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OEM OPERATING INSTRUCTIONS AND SPECIFICATIONS

NI sbRIO-9605/9606 and NI sbRIO-9623/9626/9633/9636

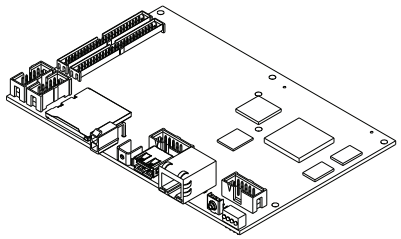
Single-Board RIO OEM Devices

This document provides dimensions, pinouts, connectivity information, and specifications for the National Instruments sbRIO-9605, sbRIO-9606, sbRIO-9623, sbRIO-9626, sbRIO-9633 and sbRIO-9636. The devices are referred to inclusively in this document as the NI sbRIO device.

The NI sbRIO device is available in different configurations. When a feature pertains only to specific models, a list at the beginning of the section shows which models support the feature.

Figure 1 shows the NI sbRIO-9636.

Figure 1. NI sbRIO-9636



Caution The NI sbRIO device 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 local ambient temperature under the maximum rating for the NI sbRIO device. Refer to the *Specifications* section for more information about the maximum local ambient temperature rating.

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Caution Do not operate the NI sbRIO device 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.

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. Visit `ni.com/info` and enter the Info Code `rdsoftwareversion` for information about software version compatibility.

- ☐ LabVIEW 2011 SP1 or later
- ☐ LabVIEW Real-Time Module 2011 SP1 or later
- ☐ LabVIEW FPGA Module 2011 SP1 or later
- ☐ NI-RIO 4.1 or later

Hardware Requirements

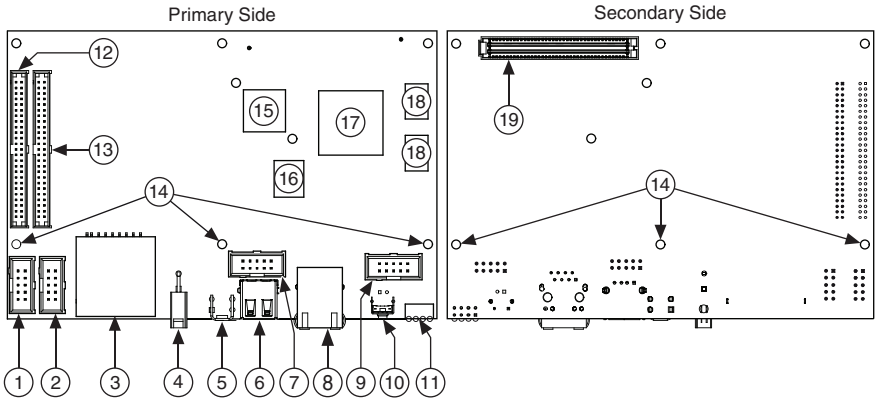
You need the following hardware to use the NI sbRIO device.

- ☐ NI sbRIO device
- ☐ 9-30 VDC power supply
- ☐ Power plug assembly
- ☐ Ethernet cable

Figure 2 shows the location of features on the NI sbRIO device. The features available vary between device models. Refer to Table 1 or the appropriate section of the manual to see if a feature is available on your model.

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Figure 2. All Possible Components on the NI sbRIO Device



1 W502, RS-485 (COM3)
2 W503, RS-232 (COM2)
3 J504, SDHC
4 J506, Power Connector
5 Chassis Ground Bracket
6 J507, USB Host Port
7 W500, CAN (CAN0)
8 J505, RJ-45 Ethernet Port
9 W501, RS-232 Serial (COM1)
10 Reset Switch
11 LEDs
12 J502, DIO
13 J503, MIO
14 Mounting Holes Connected to Chassis Ground
15 FPGA
16 NAND Flash
17 Processor
18 DDR Memory
19 J1, RIO Mezzanine Card Connector

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NI sbRIO Device Features Overview

Table 1 describes the I/O and other components populated on each NI sbRIO device.

Table 1. I/O and Other Components Available on NI sbRIO Devices

NI sbRIO Device	Memory (MB)	RAM (MB)	RS-232	RS-485	CAN	USB	SDHC	FPGA	DIO	AI	AO	RMC
sbRIO-9605	256	128	1	—	—	—	—	LX25	—	—	—	1
sbRIO-9606	512	256	1	—	1	1	—	LX45	—	—	—	1
sbRIO-9623	256	128	2	1	—	—	—	LX25	4	16ch-12bit	4ch-12bit	1
sbRIO-9626	512	256	2	1	1	1	1	LX45	4	16ch-16bit	4ch-16bit	1
sbRIO-9633	256	128	2	1	1	1	1	LX25	28	16ch-12bit	4ch-12bit	—
sbRIO-9636	512	256	2	1	1	1	1	LX45	28	16ch-16bit	4ch-16bit	—

Note Devices with a RIO Mezzanine Card (RMC) connector have 96 additional FPGA DIO pins available on the connector.

Table 2 lists and describes the connectors on the NI sbRIO device, and the part number and manufacturer of each connector. Refer to the manufacturer for information about using and matching these connectors.

