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USER GUIDE

NI sbRIO-9601/9602 and NI sbRIO-9602XT

Single-Board RIO OEM Devices

This document provides dimensions, pinouts, connectivity information, and specifications for the National Instruments sbRIO-9601, sbRIO-9602, and sbRIO-9602XT. The devices are referred to inclusively in this document as the NI sbRIO-9601/9602/9602XT.

Caution The NI sbRIO-9601/9602/9602XT must be installed inside a suitable enclosure prior to use. Hazardous voltages may be present.

Caution National Instruments makes no product safety, electromagnetic compatibility (EMC), or CE marking compliance claims for NI sbRIO devices. The end-product supplier is responsible for conformity to any and all compliance requirements.

Caution Exercise caution when placing the NI sbRIO device inside an enclosure. Auxiliary cooling may be necessary to keep the device under the maximum ambient temperature rating for the NI sbRIO device. Refer to *Specifications* section for more information about the maximum ambient temperature rating.

Figure 1 shows the NI sbRIO-9601/9602/9602XT.

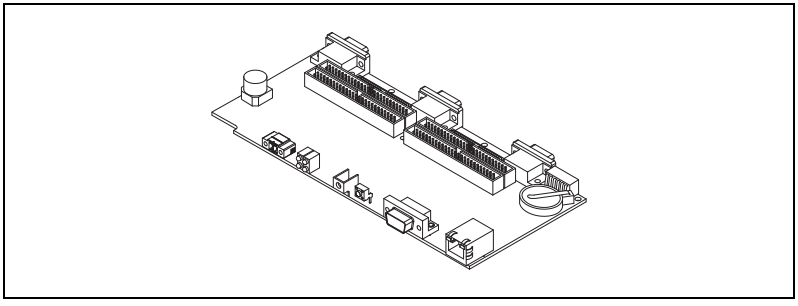


Figure 1. NI sbRIO-9601/9602/9602XT

NATIONAL INSTRUMENTS

What You Need to Get Started

This section lists the software and hardware you need to start programming the NI sbRIO device.

Software Requirements

You need a development computer with the following software installed on it. Go to `ni.com/info` and enter the Info Code `rdsoftwareversion` for information about software version compatibility.

- ❑ LabVIEW
- ❑ LabVIEW Real-Time Module
- ❑ LabVIEW FPGA Module
- ❑ NI-RIO

Hardware Requirements

You need the following hardware to use the NI sbRIO device.

- ❑ NI sbRIO-9601/9602/9602XT
- ❑ 19–30 VDC power supply
- ❑ Ethernet cable

Dimensions

This section contains dimensional drawings of the NI sbRIO devices. For three-dimensional models, refer to the **Resources** tab of the NI sbRIO product page at `ni.com`.

Note The plated mounting holes are all connected to P1, the ground lug. Connect P1 or one of the plated mounting holes securely to earth ground. Refer to the *Understanding Ground Connections* section for cautions about current loops through the grounding lug.

Figure 2 shows the dimensions of the NI sbRIO-9601/9602/9602XT.

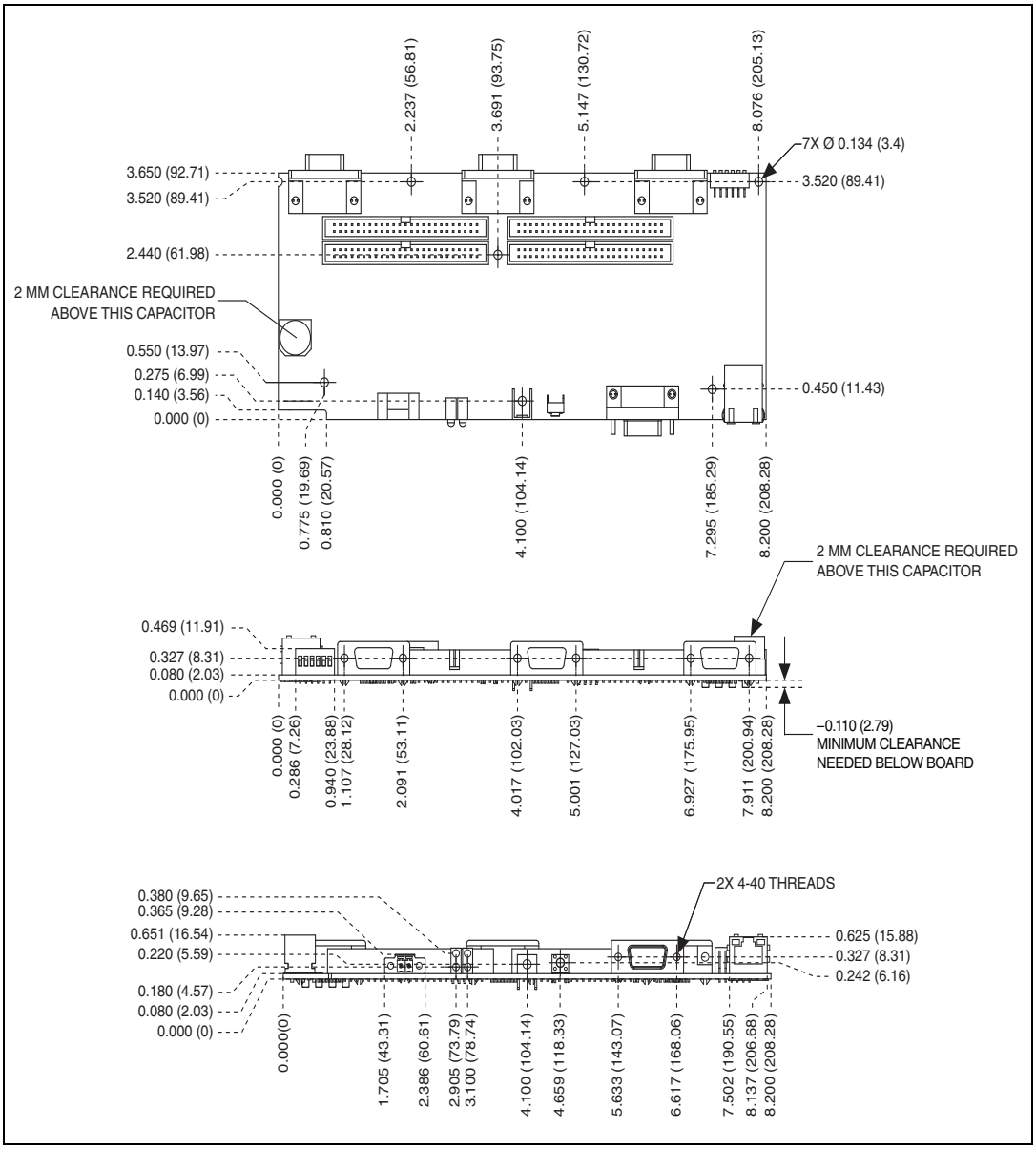


Figure 2. NI sbRIO-9601/9602/9602XT Dimensions in Inches (Millimeters)

You can install up to three board-only C Series I/O modules on the NI sbRIO device. The following figure shows the dimensions of the NI sbRIO-9601/9602/9602XT with three board-only C Series I/O modules installed.

