USER GUIDE

NI sbRIO-961*x*/963*x*/964*x*

Single-Board RIO OEM Devices

This document provides dimensions, pinouts, connectivity information, and specifications for the National Instruments sbRIO-9611, sbRIO-9612, sbRIO-9631, sbRIO-9632, sbRIO-9641, and sbRIO-9642. The devices are referred to inclusively in this document as the sbRIO-961*x*/963*x*/964*x*.

Caution National Instruments makes no product safety, electromagnetic compatibility (EMC), or CE marking compliance claims for the sbRIO-961*x*/963*x*/964*x*. The end-product supplier is responsible for conformity to any and all compliance requirements.

Caution Exercise caution when placing the sbRIO-961*x*/963*x*/964*x* inside an enclosure. Auxiliary cooling may be necessary to keep the device under the maximum ambient temperature rating of 55 °C.

The following figure shows the sbRIO-961*x*/963*x* and the sbRIO-964*x*.

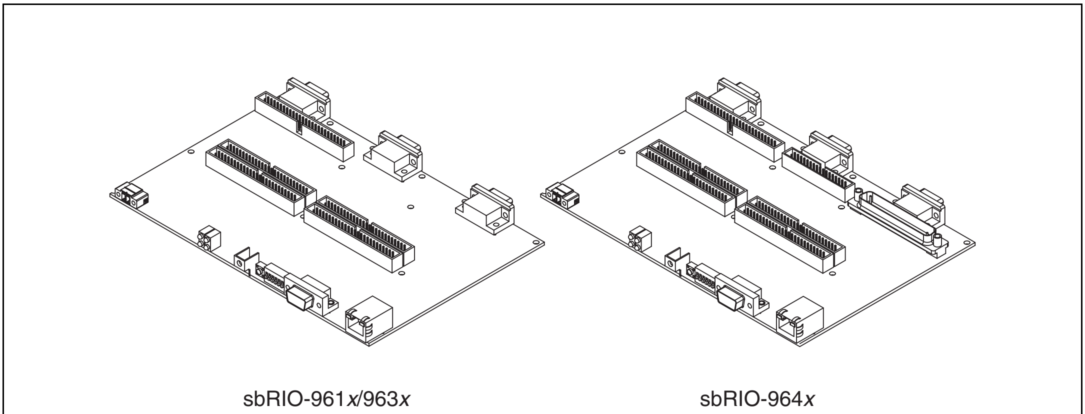


Figure 1. sbRIO-961*x*/963*x* and sbRIO-964*x*

What You Need to Get Started

This section lists the software and hardware you need to start programming the sbRIO-961*x*/963*x*/964*x*.

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 Software

Hardware Requirements

You need the following hardware to use the sbRIO device.

- ❑ sbRIO-961*x*/963*x*/964*x*
- ❑ 19–30 VDC power supply
- ❑ Ethernet cable

Dimensions

This section contains dimensional drawings of the sbRIO devices. For three-dimensional models, go to `ni.com/singleboard` and look on the **Resource** tab for the sbRIO device you are using.

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.

The following figure shows the dimensions of the sbRIO-961*x*/963*x*/964*x*.

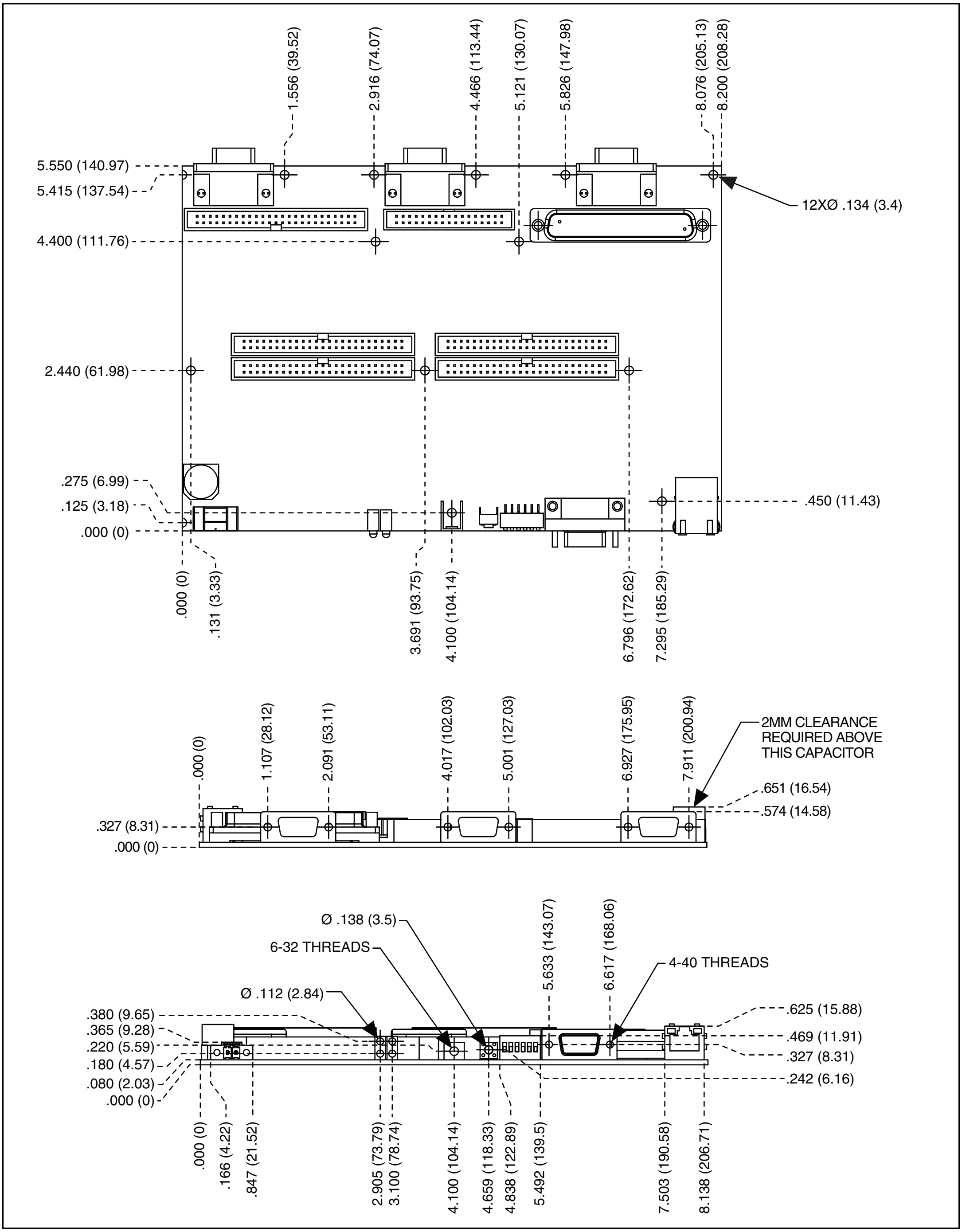


Figure 2. sbRIO-961*x*/963*x*/964*x* Dimensions in Inches (Millimeters)

You can install up to three board-only C Series I/O modules on the sbRIO-961*x*/963*x*/964*x*. The following figure shows the dimensions of the sbRIO-961*x*/963*x*/964*x* with three board-only C Series I/O modules installed.

