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OEM OPERATING INSTRUCTIONS AND SPECIFICATIONS

NI sbRIO-9605/9606

Single-Board RIO OEM Devices

This document provides dimensions, pinouts, connectivity information, and specifications for the National Instruments sbRIO-9605 and sbRIO-9606. The devices are referred to inclusively in this document as the NI sbRIO-960x.

Caution The NI sbRIO-960x 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 NI sbRIO devices inside an enclosure. Auxiliary cooling may be necessary to keep the ambient temperate under the maximum rating for the NI sbRIO device. Refer to the *Specifications* section for more information about the maximum ambient temperature rating.

Caution Do not operate the NI sbRIO-960x in a manner not specified in these operating instructions. Product misuse can result in a hazard. You can compromise the safety protection built into the product if the product is damaged in any way. If the product is damaged, return it to National Instruments for repair.

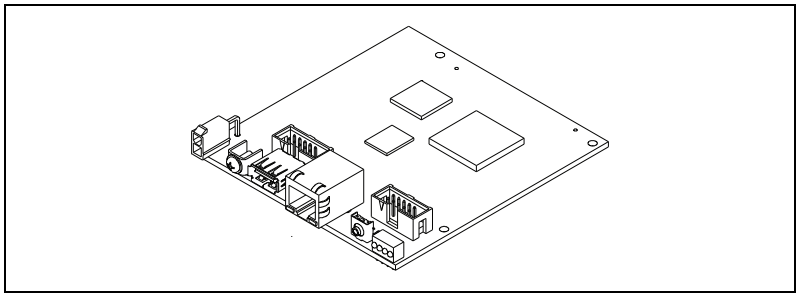


Figure 1. NI sbRIO-9606

NATIONAL INSTRUMENTS

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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 2011 or later
- ❑ LabVIEW Real-Time Module 2011 or later
- ❑ LabVIEW FPGA Module 2011 or later
- ❑ NI-RIO 4.0 or later

Hardware Requirements

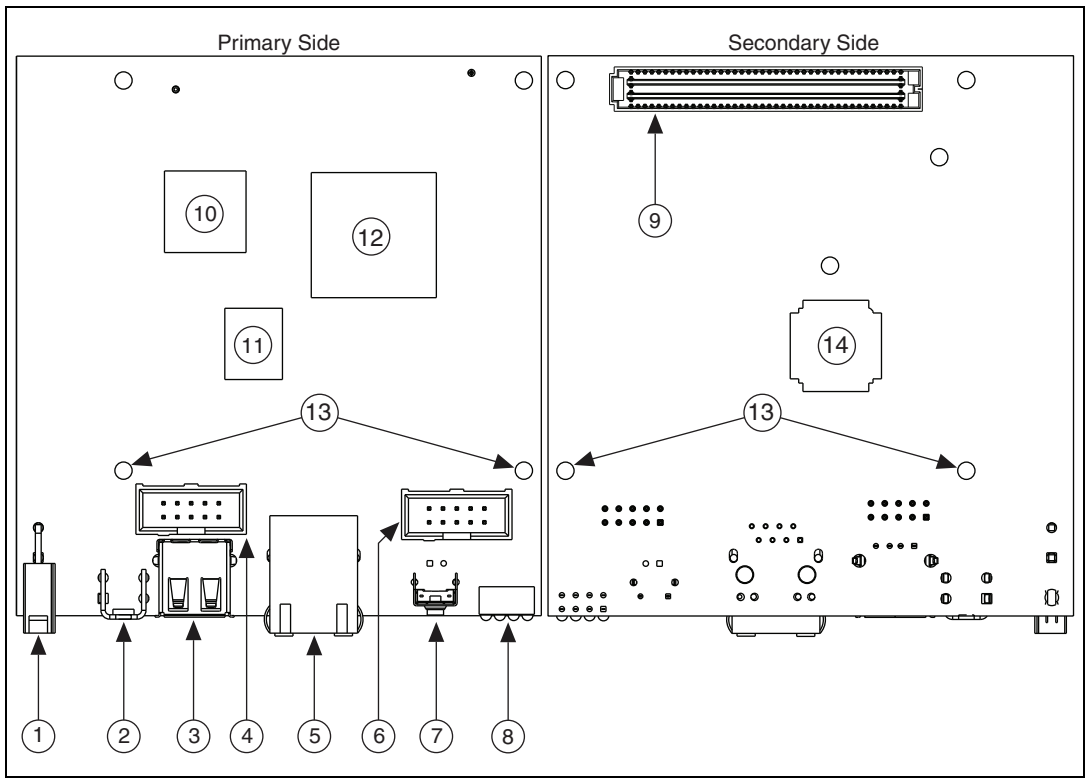
You need the following hardware to use the NI sbRIO device.

- ❑ NI sbRIO-960x
- ❑ 9–30 VDC power supply
- ❑ Ethernet cable
- ❑ Power Plug Assembly

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I/O and Other Components on the NI sbRIO Device

Figure 2 shows the locations of I/O and other components on the NI sbRIO device.



1	Power Connector	8	LEDs
2	Chassis Ground Bracket	9	RIO Mezzanine Card Connector
3	USB Host Port (sbRIO-9606 only)	10	FPGA
4	CAN IDC Header (CAN0) (sbRIO-9606 only)	11	NAND Flash
5	RJ-45 Ethernet Port	12	Processor
6	RS-232 Serial IDC Header (COM1)	13	Mounting Holes Connected to Chassis Ground
7	Reset Switch	14	CPLD

Figure 2. NI sbRIO-960x Component Location Diagram

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Table 1 lists and describes the connectors on the NI sbRIO-960x 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

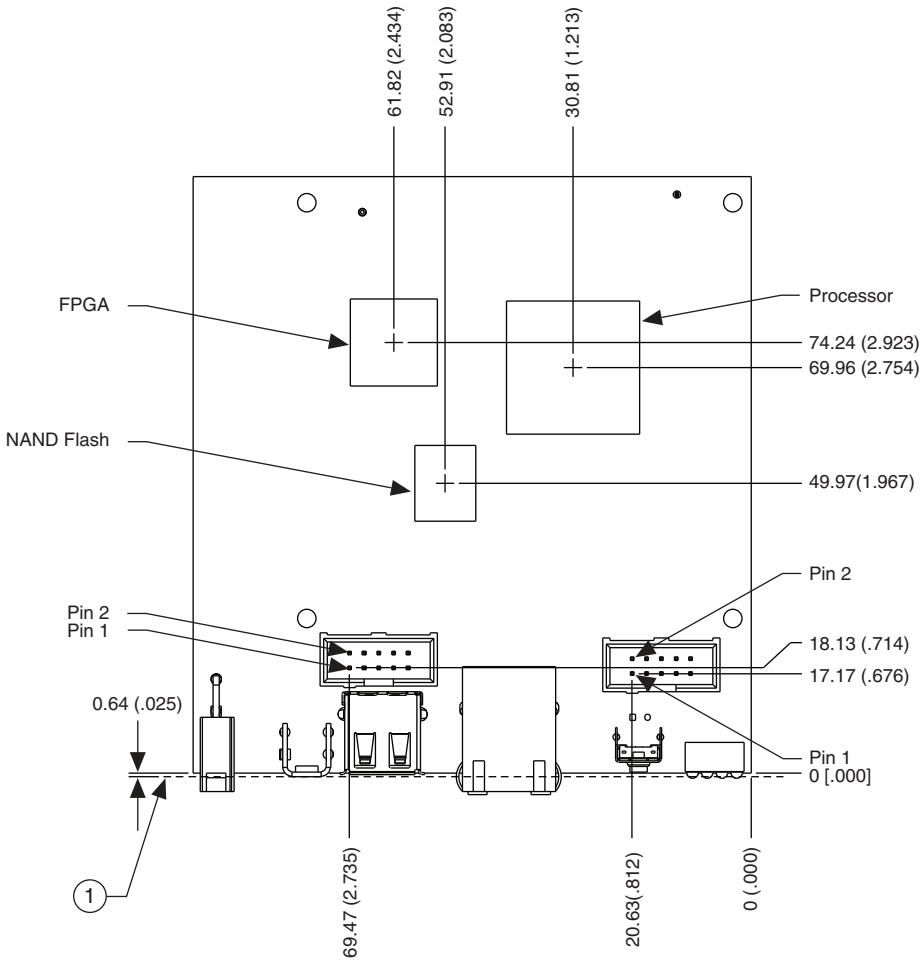
Connector	Description	Manufacturer and Part Number	Recommended Mating Connector	NI Solution
Power	2-position, mini-fit JR w/ snap-in peg locks, H = 0.411 in.	Molex, 46999-0144	Molex, 50-36-1673 w/ 0457501211	NI, 152834-01
RS-232/CAN IDC header	10-pin, 0.100 in. CT, shrouded, H = 0.370 in.	3M, N2510-6002RB or equivalent	Tyco, 1658622-1	NI, 153158-10
RMC Connector	240-pin, 40 x 6 pos., high hensity open pin field SEARAY	Samtec, SEAF-40-06.5-S-06-2-A-K-TR	Samtec, SEAM-40-03.0-S-06-2-A-K-TR	—

