ADC Resolution}}$$

where *Raw Data Value* is the value returned by the FPGA I/O Node,

*LSB Weight* is the value in volts of the increment between data values,

*Nominal Range* is the absolute value in volts of the full, peak-to-peak nominal range of the channel,

and *ADC Resolution* is the resolution of the ADC in bits. (*ADC Resolution* = 12.)

- For AI and AO channels on the MXP connectors,

$$LSB\ Weight = 5\ V \div 2^{12} = 1.221\ mV$$

$$Maximum\ reading = 4095 * 1.221\ mV = 4.999\ V$$

- For the accelerometer,

$$LSB\ Weight = 16\ g \div 2^{12} = 3.906\ mg$$

$$Maximum\ Positive\ Reading = +2047 * 3.906\ mg = +7.996\ g$$

$$Maximum\ Negative\ Reading = -2048 * 3.906\ mg = -8.000\ g$$

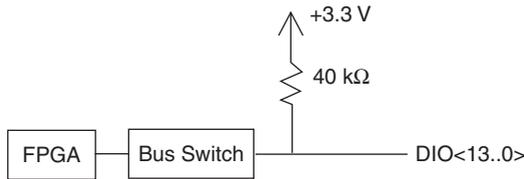
## DIO Lines

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The NI myRIO-1950 has 3.3 V general-purpose DIO lines on the MXP connectors. MXP connectors A and B have 16 DIO lines per connector. On the MXP connectors, each DIO line from 0 to 13 has a 40 kΩ pullup resistor to 3.3 V, and DIO lines 14 and 15 have 2.2 kΩ pullup resistors to 3.3 V. DGND is the reference for all the DIO lines. You can program all the lines individually as inputs or outputs. Secondary digital functions include Serial Peripheral Interface Bus (SPI), I2C, pulse-width modulation (PWM), and quadrature encoder input. Refer to the NI myRIO software documentation for information about configuring the DIO lines.

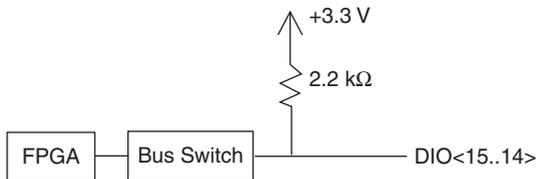
**Figure 5.** DIO Lines <13..0> on MXP Connector A or B

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**Figure 6.** DIO Lines <15..14> on MXP Connector A or B

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## UART Lines

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The NI myRIO-1950 has one UART receive input line and one UART transmit output line on each MXP connector. The UART lines are electrically identical to DIO lines 0 to 13 on the MXP connectors. Like those lines, UART.RX and UART.TX have 40 kΩ pullup resistors to 3.3 V. Use LabVIEW Real-Time to read and write over the UART lines.

# Using the Reset Button

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Pressing and releasing the Reset button restarts the processor and the FPGA.

Pressing and holding the Reset button for 5 seconds, then releasing it, restarts the processor and the FPGA and forces the NI myRIO-1950 into safe mode. In safe mode, the NI myRIO-1950 launches only the services necessary for updating configuration and installing software.

When the NI myRIO-1950 is in safe mode, you can communicate with it by using the UART lines on MXP connector A. You need the following items to communicate with the myRIO device over UART:

- USB-to-TTL serial UART converter cable (for example, part number TTL-232RG-VSW3V3-WE from FTD Chip)
- Serial-port terminal program configured with the following settings:
  - 115,200 bits per second
  - Eight data bits
  - No parity
  - One stop bit
  - No flow control

# Using the Wireless Button and LED

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For information about using the Wireless button, go to [ni.com/info](http://ni.com/info) and enter the Info Code `myriowirelessbutton`.

For information about using the Wireless LED, go to [ni.com/info](http://ni.com/info) and enter the Info Code `myriowirelessled`.

# Using Button0

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Button0 produces a logic TRUE when depressed and a logic FALSE when not depressed. Button0 is not debounced.

# Understanding LED Indications

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## Power LED

The Power LED is lit while the NI myRIO-1950 is powered on. This LED indicates that the power supply connected to the device is adequate.

## Status LED

The Status LED is off during normal operation. The NI myRIO-1950 runs a power-on self test (POST) when you apply power to the device. During the POST, the Power and Status LEDs turn on. When the Status LED turns off, the POST is complete. The NI myRIO-1950 indicates

specific error conditions by flashing the Status LED a certain number of times every few seconds, as shown in Table 2.