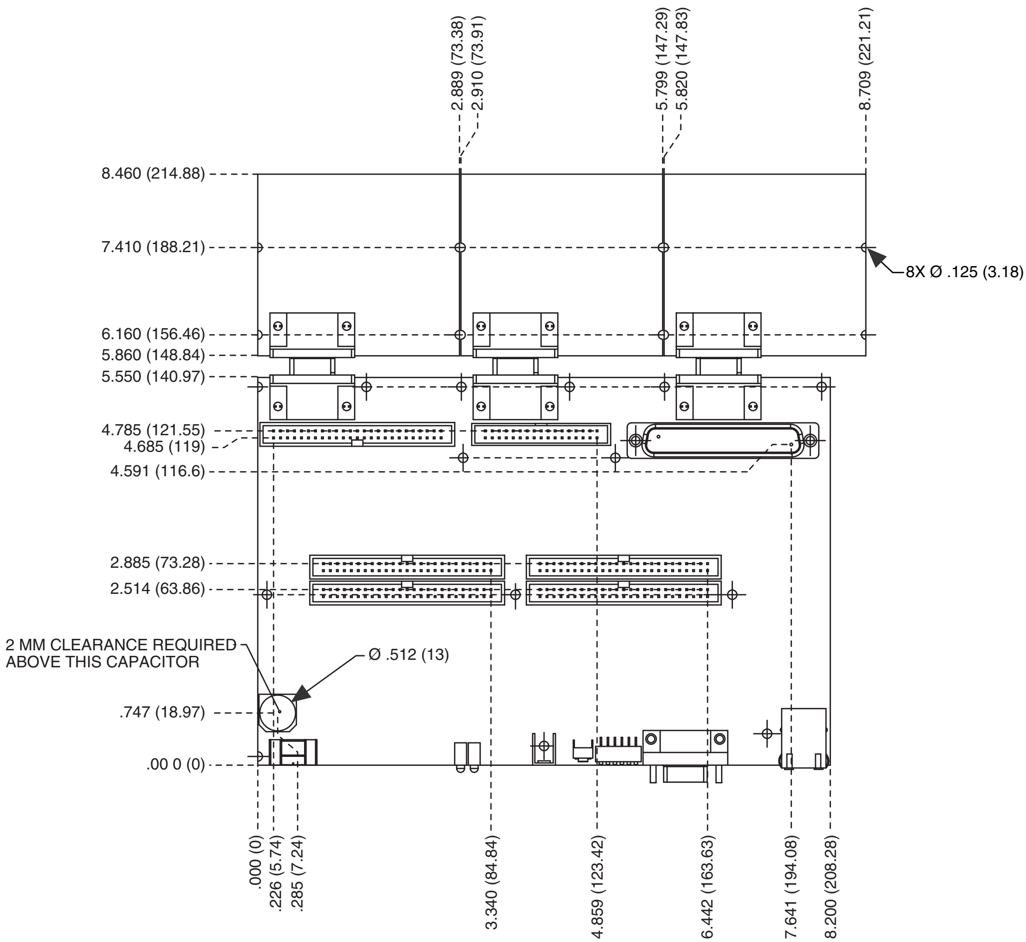
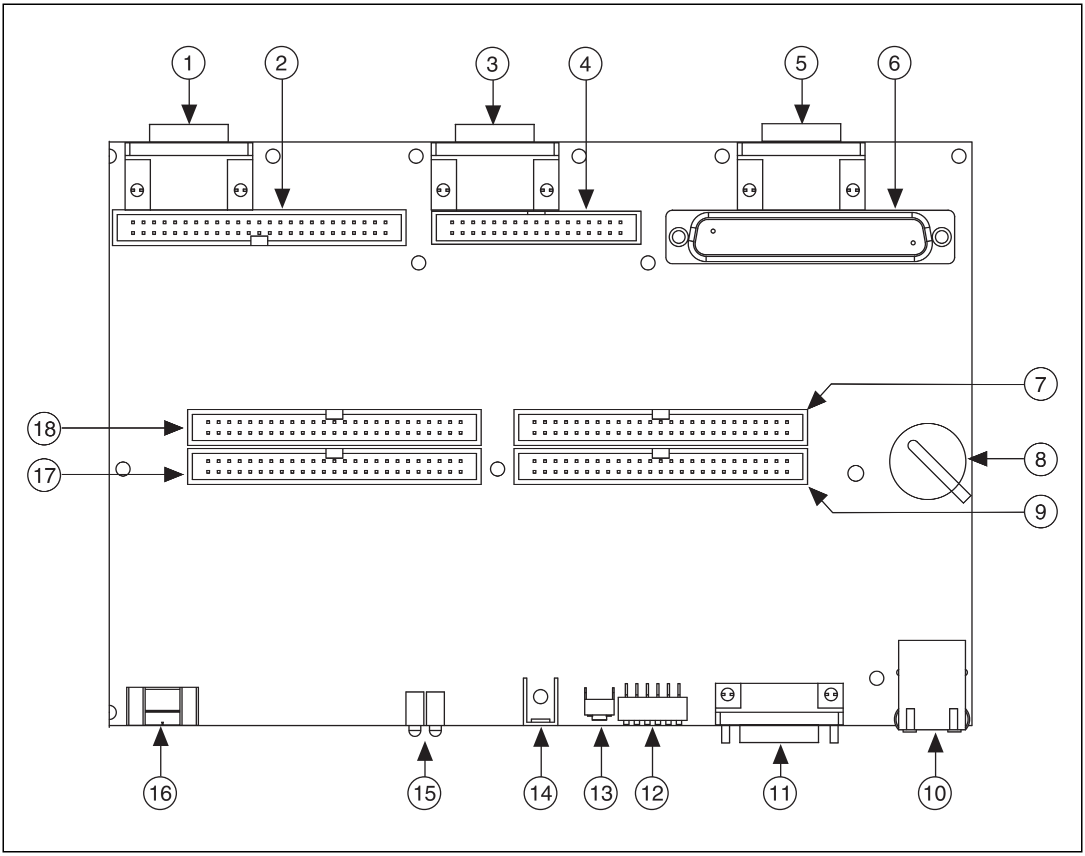


Figure 3. sbRIO-961*x*/963*x*/964*x* with C Series Modules, Dimensions in Inches (Millimeters)

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 sbRIO Device

The following figure shows the locations of parts on the sbRIO device.



1	J10, Connector for C Series Module	10	J2, RJ-45 Ethernet Port
2	J7, Analog I/O Connector	11	J1, RS-232 Serial Port
3	J9, Connector for C Series Module	12	DIP Switches
4	J6, 24 V Digital Input (sbRIO-964*x* Only)	13	Reset Button
5	J8, Connector for C Series Module	14	P1, Ground Lug
6	J5, 24 V Digital Output (sbRIO-964*x* Only)	15	LEDs
7	P4, 3.3 V Digital I/O	16	J3, Power Connector
8	Backup Battery	17	P3, 3.3 V Digital I/O
9	P2, 3.3 V Digital I/O	18	P5, 3.3 V Digital I/O

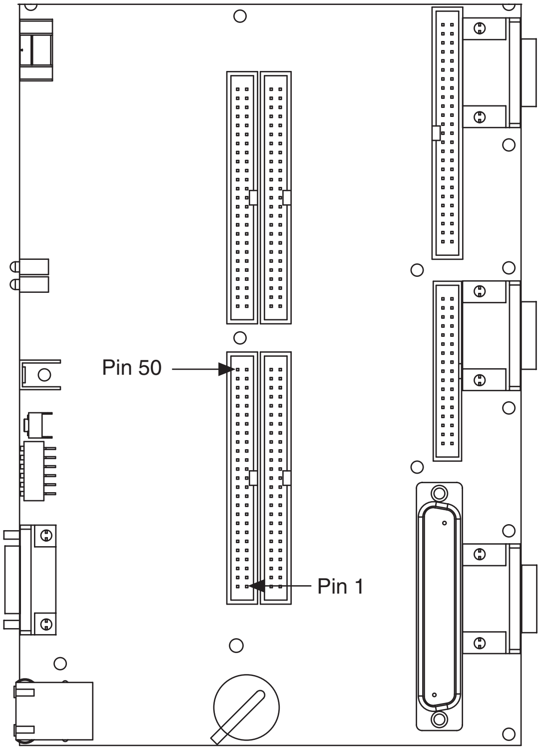
Figure 4. sbRIO-961x/963x/964x Parts Locator Diagram

The following table lists and describes the connectors on sbRIO devices and lists the part number and manufacturer of each connector. Refer to the manufacturer for information about using and matching these connectors.

Table 1. sbRIO Connector Descriptions

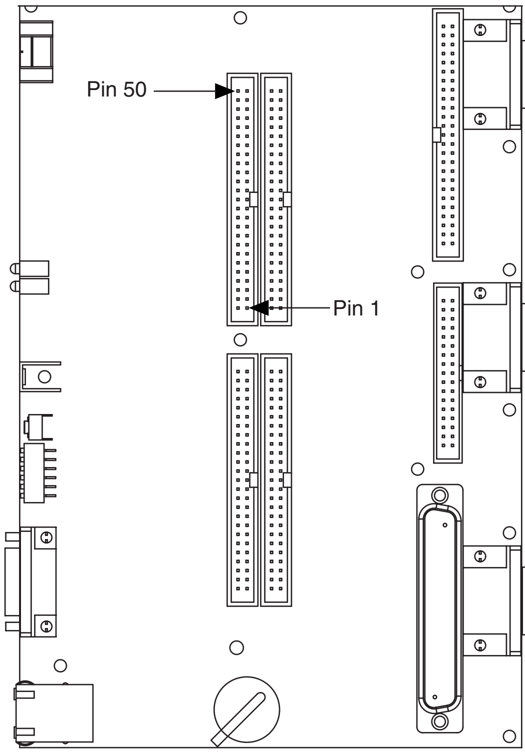
Connector	Description	Part Number and Manufacturer
J3, Power	2-position MINI-COMBICON header and plug, 0.285 in. (7.24 mm) high	1727566 from Phoenix Contact; accepts 1714977 from Phoenix Contact (included)
J1, RS-232 Serial Port	9-Pin DSUB plug, 0.318 in. (8.08 mm) high, with 4-40 jacksockets	5747840-6 from Amphenol
P2, P3, P4, P5, J7	50-pin polarized header plug, 0.100 × 0.100 in. (2.54 × 2.54 mm)	N2550-6002RB from 3M
J5	37-Pin DSUB plug with 4-40 jacksockets	D37P24B6GV00LF from FCI
J6	34-Pin polarized header plug, 0.100 × 0.100 in. (2.54 × 2.54 mm)	N2534-6002RB from 3M