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Table 2. NI sbRIO Connector Descriptions

Connector	Description	Manufacturer, Part Number	Recommended Mating Connector	NI Solution
Power	2-position, mini-fit JR, H = 0.411 in.	Molex, 46999-0144	Molex, 50-36-1673 w/ 0457501211	NI, Power Plug Assembly 152834-01
RS-232/485/CAN IDC Header	10-pin, 0.100 in. CT, shrouded, H = 0.370 in.	Samtec, TST-105-01-L-D	Tyco, 1658622-1	NI, 10-pin to 9-pin D-SUB, 153158-10
50 Pin IDC Header	50-pin, 2 mm CT, Shrouded, H = 0.155 in.	Samtec, STMM-125-02-L-D	Tyco, 2-111623-6	NI, 50 pos. ribbon cable, 154041-12
RMC Connector	240-pin, 40 × 6 pos., high density 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	—

Notes Samtec SEAM connectors come in multiple heights, indicated in mm by the *XX.X* portion of the SEAM-40-*XX.X*-S-06-2 example part number. You can order a mating connector for the RMC connector from Samtec, the connector manufacturer, or from a distributor such as Arrow or Avnet.

The height of the mating connector you select to mate to the RMC connector determines the height of the standoffs you need. Samtec requires that standoffs be 0.15 mm taller than the combined height of the RMC and mating connectors. Therefore, to determine the required standoff height, you must add the heights of the connectors plus 0.15 mm. For example, if you are using a SEAM-40-03.0-S-06-2-A-K-TR connector to mate to the RMC connector (SEAF-40-06.5-S-06-2-A-K-TR), the required standoff height is 3.0 mm + 6.5 mm + 0.15 mm = 9.65 mm. Standoffs of this height are available from National Instruments (NI 153166-12) or Samtec (SO-0965-03-02-L-N). Consult Samtec for alternative heights and options. You must observe keepouts and maximum heights with all RMC and mating connector combinations.

Refer to the *RIO Mezzanine Card Connector* section of this document for more information about connecting an RMC.

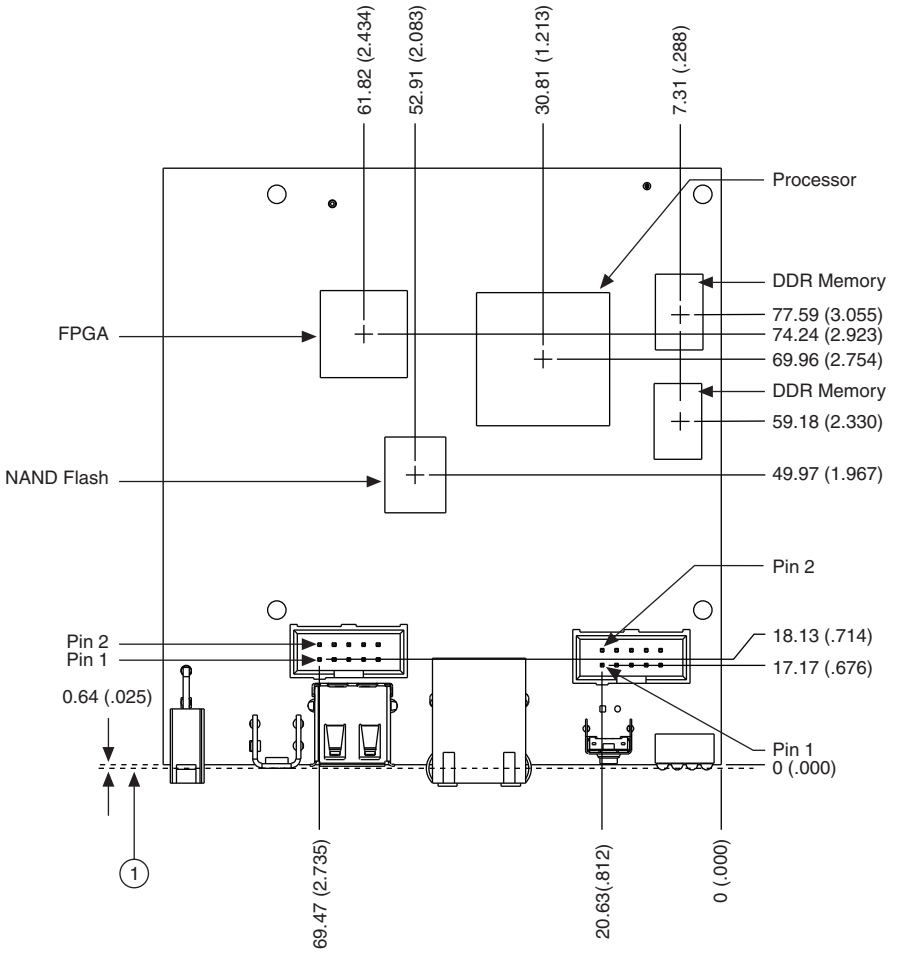
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Dimensions

This section contains dimensional drawings of the NI sbRIO devices. For dimensional drawings and three-dimensional models, refer to the **Resources** tab of the NI sbRIO device product page at `ni.com`. You can find the product page by searching for the sbRIO device. For example, enter `9605` in the Search field to find the product page for the NI sbRIO-9605.

Figure 3 shows the dimensions of the primary side of the NI sbRIO device.

Figure 3. NI sbRIO-9605/9606 Primary-Side Dimensions in mm (in.)

