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Requirements and Compatibility | Detailed Specifications | Pinouts/Front Panel Connections
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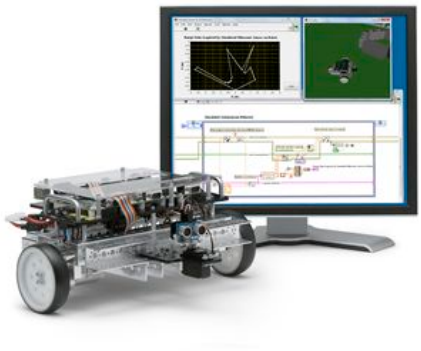
NI LabVIEW Robotics Starter Kit

Robotics Platform for Teaching, Research, and Prototyping



- Fully assembled mobile robot base starter kit
- Ultrasonic sensor, encoders, motors, battery, and charger included
- Controller based on NI Single-Board RIO
- Real-time decision making and FPGA-based I/O processing
- 180-day evaluation of LabVIEW Robotics, LabVIEW Real-Time, and LabVIEW FPGA module software
- Easily connects to a variety of robotic sensors and actuators
- Executes an obstacle avoidance program out of the box

Requirements and Compatibility

OS Information

- Windows

Driver Information

- NI-RIO

Software Compatibility

- LabVIEW
- LabVIEW FPGA Module
- LabVIEW Real-Time Module
- LabVIEW Robotics Module

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Application and Technology

The NI LabVIEW Robotics Starter Kit is an out-of-the-box mobile robot platform that features sensors, motors, and NI Single-Board RIO hardware for embedded control. The LabVIEW Robotics software included with the platform includes features for beginners and for those who are more experienced. If you are new to LabVIEW, you can use the high-level LabVIEW Robotics Starter Kit API to quickly get started and control the robot in real time. If you are a more advanced user, you can access the FPGA and perform lower-level customization.

The simplicity of this starter kit makes it ideal for teaching robotics and mechatronics concepts or for developing a robot prototype with LabVIEW Robotics. The LabVIEW Robotics Starter Kit includes a prebuilt program that executes a vector field histogram (VFH) obstacle avoidance algorithm based on feedback from the included ultrasonic sensors. With the LabVIEW Robotics Module, you can easily change the behavior of the robot by developing your own algorithms from the ground up or by using algorithms built into LabVIEW Robotics software such as A* path planning.

LabVIEW Robotics Starter Kit Features

- Pitsco Education 12 VDC motors featuring 152 rpm and 300 oz-in. of torque
- Optical quadrature encoders with 400 pulses per revolution
- PING))) ultrasonic distance sensor for distance measurements between 2 cm and 3 m
- PING))) mounting bracket for a 180-degree sweep of the environment
- Two Pitsco Education TETRIX 4 in. wheels and one omni wheel for steering

NI sbRIO-9632 Overview

The NI sbRIO-9632 embedded control and acquisition device integrates a real-time processor, a user-reconfigurable field-programmable gate array (FPGA), and I/O on a single printed circuit board (PCB). It features a 400 MHz industrial processor, a 2M gate Xilinx Spartan FPGA, 110 3.3 V (5 V tolerant/TTL compatible) digital I/O lines, 32 single-ended/16 differential 16-bit analog input channels at 250 kS/s, and four 16-bit analog output channels at 100 kS/s. It also has three connectors for expansion I/O using board-level NI C Series I/O modules. The sbRIO-9632 offers a -20 to 55 °C operating temperature range, and includes a 19 to 30 VDC power supply input range, 128 MB of DRAM for embedded operation, and 256 MB of nonvolatile memory for storing programs and data logging.

This device features a built-in 10/100 Mbit/s Ethernet port you can use to conduct programmatic communication over the network and host built-in Web (HTTP) and file (FTP) servers. You also can use the RS232 serial port to control peripheral devices.

sbRIO-9632 Features

- Integrated real-time controller, reconfigurable FPGA, and I/O on a single board
- 2M gate Xilinx Spartan FPGA
- 400 MHz Freescale real-time processor
- 128 MB DRAM, 256 MB nonvolatile storage
- RS232 serial port for peripheral devices
- 110 3.3 V (5 V tolerant/TTL compatible) digital I/O lines
- 32 single-ended/16 differential 16-bit analog input channels at 250 kS/s
- Four 16-bit analog output channels at 100 kS/s
- 10/100BASE-T Ethernet port
- Low power consumption with single 19 to 30 VDC power supply input

Software Overview

You program the sbRIO-9632 device using the LabVIEW graphical development environment. The real-time processor runs the LabVIEW Real-Time Module on the Wind River VxWorks real-time operating system (RTOS) for extreme reliability and determinism. With the addition of the LabVIEW MathScript RT Module, you can easily deploy your custom .m files to NI real-time hardware while combining both graphical and textual syntax.