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



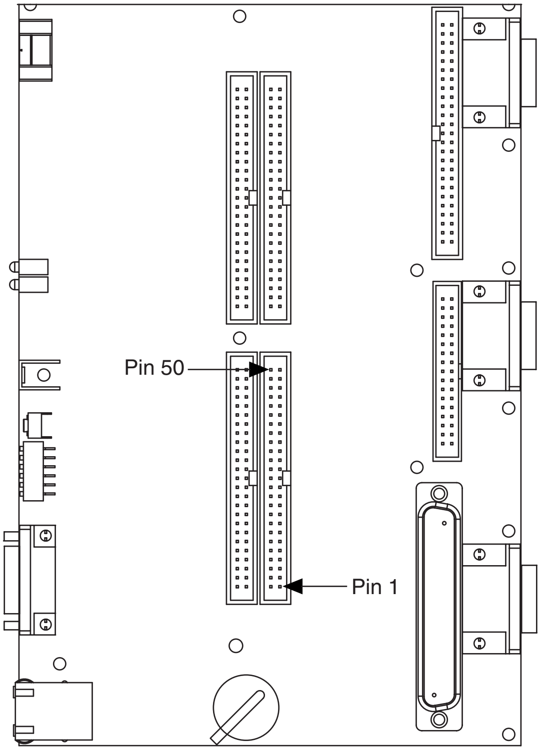
D GND	50	49	Port2/DIO8
D GND	48	47	Port2/DIO7
D GND	46	45	Port2/DIO6
D GND	44	43	Port2/DIO5
D GND	42	41	Port2/DIO4
D GND	40	39	Port6/DIO8
D GND	38	37	Port6/DIO7
D GND	36	35	Port6/DIO6
D GND	34	33	Port6/DIO5
D GND	32	31	Port6/DIO4
D GND	30	29	Port6/DIO3
D GND	28	27	Port6/DIO2
D GND	26	25	Port6/DIO1
D 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
5V	10	9	Port5/DIO3
D GND	8	7	Port5/DIO2
5V	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



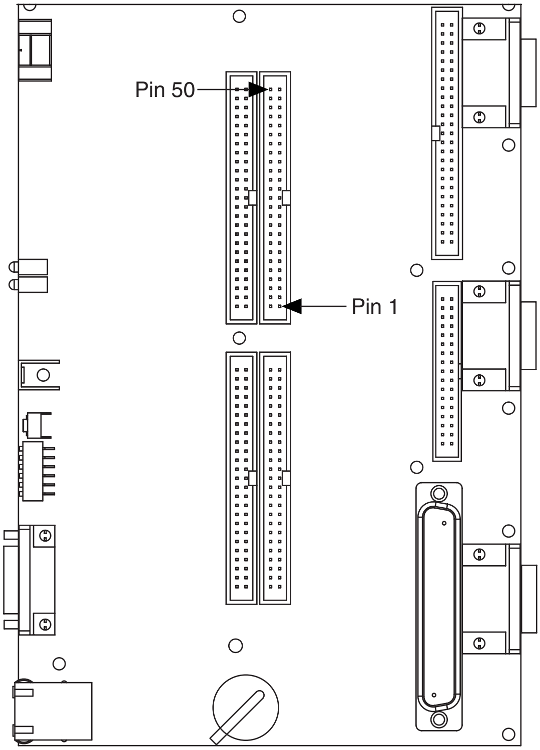
D GND	50	49	Port9/DIO8
5V	48	47	Port9/DIO7
D GND	46	45	Port9/DIO6
5V	44	43	Port9/DIO5
D GND	42	41	Port9/DIO4
D GND	40	39	Port9/DIO3
D GND	38	37	Port9/DIO2
D GND	36	35	Port9/DIO1
D GND	34	33	Port9/DIO0
Port9/DIOCTL	32	31	Port9/DIO9
D GND	30	29	Port8/DIO8
D GND	28	27	Port8/DIO7
D GND	26	25	Port8/DIO6
D 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



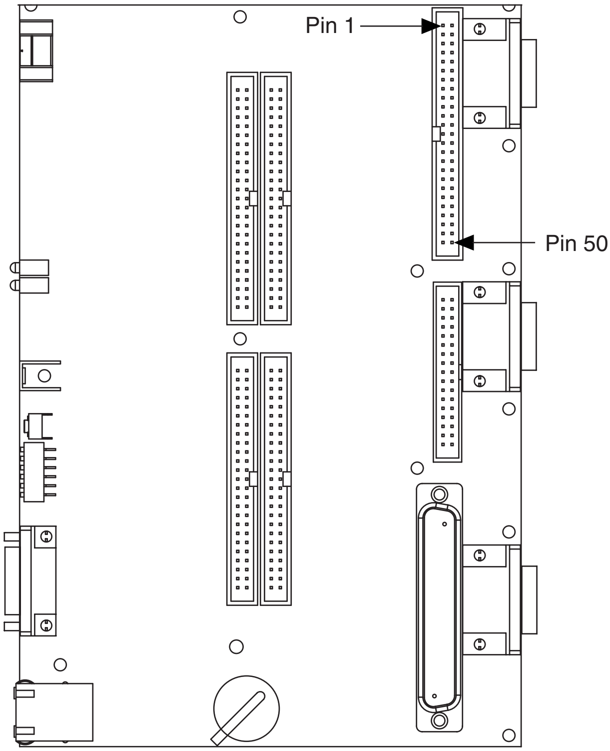
D GND	50	49	Port2/DIO3
D GND	48	47	Port2/DIO2
D GND	46	45	Port2/DIO1
D GND	44	43	Port2/DIO0
Port2/DIOCTL	42	41	Port2/DIO9
D GND	40	39	Port1/DIO8
D GND	38	37	Port1/DIO7
D GND	36	35	Port1/DIO6
D GND	34	33	Port1/DIO5
D GND	32	31	Port1/DIO4
D GND	30	29	Port1/DIO3
D GND	28	27	Port1/DIO2
D GND	26	25	Port1/DIO1
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
5V	10	9	Port0/DIO3
D GND	8	7	Port0/DIO2
5V	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



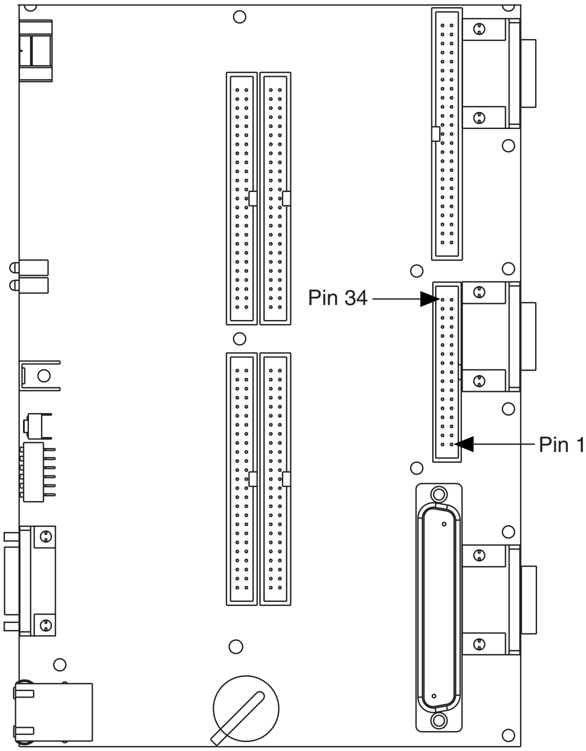
D GND	50	49	Port4/DIO8
5V	48	47	Port4/DIO7
D GND	46	45	Port4/DIO6
5V	44	43	Port4/DIO5
D GND	42	41	Port4/DIO4
D GND	40	39	Port4/DIO3
D GND	38	37	Port4/DIO2
D GND	36	35	Port4/DIO1
D GND	34	33	Port4/DIO0
Port4/DIOCTL	32	31	Port4/DIO9
D GND	30	29	Port3/DIO8
D GND	28	27	Port3/DIO7
D GND	26	25	Port3/DIO6
D 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