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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`.

Figure 3 shows the dimensions of the primary side of the NI sbRIO-960x.

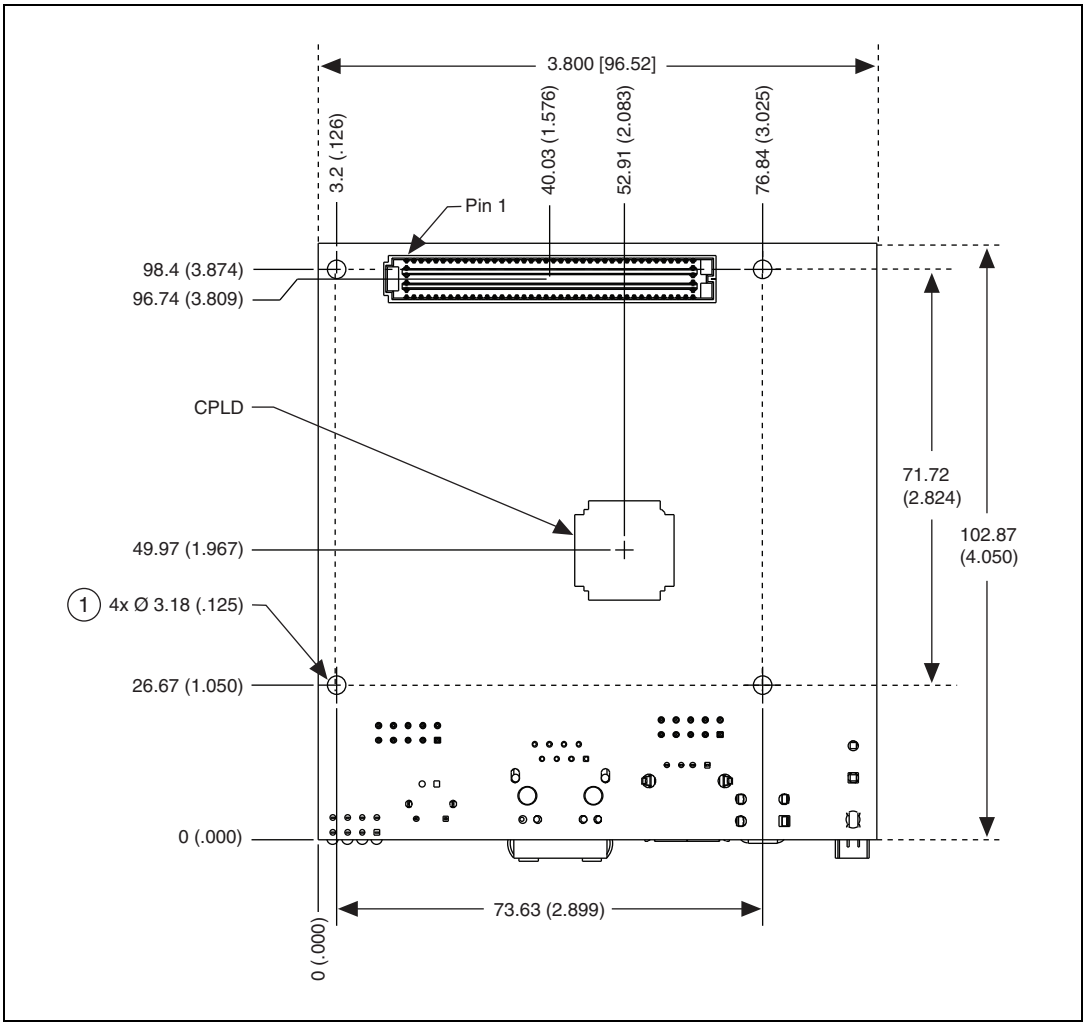


1 Back of Front Panel

Figure 3. NI sbRIO-960x Primary Side Dimensions in Millimeters (Inches)

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Figure 4 shows the dimensions of the secondary side of the NI sbRIO-960x.

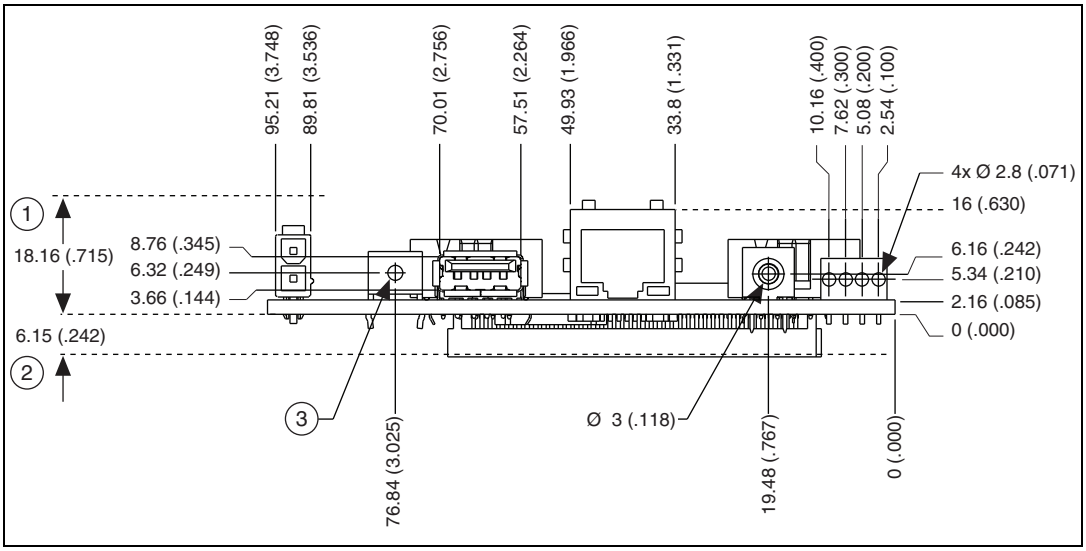


1 Holes and Keepouts Sized for M3 Standoff (4.5 mm Hex) or 4-40 Standoff (3/16” Hex)

Figure 4. NI sbRIO-960x Secondary Side Dimensions in Millimeters (Inches)

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Figure 5 shows the dimensions of the front of the NI sbRIO-960x.