You can quickly program the onboard reconfigurable FPGA using the LabVIEW FPGA Module for high-speed control, custom I/O timing, and inline signal processing. LabVIEW contains built-in drivers and APIs for handling data transfer between the FPGA and real-time processor.

The LabVIEW Robotics Module plugs into the LabVIEW development environment and delivers an extensive robotics library including the following:

- Connectivity to robotic sensors
- Foundational algorithms for intelligent operation and robust perception
- Built-in physics-based environment simulator
- Motion functions for making your robot or vehicle move
- Real-world application examples
- Forward and inverse kinematics
- Libraries for protocols including I^2C, SPI, PWM, and JAUS

The LabVIEW Robotics Module provides tools for developing a variety of robots, from simple and educational robots to sophisticated autonomous systems. The software offers software architectures or templates that you can use to easily program a simple behavior-based robot, similar to the code shown in Figure 1, and for programming complex robots with multiple subsystems executing in parallel, as shown in Figure 2.

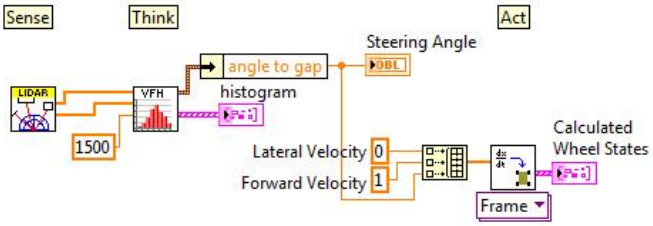

Figure 1. A Simple Behavior-Based Robot Program

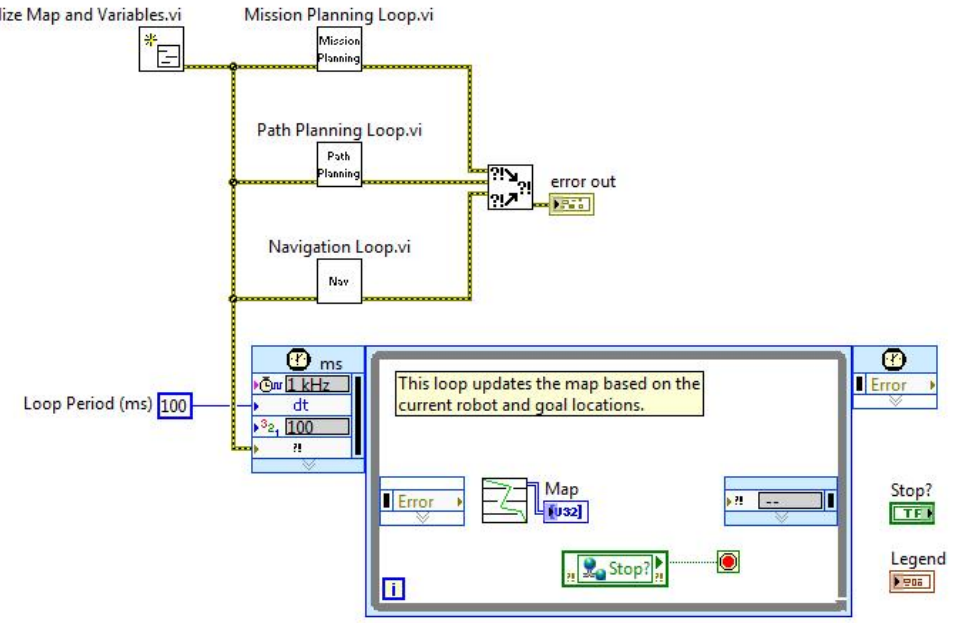

Figure 2. An Advanced Robotics Program With Multiple Subsystems Executing in Parallel

The LabVIEW Robotics Module includes built-in drivers for the following sensors and cameras for the NI Single-Board RIO and NI CompactRIO embedded platforms:

- Hokuyo, SICK, and Velodyne LIDAR
- Sharp infrared sensors
- Garmin, NavCom, and u-blox GPS
- Crossbow, Microstrain, and OceanServer inertial measurement unit (IMU) [j1]
- Devantech and MaxSonar sonar sensors
- Devantech compass
- Basler and Axis IP cameras
- Analog cameras with the AF-1501 analog frame grabber from moviMED

The LabVIEW Academic Site License and the LabVIEW Academic Premium Suite include all of the required software for the LabVIEW Robotics Starter Kit at an exceptional value for academic institutions. For more information on the academic licensing, see ni.com/academic/purchasing.

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Support and Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

Technical Support

Get answers to your technical questions using the following National Instruments resources.

- **Support** - Visit ni.com/support to access the NI KnowledgeBase, example programs, and tutorials or to contact our applications engineers who are located in NI sales offices around the world and speak the local language.
- **Discussion Forums** - Visit forums.ni.com for a diverse set of discussion boards on topics you care about.
- **Online Community** - Visit community.ni.com to find, contribute, or collaborate on customer-contributed technical content with users like you.