AI GND	1	2	AI0
AI8	3	4	AI9
AI1	5	6	AI GND
AI2	7	8	AI10
AI11	9	10	AI3
AI GND	11	12	AI4
AI12	13	14	AI13
AI5	15	16	AI GND
AI6	17	18	AI14
AI15	19	20	AI7
AI GND	21	22	AI16
AI24	23	24	AI25
AI17	25	26	AI GND
AI18	27	28	AI26
AI27	29	30	AI19
AI GND	31	32	AI20
AI28	33	34	AI29
AI21	35	36	AI GND
AI22	37	38	AI30
AI31	39	40	AI23
AI SENSE	41	42	AO GND
AO3	43	44	AO GND
AO2	45	46	AO GND
AO1	47	48	AO GND
AO0	49	50	AI GND

Figure 9. Pinout of I/O Connector J7, Analog I/O



D GND	34	33	DI31
DI30	32	31	DI29
DI28	30	29	DI27
DI26	28	27	DI25
DI24	26	25	DI23
DI22	24	23	DI21
DI20	22	21	DI19
DI18	20	19	DI17
DI16	18	17	DI15
DI14	16	15	DI13
DI12	14	13	DI11
DI10	12	11	DI9
DI8	10	9	DI7
DI6	8	7	DI5
DI4	6	5	DI3
DI2	4	3	DI1
DI0	2	1	D GND

Figure 10. Pinout of I/O Connector J6, 24 V Digital Input (sbRIO-964*x* Only)

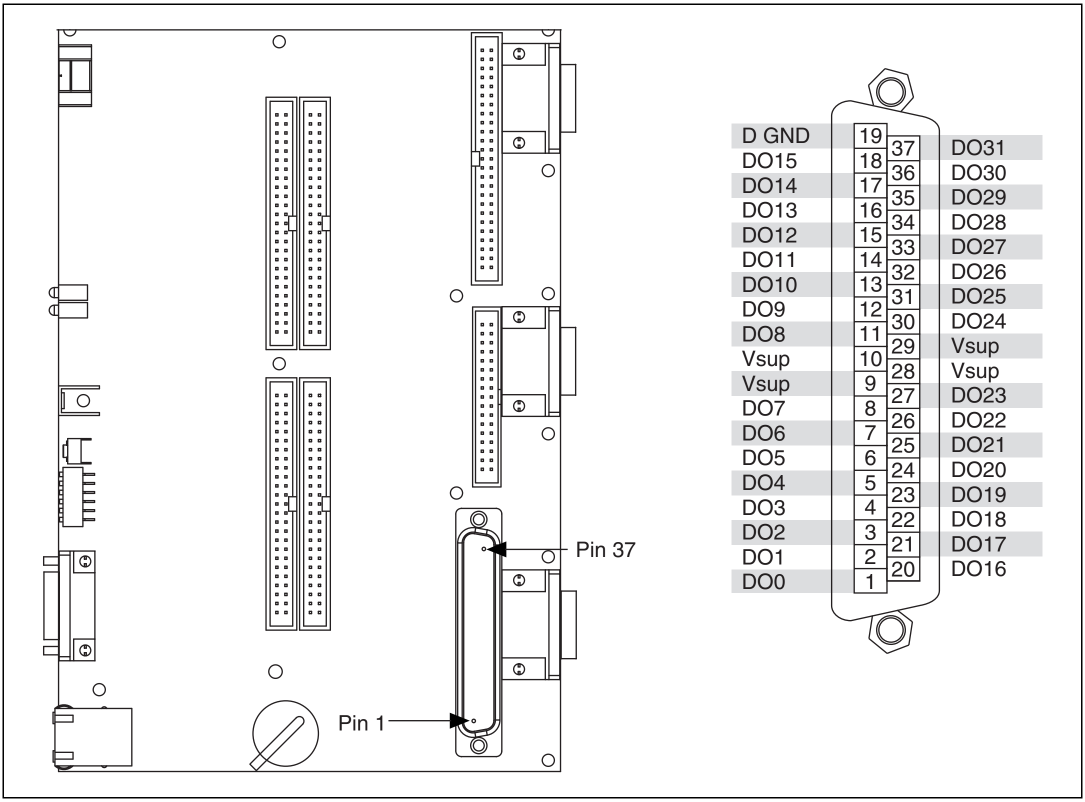


Figure 11. Pinout of I/O Connector J5, 24 V Digital Output (sbRIO-964*x* Only)

The following figure and table show the signals on J1, the RS-232 serial port.

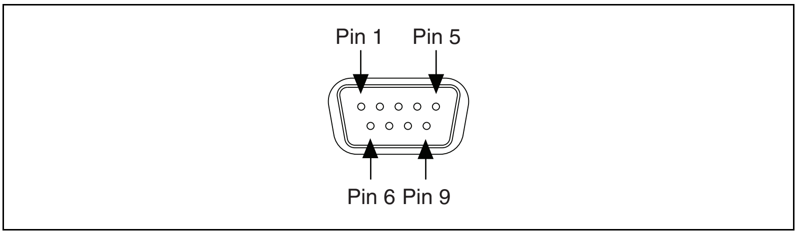


Figure 12. J1, RS-232 Serial Port

Table 2. RS-232 Serial Port Pin Descriptions

Pin	Signal
1	DCD
2	RXD
3	TXD
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RI

Connecting the 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 sbRIO Device

The 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 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 sbRIO device can require power: sbRIO internal operation, including integrated analog and digital I/O; 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.

1. Remove the MINI-COMBICON plug from connector J3 of the sbRIO-961*x*/963*x*/964*x*. 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.

Note The 24 V digital output of the sbRIO-964x requires a separate, additional power supply. Refer to the *Integrated 24 V Digital Output (sbRIO-964x Only)* and *Specifications* sections for more information about powering digital output channels.

Powering On the sbRIO Device

When you apply power to the sbRIO-961*x*/963*x*/964*x*, the device runs a power-on self test (POST). During the POST, the Power and Status LEDs turn on. The Status LED turns off, indicating that 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 3 lists the reset options available on sbRIO devices. These options determine how the FPGA behaves when the device is reset in various conditions.

Table 3. sbRIO Reset Options

Reset Option	Behavior
Do Not Autoload VI	Does not load the FPGA bit stream from flash memory.
Autoload VI on Device Power-Up	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.

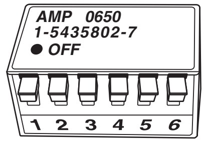
Connecting Serial Devices to the sbRIO Device

The sbRIO-961*x*/963*x*/964*x* 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 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 13. DIP Switches

All of the DIP switches are in the OFF (up) position when the 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 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 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 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*.

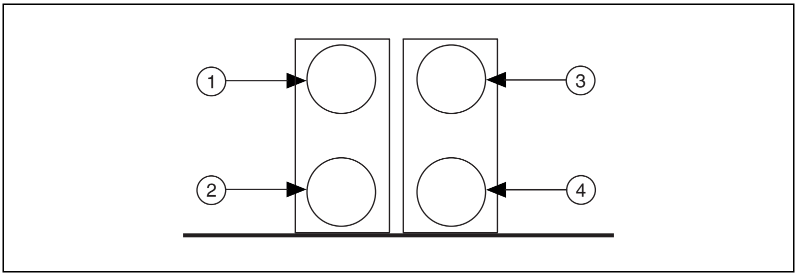
NO FPGA Switch

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



1	FPGA	3	POWER
2	USER	4	STATUS

Figure 14. sbRIO-961*x*/963*x*/964*x* 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 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 sbRIO device indicates specific error conditions by flashing the STATUS LED a certain number of times as shown in Table 4.

Table 4. Status LED Indications

Number of Flashes	Indication
1	The device is unconfigured. Use MAX to configure the device. Refer to the *Measurement & Automation Explorer Help* for information about configuring the device.
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.
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.
Continuous flashing or solid	The device may be configured for DHCP but unable to get an IP address because of a problem with the DHCP server. Check the network connection and try again. If the problem persists, contact National Instruments.

Resetting the Network Configuration of the sbRIO Device

If the 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.

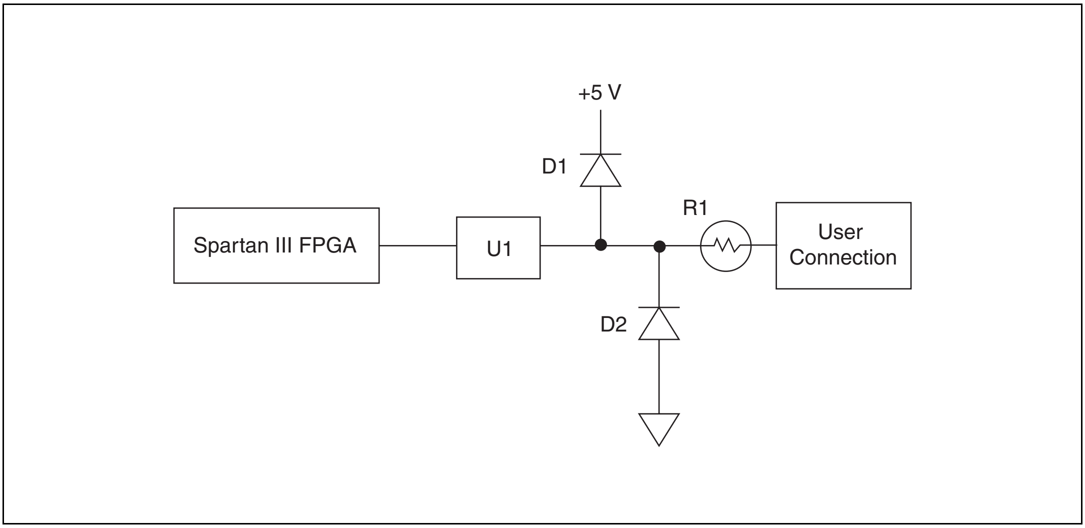
The network settings are restored. You can reconfigure the settings in MAX from a computer on the same subnet. Refer to the *Measurement &*

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.