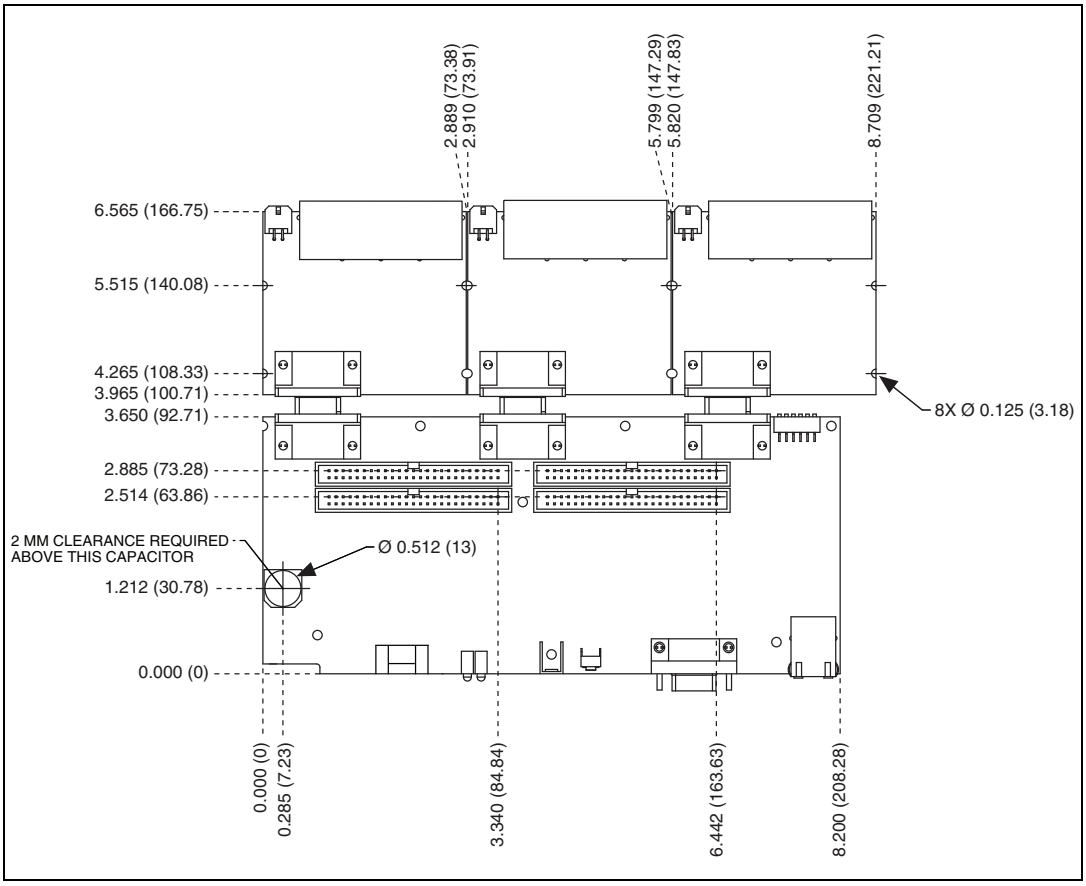
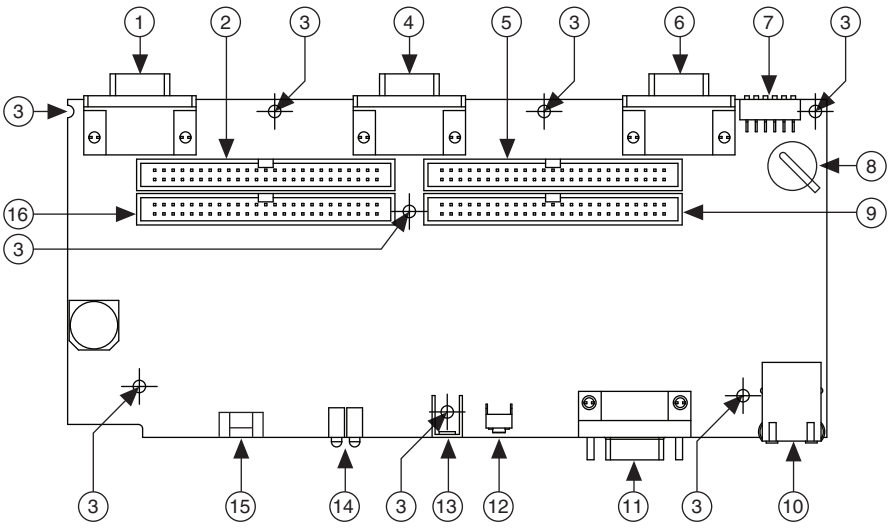


Figure 3. NI sbRIO-9601/9602/9602XT with C Series Modules, Dimensions in Inches (Millimeters)

Note To maintain isolation clearances on the C Series modules, do not use mounting hardware larger than 0.240 in. (6.1 mm) in diameter and maintain an air gap of at least 0.200 in. (5.0 mm) from the modules to anything else.

I/O and Other Connectors on the NI sbRIO Device

Figure 4 shows the locations of parts on the NI sbRIO device.