Repair

While you may never need your hardware repaired, NI understands that unexpected events may lead to necessary repairs. NI offers repair services performed by highly trained technicians who quickly return your device with the guarantee that it will perform to factory specifications. For more information, visit ni.com/repair.

Training and Certifications

The NI training and certification program delivers the fastest, most certain route to increased proficiency and productivity using NI software and hardware. Training builds the skills to more efficiently develop robust, maintainable applications, while certification validates your knowledge and ability.

- **Classroom training in cities worldwide** - the most comprehensive hands-on training taught by engineers.
- **On-site training at your facility** - an excellent option to train multiple employees at the same time.
- **Online instructor-led training** - lower-cost, remote training if classroom or on-site courses are not possible.
- **Course kits** - lowest-cost, self-paced training that you can use as reference guides.
- **Training memberships** and training credits - to buy now and schedule training later.

Visit ni.com/training for more information.

Extended Warranty

NI offers options for extending the standard product warranty to meet the life-cycle requirements of your project. In addition, because NI understands that your requirements may change, the extended warranty is flexible in length and easily renewed. For more information, visit ni.com/warranty.

OEM

NI offers design-in consulting and product integration assistance if you need NI products for OEM applications. For information about special pricing and services for OEM customers, visit ni.com/oem.

Alliance

Our Professional Services Team is comprised of NI applications engineers, NI Consulting Services, and a worldwide National Instruments Alliance Partner program of more than 700 independent consultants and integrators. Services range from start-up assistance to turnkey system integration. Visit ni.com/alliance.

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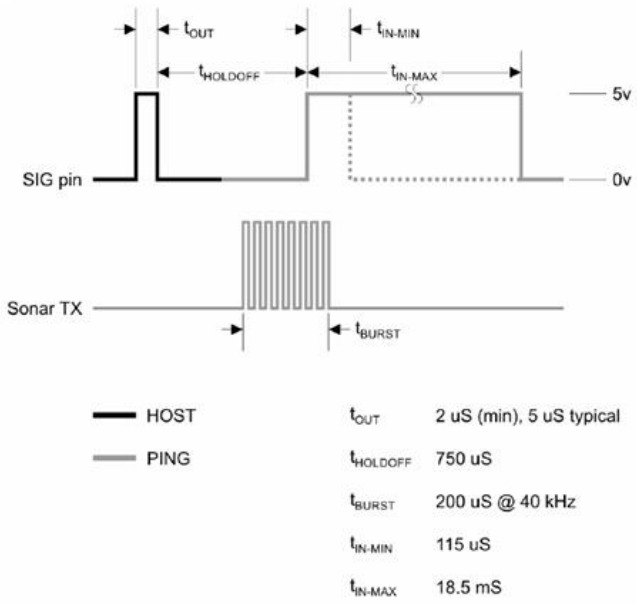
Detailed Specifications

Platform	
Size	405 mm x 368 mm x 150 mm (15.9" x 14.5" x 5.9")
Weight	3.6 kg (7.9 lb)
Battery charge time	1.7 hours
Battery charge time (with the motors turned on)*	1 hour
Battery charge time (with the motors turned off)	4 hours

* *Assuming that the robot is running the startup application (obstacle avoidance) on a fully charged battery*

Ultrasonic Sensor

The Parallax PING))) ultrasonic sensor detects objects by emitting a short ultrasonic burst and then “listening” for the echo. Under the control of a host microcontroller (trigger pulse), the sensor emits a short 40 kHz (ultrasonic) burst. This burst travels through the air at about 1130 feet per second, hits an object, and then bounces back to the sensor. The PING))) sensor provides an output pulse to the host that terminates when the echo is detected; hence, the width of this pulse corresponds to the distance to the target.



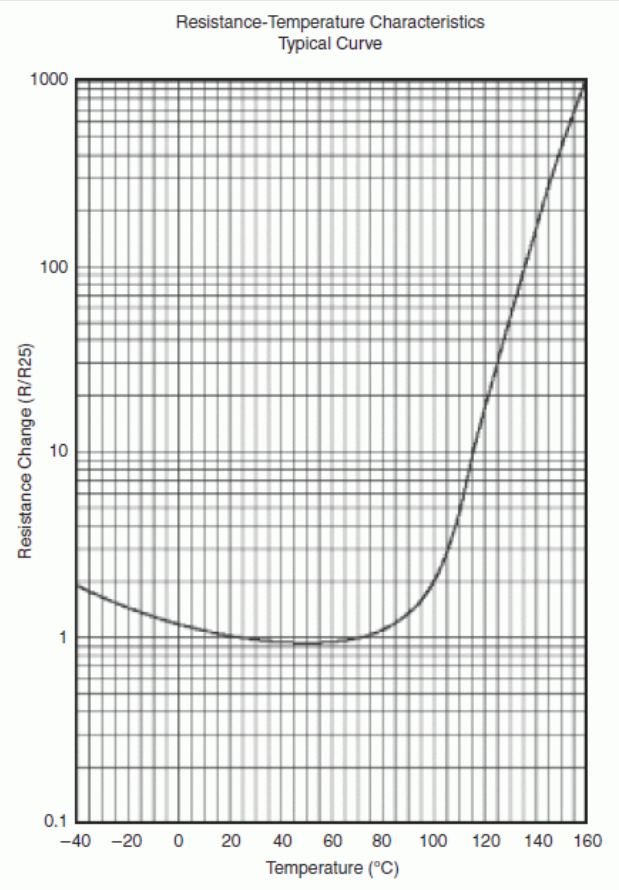
Supply voltage	5 VDC
Supply current	30 mA typ; 35 mA max