1 Minimum Clearance for Latch on Mating Power Connector
2 Maximum Height of RIO Mezzanine Card Components
3 4-40 threads, Maximum Torque of 3.6 in.-lbs

Figure 5. NI sbRIO-960x Front Dimensions in Millimeters (Inches)

Note For more information about the dimensions of the NI sbRIO-960x, including detailed dimensional drawings, go to `ni.com/dimensions`.

Maximum Component Heights

The primary side of the NI sbRIO-960x is the top side of the PCB where the power connector and Ethernet connector are populated. The maximum component height on the primary side of the PCB is split into two regions, with the maximum component height of 17.27 mm (0.680 in.) on the front edge and 4.06 mm (0.160 in.) on the remaining primary side. The maximum component height on the secondary side of the PCB is 6.15 mm (0.242 in.), excluding the RIO Mezzanine Card (RMC) Connector. NI recommends that adjacent PCBs and surfaces observe a minimum keepaway distance of 19.05 mm (0.75 in.) from the primary-side surface and 7.62 mm (0.360 in.) from the secondary-side surface. For more information refer to Figure 6, Figure 7, and Figure 8.

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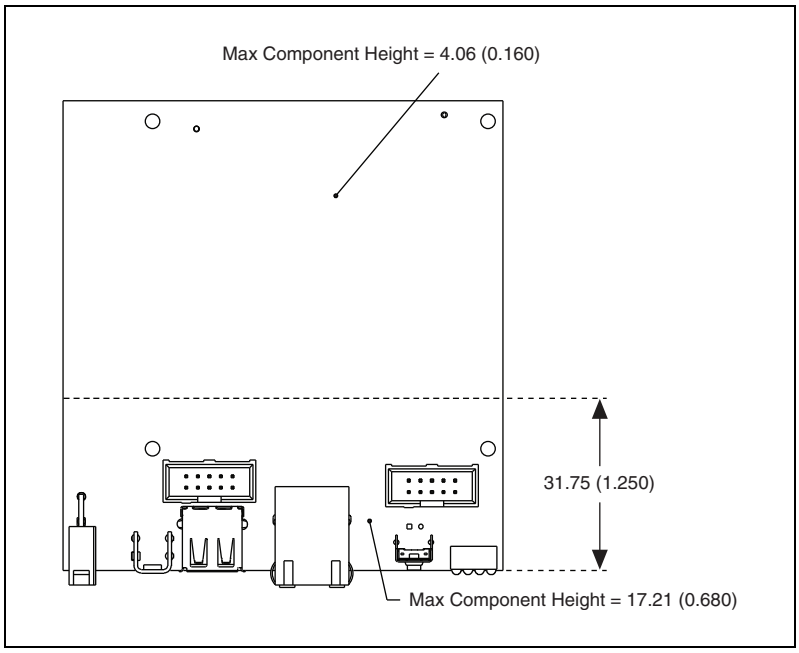


Figure 6. NI sbRIO-960x Maximum Component Height of Primary Surface in Millimeters (Inches)

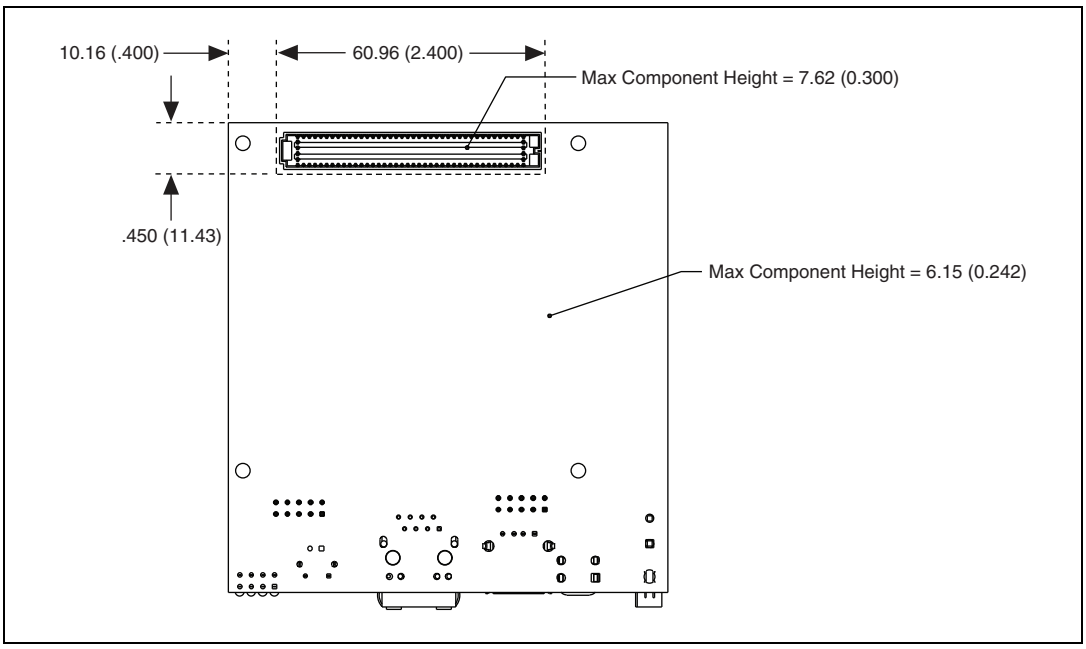


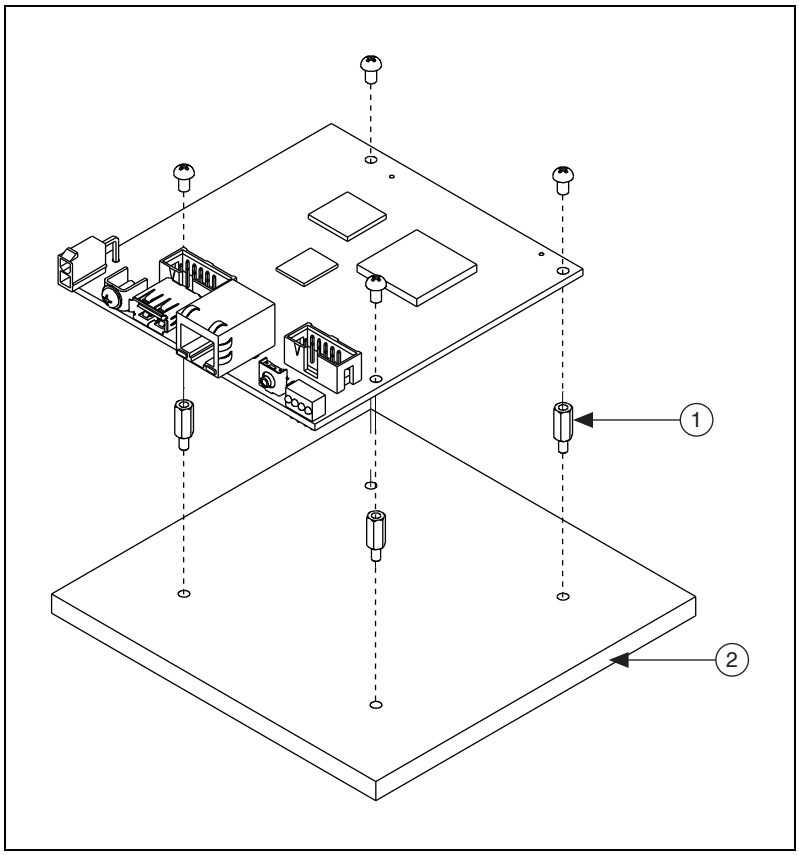
Figure 7. NI sbRIO-960x Max Component Height of Secondary Surface in Millimeters (Inches)

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Mounting the NI sbRIO-960x

The following sections describe how to mount and mate RIO Mezzanine Cards to the NI sbRIO-960x.