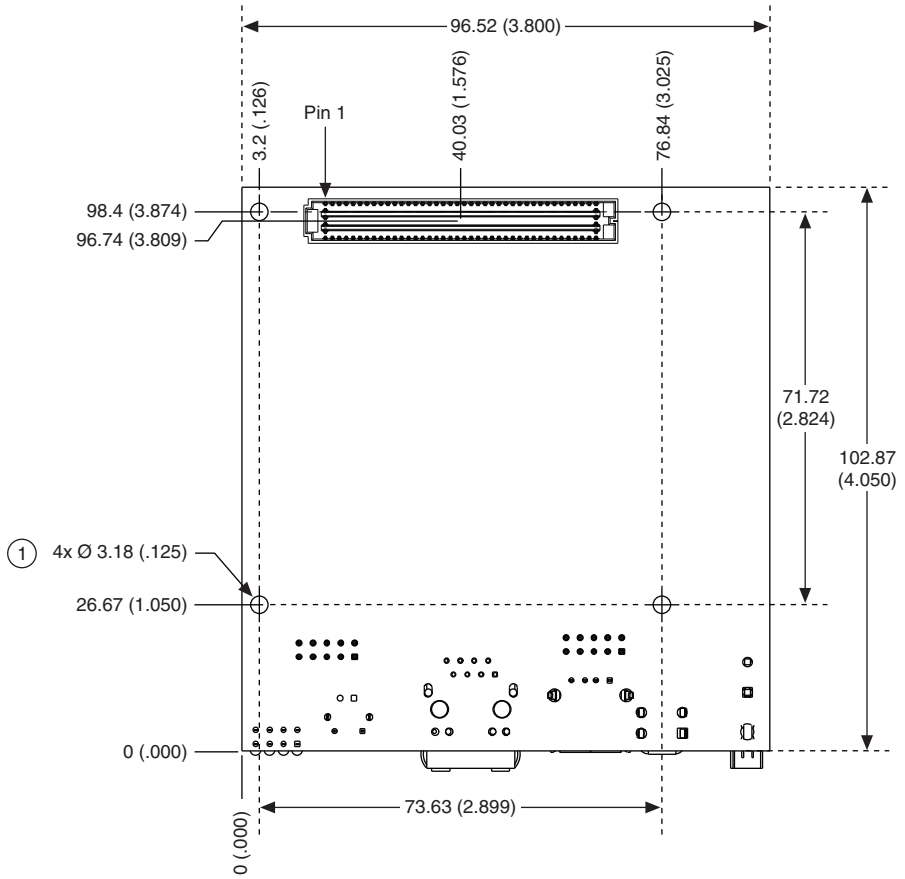


1 Back of Front Panel

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Figure 4 shows the dimensions of the secondary side of the NI sbRIO device.

Figure 4. NI sbRIO-9605/9606 Secondary-Side Dimensions in mm (in.)

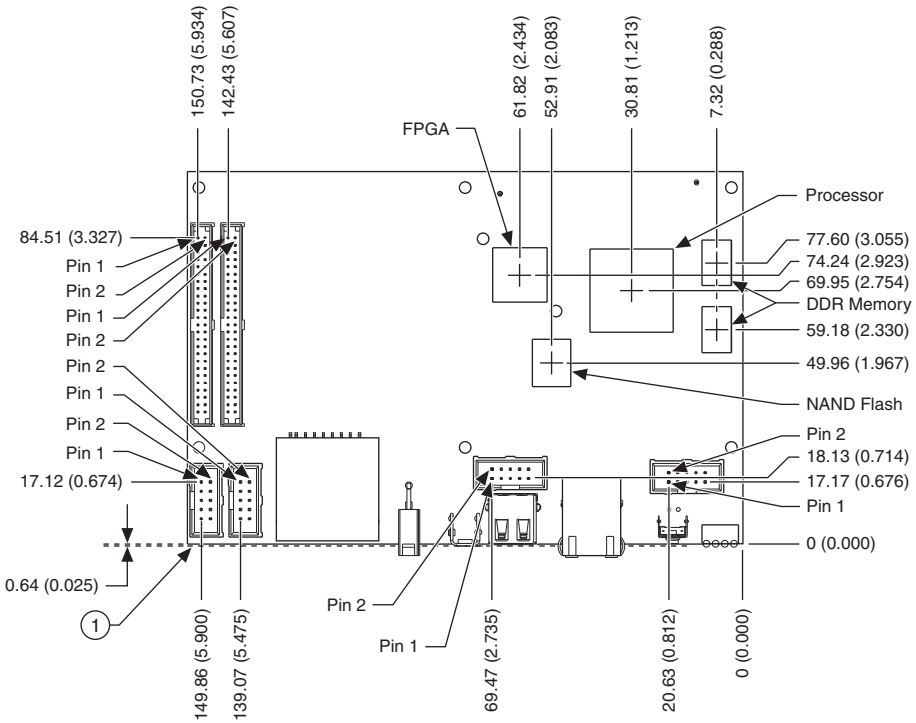


1 Holes and Keepouts Sized for M3 Standoff (4.5 mm Hex) or 4-40 Standoff (3/16-in. Hex)

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Figure 5 shows the dimensions of the primary side of the NI sbRIO device.

Figure 5. NI sbRIO-9623/9633/9626/9636 Primary-Side Dimensions in mm (in.)