Integrated 3.3 V Digital I/O

The four 40-pin IDC headers, P2–P5, provide connections for 110 low-voltage DIO channels, 82 DGND, 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 15. 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 sbRIO devices were 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

The sbRIO boards were designed with 60 Ω characteristic trace impedance. The characteristic impedance of most IDC ribbon cables is 110 Ω, which is grossly mismatched from the board. However, headers P2–P5 were designed such that the signals are interwoven with ground (signal/ground/signal/ground, etc.), which greatly improves the signal integrity. This is sufficient for most applications

For the best possible signal integrity, use 3M™ ribbon cable #3353, 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. This +5 V outputs are referenced to DGND on the headers and are connected directly to the internal 5 V power plane of the 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 sbRIO power supply is designed for 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.

Integrated Analog Input

Connector J7 provides connections for 32 single-ended analog input channels or 16 differential analog input channels. Connector J7 also provides one connection for AI SENSE and nine connections for AI GND. Refer to the *I/O and Other Connectors on the sbRIO Device* section for a pinout of connector J7.

The integrated analog input of the sbRIO device is similar to that of the NI 9205, but there is no isolation or digital I/O. The following figure shows the input circuitry for one channel.

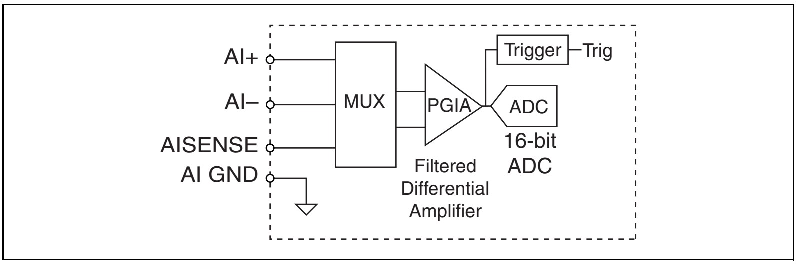


Figure 16. Input Circuitry for One Analog Channel

The remainder of this section provides a brief discussion of possible analog input configurations. For a more in-depth discussion and examples, refer to the *Analog Input* chapter of the *M Series User Manual* on `ni.com`.

Differential Measurement Configurations

You can use a differential measurement configuration to attain more accurate measurements and less noise. A differential measurement configuration requires two inputs for each measurement, thus reducing the number of available channels to 16. Table 5 shows the signal pairs that are valid for differential connection configurations.

Table 5. Differential Pairs

Channel	Signal+	Signal–	Channel	Signal+	Signal–
0	AI0	AI8	16	AI16	AI24
1	AI1	AI9	17	AI17	AI25
2	AI2	AI10	18	AI18	AI26
3	AI3	AI11	19	AI19	AI27
4	AI4	AI12	20	AI20	AI28
5	AI5	AI13	21	AI21	AI29
6	AI6	AI14	22	AI22	AI30
7	AI7	AI15	23	AI23	AI31

The following figure shows how to make a differential connection for a floating signal and for a ground-referenced signal.

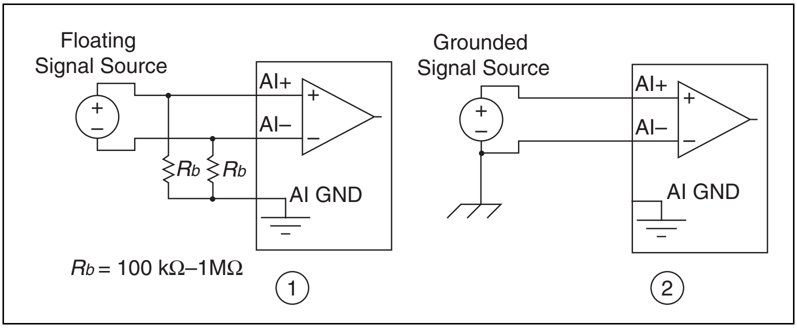


Figure 17. Differential Analog Input Connection

Referenced Single-Ended (RSE) Measurements

You can use an RSE measurement configuration to take measurements on 32 channels when all channels share a common ground. The following figure shows how to make an RSE analog input connection for a floating signal. National Instruments does *not* recommend making an RSE connection for a ground-referenced signal.

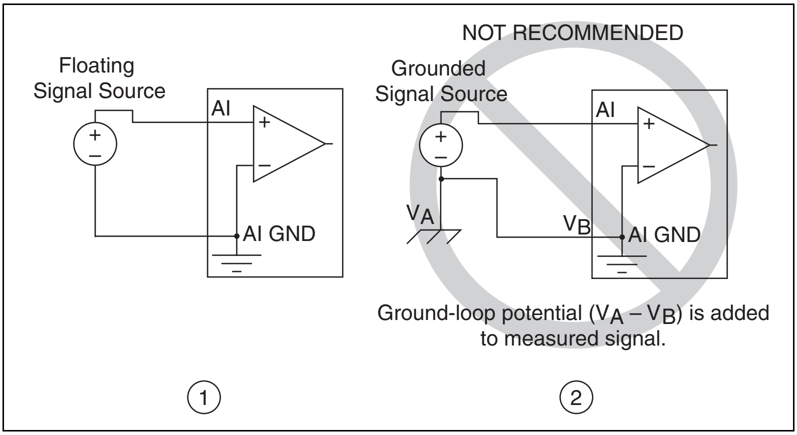


Figure 18. RSE Analog Input Connection

In an RSE connection configuration, the sbRIO device measures each input channel with respect to AI GND.

Non-Referenced, Single-Ended (NRSE) Measurements

You can use an NRSE measurement configuration to take measurements on all 32 channels while reducing noise more effectively than with an RSE connection configuration. This configuration provides remote sense for the negative (–) input of the programmable gain instrumentation amplifier (PGIA) that is shared by all channels configured for NRSE mode. The behavior of this configuration is similar to the behavior of RSE connections, but it provides improved noise rejection. The following figure shows how to make an NRSE analog input connection for a floating signal and for a ground-referenced signal.

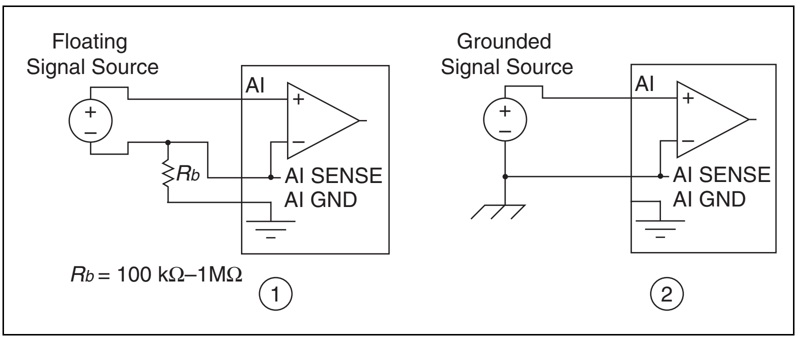


Figure 19. NRSE Analog Input Connection

Note The analog input and analog output of the sbRIO-963*x*/964*x* share an internal power supply. Putting the analog input into Sleep Mode turns off analog output as well. However, putting analog output into Sleep Mode does not turn off analog input.

Integrated Analog Output (sbRIO-963*x*/964*x* Only)

Connector J7 of the sbRIO-963x/964*x* provides connections for four analog output channels. Refer to the *I/O and Other Connectors on the sbRIO Device* section for a pinout of connector J7.

The integrated analog output of the sbRIO device is similar to that of the NI 9263, but there is no isolation. Each channel has a digital-to-analog converter that produces a voltage signal. Each channel also has overvoltage and short-circuit protection. Refer to the *Specifications* section for information about the overvoltage and short-circuit protection.

The following figure shows the analog output circuitry for one channel.