Mounting the NI sbRIO-960x to Surface



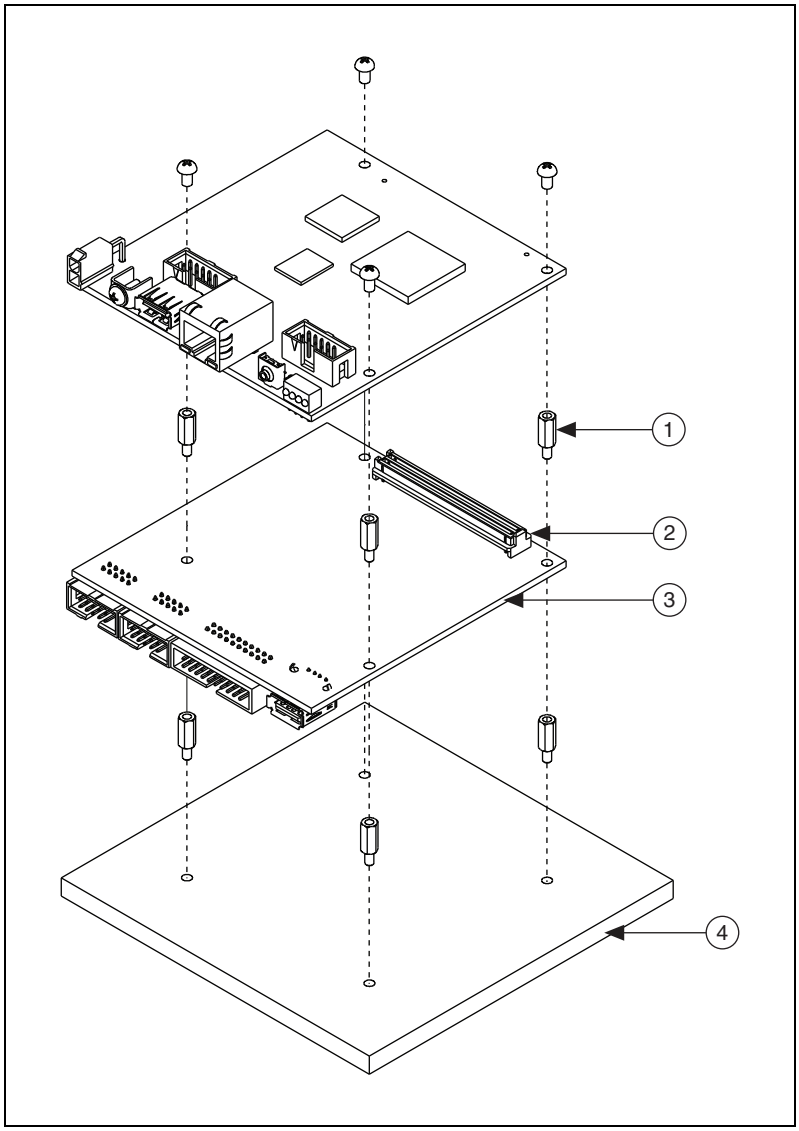
1	0.300 in. Keepaway Distance	2	Mounting Surface

Figure 8. NI sbRIO-960x Mounting Procedure

Note Mounting holes on the NI sbRIO-960x are designed to accommodate M3 or 4-40 fasteners, and standoffs or bosses up to 4.5 mm or 3/16 in. in diameter.

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Mating the NI sbRIO-960x to a RIO Mezzanine Card



1	M3 or 4-40 Standoff or Fastener	3	Example RMC
2	RIO Mezzanine Card (RMC) Connector	4	Mounting Surface

Figure 9. NI sbRIO-960x Mating Procedure

Note When using the recommended Samtec SEARAY male connector (SEAM-40-03.0-5-06-2-A-K-TR), separate the boards with a 9.65 mm (0.380 in.) standoff, such as NI 153166-01.

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Connector Pinouts

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

Power Connector

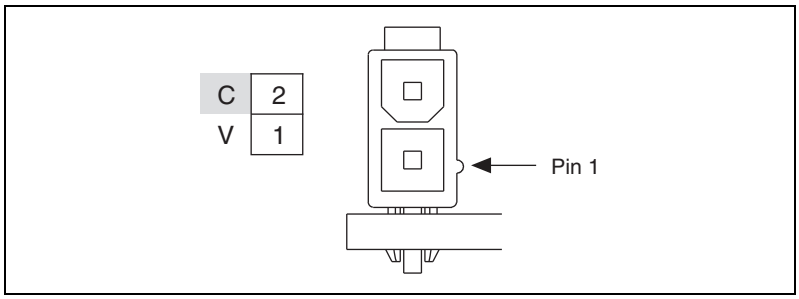


Figure 10. Pinout of the Power Connector

RS-232 / CAN Connectors

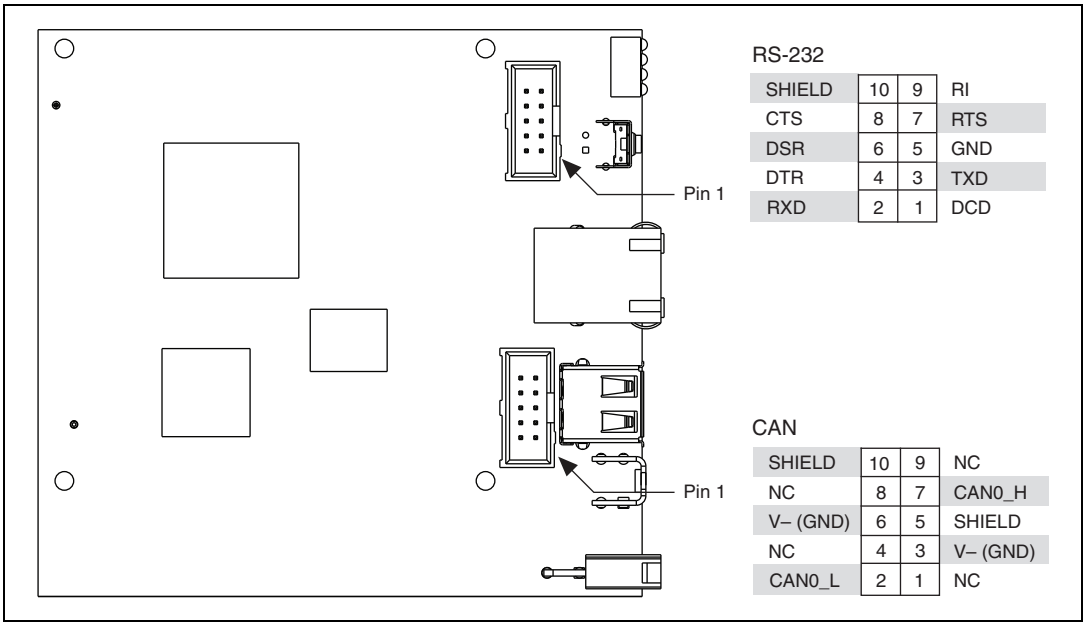


Figure 11. Pinout of the 10-Pin RS-232 and CAN Connectors

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RIO Mezzanine Card Connector

The RIO Mezzanine Card connector provides connections for 96 FPGA I/O channels, as well as pins reserved for future use.