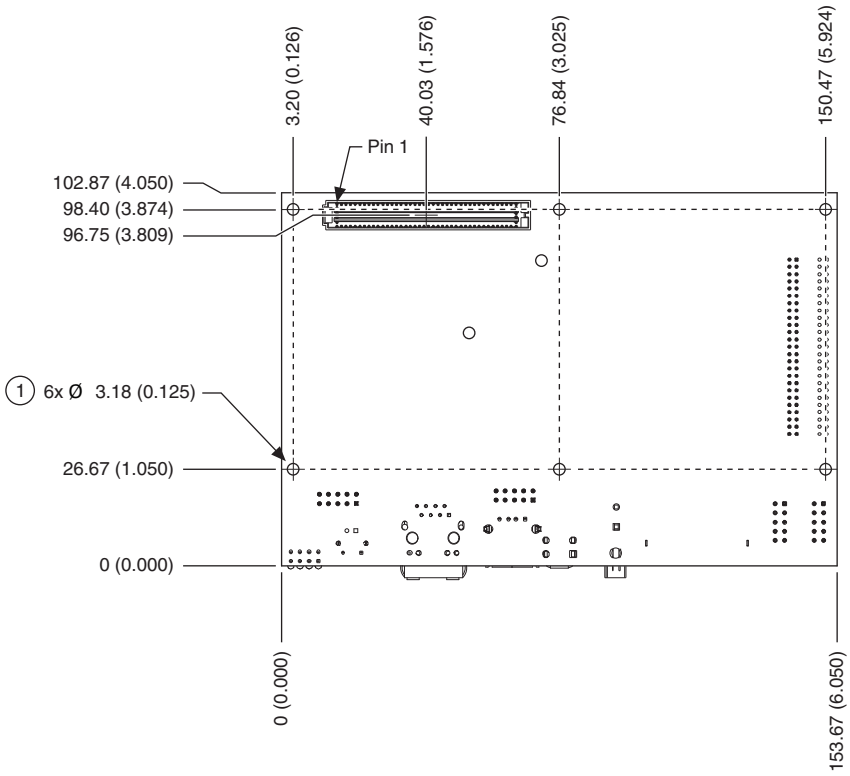


1 Back of Front Panel

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Figure 6 shows the dimensions of the secondary side of the NI sbRIO device.

Figure 6. NI sbRIO-9623/9633/9626/9636 Secondary-Side Dimensions in mm (in.)

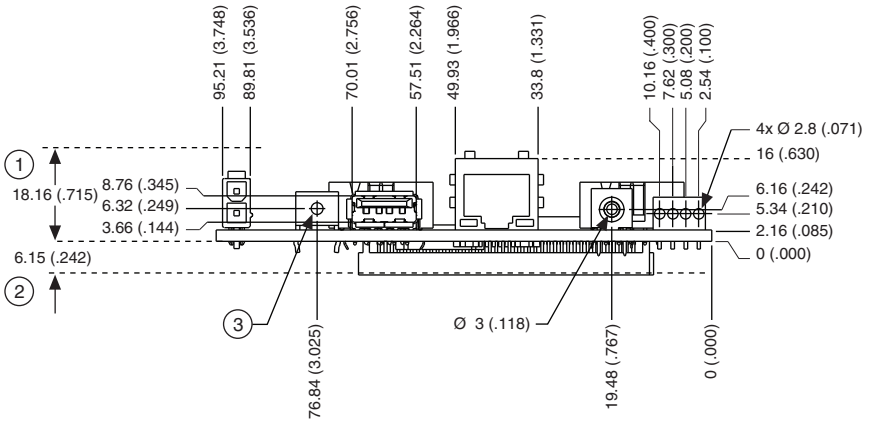


1 Holes and Keepouts Sized for M3 Standoff (4.5 mm Hex) or 4-40 Standoff (3/16-in. Hex)

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Figure 7 shows the dimensions of the front of the NI sbRIO device.

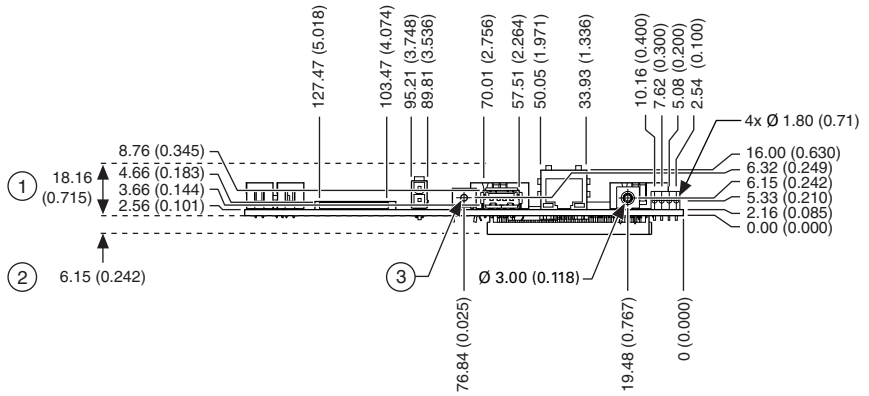
Figure 7. NI sbRIO-9605/9606 Front Dimensions in mm (in.)



1 Minimum Clearance for Latch on Mating Power Connector
2 Minimum Keepaway for RIO Mezzanine Card Components
3 4-40 threads, Maximum Torque of 0.41 N · m (3.6 lb · in.))

Figure 8 shows the dimensions of the front of the NI sbRIO device.

Figure 8. NI sbRIO-9623/9633/9626/9636 Front Dimensions in mm (in.)



1 Minimum Clearance for Latch on Mating Power Connector
2 Minimum Keepaway for RIO Mezzanine Card Components
3 4-40 threads, Maximum Torque of 0.41 N · m (3.6 lb · in.)

Note For more information about the dimensions of the NI sbRIO device, including detailed dimensional drawings, visit `ni.com/dimensions`.

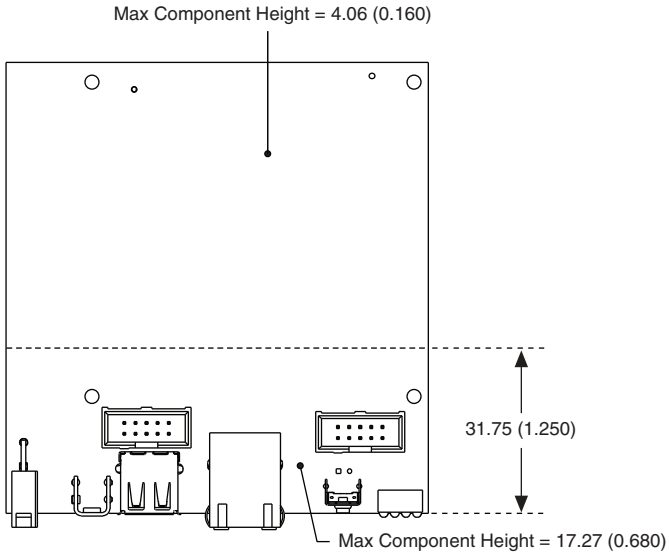
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Maximum Component Heights

The primary side of the NI sbRIO device is the top side of the PCB populated with the power and Ethernet connectors. The secondary side is the bottom. Figures 9 through 12 show the maximum component heights for the different regions of the primary and secondary sides.