1	J11, Connector for C Series Module 3	9	P2, 3.3 V Digital I/O
2	P5, 3.3 V Digital I/O	10	J5, RJ-45 Ethernet Port
3	Plated Mounting Holes	11	J1, RS-232 Serial Port
4	J10, Connector for C Series Module 2	12	Reset Button
5	P4, 3.3 V Digital I/O	13	P1, Ground Lug
6	J9, Connector for C Series Module 1	14	LEDs
7	DIP Switches	15	J3, Power Connector
8	Backup Battery	16	P3, 3.3 V Digital I/O

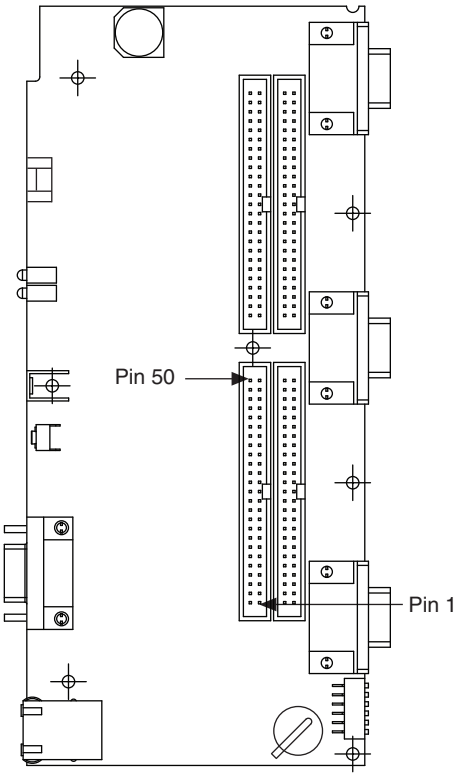
Figure 4. NI sbRIO-9601/9602/9602XT Parts Locator Diagram

Table 1 lists and describes the connectors on NI sbRIO devices and the part number and manufacturer of each connector. Refer to the manufacturer for information about using and matching these connectors.

Table 1. NI sbRIO Connector Descriptions

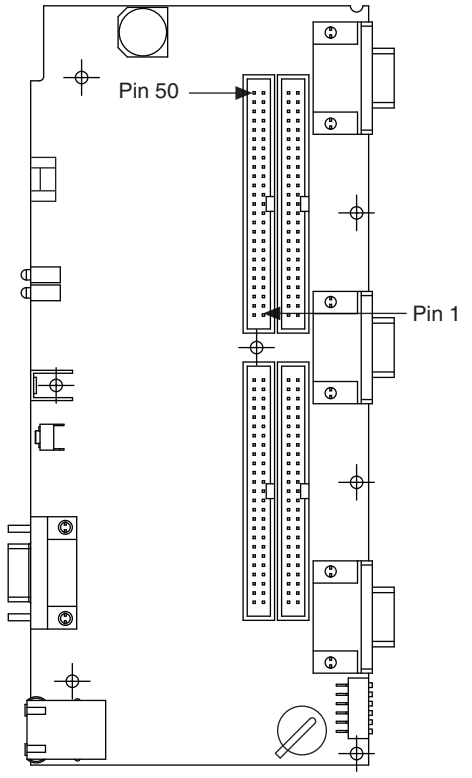
Connector	Description	Manufacturer and Part Number	Recommended Mating Connector
J3, Power	2-position MINI-COMBICON header and plug, 0.285 in. (7.24 mm) high	Phoenix Contact, 1727566	Sauro, CTF02BV8-BN (included)
J1, RS-232 Serial Port	9-pin DSUB plug, 0.318 in. (8.08 mm) high, with 4-40 jacksockets	Tyco Electronics, 5747840-6	—
P2, P3, P4, P5	50-pin polarized header plug, 0.100 × 0.100 in. (2.54 × 2.54 mm)	3M, N2550-6002RB	3M, 8550-4500PL

The following figures show the pinouts of the I/O connectors on the NI sbRIO devices.



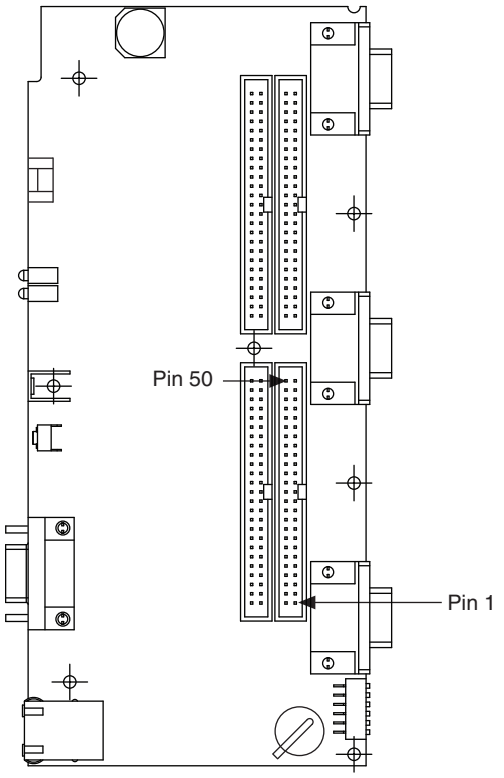
D GND	50	49	Port2/DIO8
D GND	48	47	Port2/DIO7
D GND	46	45	Port2/DIO6
D GND	44	43	Port2/DIO5
D GND	42	41	Port2/DIO4
D GND	40	39	Port6/DIO8
D GND	38	37	Port6/DIO7
D GND	36	35	Port6/DIO6
D GND	34	33	Port6/DIO5
D GND	32	31	Port6/DIO4
D GND	30	29	Port6/DIO3
D GND	28	27	Port6/DIO2
D GND	26	25	Port6/DIO1
D GND	24	23	Port6/DIO0
Port6/DIOCTL	22	21	Port6/DIO9
D GND	20	19	Port5/DIO8
D GND	18	17	Port5/DIO7
D GND	16	15	Port5/DIO6
D GND	14	13	Port5/DIO5
D GND	12	11	Port5/DIO4
5 V	10	9	Port5/DIO3
D GND	8	7	Port5/DIO2
5 V	6	5	Port5/DIO1
Port5/DIO9	4	3	Port5/DIO0
Port5/DIOCTL	2	1	D GND