Range	2cm to 3m
Input trigger	positive TTL pulse, 2 µS min, 5 µs typ
Echo pulse	positive TTL pulse, 115 µS to 18.5 ms
Echo holdoff	750 µs from fall of trigger pulse
Burst frequency	40 kHz for 200 µs
Burst indicator	LED shows sensor activity
Delay before next measurement	200 µs
Size (H by W by D)	22mm x 46mm x 16 mm (0.84in. x 1.8in x 0.6 in.)
DC Motors	
Supply voltage	12V
Torque	300 oz-in.
RPM	152
Encoders	
Supply voltage	5V
Cycles per revolution	100 CPR
Pulses per revolution	400 PPR
NI sbRIO-9632 **Network**	
Network interface	10BaseT and 100BaseTX Ethernet
Compatibility	IEEE 802.3
Communication rates	10 Mbps, 100 Mbps, auto-negotiated
Maximum cabling distance	100 m/segment
RS-232 DTE Serial Port	
Baud rate support	Arbitrary
Maximum baud rate	115,200 bps
Data bits	5, 6, 7, 8
Stop bits	1, 2
Parity	Odd, Even, Mark, Space, None
Flow control	RTS/CTS, XON/XOFF, DTR/DSR, None
Processor Speed	
NI sbRIO-9611/9631/9641	266 MHz
NI sbRIO-9612/9632/9642 and NI sbRIO-96x2XT	400 MHz
Memory	
Non-volatile memory	
NI sbRIO-9611/9631/9641	128 MB
NI sbRIO-9612/9632/9642 and NI sbRIO-96x2XT	256 MB
System memory	
NI sbRIO-9611/9631/9641	64 MB
NI sbRIO-9612/9632/9642 and NI sbRIO-96x2XT	128 MB

For information about the life span of the nonvolatile memory and about best practices for using nonvolatile memory, go to ni.com/info and enter the Info Code SSDBP.

Xilinx Spartan-3 Reconfigurable FPGA	
Number of logic cells	

NI sbRIO-9611/9631/9641	17,280
NI sbRIO-9612/9632/9642 and NI sbRIO-96x2XT	46,080
Available embedded RAM	
NI sbRIO-9611/9631/9641	432 kbits
NI sbRIO-9612/9632/9642 and NI sbRIO-96x2XT	720 kbits
3.3 V Digital I/O	
Number of DIO channels	110
Maximum tested current per channel	3 mA
Maximum total current, all lines	330 mA
Maximum tested DIO frequency	10 MHz
Input logic levels	
Input high voltage, V_{IH}	2.0 V min; 5.25 V max
Input low voltage, V_{IL}	0 V min; 0.8 V max
Output logic levels	
Output high voltage, V_{OH}, sourcing 3 mA	2.7 V min; 3.3 V max
Output low voltage, V_{OL}, sinking 3 mA	0.07 V min; 0.54 V max
Overvoltage protection (maximum 2 pins in overvoltage)	
NI sbRIO-961*x*/963*x*/964*x*	
at –20 to 55 °C	±20 V
NI sbRIO-96*x*2XT	
at –20 to 85 °C	±20 V
at –40 to –20 °C	±7 V
Posistor (PRG18BB330MS1RB from Murata)	
Maximum peak abnormal-condition current	760 mA
Maximum hold current at 25 °C	36 mA
Maximum hold current at 70 °C	20 mA
Maximum hold current at 85 °C (NI sbRIO-96x2XT only)	3 mA
Trip current at 25 °C	71 mA
Resistance at 25 °C	33 Ω ±20%
Resistance-temperature characteristics, typical curve	