Note In addition to the maximum component heights, you must also observe minimum keepaway distances for adjacent PCBs and surfaces. Allow 19.05 mm (0.75 in.) from the surface of the primary side and 7.62 mm (0.300 in.) from the surface of the secondary side.

Figure 9. NI sbRIO-9605/9606 Maximum Component Height of Primary Side in mm (in.)



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Figure 10. NI sbRIO-9623/9633/9626/9636 Maximum Component Height of Primary Side in mm (in.)

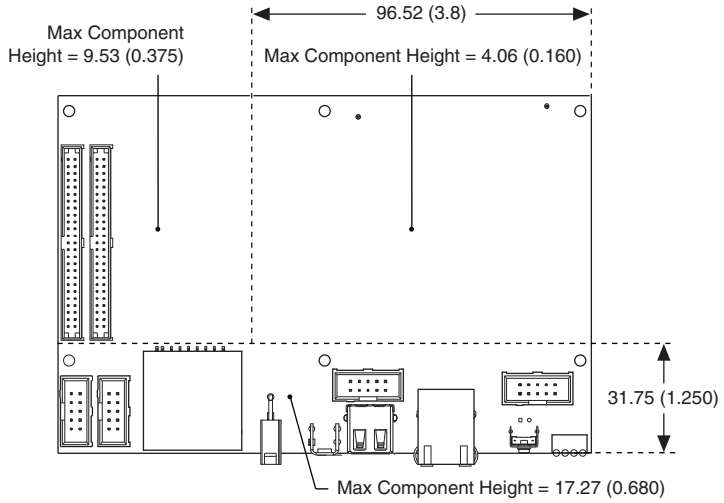
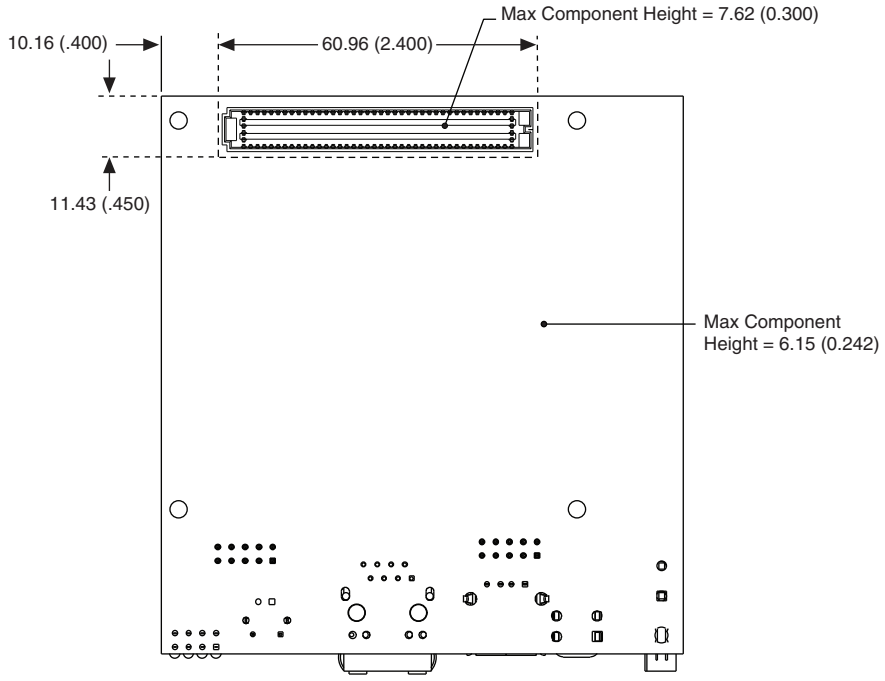
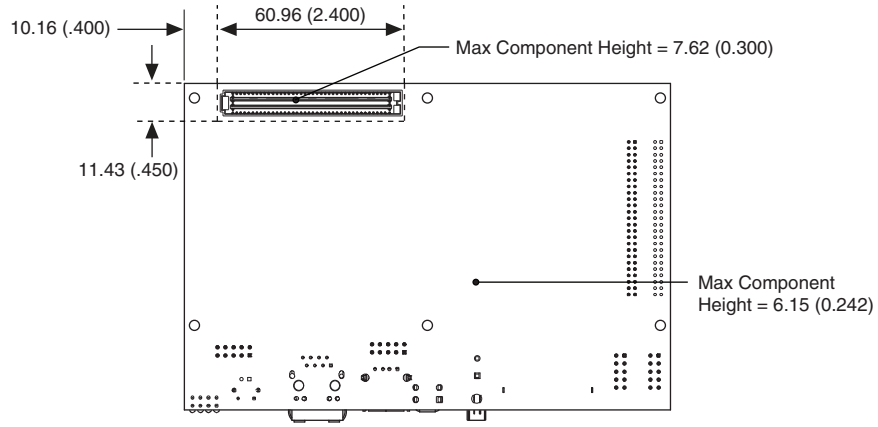


Figure 11. NI sbRIO-9605/9606 Max Component Height of Secondary Side in mm (in.)



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Figure 12. NI sbRIO-9623/9633/9626/9636 Max Component Height of Secondary Side in mm (in.)