Figure 5. Pinout of I/O Connector P2, 3.3 V Digital I/O



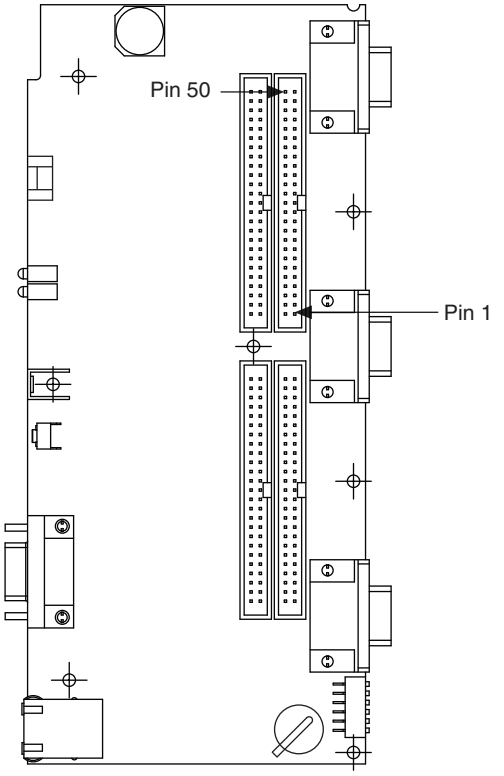
D GND	50	49	Port9/DIO8
5 V	48	47	Port9/DIO7
D GND	46	45	Port9/DIO6
5 V	44	43	Port9/DIO5
D GND	42	41	Port9/DIO4
D GND	40	39	Port9/DIO3
D GND	38	37	Port9/DIO2
D GND	36	35	Port9/DIO1
D GND	34	33	Port9/DIO0
Port9/DIOCTL	32	31	Port9/DIO9
D GND	30	29	Port8/DIO8
D GND	28	27	Port8/DIO7
D GND	26	25	Port8/DIO6
D GND	24	23	Port8/DIO5
D GND	22	21	Port8/DIO4
D GND	20	19	Port8/DIO3
D GND	18	17	Port8/DIO2
D GND	16	15	Port8/DIO1
D GND	14	13	Port8/DIO0
Port8/DIOCTL	12	11	Port8/DIO9
D GND	10	9	Port7/DIO8
D GND	8	7	Port7/DIO7
D GND	6	5	Port7/DIO6
D GND	4	3	Port7/DIO5
Port7/DIO4	2	1	D GND

Figure 6. Pinout of I/O Connector P3, 3.3 V Digital I/O



D GND	50	49	Port2/DIO3
D GND	48	47	Port2/DIO2
D GND	46	45	Port2/DIO1
D GND	44	43	Port2/DIO0
Port2/DIOCTL	42	41	Port2/DIO9
D GND	40	39	Port1/DIO8
D GND	38	37	Port1/DIO7
D GND	36	35	Port1/DIO6
D GND	34	33	Port1/DIO5
D GND	32	31	Port1/DIO4
D GND	30	29	Port1/DIO3
D GND	28	27	Port1/DIO2
D GND	26	25	Port1/DIO1
D GND	24	23	Port1/DIO0
Port1/DIOCTL	22	21	Port1/DIO9
D GND	20	19	Port0/DIO8
D GND	18	17	Port0/DIO7
D GND	16	15	Port0/DIO6
D GND	14	13	Port0/DIO5
D GND	12	11	Port0/DIO4
5 V	10	9	Port0/DIO3
D GND	8	7	Port0/DIO2
5 V	6	5	Port0/DIO1
Port0/DIO9	4	3	Port0/DIO0
Port0/DIOCTL	2	1	D GND

Figure 7. Pinout of I/O Connector P4, 3.3 V Digital I/O



D GND	50	49	Port4/DIO8
5 V	48	47	Port4/DIO7
D GND	46	45	Port4/DIO6
5 V	44	43	Port4/DIO5
D GND	42	41	Port4/DIO4
D GND	40	39	Port4/DIO3
D GND	38	37	Port4/DIO2
D GND	36	35	Port4/DIO1
D GND	34	33	Port4/DIO0
Port4/DIOCTL	32	31	Port4/DIO9
D GND	30	29	Port3/DIO8
D GND	28	27	Port3/DIO7
D GND	26	25	Port3/DIO6
D GND	24	23	Port3/DIO5
D GND	22	21	Port3/DIO4
D GND	20	19	Port3/DIO3
D GND	18	17	Port3/DIO2
D GND	16	15	Port3/DIO1
D GND	14	13	Port3/DIO0
Port3/DIOCTL	12	11	Port3/DIO9
D GND	10	9	Port7/DIO3
D GND	8	7	Port7/DIO2
D GND	6	5	Port7/DIO1
Port7/DIO9	4	3	Port7/DIO0
Port7/DIOCTL	2	1	D GND

Figure 8. Pinout of I/O Connector P5, 3.3 V Digital I/O

Figure 9 shows the signals on J1, the RS-232 serial port.

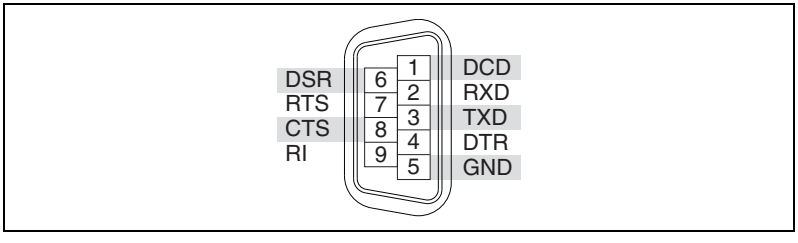


Figure 9. J1, RS-232 Serial Port Pin Assignments

Understanding Ground Connections

All of the grounds (D GND, ground lug P1, and the plated mounting holes) are connected together internally on the NI sbRIO device. The ESD protection diodes are connected to the plated mounting holes with a lower inductive path than the path to D GND, so the best ESD protection is provided by connecting the plated mounting holes and ground lug P1 to a low inductive earth ground.

Care must be taken to *not* connect the grounds in such a way that stray power supply currents traverse through the board. A good rule of thumb is current flowing out of the connector should match current flowing in.

To verify correct grounding of the NI sbRIO device, make sure current flowing into the power connector J3 equals the current flowing out of power connector J3. These currents should be measured with a current probe after final assembly of the end product and any current differences investigated and removed.

All external power supplies should have their connected to a system ground external to the NI sbRIO device. Do not use the NI sbRIO device as the common system grounding point. Significant currents traversing through the NI sbRIO grounds can result in digital component failures. If more than 3 A flows through the common (–) pin on the J3 power connector, components start to fuse open.

Connecting the NI sbRIO Device to a Network

Use a standard Category 5 (CAT-5) or better Ethernet cable to connect the RJ-45 Ethernet port to an Ethernet network.

Caution To prevent data loss and to maintain the integrity of your Ethernet installation, do *not* use a cable longer than 100 m.

If you need to build your own cable, refer to the *Cabling* section for more information about Ethernet cable wiring connections.