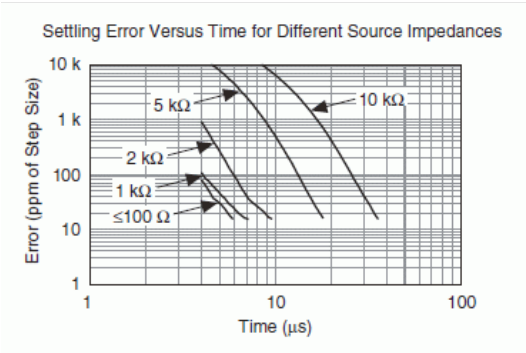


Analog Input

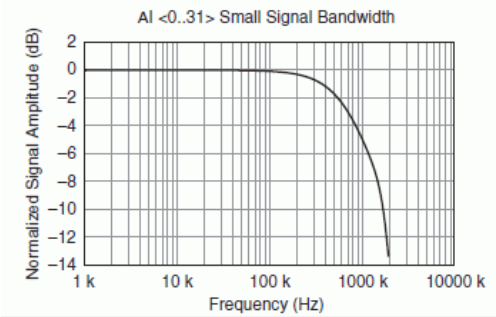
All voltages are relative to AI GND unless otherwise noted.	
Number of channels	32 single-ended or 16 differential analog input channels
ADC resolution	16 bits
Differential nonlinearity	No missing codes guaranteed
Integrated nonlinearity	Refer to the AI Absolute Accuracy Tables and Formulas.
Conversion time	4.00 µs (250 kS/s)
Input coupling	DC
Nominal input ranges	±10 V, ±5 V, ±1 V, ±0.2 V
Minimum overrange (for 10 V range)	4%
Maximum working voltage for analog inputs (signal + common mode)	Each channel must remain within ±10.4 V of common
Input impedance (AI-to-AI GND)	
Powered on	>10 GΩ in parallel with 100 pF
Powered off/overload	1.2 kΩ min
Input bias current	±100 pA
Crosstalk (at 100 kHz)	
Adjacent channels	–65 dB
Non-adjacent channels	–70 dB
Small-signal bandwidth	700 kHz
Overvoltage protection	
AI channel (0 to 31)	±24 V (one channel only)
AISENSE	±24 V
CMRR (DC to 60 Hz)	92 dB

Typical performance graphs

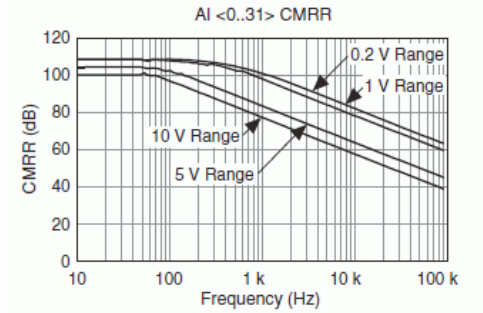
Settling Error Versus Time for Different Source Impedances



AI <0..31> Small Signal Bandwidth



AI <0..31> CMRR



Settling time for multichannel measurements, accuracy, all ranges	
±120 ppm of full-scale step	
(±8 LSB)	4 µs convert interval, 5.5 µs (from 50 to 85 °C)
±30 ppm of full-scale step	
(±2 LSB)	8 µs convert interval
Analog triggers	
Number of triggers	1
Resolution	10 bits, 1 in 1,024
Bandwidth (–3 dB)	700 kHz
Accuracy	±1% of full scale

Scaling coefficients	
Nominal Range (V)	**Typical Scaling Coefficient (µV/LSB)**
±10	324.5
±5	162.2
±1	32.45
±0.2	6.49

AI Absolute Accuracy Tables and Formulas

The values in the following tables are based on calibrated scaling coefficients, which are stored in an onboard EEPROM. Values are valid for a two-year period between external calibrations.

Accuracy summary					
Nominal Range (V)	Absolute Accuracy at Full Scale, within 5 °C of Last Internal Calibration (µV)	Absolute Accuracy at Full Scale, –20 to 55 °C (mV)	(XT Devices Only) Absolute Accuracy at Full Scale, –40 to 85 °C (mV)	Random Noise, σ (μV_{rms})	Sensitivity [1] (µV)
±10	7,820	36.6	52.0	244	97.6
±5	3,990	18.6	26.4	122	48.8
±1	870	4.27	6.07	30	12.0
±0.2	244	1.37	1.96	16	5.2

Accuracy details						
Nominal Range (V)	Residual Gain Error (ppm of Reading)	Gain Tempco (ppm/°C)	Reference Tempco	Residual Offset Error (ppm of Range)	Offset Tempco (ppm of Range/°C)	INL Error (ppm of Range)
±10	94	23	5	20	49	76
±5	104	23	5	20	50	76
±1	114	23	5	25	62	76
±0.2	154	23	5	40	118	76

Absolute accuracy formulas

AbsoluteAccuracy = *Reading* · *GainError* + *Range* · *OffsetError* + *NoiseUncertainty*

GainError = *ResidualGainError* + *GainTempco* · *TempChangeFromLastInternalCal* + *ReferenceTempco* · *TempChangeFromLastExternalCal*

OffsetError = *ResidualOffsetError* + *OffsetTempco* · *TempChangeFromLastInternalCal* + *INL_Error*

NoiseUncertainty = (*RandomNoise* · 3) / $\sqrt{100}$ for a coverage factor of 3σ and averaging 100 points.