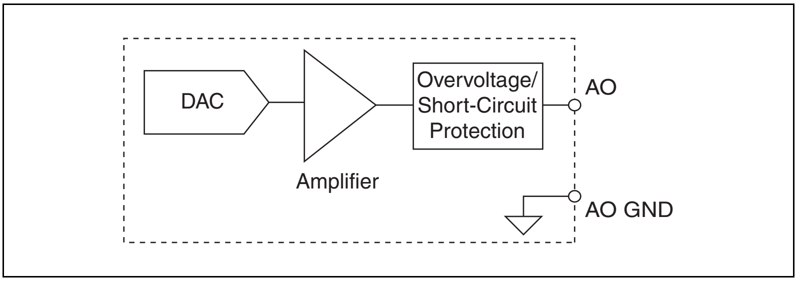


Figure 20. Analog Output Circuitry for One Channel

When you apply power to the sbRIO device, analog output channels are unpowered until data is written to them. When the channels receive the first data, they turn on and drive the output voltage configured in software. This behavior is similar to that of the NI 9263. Refer to the *Specifications* section for more information about power-on voltage. Refer to the software documentation for information about configuring initial output values in software.

Connect the positive lead of the load to the AO terminal. Connect the ground of the load to an AO GND terminal. The following figure shows a load connected to one analog input channel.

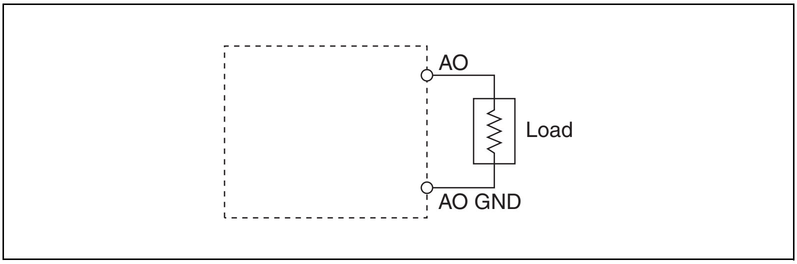


Figure 21. Load Connected to One Analog Input Channel

Integrated 24 V Digital Input (sbRIO-964*x* Only)

Connector J6 of the sbRIO-964*x* provides connections for 32 simultaneously sampled digital input channels. Each channel has one pin, DI, to which you can connect a digital input signal. The remaining two pins of J6 are the ground reference pins, DGND. Refer to the *I/O and Other Connectors on the sbRIO Device* section for a pinout of connector J6.

The integrated digital input of the sbRIO device is similar to that of the NI 9425, but there is no isolation. The 24 V digital input channels are sinking inputs, meaning that when current goes through or voltage is applied to the DI pin, the pin provides a path to DGND for the current or voltage. DGND is the current return path for sourcing digital input devices. The sbRIO-964*x* internally limits current signals connected to DI. For more information about input current protection, refer to the *Specifications* section.

You can connect 2-, 3-, and 4-wire sourcing-output devices to the sbRIO-964*x*. A sourcing-output device drives current or applies voltage to the DI pin. An example of a sourcing-output device is a PNP open collector. The following figure shows a possible configuration.

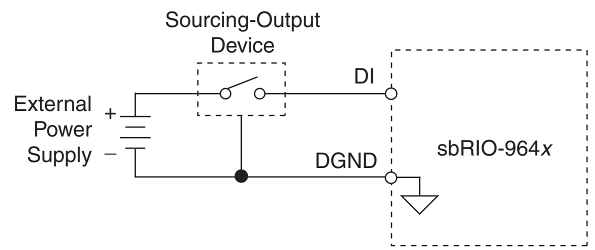


Figure 22. Device Connected to One Digital Input Channel

The digital input channel registers as ON when the sourcing-output device applies a voltage or drives a current to the DI pin that is in the input ON range. The channel registers as OFF when the device applies a voltage or drives a current to the DI pin that is in the input OFF range. If no device is connected to the DI pin, the channel registers as OFF. Refer to the *Specifications* section for more information about ON and OFF ranges.

Integrated 24 V Digital Output (sbRIO-964*x* Only)

Connector J5 of the sbRIO-964*x* provides connections for 32 current-sourcing digital output channels. Refer to the *I/O and Other Connectors on the sbRIO Device* section for a pinout of connector J5.

The DO pin of the channel drives current or applies voltage to a connected device. You can directly connect the sbRIO-964*x* to a variety of industrial devices such as motors, actuators, relays, and lamps. Make sure the devices you connect to the sbRIO-964*x* are compatible with the output specifications. Refer to the *Specifications* section for the output specifications.

The 24 V digital outputs of the sbRIO-964*x* require a 6–35 VDC power supply separate from the power supply connected to J3.

Connect the device to DO and DGND, and connect the external power supply to V_{sup} and DGND, as shown in the following figure.

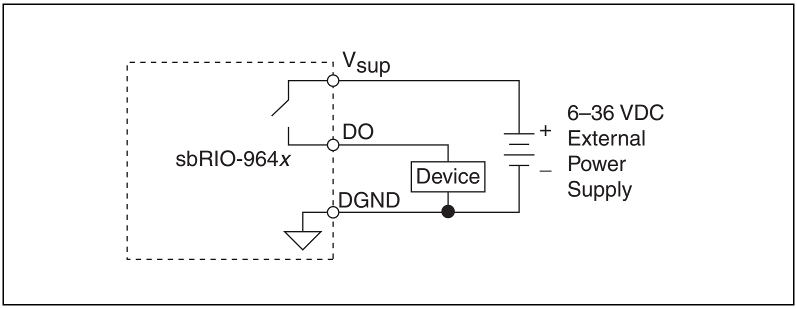


Figure 23. Device Connected to One Digital Output Channel

Increasing Current Drive

If you do not modify the sbRIO device, each channel has a continuous output current of 250 mA. If you want to increase the output current to a device, you can connect any number of channels together in parallel. For example, if you want to drive 1 A of current, connect DO<0..3> in parallel as shown in Figure 24. You must turn all parallel channels on and off simultaneously so that the current on any single channel cannot exceed the 250 mA rating. You must also select heavier cabling for the connection between the negative terminal of the device and the negative terminal of the power supply for the device. Refer to the following figure and use heavier cabling where indicated by heavier traces.

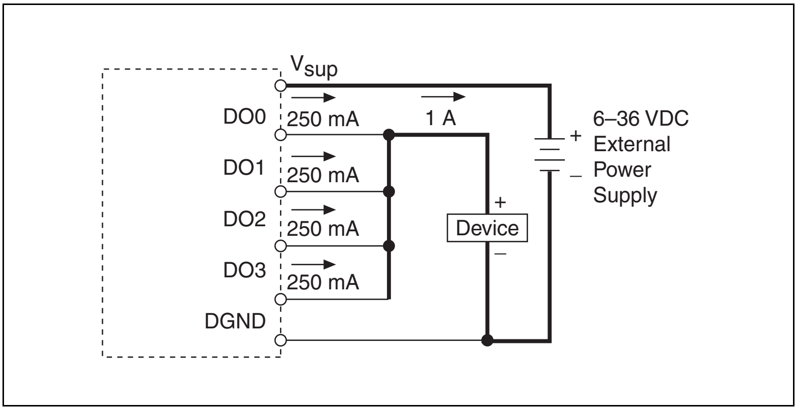


Figure 24. Increasing the Current to a Device

If you add heat sinks to the output transistors U49–U56 and U110–U117, such that the measured case temperature of the transistors remains below 65 °C at ambient temperature of 55 °C, each channel can drive up to 1.5 A. However, the total current through all channels must not exceed 20 A.[1] Use a heat sink that dissipates 0.5 W for each transistor driving up to 1.5 A. For example, for four transistors, each driving 1.5 A, use a 2 W heat sink. The following table shows the channels associated with the output transistors.

Table 6. Transistors Associated with DO Channels

DO Channels	Transistor
0, 1	U49
2, 3	U50
4, 5	U51
6, 7	U52
8, 9	U53
10, 11	U54
12, 13	U55
14, 15	U56
16, 17	U117
18, 19	U116
20, 21	U115

[1] The 20 A total-current limit is based on the maximum current rating of the DSUB connector pins, 5 A, multiplied by 4, the number of V_{sup} pins.

Table 6. Transistors Associated with DO Channels (Continued)

DO Channels	Transistor
22, 23	U114
24, 25	U113
26, 27	U112
28, 29	U111
30, 31	U110

Protecting the sbRIO Device from Flyback Voltages

If a digital output channel is switching an inductive or energy-storing device such as a motor, solenoid, or relay, and the device does not have flyback protection, install a flyback diode as shown in Figure 25.