The host computer communicates with the device over a standard Ethernet connection. If the host computer is on a network, you must configure the device on the same subnet as the host computer. If neither the host computer nor the device is connected to a network, you can connect the two directly using a crossover cable.

If you want to use the device on a subnet other than the one the host computer is on, first connect the device on the same subnet as the host computer. Use DHCP to assign an IP address or reassign a static IP address

for the subnet where you want it to be and physically move it to the other subnet. Refer to the *Measurement & Automation Explorer Help* for more information about configuring the device in Measurement & Automation Explorer (MAX).

Powering the NI sbRIO Device

The NI sbRIO device requires a power supply connected to J3. The supply voltage and current must meet the specifications in the *Power Requirements* section of this document, but the actual power requirement depends on how the device is physically configured, programmed, and used. To determine the power requirement of your application, you must measure the power consumption during execution, and add 20% to your estimates to account for transient and startup conditions.

Note Select a high-quality power supply with less than 20 mV ripple. The NI sbRIO device has some internal power-supply filtering on the positive side, but a low-quality power supply can inject noise into the ground path, which is unfiltered.

Four elements of the NI sbRIO device can require power: sbRIO internal operation; 3.3 V DIO; 5 V output; and board-only C Series modules installed on the device. Refer to the *Power Requirements* section for formulas and examples for calculating power requirements for different configurations and application types.

Complete the following steps to connect a power supply to the device. Refer to Figure 10 for an illustration of the power supply connections.

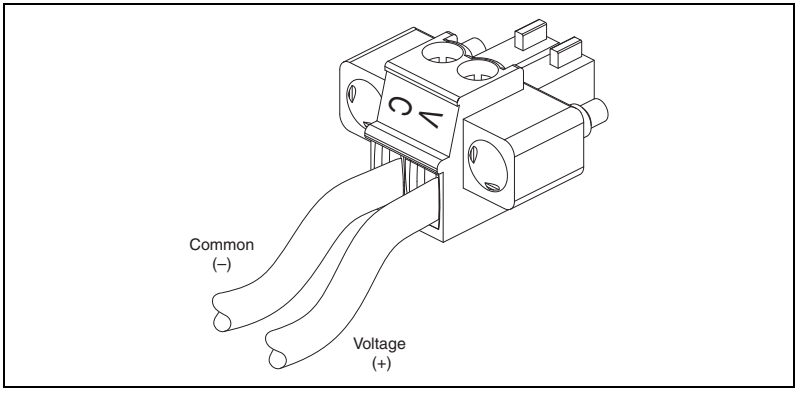


Figure 10. Connecting a Power Supply

1. Remove the MINI-COMBICON plug from connector J3 of the NI sbRIO device. Refer to Figure 4 for the location of J3.
2. Connect the positive lead of the power supply to the V terminal of the MINI-COMBICON plug.
3. Connect the negative lead of the power supply to the C terminal of the MINI-COMBICON plug.
4. Re-install the MINI-COMBICON connector in connector J3.

Powering On the NI sbRIO Device

The NI sbRIO device 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. If the LEDs do not behave in this way when the system powers on, refer to the *Understanding LED Indications* section.

You can configure the device to launch an embedded stand-alone LabVIEW RT application each time it is booted. Refer to the *Running a Stand-Alone Real-Time Application (RT Module)* topic of the *LabVIEW Help* for more information.

Boot Options

Table 2 lists the reset options available on NI sbRIO devices. These options determine how the FPGA behaves when the device is reset in various conditions. Use the RIO Device Setup utility to select reset options. Access the RIO Device Setup utility by selecting **Start»All Programs»National Instruments»NI-RIO»RIO Device Setup**.

Table 2. NI sbRIO Reset Options

Reset Option	Behavior
Do not autoload VI	Does not load the FPGA bit stream from flash memory.
Autoload VI on device powerup	Loads the FPGA bit stream from flash memory to the FPGA when the device powers on.
Autoload VI on device reboot	Loads the FPGA bit stream from flash to the FPGA when you reboot the device either with or without cycling power.

Note If you want a VI to run when loaded to the FPGA, complete the following steps.

1. Right-click the FPGA Target item in the **Project Explorer** window in LabVIEW.
2. Select **Properties**.

3. In the **General** category of the **FPGA Target Properties** dialog box, place a check in the **Run when loaded to FPGA** checkbox.
4. Compile the FPGA VI.

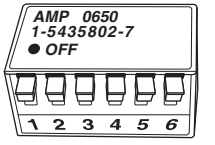
Connecting Serial Devices to the NI sbRIO Device

The NI sbRIO device has an RS-232 serial port to which you can connect devices such as displays or input devices. Use the Serial VIs to read from and write to the serial port from a LabVIEW RT application. For more information about using the Serial VIs, refer to the *Serial VIs and Functions* topic of the *LabVIEW Help*.

Using the Internal Real-Time Clock

The system clock of the NI sbRIO device gets the date and time from the internal real-time clock at startup. This synchronization provides timestamp data to the device.

Configuring DIP Switches



1	SAFE MODE	3	IP RESET	5	USER1
2	CONSOLE OUT	4	NO APP	6	NO FPGA

Figure 11. DIP Switches

All of the DIP switches are in the OFF (up) position when the NI sbRIO device is shipped from National Instruments.

SAFE MODE Switch

The position of the SAFE MODE switch determines whether the embedded LabVIEW Real-Time engine launches at startup. If the switch is in the OFF position, the LabVIEW Real-Time engine launches. Keep this switch in the OFF position during normal operation. If the switch is in the ON position at startup, the sbRIO device launches only the essential services required for updating its configuration and installing software. The LabVIEW Real-Time engine does not launch.

Push the SAFE MODE switch to the ON position if the software on the sbRIO device is corrupted. Even if the switch is not in the ON position, if there is no software installed on the device, the device automatically boots into safe mode. The SAFE MODE switch must be in the ON position to reformat the drive on the device. Refer to the *Measurement & Automation Explorer Help* for more about installing software and reformatting the drive.

CONSOLE OUT Switch

With a serial-port terminal program, you can use the serial port to read the IP address and firmware version of the NI sbRIO device. Use a null-modem cable to connect the serial port on the device to a computer. Push the CONSOLE OUT switch to the ON position. Make sure that the serial-port terminal program is configured to the following settings:

- 9,600 bits per second
- Eight data bits
- No parity
- One stop bit
- No flow control

Keep this switch in the OFF position during normal operation. If CONSOLE OUT is enabled, LabVIEW RT cannot communicate with the serial port.