Absolute accuracy at full scale on the analog input channels is determined using the following assumptions:

TempChangeFromLastExternalCal = 45 °C

TempChangeFromLastInternalCal = 5 °C

NumberOfReadings = 100

CoverageFactor = 3 σ

For example, on the 10 V range, the absolute accuracy at full scale is as follows:

GainError = 94 ppm + 23 ppm · 5 + 5 ppm · 45 *GainError* = 434 ppm

OffsetError = 20 ppm + 49 ppm · 5 + 76 ppm *OffsetError* = 341 ppm

NoiseUncertainty = (244 µV · 3) / $\sqrt{100}$
Noise Uncertainty = 73.2 µV

AbsoluteAccuracy = 10 V · 434 ppm + 10 V · 341 ppm + 73.2 µV
AbsoluteAccuracy = 7,823 µV (rounds to 7,820 µV)

To determine the absolute accuracy over the full operating temperature range, let:

TempChangeFromLastInternalCal = 45 °C

Analog Output (NI sbRIO-963*x*/9632XT and NI sbRIO-964*x*/9642XT Only)

Number of channels	4 analog output channels
DAC resolution	16 bits
Type of DAC	String
Output range	±10 V
Operating voltage	
Nominal	±10.7 V
Minimum	±10.3 V
Maximum	±11 V
Current drive	±3 mA per channel
Output impedance	0.1 Ω

Accuracy		
Measurement Conditions	**Percent of Reading (Gain Error)**	**Percent of Range [2] (Offset Error)**
Calibrated, max (–40 to 85 °C)	0.35%	0.75%
Calibrated, typ (25 °C, ±5 °C)	0.01%	0.1%
Uncalibrated, max (–40 to 85 °C)	2.2%	1.7%
Uncalibrated, typ (25 °C, ±5 °C)	0.3%	0.25%

Stability	
Offset drift	80 µV/°C
Gain drift	6 ppm/°C
Protection	
Overvoltage	±25 V at 25 °C
Short-circuit	Indefinitely
Power-on voltage	0 V

Note All analog outputs are unpowered until a value is written to an analog output.

Update time	
One channel in use	3 µs
Two channels in use	5 µs
Three channels in use	7.5 µs
Four channels in use	9.5 µs
Noise	
Updating at 100 kS/s	600 μV_{rms}
Not updating	260 μV_{rms}
Slew rate	4 V/µs
Crosstalk	76 dB
Settling time (100 pF load, to 1 LSB)	
FS step	20 µs
3 V step	10 µs
0.1 V step	8 µs
Glitch energy (256 steps, worst case)	2 mV for 2 µs
Capacitive drive	1,500 pF min
Monotonicity	16 bits
Differential nonlinearity	–1 to 2 LSBs max
Integrated nonlinearity (endpoint)	16 LSBs max

Power Limits

Caution Exceeding the power limits may cause unpredictable behavior by the device.

5 V pins (P2, P3, P4, P5)	+5 V ±5%, 2 A max (shared with C Series modules)

Power Requirements

The NI sbRIO device requires a power supply connected to connector J3. Refer to the *Powering the NI sbRIO Device* section in the User Guide for information about connecting the power supply.

Power supply voltage range	19–30 VDC [6]
Power supply current limit	1.8 A
Power connector internal fuse	2 A non-replaceable

Total power requirement = $P_{int} + P_{DIO} + P_{5V} + P_{CSer}$, where:

P_{int} is the consumption by sbRIO internal operation, including integrated I/O

P_{DIO} is the consumption by the 3.3 V DIO

P_{5V} is the consumption by the 5 V voltage output

P_{CSer} is the consumption by installed board-only C Series modules.

Note You must add 20% to the calculated or measured total power requirement to account for transient and startup conditions.

Maximum P_{int}	
NI sbRIO-961x/9612XT	7.50 W
NI sbRIO-963x/9632XT	7.75 W
NI sbRIO-964x/9642XT	8.00 W
Maximum P_{DIO}	1.28 W
P_{DIO} = *Total DIO Current* × 3.3 V/0.85	
Maximum P5V	11.1 W
P_{5V} = *Total 5 V Output Current* × 5 V/0.9	
Maximum P_{CSer}	3.3 W; each installed C Series module consumes up to 1.1 W.