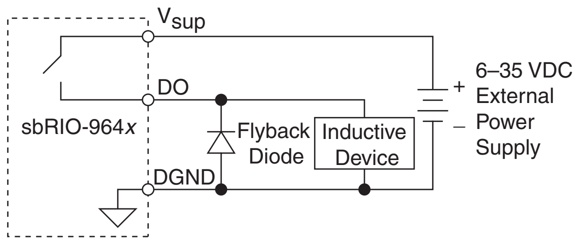


Figure 25. Connecting a Flyback Diode to the sbRIO 964*x*

I/O Protection

The sbRIO-964*x* is protected against overcurrent, inrush, and short-circuit conditions in accordance with IEC 1131-2.

Each digital output channel on the sbRIO-964*x* has circuitry that protects it from voltage and current surges resulting from short circuits.

Caution The sbRIO-964*x* can be damaged under overvoltage and reverse bias voltage conditions. Check the voltage specifications for all devices that you connect to the sbRIO-964*x*.

Excessive current through a DO pin causes the channel to go into an overcurrent state. In an overcurrent state, the channel cycles off and on until the short circuit is removed or the current returns to an acceptably low level.

Refer to the *24 V Digital Output (sbRIO-964x Only)* section for typical trip currents.

Each channel has a status line that indicates in software whether the channel is in an overcurrent state. Refer to the software documentation for information about the status line.

Specifications

The following specifications are typical for the range –20 to 55 °C unless otherwise noted.

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

Processor Speed

sbRIO-9611/9631/9641 ....266 MHz

sbRIO-9612/9632/9642 ....400 MHz

Memory

Non-volatile memory

- sbRIO-9611/9631/9641 ....128 MB
- sbRIO-9612/9632/9642 ....256 MB

System memory

- sbRIO-9611/9631/9641 ....64 MB
- sbRIO-9612/9632/9642 ....128 MB

Xilinx Spartan 3 Reconfigurable FPGA

Number of logic cells

- sbRIO-9611/9631/9641 17,280
- sbRIO-9612/9632/9642 46,080

Available embedded RAM

sbRIO-9611/9631/9641 .... 432 kbits

sbRIO-9612/9632/9642 .... 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 at –20 to 70 °C .... ±20 V (maximum 2 pins in overvoltage)

Posistor (PRG18BB330MS1RB from Murata)

Maximum peak abnormal-condition current............. 760 mA

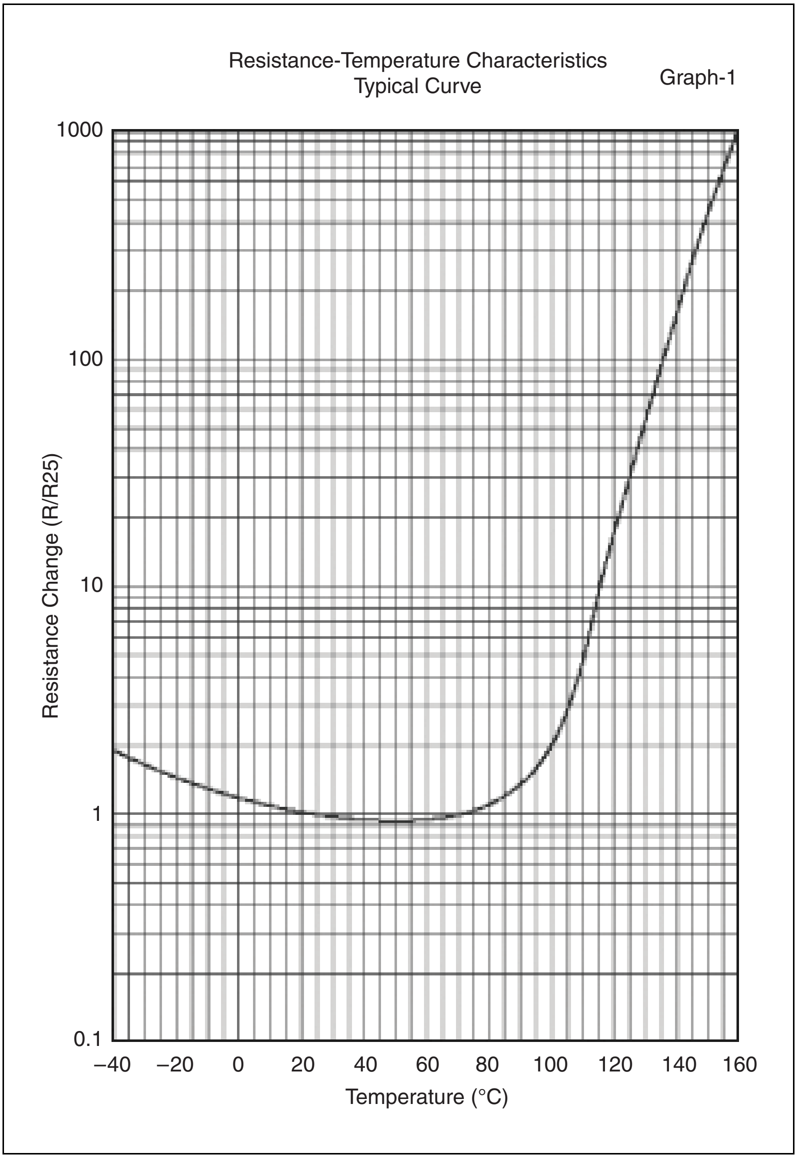
Maximum hold current at 25 °C ..... 36 mA

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

Trip current at 25 °C .... 71 mA

Resistance at 25 °C .... 33 Ω ±20%

Resistance–temperature characteristics, typical curve

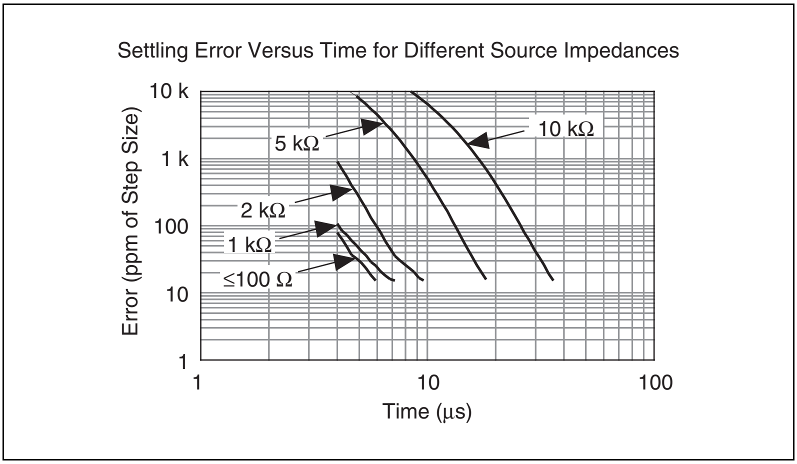


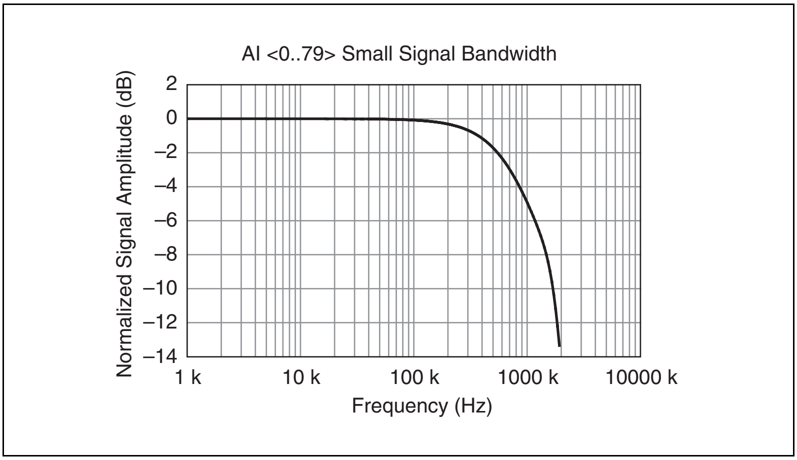
Analog Input

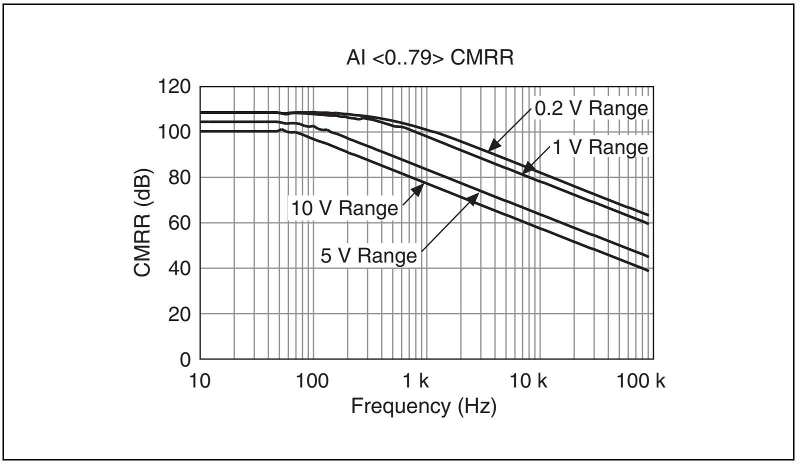
All voltages are relative to AI GND unless otherwise noted.