IP RESET Switch

Push the IP RESET switch to the ON position and reboot the NI sbRIO device to reset the IP address to `0.0.0.0`. If the device is on your local subnet and the IP RESET switch is in the ON position, the device appears in MAX with IP address `0.0.0.0`. You can configure a new IP address for the device in MAX. Refer to the *Resetting the Network Configuration of the NI sbRIO Device* section for more information about resetting the IP address.

NO APP Switch

Push the NO APP switch to the ON position to prevent a LabVIEW RT startup application from running at startup. If you want to permanently disable a LabVIEW RT application from running at startup, you must disable it in LabVIEW. To run an application at startup, push the NO APP switch to the OFF position, create an application using the LabVIEW Application Builder, and configure the application in LabVIEW to launch at startup. For more information about automatically launching VIs at

startup and disabling VIs from launching at startup, refer to the *Running a Stand-Alone Real-Time Application (RT Module)* topic of the *LabVIEW Help*.

USER1 Switch

You can define the USER1 switch for your application. To define the purpose of this switch in your embedded application, use the RT Read Switch VI in your LabVIEW RT embedded VI. For more information about the RT Read Switch VI, refer to the *LabVIEW Help*.

NO FPGA Switch

Push the NO FPGA switch to the ON position to prevent a LabVIEW FPGA application from loading at startup. The NO FPGA switch overrides the options described in the *Boot Options* section. After startup you can download bit files to flash memory from a LabVIEW project regardless of switch position. If you already have an application configured to launch at startup and you push the NO FPGA switch from ON to OFF, the startup application is automatically enabled.

Using the Reset Button

Pressing the Reset button reboots the processor. The FPGA continues to run unless you select the **Autoload VI on device reboot** boot option. Refer to the *Boot Options* section for more information.

Understanding LED Indications

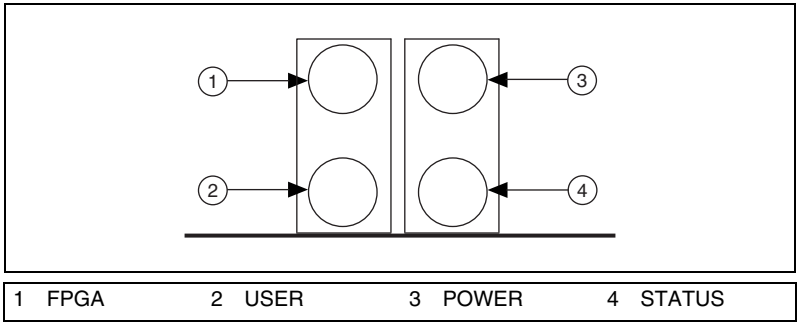


Figure 12. NI sbRIO Device LEDs

FPGA LED

You can use the FPGA LED to help debug your application or easily retrieve application status. Use the LabVIEW FPGA Module and NI-RIO software to define the FPGA LED to meet the needs of your application. Refer to *LabVIEW Help* for information about programming this LED.

USER LED

You can define the USER LED to meet the needs of your application. To define the LED, use the RT LEDs VI in LabVIEW. For more information about the RT LEDs VI, refer to the *LabVIEW Help*.

POWER LED

The POWER LED is lit while the NI sbRIO device is powered on. This LED indicates that the 5 V and 3.3 V rails are stable.

STATUS LED

The STATUS LED is off during normal operation. The NI sbRIO device indicates specific error conditions by flashing the STATUS LED a certain number of times as shown in Table 3.

Table 3. Status LED Indications

Number of Flashes	Indication
1 (one flash every couple seconds)	The device is unconfigured. Use MAX to configure the device. Refer to the *Measurement & Automation Explorer Help* for information about configuring the controller.
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. Refer to the *Measurement & Automation Explorer Help* for information about installing software on the device.
3	The device is in safe mode because the SAFE MODE DIP switch is in the ON position. Refer to the *Configuring DIP Switches* section for information about the SAFE MODE DIP switch.

Table 3. Status LED Indications (Continued)

Number of Flashes	Indication
4	The device 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 device memory usage. Modify the VI as necessary to solve the memory usage issue.
Continuous flashing or solid	The device has detected an unrecoverable error. Format the hard drive on the device. If the problem persists, contact National Instruments.

Resetting the Network Configuration of the NI sbRIO Device

If the NI sbRIO device is not able to communicate with the network, you can use the IP RESET switch to manually restore the device to the factory network settings. When you restore the device to the factory network settings, the IP address, subnet mask, DNS address, gateway, and Time Server IP are set to `0.0.0.0`. Power-on defaults, watchdog settings, and VIs are unaffected.

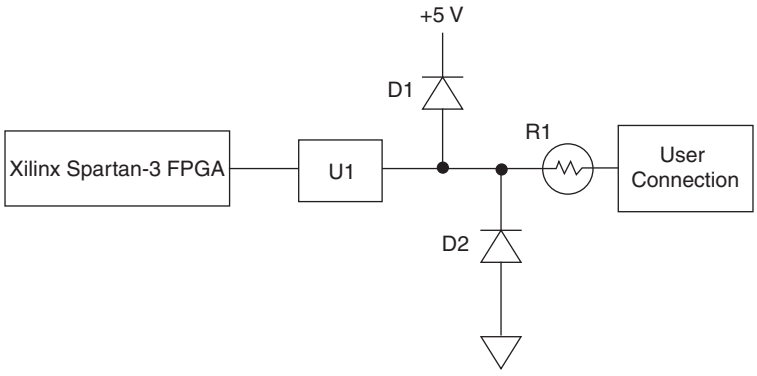
Complete the following steps to restore the device to the factory network settings.

1. Move the IP RESET DIP switch to the ON position.
2. Press the Reset button.
3. Move the IP RESET switch to the OFF position.

The network settings are restored. You can reconfigure the settings in MAX from a computer on the same subnet. Refer to the *Measurement & Automation Explorer Help* for more information about configuring the device.

Note If the device is restored to the factory network settings, the LabVIEW run-time engine does not load. You must reconfigure the network settings and reboot the device for the LabVIEW run-time engine to load.

The four 40-pin IDC headers, P2–P5, provide connections for 110 low-voltage DIO channels, 82 D GND, and eight +5 V voltage outputs. The following figure represents a single DIO channel.