Example power requirement calculations:

For an NI sbRIO-9642/9642XT with three installed board-only C Series modules, 20 mA total current through the 3.3 V DIO pins, and 1 A of current through the 5 V output, calculate the total power requirement as follows:

P_{int} = 8.00 W
P_{CSer} = 3.30 W
P_{DIO} = 0.08 W
P_{5V} = 5.55 W

Adding 20% for transient conditions, 16.93 W × 1.2 = 20.32 W

Total power requirement = 20.32 W

For an sbRIO-9612/9612XT with one installed board-only C Series module, 330 mA total current through the 3.3 V DIO pins, and no 5 V output used, calculate the total power requirement as follows:

P_{int} = 7.50 W
P_{CSer} = 1.10 W
P_{DIO} = 1.28 W
P_{5V} = 0.00 W

Adding 20% for transient conditions, 9.88 W × 1.2 = 11.86 W

Total power requirement = 11.86 W

Backup battery	3 V lithium coin cell, BR2032 (–40 to 85 °C)

Safety Voltages

Connect only voltages that are within this limit.	
V terminal to C terminal	35 VDC max, Measurement Category I

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS [7] voltage. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special hardware, limited-energy parts of hardware, circuits powered by regulated low-voltage sources, and electronics.

Caution Do not connect the system to signals or use for measurements within Measurement Categories II, III, or IV.

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 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 Electrical and Electronic Equipment, visit ni.com/environment/weee.htm.

Battery Replacement and Disposal

Battery Directive This device contains a long-life coin cell battery. If you need to replace it, use the Return Material Authorization (RMA) process or contact an authorized National Instruments service representative. For more information about compliance with the EU Battery Directive 2006/66/EC about Batteries and Accumulators and Waste Batteries and Accumulators, visit ni.com/environment/batterydirective.

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.)

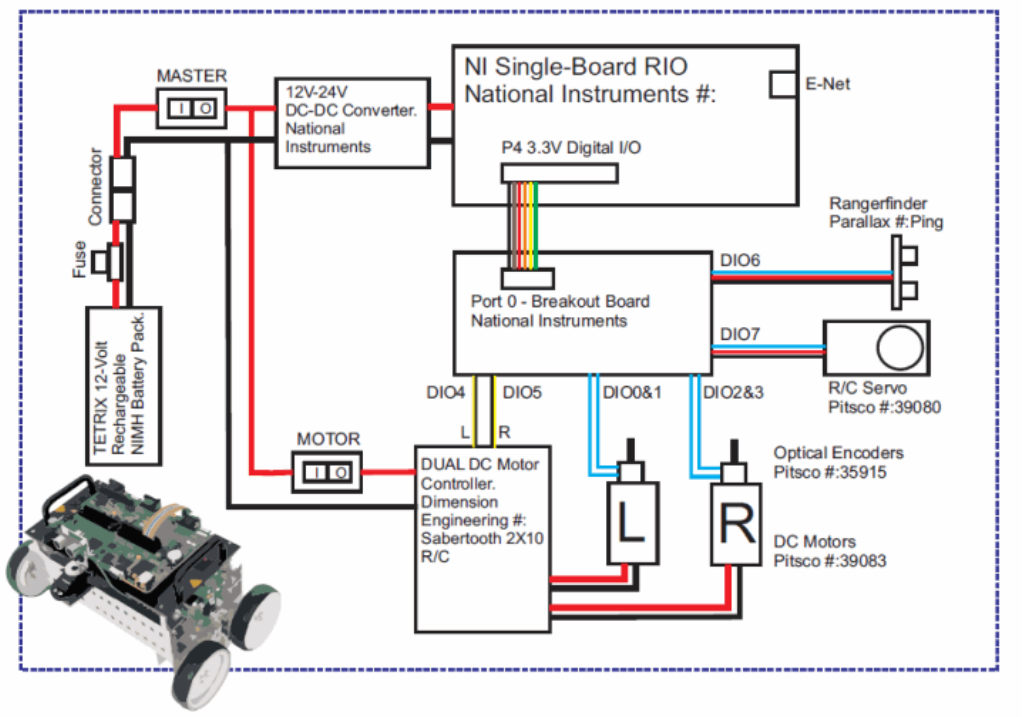
Environmental

The NI sbRIO-96*xx*/96*x*2XT is intended for indoor use only.	
Ambient temperature in enclosure (IEC 60068-2-1, IEC 60068-2-2)	
NI sbRIO-961x/963x/964x	–20 to 55 °C
NI sbRIO-96x2XT	–40 to 85 °C
Storage temperature (IEC 60068-2-1, IEC 60068-2-2)	–40 to 85 °C
Operating humidity (IEC 60068-2-56)	10 to 90% RH, noncondensing
Storage humidity (IEC 60068-2-56)	5 to 95% RH, noncondensing
Maximum altitude	2,000 m
Pollution Degree (IEC 60664)	2

Physical Characteristics

Torque for screw terminals on J3	0.5 to 0.6 N · m (4.4 to 5.3 lb · in.)
Weight	269.3 g (9.5 oz)

Block Diagram



[1] Sensitivity is the smallest voltage change that can be detected. It is a function of noise.
[2] Range equals ±10.7 V
[3] *Setup time* is the amount of time input signals must be stable before you can read from the module.
[4] *Transfer time* is the maximum time FPGA Device I/O functions take to read data from the module.
[5] Refer to the *Increasing Current Drive section* in the User Guide for information about installing heat sinks.
[6] The NI sbRIO device is 1–2% more efficient with a 19 V supply than with a 30 V supply.
[7] MAINS is defined as a hazardous live electrical supply system that powers hardware. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