The table on the following page lists the pinout for the RIO Mezzanine Card connector, indicating the pin number and corresponding function.

Note Users interested in additional processor functionality such as serial, CAN, USB, or Ethernet should contact a local National Instruments representative for custom design opportunities. A non-recurring engineering charge (NRE) may apply.

Note Reserved and unused lines should be left disconnected on RIO Mezzanine Cards. Future versions of this manual may update their definition.

Note National Instruments suggests using pins DIO0 through DIO63 first to maintain future compatibility. DIO64 through DIO95 are not guaranteed to be provided on future products.

Caution RMCs are not hot-swappable. Disconnect power before mating.

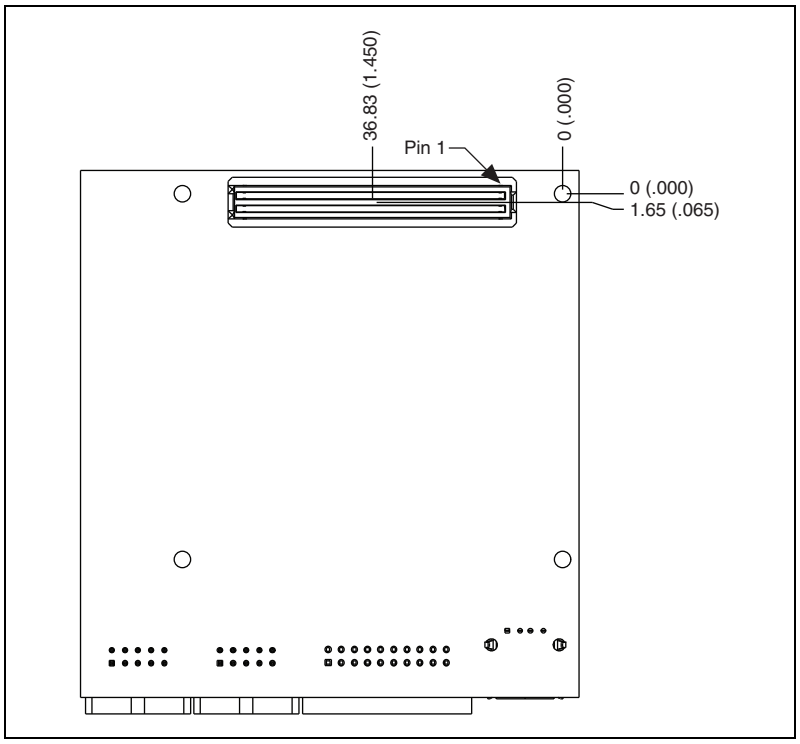


Figure 12. RMC Connector Location and Dimensions on Example RIO Mezzanine Card

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Table 2. RIO Mezzanine Card Connector Pinout

1-RESERVED	2-RESERVED	3-RESERVED	4-RESERVED	5-RESERVED	6-RESERVED
7-RESERVED	8-RESERVED	9-RESERVED	10-RESERVED	11-RESERVED	12-RESERVED
13-RESERVED	14-RESERVED	15-RESERVED	16-RESERVED	17-GND	18-RESERVED
19-RESERVED	20-RESERVED	21-RESERVED	22-RESERVED	23-GND	24-RESERVED
25-RESERVED	26-RESERVED	27-RESERVED	28-RESERVED	29-USB_D+	30-GND
31-RESERVED	32-RESERVED	33-RESERVED	34-RESERVED	35-USB_D–	36-GND
37-RESERVED	38-RST#	39-RESERVED	40-RESERVED	41-GND	42-RESERVED
43-RESERVED	44-RESERVED	45-RESERVED	46-RESERVED	47-GND	48-RESERVED
49-RESERVED	50-RESERVED	51-RESERVED	52-RESERVED	53-RESERVED	54-5V
55-RESERVED	56-RESERVED	57-RESERVED	58-RESERVED	59-RESERVED	60-5V
61-RESERVED	62-RESERVED	63-RESERVED	64-RESERVED	65-RESERVED	66-5V
67-RESERVED	68-RESERVED	69-RESERVED	70-RESERVED	71-RESERVED	72-5V
73-RESERVED	74-RESERVED	75-RESERVED	76-RESERVED	77-RESERVED	78-GND
79-RESERVED	80-RESERVED	81-RESERVED	82-RESERVED	83-GND	84-RESERVED
85-RESERVED	86-RESERVED	87-RESERVED	88-GND	89-DIO47	90-DIO15
91-RESERVED	92-DIO63	93-GND	94-DIO79	95-DIO46	96-GND
97-DIO95	98-GND	99-DIO31	100-DIO78	101-GND	102-DIO14
103-GND	104-DIO62	105-DIO30	106-GND	107-DIO45	108-DIO13
109-DIO94	110-DIO61	111-GND	112-DIO77	113-DIO44	114-GND
115-DIO93	116-GND	117-DIO29	118-DIO76	119-GND	120-DIO12
121-GND	122-DIO60	123-DIO28	124-GND	125-DIO43	126-DIO11
127-DIO92	128-DIO59	129-GND	130-DIO75	131-DIO42	132-GND
133-DIO91	134-GND	135-DIO27	136-DIO74	137-GND	138-DIO10
139-GND	140-DIO58	141-DIO26	142-GND	143-DIO41	144-DIO9
145-DIO90	146-DIO57	147-GND	148-DIO73	149-DIO40	150-GND
151-DIO89	152-GND	153-DIO25	154-DIO72	155-GND	156-DIO8
157-GND	158-DIO56	159-DIO24	160-GND	161-DIO39	162-DIO7
163-DIO88	164-DIO55	165-GND	166-DIO71	167-DIO38	168-GND
169-DIO87	170-GND	171-DIO23	172-DIO70	173-GND	174-DIO6
175-GND	176-DIO54	177-DIO22	178-GND	179-DIO37	180-DIO5
181-DIO86	182-DIO53	183-GND	184-DIO69	185-DIO36	186-GND
187-DIO85	188-GND	189-DIO21	190-DIO68	191-GND	192-DIO4
193-GND	194-DIO52	195-DIO20	196-GND	197-DIO35	198-DIO3
199-DIO84	200-DIO51	201-GND	202-DIO67	203-DIO34	204-GND
205-DIO83	206-GND	207-DIO19	208-DIO66	209-GND	210-DIO2
211-GND	212-DIO50	213-DIO18	214-GND	215-DIO33	216-DIO1
217-DIO82	218-DIO49	219-GND	220-DIO65	221-DIO32	222-GND
223-DIO81	224-GND	225-DIO17	226-DIO64	227-GND	228-DIO0
229-GND	230-DIO48	231-DIO16	232-GND	233-RESERVED	234-FPGA_VIO
235-DIO80	236-VBAT	237-GND	238-RESERVED	239-RESERVED	240-FPGA_VIO

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RMC Power Requirements

The RIO Mezzanine Card connector provides power on six pins. The 5 V rail consists of pins 54, 60, 66, and 72, and is the main source of power to a RIO Mezzanine Card. The FPGA_VIO rail consists of pins 234 and 240, and is used to supply I/O power and determine I/O levels for the FPGA I/O pins.

Table 3 lists the rail requirements for each of the rails on a RIO Mezzanine Card connector.