U1: 5 V to 3.3 V Level Shifter, SN74CBTD3384CDGV from Texas Instruments
D1 and D2: ESD-Rated Protection Diodes, NUP4302MR6T1G from ON Semiconductor
R1: Current-Limiting Posistor, PRG18BB330MS1RB from Murata

Figure 13. Circuitry of One 3.3 V DIO Channel

I/O Protection

The 33 Ω current-limiting posistor, R1, and the protection diodes, D1 and D2, protect each DIO channel against externally applied voltages of ±20 V and ESD events. The combination of R1 and D1 protects against overvoltage, and the combination of R1 and D2 protects against undervoltage. The resistance of R1 increases rapidly with temperature. During overvoltage conditions, high current flows through R1 and into the protection diodes. High current causes internal heating in the posistor, which increases the resistance and limits the current. Refer to the *Specifications* section for current-limiting and resistance values.

Drive Strength

The NI sbRIO devices are tested with all 110 DIO channels driving 3 mA DC loads, for a total of 330 mA sourcing from the FPGA. The FPGA uses minimum 8 mA drivers, but the devices are not characterized for loads higher than 3 mA.

Signal Integrity

NI sbRIO boards have a 60 Ω characteristic trace impedance. The characteristic impedance of most IDC ribbon cables is 110 Ω, which does not match the board. However, headers P2–P5 have signals that are interwoven with ground (signal/ground/signal/ground, and so on), which greatly improves the signal integrity. This is sufficient for most applications.

For the best possible signal integrity, use a 3M 3353 series ribbon cable, which has a characteristic impedance of 65 Ω. This cable has a ground plane that connects to the ground plane of the board at pin 1 and pin 50. The internal ground plane of this cable also reduces noise and radiated emissions.

Using +5 V Power from 3.3 V DIO Headers P2–P5

Each of the four DIO headers has two pins to provide +5 V power for external applications. These +5 V outputs are referenced to D GND on the headers and are connected directly to the internal 5 V power plane of the NI sbRIO device. The +5 V source has current limiting and overvoltage clamps. Nevertheless, sudden current steps and noisy loads can inject high-frequency transients into the power planes of the device. Such transients can cause intermittent failures in the digital timing and lead to unexpected behavior. Add filters and/or additional current limiting between the external load and the +5 V output if the external load is not a quiet, slowly ramping DC load. An LC filter of 6.8 µH and 100 µF per 200 mA load should be sufficient, but the OEM user is responsible for final requirements and testing.

The NI sbRIO power supply has a total of 2 A external load at 5 V. This total includes 200 mA per installed C Series module. For example, if three C Series modules are installed, only 2 A – (3 × 0.2) = 1.4 A is available for use on headers P2–P5. Each pin on the headers is rated for 2 A, but a typical 28 AWG ribbon cable is rated for only 225 mA per conductor. The OEM user is responsible for determining cabling requirements and ensuring that current limits are not exceeded.

Specifications

Unless otherwise noted, the following specifications are typical for the range –40 to 85 °C for the NI sbRIO-9602XT, and for the range –20 to 55 °C for the NI sbRIO-9601 and NI sbRIO-9602.

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-9601	266 MHz
NI sbRIO-9602/9602XT	400 MHz

Memory

Nonvolatile memory

NI sbRIO-9601 .....128 MB minimum

NI sbRIO-9602/9602XT.....256 MB minimum

System memory

NI sbRIO-9601 .....64 MB minimum

NI sbRIO-9602/9602XT.....128 MB minimum

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-9601 17,280

NI sbRIO-9602/9602XT.....46,080

Available embedded RAM

NI sbRIO-9601 .....432 kbits

NI sbRIO-9602/9602XT.....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-9601/9602

at –20 to 55 °C ..... ±20 V

NI sbRIO-9602XT

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

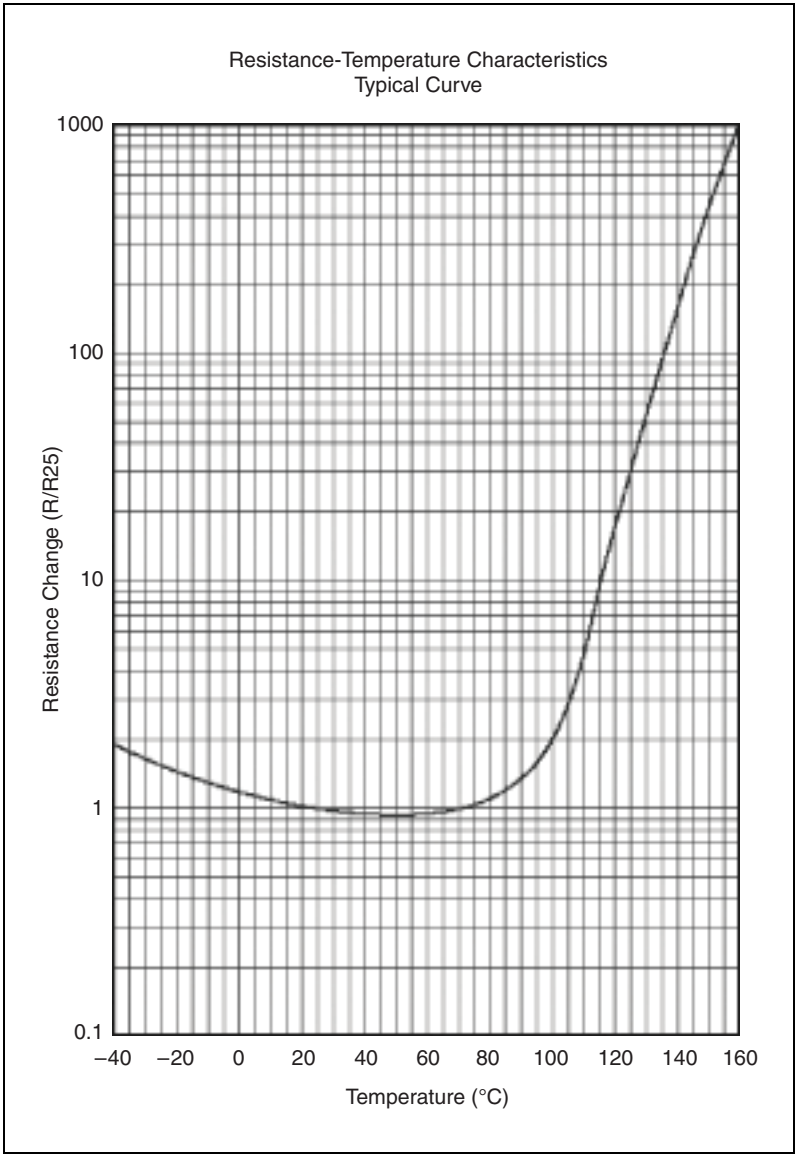
Maximum hold current at 70 °C ..... 20 mA

Maximum hold current at 85 °C (NI sbRIO-9602XT only) ..... 3 mA

Trip current at 25 °C ..... 71 mA

Resistance at 25 °C ..... 33 Ω ±20%

Resistance-temperature characteristics, typical curve



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 Figure 4 for the location of J3. Refer to the *Powering the NI sbRIO Device* section for information about connecting the power supply.