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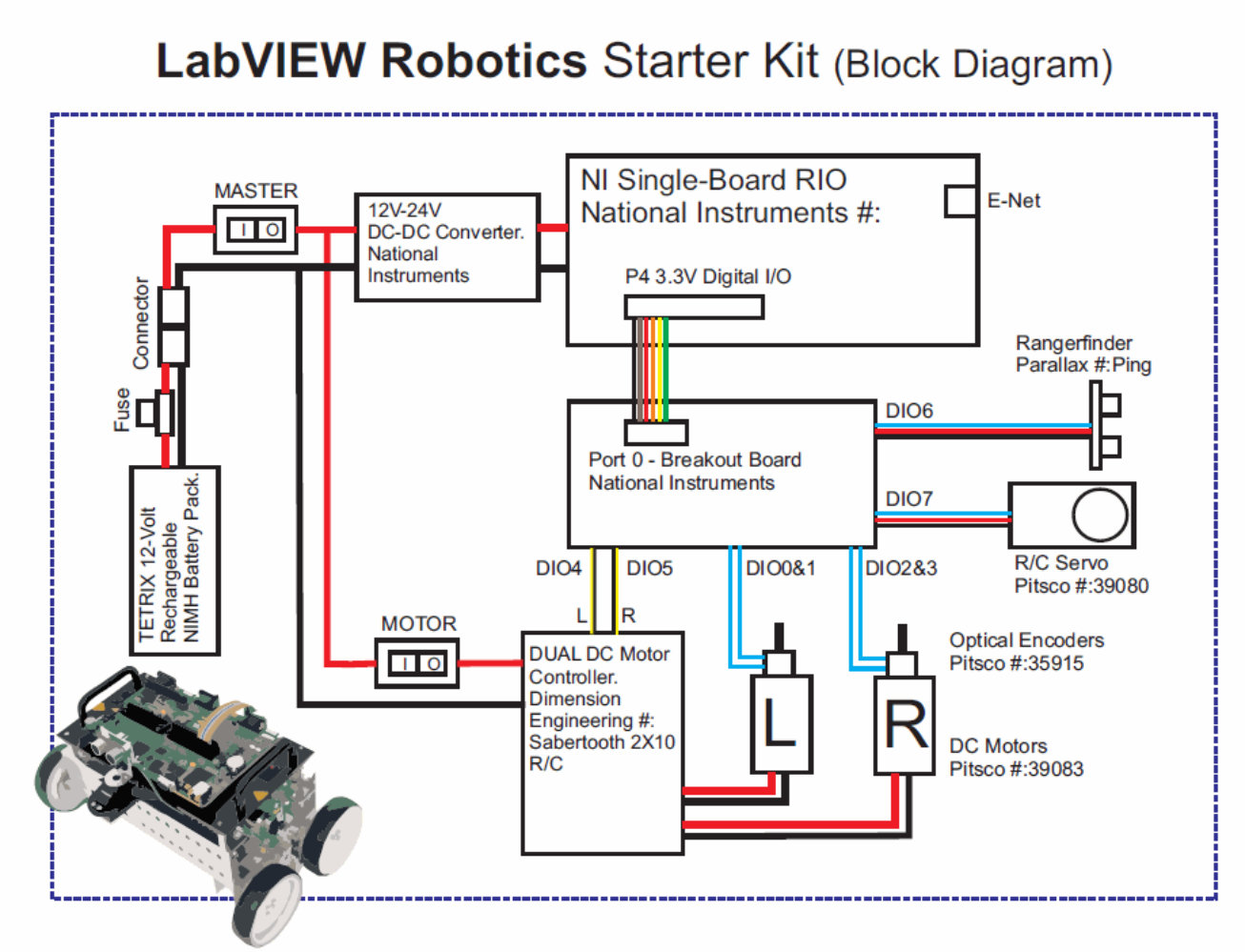
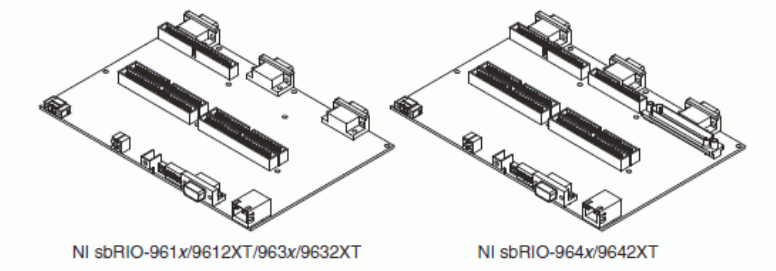


LabVIEW Robotics Starter Kit (Block Diagram)



NI sbRIO-961x/9612XT/963x/9632XT and NI sbRIO-964x/9642XT

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