Table 3. NI RIO Mezzanine Card Rail Requirements

	Voltage Tolerance	Max Current	Max Ripple and Noise
5 V	+/– 5%	1.5 A	50 mV
FPGA_VIO (3.3 V)	+/– 5%	0.33 A	50 mV

RIO Mezzanine Cards should not source any current onto any of the power pins and should be able to tolerate 5 V and FPGA_VIO coming up in any order.

3.3 V Digital I/O

The NI sbRIO-960x provides 3.3 V digital I/O via the RIO Mezzanine Card connector. The following sections provide figures and specifications for a single DIO channel on each connector.

3.3 V DIO on RMC Connector

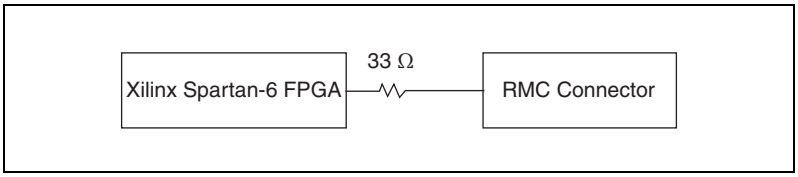


Figure 13. Circuitry of One 3.3 V DIO Channel on the RIO Mezzanine Card Connector

The NI sbRIO 960x is tested with all DIO channels driving 3 mA DC loads. DIO lines are floating before and during FPGA configuration. To ensure startup values, place pull-up or pull-down resistors on a RIO Mezzanine Card. The DIO channels on the NI sbRIO device are routed with a 55 Ω characteristic trace impedance. Route all RIO Mezzanine Cards with a similar impedance to ensure the best signal quality. Refer to *3.3 V DIO on RMC Connector* in the *Specifications* section for the logic levels.

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RMC VBAT

The NI sbRIO-960x implements an onboard real-time clock (RTC) to keep track of absolute time. The RMC connector provides a VBAT line to power the RTC. Without a battery, absolute time will be reset during a power cycle. Batteries connected to VBAT must have a nominal output between 3.0 V and 3.6 V, and a maximum output of 3.7 V. If VBAT is not being used, leave it disconnected.

USB on RMC Connector

The USB pair on the RMC Connector has a 90 Ω differential trace impedance. To ensure the best possible signal integrity, route the USB pair with a similar trace impedance. If USB is not being used, leave it disconnected.

RMC RST#

The RST# signal indicates that power provided through the RMC Connector is valid. RST# is guaranteed to be asserted for at least 1 ms. There should be no more than 30 pF on the RST# line of a RIO Mezzanine Card. This includes the RMC Connector, traces, vias, and device pins. Refer to *3.3 V Digital I/O on RIO Mezzanine Card Connector* in the *Specifications* section for output logic levels.

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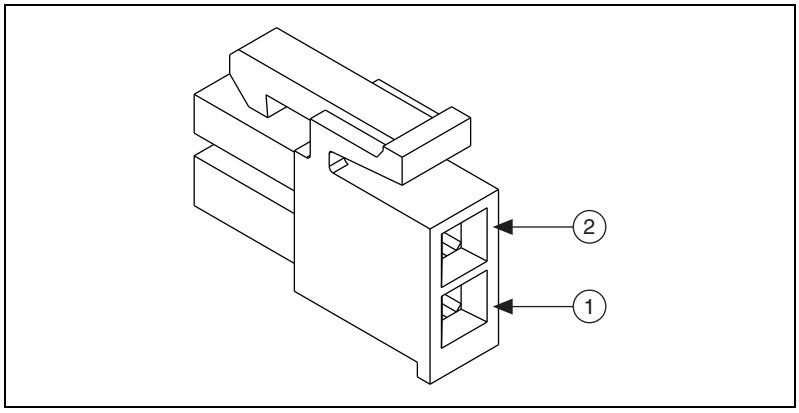
Powering the NI sbRIO Device

The NI sbRIO-960x requires an external power supply that meets the specifications in the *Power Requirements* section. The NI sbRIO-960x filters and regulates the supplied power and provides power for RIO Mezzanine Cards. The NI sbRIO-960x has one layer of reverse-voltage protection. Complete the following steps to connect a power supply to the chassis.

Caution Do not mate or unmate the power supply connectors while power is applied.

1. Ensure the power supply is off.
2. Connect the V lead of the power supply to position 1 of the power connector, Figure 14 shows the positions on the power connector

.



1	V Terminal	2	C Terminal

Figure 14. NI sbRIO 960x Power Connector

3. Connect the C lead of the power supply to position 2 of the 2-position power connector.
4. Insert the power connector into the front panel of the NI sbRIO-960x until the connector latches into place.
5. Turn on the power supply.

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.

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Device Startup Options

You can configure the following device startup options in MAX:

- Safe Mode
- Console Out
- IP Reset
- No App
- No FPGA App

To turn these startup options on or off, select the controller under **Remote Systems** in the MAX configuration tree, then select the **Controller Settings** tab. Refer to the MAX Help for information about the startup options and how to configure the controller.

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

Device Reset Options

You can configure the device to launch a LabVIEW FPGA application each time it is reset. Table 4 lists the reset options available on the NI sbRIO 960x. 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 4. 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.

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Understanding Ground Connections

The front I/O connector shields, chassis ground bracket, and mounting holes near the front I/O are connected together internally to form chassis ground. Chassis ground is capacitively coupled to digital ground near the power connector. For the best possible ESD protection, connec chassis ground at the mounting holes or the chassis ground bracket to a low inductive earth ground.

When connecting the NI sbRIO-960x to external devices, ensure that stray ground currents are not using the device as a return path. Significant stray currents traversing through the NI sbRIO-960x can result in device failure.

To verify correct grounding of the NI sbRIO 960x, make sure the current flowing into the power connector equals the current flowing out of the power connector. These currents should be measured with a current probe after final assembly of the end system. Investigate and remove any current differences.

Connecting the NI sbRIO Device to a Network

Connect the device to an Ethernet network using the RJ-45 Ethernet port on the controller front panel. Use a standard Category 5 (CAT-5) or better shielded, twisted-pair Ethernet cable to connect the chassis to an Ethernet hub, or use an Ethernet crossover cable to connect the chassis directly to a computer.

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

The first time you power up the chassis, it attempts to initiate a DHCP network connection. If the chassis is unable to initiate a DHCP connection, it connects to the network with a link-local IP address with the form `169.254.x.x`. After powerup, you must install software on the chassis and configure the network settings in Measurement & Automation Explorer (MAX).

Note Installing software may change the network behavior of the chassis. For information about network behavior by installed software version, go to `ni.com/info` and enter the Info Code `ipconfigcrio`.

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Connecting Serial Devices

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*.

Connecting CAN Networks

The NI sbRIO-9606 has one IDC header that provides connections to a CAN bus. The NI sbRIO-9606 has pins for CAN_H and CAN_L, which can connect to the CAN bus signals. The CAN port uses an NXP PCA82C251T high-speed CAN transceiver that is fully compatible with the ISO 11898 standard and supports baud rates up to 1 Mbps.

The port has two common pins (GND) that serve as the reference ground for CAN_H and CAN_L. You can connect the CAN bus reference ground (sometimes referred to as CAN_V–) to one or both COM pins. The port also has an optional shield pin (SHLD) that can connect to a shielded CAN cable. Connecting SHLD may improve signal integrity and EMC performance.