Power supply voltage range ..... 19–30 VDC[1]

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
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}..... 6.0 W

Maximum P_{DIO}..... 1.28 W

$P_{DIO} = Total\ DIO\ Current \times 3.3\ V/0.85$

Maximum P_{5V} ..... 11.1 W

$P_{5V} = Total\ 5\ V\ Output\ Current \times 5\ V/0.9$

Maximum P_{CSer} ..... 3.3 W; each installed C Series module consumes up to 1.1 W

[1] The NI sbRIO device is 1–2% more efficient with a 19 V supply than with a 30 V supply.

Example power requirement calculations:

- For an NI sbRIO-9602/9602XT 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:

$$P_{int} = 6.0 \text{ W}$$
$$P_{CSer} = 3.30 \text{ W}$$
$$P_{DIO} = 0.08 \text{ W}$$
$$P_{5V} = 5.55 \text{ W}$$

Adding 20% for transient conditions, 14.93 W × 1.2 = 17.92 W

Total power requirement = 17.92 W

- For an NI sbRIO-9601 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:

$$P_{int} = 6.0 \text{ W}$$
$$P_{CSer} = 1.10 \text{ W}$$
$$P_{DIO} = 1.28 \text{ W}$$
$$P_{5V} = 0.00 \text{ W}$$

Adding 20% for transient conditions, 8.38 W × 1.2 = 10.06 W

Total power requirement = 10.06 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 voltage. MAINS is a hazardous live electrical supply system that powers equipment. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, 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 to the environment and 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 and Electronic Equipment, visit `ni.com/environment/weee`.

Battery Replacement and Disposal

Cd/Hg/Pb

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-9601/9602/9602XT is intended for indoor use only.

Ambient temperature in enclosure
(IEC 60068-2-1, IEC 60068-2-2)

NI sbRIO-9601/9602 ..... –20 to 55 °C

NI sbRIO-9602XT ..... –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

Indoor use only

Physical Characteristics

Torque for screw terminals on J3 .....0.5 to 0.6 N · m
(4.4 to 5.3 lb · in.)

Weight .....198.45 g (7.0 oz)

Cabling

Table 4 shows the standard Ethernet cable wiring connections for both normal and crossover cables.

Table 4. Ethernet Cable Wiring Connections

Pin	Connector 1	Connector 2 (Normal)	Connector 2 (Crossover)
1	white/orange	white/orange	white/green
2	orange	orange	green
3	white/green	white/green	white/orange
4	blue	blue	blue
5	white/blue	white/blue	white/blue
6	green	green	orange
7	white/brown	white/brown	white/brown
8	brown	brown	brown

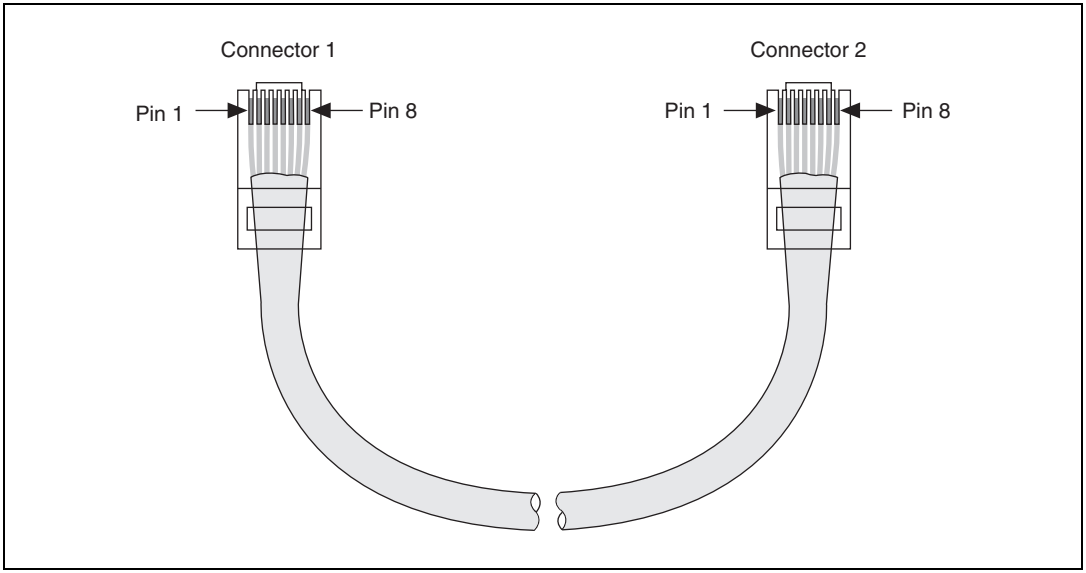


Figure 14. Ethernet Connector Pinout

Where to Go for Support

The National Instruments Web site is your complete resource for technical support. At `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.

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` and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

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Canada 800 433 3488, China 86 21 5050 9800,
Czech Republic 420 224 235 774, Denmark 45 45 76 26 00,
Finland 358 (0) 9 725 72511, France 01 57 66 24 24,
Germany 49 89 7413130, India 91 80 41190000, Israel 972 3 6393737,
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Lebanon 961 (0) 1 33 28 28, Malaysia 1800 887710,
Mexico 01 800 010 0793, Netherlands 31 (0) 348 433 466,
New Zealand 0800 553 322, Norway 47 (0) 66 90 76 60,
Poland 48 22 328 90 10, Portugal 351 210 311 210,

Russia 7 495 783 6851, Singapore 1800 226 5886,
Slovenia 386 3 425 42 00, South Africa 27 0 11 805 8197,
Spain 34 91 640 0085, Sweden 46 (0) 8 587 895 00,
Switzerland 41 56 2005151, Taiwan 886 02 2377 2222,
Thailand 662 278 6777, Turkey 90 212 279 3031,
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