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 time for multichannel measurements, accuracy, all ranges

±120 ppm of full-scale step (±8 LSB) .... 4 µs convert interval

±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, over Full Operating Temperature Range* (mV)	Random Noise, σ (µVrms)	Sensitivity† (µV)
±10	7,820	36.6	244	97.6
±5	3,990	18.6	122	48.8
±1	870	4.27	30	12.0
±0.2	244	1.37	13	5.2

* Absolute accuracy values are determined by averaging 100 samples on analog input channels operating within 45 °C of the last external calibration. Refer to the *Absolute accuracy formulas* for more information.

† Sensitivity is the smallest voltage change that can be detected. It is a function of noise.

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

$$AbsoluteAccuracy = Reading \cdot GainError + Range \cdot OffsetError + NoiseUncertainty$$

$$GainError = ResidualGainError + GainTempco \cdot TempChangeFromLastInternalCal + ReferenceTempco \cdot TempChangeFromLastExternalCal$$

$$OffsetError = ResidualOffsetError + OffsetTempco \cdot TempChangeFromLastInternalCal + INL\_Error$$

$NoiseUncertainty = (RandomNoise \cdot 3) / \sqrt{100}$ 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:

$$TempChangeFromLastExternalCal = 45\ °C$$

$$TempChangeFromLastInternalCal = 5\ °C$$

$$NumberOfReadings = 100$$

$$CoverageFactor = 3\ \sigma$$

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

$$GainError = 94\text{ ppm} + 23\text{ ppm} \cdot 5 + 5\text{ ppm} \cdot 45$$
$$GainError = 434\text{ ppm}$$

$$OffsetError = 20\text{ ppm} + 49\text{ ppm} \cdot 5 + 76\text{ ppm}$$
$$OffsetError = 341\text{ ppm}$$

$$NoiseUncertainty = (244\ \mu V \cdot 3) / \sqrt{100}$$
$$Noise\ Uncertainty = 73.2\ \mu V$$

$$AbsoluteAccuracy = 10\text{ V} \cdot 434\text{ ppm} + 10\text{ V} \cdot 341\text{ ppm} + 73.2\ \mu V$$
$$AbsoluteAccuracy = 7{,}823\ \mu V \text{ (rounds to } 7{,}820\ \mu V)$$

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

$$TempChangeFromLastInternalCal = 45\ °C$$

Analog Output (sbRIO-963*x* and sbRIO-964*x* 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

Error	Percent of Reading	Percent of Range*
Calibrated, max (–20 to 55 °C)	0.35%	0.75%
Calibrated, typ (25 °C, ±5 °C)	0.01%	0.1%
Uncalibrated, max (–20 to 55 °C)	2.2%	1.7%
Uncalibrated, typ (25 °C, ±5 °C)	0.3%	0.25%
* Range equals ±10.7 V		

Stability

- Offset drift....................................... 80 μV/°C
- Gain drift... 6 ppm/°C

Protection

- Overvoltage.................................... ±25 V
- 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 .... 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

24 V Digital Input (sbRIO-964*x* Only)

Number of channels 32

Input type .... Sinking

Digital logic levels

OFF state

Input voltage............................. ≤5 V

Input current .... ≤150 µA

ON state

Input voltage............................. ≥10 V

Input current .... ≥330 µA

Hysteresis

Input voltage............................. 2 V min

Input current .... 60 µA min

Input impedance .... 30 kΩ ±5%

Input protection

Eight channels.......................... 60 VDC max

32 channels .... 30 VDC max

Setup time[1] .... 1 µs max

Transfer time[2].. 7 µs max

24 V Digital Output (sbRIO-964*x* Only)

Number of channels 32

Output type.. Sourcing

Output voltage (V_0)............................... $V_{sup} - (I_0R_0)$

Input voltage from
external power supply .... 6–35 VDC

Continuous output current (I_0) on each channel

No heat sinks.................................. 250 mA max

With external heat
sinks added[3] .... 1.5 A max

Maximum total output current
on all channels....................................... 20 A

Output impedance (R_0) .... 0.3 Ω max

Continuous overvoltage
protection range (V_{sup}) .... 40 V

Reversed-voltage protection .... None

Current limiting..................................... None

Short-circuit protection .... Indefinitely protected when a channel is shorted to DGND or to a voltage up to V_{sup}

---

[1] *Setup time* is the amount of time input signals must be stable before you can read from the module.

[2] *Transfer time* is the maximum time FPGA Device I/O functions take to read data from the module.

[3] Refer to the *Increasing Current Drive* section for information about installing heat sinks.

Trip current for one channel

With all other channels at 250 mA current ....3 A typ

With all other channels off ....5 A typ

V_{sup} quiescent current consumption ....28 mA max

Propagation delay ....500 µs max

Power Requirements

The sbRIO device requires a power supply connected to connector J3. Refer to Figure 4 for the location of J3. Refer to the *Powering the 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

$$\text{Total power requirement} = P_{int} + P_{DIO} + P_{5V} + P_{CSer},$$

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}

sbRIO-961*x*.....................................7.50 W

sbRIO-963*x*.....................................7.75 W

sbRIO-964*x*.....................................8.00 W

Maximum P_{DIO} ....1.28 W

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

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

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

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

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

Example power requirement calculations:

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

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

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

Total power requirement = 20.32 W

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

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

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

Total power requirement = 11.86 W

Backup battery .... 3 V lithium coin cell, BR2032

Working I/O Voltages

Connect only voltages that are within these limits.

V terminal to C terminal .... 35 VDC max, Measurement Category I

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

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 sbRIO-96*xx* is intended for indoor use only.

Ambient temperature in enclosure
(IEC 60068-2-1, IEC 60068-2-2)................–20 to 55 °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

sbRIO-961*x*..................................... 266.5 g (9.4 oz)

sbRIO-963*x*..................................... 269.3 g (9.5 oz)

sbRIO-964*x*..................................... 292.0 g (10.3 oz)

Cabling

Table 7 shows the standard Ethernet cable wiring connections for both normal and crossover cables.

Table 7. 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

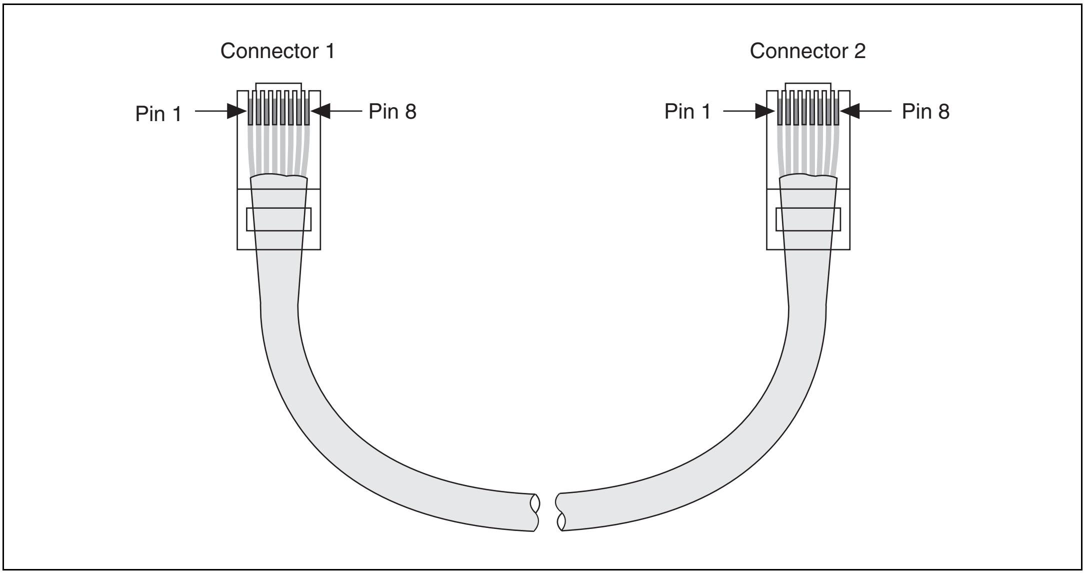


Figure 26. Ethernet Connector Pinout

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:

Australia 1800 300 800, Austria 43 662 457990-0,
Belgium 32 (0) 2 757 0020, Brazil 55 11 3262 3599,
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,
Italy 39 02 41309277, Japan 0120-527196, Korea 82 02 3451 3400,
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 3390150, 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, United Kingdom 44 (0) 1635 523545

375052A-01 Aug08