CAN Bus Topology and Termination

A CAN bus consists of two or more CAN nodes cabled together. The CAN_H and CAN_L pins of each node are connected to the main CAN bus cable through a short connection called a *stub*. The pair of signal wires, CAN_H and CAN_L, constitutes a transmission line. If the transmission line is not terminated, signal changes on the bus cause reflections that can cause communication errors. The CAN bus is bidirectional, and both ends of the cable must be terminated. This requirement does not mean that every node on the bus should have a termination resistor; only the two nodes at the far end of the cable should have termination resistors.

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Figure 15 shows a simplified diagram of a CAN bus with multiple CAN nodes and proper termination resistor (Rt) locations.

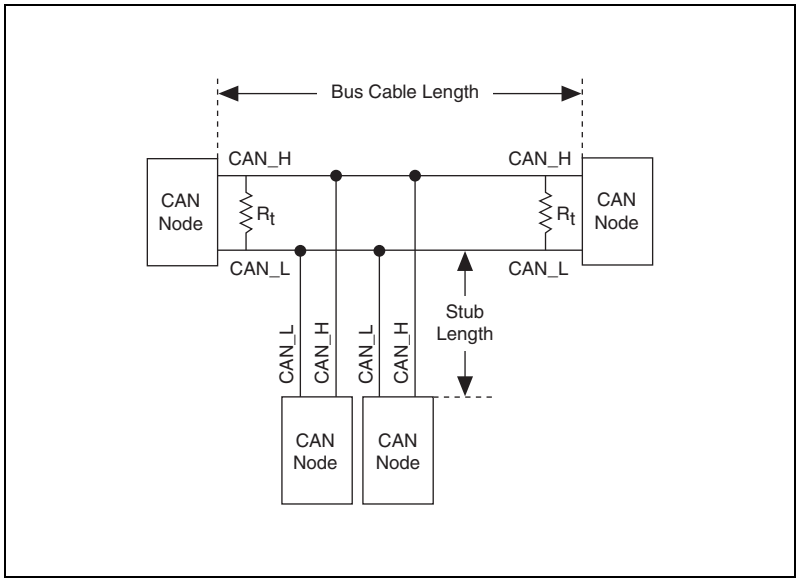


Figure 15. CAN Bus Topology and Termination Resistor Locations

Cable Specifications

Cables should meet the physical medium requirements specified in ISO 11898, shown in Table 5. Belden cable (3084A) meets all these requirements and is suitable for most applications.

Table 5. ISO 11898 Specifications for Characteristics of a CAN_H and CAN_L Pair of Wires

Characteristic	Value
Impedance	95 Ω minimum, 120 Ω nominal, 140 Ω maximum
Length-related resistance	70 mΩ/m nominal
Specific line delay	5 ns/m nominal

Termination Resistors

The termination resistors (R_t) should match the nominal impedance of the CAN cable and therefore comply with the values in Table 6.

Table 6. Termination Resistor Specification

Characteristic	Value	Condition
Termination resistor, R_t	100 Ω min, 120 Ω nominal, 130 Ω max	Minimum power dissipation: 220 mW

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Cable Lengths

The cabling characteristics and desired bit transmission rates affect the allowable cable length. You can find detailed cable length recommendations in the ISO 11898, CiA DS 102, and DeviceNet specifications.

ISO 11898 specifies 40 m total cable length with a maximum stub length of 0.3 m for a bit rate of 1 Mb/s. The ISO 11898 specification allows for significantly longer cable lengths at lower bit rates, but each node should be analyzed for signal integrity problems.

Number of CAN Nodes

The maximum number of nodes depends on the electrical characteristics of the nodes on the network. If all nodes meet the ISO 11898 requirements, you can connect at least 30 nodes to the bus. You can connect higher numbers of nodes if the electrical characteristics of the node do not degrade signal quality below ISO 11898 signal level specifications.

USB Ports

The NI sbRIO-9606 supports common USB mass-storage devices such as USB Flash drives and USB-to-IDE adapters formatted with FAT16 and FAT32 file systems. LabVIEW usually maps USB devices to the `U:`, `V:`, `W:`, or `X:` drive, starting with the `U:` drive if it is available. Refer to Figure 16 and Table 7 for USB pin locations and signal descriptions.

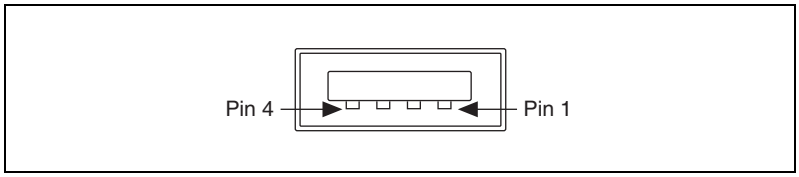


Figure 16. USB Port Pin Locations

Table 7. USB Port Signal Descriptions

Pin	Signal Name	Signal Description
1	VCC	Cable power (+5 V)
2	D–	USB data–
3	D+	USB data+
4	GND	Ground

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Using the System Clock to Provide Data Timestamps

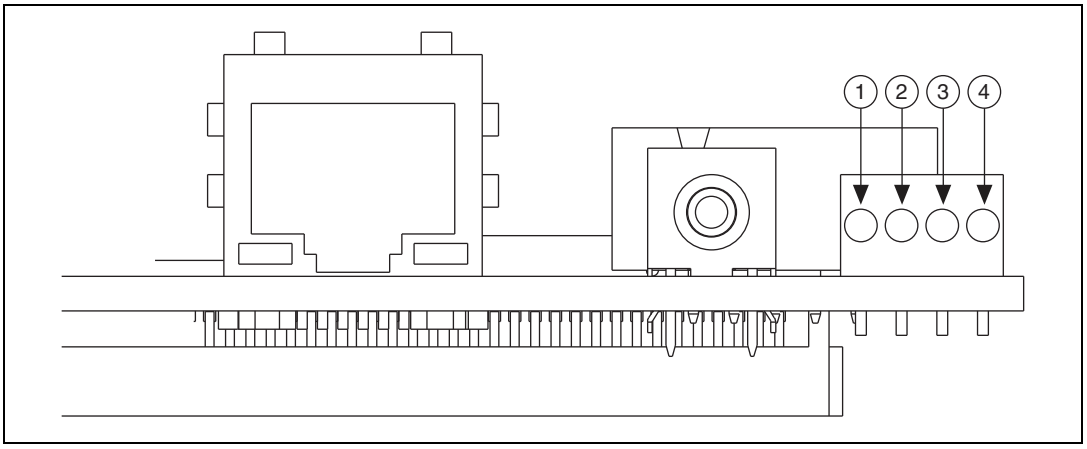
At startup, the system clock resets to January 1, 1970, 12:00 a.m. (midnight), unless VBAT is implemented on the RMC. For information about synchronizing the system clock with an SNTP time server on the network at startup, go to `ni.com/info` and enter the Info Code `criosntp`.

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 *Device Reset Options* section for more information.

Note To force the device into safe mode, hold the reset button down for 5 s, then release. The device will be in safe mode with output from the serial port enabled.

Understanding LED Indications



1	Power LED	3	User1 LED
2	Status LED	4	User FPGA1 LED

Figure 17. NI sbRIO 960x LEDs

Power LED

The Power LED is lit while the NI sbRIO-960x is powered on. This LED indicates that the power supply connected to the device is adequate.

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Status LED

The STATUS LED is off during normal operation. 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. The NI sbRIO-960x indicates specific error conditions by flashing the Status LED a certain number of times every few seconds, as shown in Table 8.