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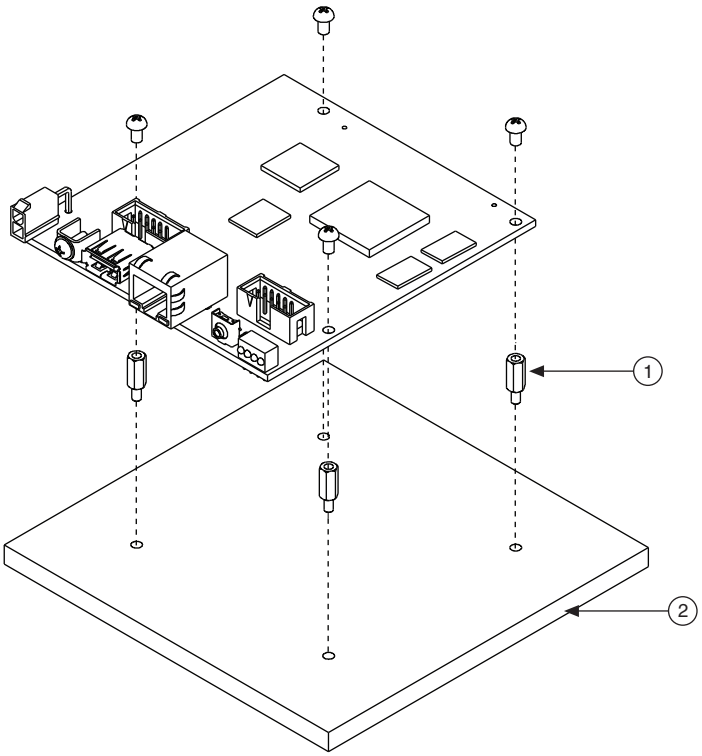
Mounting the NI sbRIO Device

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

Mounting the NI sbRIO Device

Figure 13 shows how to mount the NI sbRIO device.

Figure 13. NI sbRIO Device Mounting Procedure



1	M3 or 4-40 Standoff (Not Included)	2	Mounting Surface (Not Included)

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

Note Maintain a minimum keepaway distance of 7.62 mm (0.300 in.) when mounting NI sbRIO devices with an RMC connector, and a minimum keepaway distance of 6.15 mm (0.242 in.) when mounting NI sbRIO devices without an RMC connector.

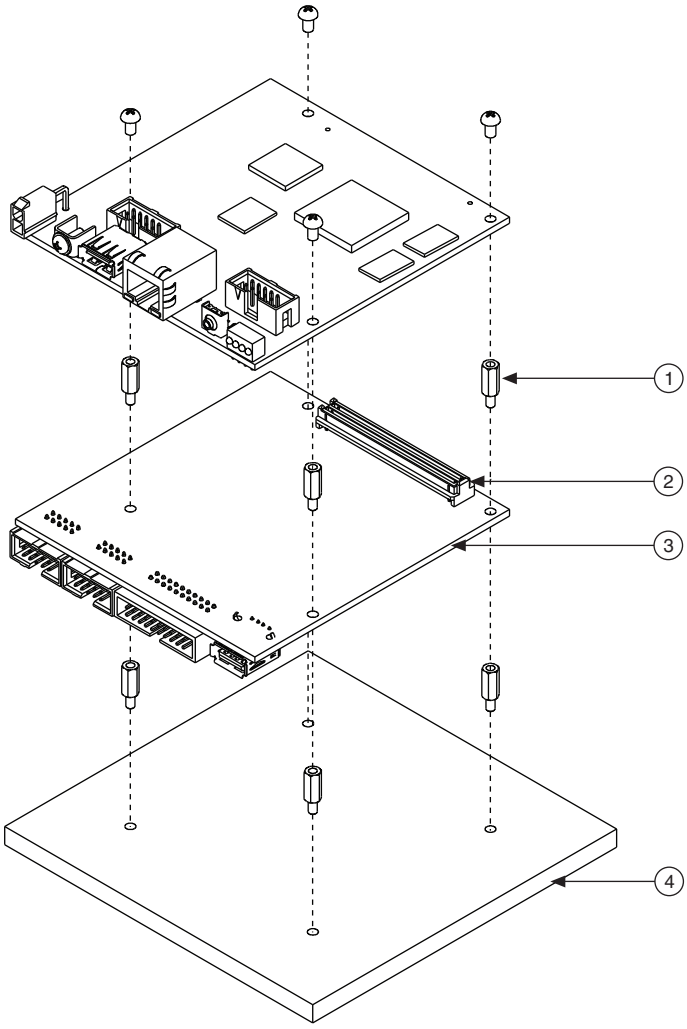
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Mating the NI sbRIO Device to a RIO Mezzanine Card

Figure 14 shows how to mate one of the following NI sbRIO devices to an RMC:

- NI sbRIO-9605
- NI sbRIO-9606
- NI sbRIO-9623
- NI sbRIO-9626

Figure 14. NI sbRIO- Device Mating Procedure



1	M3 or 4-40 Standoff (Not Included)	3	Example RMC (Not Included)
2	RMC Connector	4	Mounting Surface (Not Included)

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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, connect chassis ground at the mounting holes or the chassis ground bracket to a low inductance earth ground.

When connecting the NI sbRIO device 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 device can result in device failure.

To verify correct grounding of the NI sbRIO device, 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.

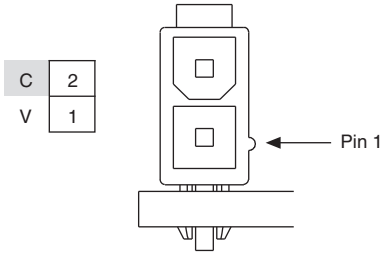
Connector Pinouts

Figures 15 through 17 show the pinouts of the I/O connectors on the NI sbRIO device.