**Table 2.** Status LED Indications

<b>Number of Flashes Every Few Seconds</b>	<b>Indication</b>
2	The device has detected an error in its software. This usually occurs when an attempt to upgrade the software is interrupted. Reinstall software on the device.
3	The device is in safe mode.
4	The software has crashed twice without rebooting or cycling power between crashes. This usually occurs when the device runs out of memory. Review your RT VI and check the memory usage. Modify the VI as necessary to solve the memory usage issue.
Continuously flashing or solid	The device has detected an unrecoverable error. Contact National Instruments.

## LEDs 0–3

You can use LEDs 0–3 to help debug your application or easily retrieve application status. Logic TRUE turns an LED on and logic FALSE turns an LED off.

## Using the USB Host Port

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The NI myRIO-1950 USB host port supports Web cameras that conform to the USB Video Device Class (UVC) protocol as well as machine vision cameras that conform to the USB3 Vision standard and are USB 2.0 backward compatible. The NI myRIO-1950 USB host port also supports Basler ace USB3 cameras.

The NI myRIO-1950 USB host port also supports USB Flash drives and USB-to-IDE adapters formatted with FAT16 and FAT32 file systems. LabVIEW usually maps USB devices to the /U, /V, /W, or /X drive, starting with the /U drive if it is available.

# Cables and Accessories

**Table 3.** Accessories Available from NI

Accessory	Description	NI Part Number
Power supply	Power supply for NI myRIO-1950	723403-01
MXP breakout	Set of five MXP breakout boards for NI myRIO-1950	XXXXXX-01

## Specifications

The following specifications are typical for the 0 to 40 °C operating temperature range unless otherwise noted.

### Processor

Processor type..... Xilinx Z-7010  
Processor speed..... 667 MHz  
Processor cores ..... 2

### Memory

Nonvolatile memory ..... 256 MB  
DDR3 memory ..... 512 MB  
    DDR3 clock frequency ..... 533 MHz  
    DDR3 data bus width ..... 16 bits

For information about the lifespan of the nonvolatile memory and about best practices for using nonvolatile memory, go to [ni.com/info](http://ni.com/info) and enter the Info Code SSDBP.

### FPGA

FPGA type..... Xilinx Z-7010

### Wireless Characteristics

Radio mode..... IEEE 802.11 b,g,n  
Frequency band..... ISM 2.4 GHz  
Channel width..... 20 MHz  
Channels ..... USA 1–11, International 1–13  
TX power ..... +10 dBm max (10 mW)  
Outdoor range ..... Up to 150 m (line of sight)

Antenna directivity .....	Omnidirectional
Security .....	WPA, WPA2, WPA2-Enterprise

## USB Ports

USB host port.....	USB 2.0 Hi-Speed
USB device port.....	USB 2.0 Hi-Speed

## Analog Input

Aggregate sample rate .....	500 kS/s
Resolution .....	12 bits
Overvoltage protection .....	±16 V

### MXP connectors

Configuration .....	Four single-ended channels per connector
Input impedance.....	>500 k $\Omega$ acquiring at 500 kS/s 1 M $\Omega$ powered on and idle 4.7 k $\Omega$ powered off
Recommended source impedance.....	3 k $\Omega$ or less
Nominal range.....	0 V to +5 V
Absolute accuracy.....	±50 mV
Bandwidth.....	>300 kHz

## Analog Output

### Aggregate maximum update rates

All AO channels on MXP connectors.....	345 kS/s
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Resolution .....	12 bits
Overload protection .....	±16 V
Startup voltage .....	0 V after FPGA initialization

### MXP connectors

Configuration .....	Two single-ended channels per connector
Range .....	0 V to +5 V
Absolute accuracy.....	50 mV
Current drive .....	3 mA
Slew rate .....	0.3 V/ $\mu$ s

## Digital I/O

### Number of lines

MXP connectors .....	2 ports of 16 DIO lines (one port per connector); one UART.RX and one UART.TX line per connector
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Direction control.....	Each DIO line individually programmable as input or output
Logic level.....	5 V compatible LVTTL input; 3.3 V LVTTL output
Input logic levels	
Input low voltage, $V_{IL}$ .....	0 V min; 0.8 V max
Input high voltage, $V_{IH}$ .....	2.0 V min; 5.25 V max
Output logic levels	
Output high voltage, $V_{OH}$ sourcing 4 mA.....	2.4 V min; 3.465 V max
Output low voltage, $V_{OL}$ sinking 4 mA.....	0 V min; 0.4 V max
Maximum hardware update rate.....	8 MS/s
Maximum frequencies for secondary digital functions	
SPI.....	4 MHz
PWM.....	100 kHz
Quadrature encoder input.....	100 kHz
I <sup>2</sup> C.....	400 kHz
UART lines	
Maximum baud rate.....	230,400 bps
Data bits.....	5, 6, 7, 8
Stop bits.....	1, 2
Parity.....	Odd, Even, Mark, Space
Flow control.....	XON/XOFF