Table 8. Status LED Indications

Number of Flashes Every Few Seconds	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. Refer to the *Measurement & Automation Explorer Help* for information about safe mode.
4	The software has crashed twice without rebooting or cycling power between crashes. This usually occurs when the device runs out of memory. Review your RT VI and check the memory usage. Modify the VI as necessary to solve the memory usage issue.
Continuously flashing or solid	The device has detected an unrecoverable error. Contact National Instruments.

User1 LED

You can define the User1 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*.

User FPGA1 LED

You can use the User FPGA1 LED to help debug your application or easily retrieve application status. Use the LabVIEW FPGA Module and NI-RIO software to define the User FPGA1 LED to meet the needs of your application. Refer to *LabVIEW Help* for information about programming this LED.

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Troubleshooting Network Communication

If the NI sbRIO-960x cannot communicate with the network, you can perform the following troubleshooting steps.

1. Hold the Reset button down for 5 s, then release it. The Status LED turns on, then starts blinking three times every few seconds. The device is now in Safe Mode with output from the serial port enabled. You can use a serial port terminal to read the IP address of the controller. If you want the controller to attempt a new DHCP connection, proceed to step 2.
2. Hold the Reset button down for 5 s, then release it. The Status LED repeats the same behavior. The NI sbRIO-960x attempts to establish a new DHCP connection. If it fails, it assigns itself a link-local IP address. If the DHCP connection is successful and appropriate for your application, skip to step 4.
3. Configure the IP and other network settings in MAX.
4. Press and release the Reset button to reboot 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.

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Specifications

Unless otherwise noted, the following specifications are typical for the range –40 to 70 °C for the NI sbRIO-960x.

Processor Speed

NI sbRIO-960x ..... 400 MHz

Memory

NI sbRIO-9605

- Nonvolatile memory ..... 256 MB minimum
- System memory ..... 128 MB minimum

NI sbRIO-9606

- Nonvolatile memory ..... 512 MB minimum
- System memory ..... 256 MB minimum

Note 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`.

FPGA

NI sbRIO-9605

- FPGA type ..... Xilinx Spartan-6 LX25
- Number of flip-flops 30,064
- Number of 6-input LUTs 15,032
- Number of DSP48s 58
- Available block RAM ..... 936 kbits
- Number of DMA channels 5

NI sbRIO-9606

- FPGA type ..... Xilinx Spartan-6 LX45
- Number of flip-flops 54,576
- Number of 6-input LUTs 27,288
- Number of DSP48s 58
- Available block RAM ..... 2,088 kbits
- Number of DMA channels 5

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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.....230,400 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

Embedded CAN

Transceiver .....NXP PCA82C251T

Maximum baud rate.....1 Mbps

Minimum baud rate .....10 kbps

USB Port

Maximum data rate .....480 Mb/s

Maximum current .....500 mA

Internal RTC

Accuracy.....200 ppm; 35 ppm @ 25 °C

VBAT input range .....3.0 to 3.6 V (Nominal); 3.7 V Max

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3.3 V Digital I/O on RIO Mezzanine Card Connector

Number of DIO channels 96

Max tested current per channel ..... 3 mA

Max total current, all lines ..... 288 mA

Note The performance of the RMC DIO lines is bounded by the FPGA, signal integrity, the applications timing requirements, and the RMC design. A general SPI application will typically be able to meet these requirements and achieve frequencies of up to 10 MHz. For more information on using DIO to connect to RMCs, go to `ni.com/info` and enter the Info Code `RMCDIO`.

Input logic levels

Input low voltage, V_{IL} ..... 0 V min; 0.8 V max

Input high voltage, V_{IH}..... 2.0 V min; 3.465 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..... 0.0 V min; 0.4 V max

Power Requirements

The NI sbRIO device requires a power supply connected to the power connector. Refer to Figure 2 for the location of the power connector. Refer to the *Powering the NI sbRIO Device* section for information about connecting the power supply.

Caution You must use a UL Listed ITE power supply marked LPS with the NI sbRIO device.

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

Recommended power supply ..... 55 W, 30 VDC max

Power supply voltage range ..... 9–30 VDC[1]

[1] The NI sbRIO device is 1–2% more efficient with a 9 V power supply than with a 30 V power supply.

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The total power required by the NI sbRIO-960x from its power supply depends heavily on how it is being used, and can be approximated by the following calculations:

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

where P_{int} is the power consumption by the NI sbRIO device internal operation, including integrated I/O functions

P_{DIO} is the power consumption by the 3.3 V DIO lines across the RMC Connector

P_{5V} is the power consumption by the 5 V voltage output across the RMC Connector

$P_{3.3V}$ is the power consumption by the 3.3 V voltage output across the RMC Connector

P_{USB} is the power consumption of a device plugged into the USB port (NI sbRIO-9606 only)

When calculating each component of the maximum power consumption the following efficiency factors must be used:

$$\eta_{3.3}\text{ V and }\eta_{DIO} = 80\%$$

$$\eta_{5}\text{ V and }\eta_{USB} = 90\%$$

Note You must add 10% to the calculated or measured total power requirement to account for transient and startup conditions.

Maximum P_{int}

NI sbRIO-9605 .....5.66 W

NI sbRIO-9606 .....8.10 W

Maximum P_{DIO} .....1.79 W

P_{DIO} = Total DIO Current × 3.3 V / 0.8

Maximum P_{5V} .....8.33 W

P_{5V} = Total 5 V output × 5 V / 0.9

Maximum $P_{3.3V}$ .....1.36 W

$P_{3.3V}$ = Total 3.3 V output × 3.3 V / 0.8

Maximum P_{USB} .....2.78 W

P_{USB} = Total USB Current × 5 V / 0.9

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Example power requirement calculations:

For an NI sbRIO-9606 with an RMC board drawing 1 A of current from the 5 V output 100 mA of current from the 3.3 V output, 30 mA total current through the 3.3 V DIO pins, and a USB device pulling 200 mA, calculate the total power requirement as follows:

P_{int} = 8.10 W

$P_{3.3V}$ = 0.41 W

P_{DIO} = 0.12 W

P_{5V} = 5.56 W

P_{USB} = 1.11 W

Adding 10% for transient conditions, 15.55 W × 1.1 = 17.11 W

Total Power Requirement = 17.11 W

Note These calculations are intended to approximate the maximum power requirements for an NI sbRIO-960x system. For a more accurate estimate of a specific application's power consumption it is recommended to directly measure a board running the application in an environment representative of the intended use case.

NI sbRIO-9605

Power consumption while sourcing RMC ..... 19.1 W Max

NI sbRIO-9606

Power consumption while sourcing RMC ..... 25.4 W Max

Environmental

The NI sbRIO-960x is intended for indoor use only.

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

NI sbRIO-960x ..... –40 to 70 °C

Note Measure the ambient temperature by placing thermocouples on both sides of the PCB, 0.2 in. (5 mm) from the board surface. Avoid placing thermocouples next to hot components such as the FPGA, processor, or CPLD, or near board edges, which can cause inaccurate ambient temperature measurements. In addition to the ambient temperature, the case temperature of the components should not exceed the recommended maximum case temperature.

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Component Maximum Case Temperature
Xilinx Spartan-6
LX, CSG324 FPGA.....93 °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.....5,000 m

Pollution Degree (IEC 60664).....2

Indoor use only

Physical Characteristics

Weight

NI sbRIO-9605 .....85 g (2.998 oz.)

NI sbRIO-9606 .....89 g (3.139 oz.)

Safety

Safety Voltages

Connect only voltages that are within this limit.

V terminal to C terminal.....30 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.

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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, visit the Worldwide Offices section of `ni.com/niglobal` to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

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373378A-01 Sept11

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