Power Connector

Figure 15 shows the power connector pinout on the NI sbRIO device.

Figure 15. Pinout of the Power Connector

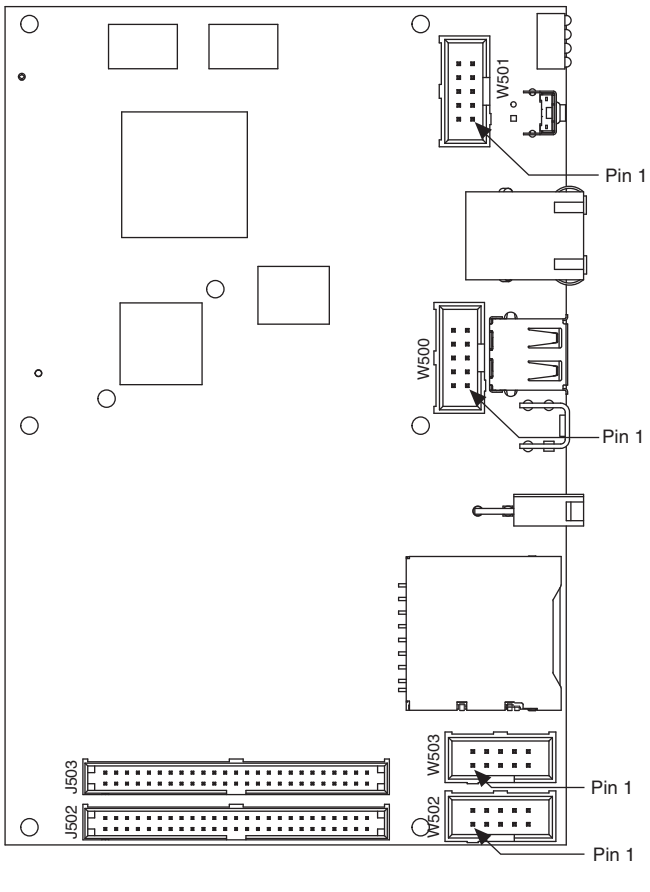


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RS-232/CAN Connectors

Figure 16 shows the RS-232 and CAN connector pinouts on the NI sbRIO device.

Figure 16. Pinout of the Serial and CAN Connectors



W501, RS-232 (COM1)

SHIELD	10	9	RI
CTS	8	7	RTS
DSR	6	5	GND
DTR	4	3	TXD
RXD	2	1	DCD

W500, CAN 0

SHIELD	10	9	NC
NC	8	7	CAN0_H
V– (GND)	6	5	SHIELD
NC	4	3	V– (GND)
CAN0_L	2	1	NC

W503, RS-232 (COM2)

SHIELD	10	9	RI
CTS	8	7	RTS
DSR	6	5	GND
DTR	4	3	TXD
RXD	2	1	DCD

W502, RS-485 (COM3)

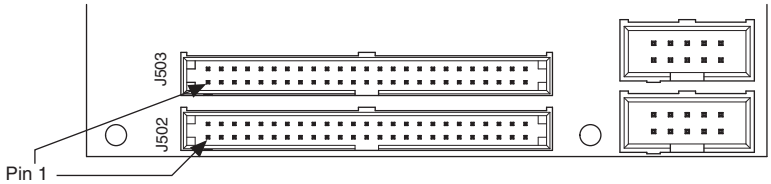
SHIELD	10	9	TXD–
TXD+	8	7	NC
NC	6	5	RXD–
RXD+	4	3	NC
NC	2	1	GND

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J503/DIO Connectors

Figure 17 shows the J503 and DIO connector pinouts on the NI sbRIO device.

Figure 17. Pinout of DIO and MIO Connectors



J502, DIO

D GND	1	2	DIO4
D GND	3	4	DIO5
D GND	5	6	DIO6
D GND	7	8	DIO7
D GND	9	10	DIO8
D GND	11	12	DIO9
D GND	13	14	DIO10
D GND	15	16	DIO11
D GND	17	18	DIO12
D GND	19	20	DIO13
D GND	21	22	DIO14
D GND	23	24	DIO15
D GND	25	26	DIO16
D GND	27	28	DIO17
D GND	29	30	DIO18
D GND	31	32	DIO19
D GND	33	34	DIO20
D GND	35	36	DIO21
D GND	37	38	DIO22
D GND	39	40	DIO23
D GND	41	42	DIO24
D GND	43	44	DIO25
D GND	45	46	DIO26
D GND	47	48	DIO27
+5V	49	50	+5V

J503, MIO

AI GND	1	2	AI0
AI8	3	4	AI GND
AI9	5	6	AI1
AI GND	7	8	AI2
AI10	9	10	AI GND
AI11	11	12	AI3
AI GND	13	14	AI4
AI12	15	16	AI GND
AI13	17	18	AI5
AI GND	19	20	AI6
AI14	21	22	AI GND
AI15	23	24	AI7
AI GND	25	26	AI GND
AO GND	27	28	AO0
AO GND	29	30	AO1
AO GND	31	32	AO2
AO GND	33	34	AO3
AO GND	35	36	NC
AO GND	37	38	NC
AO GND	39	40	NC
AO GND	41	42	NC
D GND	43	44	DIO0
D GND	45	46	DIO1
D GND	47	48	DIO2
D GND	49	50	DIO3