## Accelerometer

Number of axes.....	3
Range.....	±8 g
Resolution.....	12 bits
Sample rate.....	800 S/s
Noise.....	3.9 mg <sub>rms</sub> typical at 25 °C

## Power Output

+5 V power output	
Output voltage.....	4.75 V to 5.25 V
Maximum current on each connector.....	100 mA

+3.3 V power output	
Output voltage.....	3.0 V to 3.6 V
Maximum current on each connector .....	150 mA
+15 power output	
Output voltage.....	+15 V to +16 V
Maximum current .....	32 mA (16 mA during startup)
-15 V power output	
Output voltage.....	-15 V to -16 V
Maximum current .....	32 mA (16 mA during startup)
Maximum combined power from +15 V and -15 V power output.....	
	500 mW

## Power Requirements

NI myRIO-1950 requires a power supply connected to the power connector.



**Caution** You must use either the power supply provided in the shipping kit, or another UL Listed ITE power supply marked *LPS*, with the NI myRIO-1950.

Power supply voltage range.....	6–16 VDC
Maximum power consumption .....	14 W
Typical idle power consumption .....	2.6 W

## Environmental

To meet these specifications, you must operate the NI myRIO-1950 with the window facing away from the mounting surface and ensure that there is at least 1 in. of clearance in front of the window during use.

Ambient temperature near device (IEC 60068-2-1, IEC 600682-2).....	
	0 to 40 °C
Storage temperature (IEC 60068-2-1, IEC 600682-2).....	
	-20 to 70 °C
Operating humidity (IEC 60068-2-56).....	
	10 to 90% RH, noncondensing
Storage humidity (IEC 60068-2-56).....	
	10 to 90% RH, noncondensing
Maximum altitude.....	2,000 m
Pollution Degree (IEC 60664).....	2
Indoor use only.	

# Physical Characteristics

Weight..... XXX g (X.X oz)

## Safety

### Safety Standards

This product is 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 the [Online Product Certification](#) section.



**Caution** Using the NI myRIO-1950 in a manner not described in this document may impair the protection the NI myRIO-1950 provides.

### Hazardous Locations

The NI myRIO-1950 is not certified for use in hazardous locations.

## 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 55022 (CISPR 22): Group 1, Class A emissions
- EN 55011 (CISPR 11): Group 1, Class A emissions
- AS/NZS CISPR 11: Group 1, Class A emissions
- AS/NZS CISPR 22: Group 1, Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions



**Note** For EMC declarations and certifications, refer to the [Online Product Certification](#) section.

## CE Compliance

This product meets the essential requirements of applicable European Directives as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)
- 1999/5/EC; Radio and Telecommunications Terminal Equipment Directive (R&TTE)

## Online Product Certification

To obtain product certifications and the Declaration of Conformity (DoC) for this product, visit [ni.com/certification](http://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](http://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 products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers, National Instruments WEEE initiatives, and compliance with WEEE Directive 2002/96/EC on Waste and Electronic Equipment, visit [ni.com/environment/weee](http://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](http://ni.com/environment/rohs_china)。(For information about China RoHS compliance, go to [ni.com/environment/rohs\\_china](http://ni.com/environment/rohs_china).)

## Warranty

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For customers other than private individual users in the EU: The NI myRIO-1950 is warranted against defects in materials and workmanship for a period of one year from the date of shipment, as evidenced by receipts or other documentation. National Instruments will, at its option, repair or replace equipment that proves to be defective during the warranty period. This warranty includes parts and labor.

For private individual users in the EU: Based on your statutory rights, National Instruments will—through its distributor—cure defects in materials and workmanship within two years from delivery.

## Where to Go for Support

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The National Instruments Web site is your complete resource for technical support. At [ni.com/support](http://ni.com/support) you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

A Declaration of Conformity (DoC) is our claim of compliance with the Council of the European Communities using the manufacturer's declaration of conformity. This system affords the user protection for electromagnetic compatibility (EMC) and product safety. You can obtain the DoC for your product by visiting [ni.com/certification](http://ni.com/certification). If your product supports calibration, you can obtain the calibration certificate for your product at [ni.com/calibration](http://ni.com/calibration).

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world to help address your support needs. For telephone support in the United States, create your service request at [ni.com/support](http://ni.com/support) and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, visit the Worldwide Offices section of [ni.com/niglobal](http://ni.com/niglobal) to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.