RIO Mezzanine Card Connector

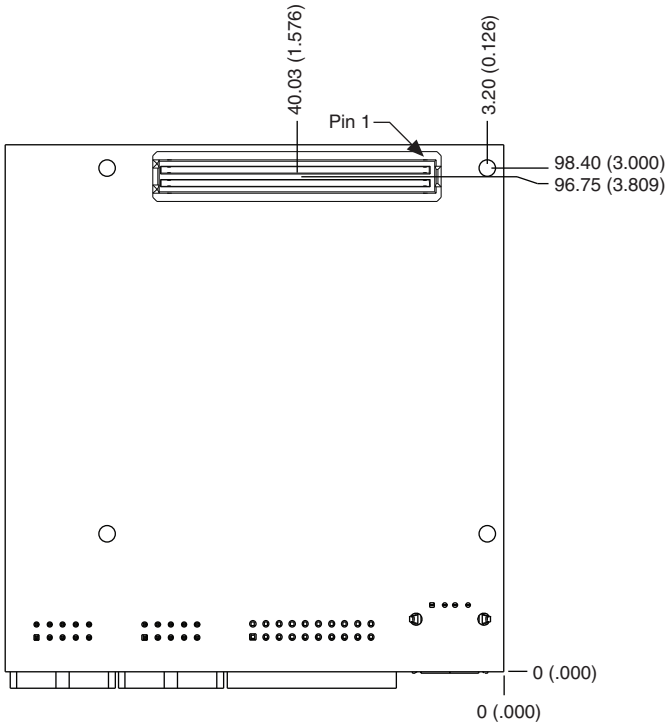
Note The information in this section applies only to the NI sbRIO-9605, NI sbRIO-9606, NI sbRIO-9623, and NI sbRIO-9626.

Use the connectors described in Table 2 of the *NI sbRIO Device Features Overview* section of this document to the NI sbRIO device.

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Figure 18 shows the dimensions of an example RMC and the locations for connecting to the NI sbRIO device.

Figure 18. RMC Connector Location and Dimensions on Example RMC



Note RMCs are not hot-swappable. Disconnect power before mating or unmating.

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RMC Connector Pins

The pins on the RMC connector are divided into the following groups:

- Pins with dedicated functions, as described in Table 3.

Table 3. RMC Connector Pins with Dedicated Functions

Pin Group	Pin Name	Direction (from Host System)	I/O Standard	Description
Power	GND	O	—	Digital ground from the RMC connector host system.
	3.3 V_AUX	O	—	3.3 V_AUX from the RMC connector host system. The rail is always on when the main host system is connected to power.
	5 V	O	—	5 V from the RMC connector host system.
	PROC_VIO	O	—	I/O voltage for the GP_PORT[*x*] pins.
	FPGA_VIO	O	—	I/O voltage for the $FPGA_{3.3V}$ pins.
Resets	RST#	O	$LVTTL_{3.3V}$	Reset that indicates that the main power is not ideal, or that the RMC connector host system has been reset.
	SYS_RST#	I	$OD_LVTTL_{3.3V}$	System reset used to reset the RMC connector host system. Asserting this pin causes the RST# pin to also assert.

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Table 3. RMC Connector Pins with Dedicated Functions (Continued)

Pin Group	Pin Name	Direction (from Host System)	I/O Standard	Description
System management bus (SMBus)*	SMBCLK	O	Defined by SMBus spec	SMBus clock.
	SMBDATA	I/O	Defined by SMBus spec	SMBus data.
High speed USB (after PHY)	USB_D+ USB_D-	I/O	Defined by USB	Port for hi-speed differential USB.
RTC VBAT	VBAT	I	—	If you use this pin, connect it to a battery on the RMC to provide power to the RTC on the host system when the host loses power so that the host can continue to track absolute time.
* An electrically erasable, programmable, read-only memory (EEPROM) is required to connect to the SMBus.				

- General purpose pins, as described in Table 4. Refer to the *RMC Connector General Purpose Port Pin Implementations* section of this document for information about how to use the general purpose pins for a particular device. You must use EEPROM to define the specific use of these pins. Refer to the *Identifying RMC Connectors with EEPROM* section of this document for more information about EEPROM.

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Table 4. RMC Connector General Purpose Pins

Pin Group	Pin Name	Direction (from Host System)	I/O Standard	Description
Optional general purpose pins	GP_PORT[22..0]	I/O	$PROC_{3.3V}$	Pins for enabling serial, CAN, Ethernet, or SDHC peripherals on an RMC.
General purpose digital I/O pins	DIO[95..0]	I/O	$FPGA_{3.3V}$	Pins for connecting directly to the FPGA through a series resistor. Refer to the *3.3 V Digital I/O* section for more information.

Caution National Instruments suggests using pins DIO0 through DIO63 first to maintain compatibility. National Instruments does not guarantee that future NI sbRIO products will provide DIO64 through DIO95 pins.

Caution National Instruments does not guarantee that future NI sbRIO products will provide the same GP_PORT pin configuration, or that future NI sbRIO products will provide any GP_PORT pins.

- Pins reserved for future use.

Note Leave reserved and unused pins disconnected on RMCs.

RMC Connector Pin Listing by Location

Table 5 lists the pinout for the RMC connector and indicates the pin number and corresponding function.

Key:

Power	GND	Differential I/O	Single-ended I/O	Reserved

Table 5. RMC 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

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Table 5. RMC Connector Pinout (Continued)

25-SMBCLK	26-GND	27-SMBDATA	28-GND	29-USB_D+	30-GND
31-RESERVED	32-RESERVED	33-RESERVED	34-RESERVED	35-USB_D-	36-GND
37-RESERVED	38-RST#	39-GND	40-GP_PORT[0]	41-GND	42-PROC_VIO
43-SYS_RST#	44-GND	45-GP_PORT[2]	46-GP_PORT[1]	47-GND	48-3.3V_AUX
49-GND	50-GP_PORT[4]	51-GP_PORT[3]	52-GND	53-GP_PORT[8]	54-5V
55-GP_PORT[6]	56-GP_PORT[5]	57-GND	58-GP_PORT[9]	59-RESERVED	60-5V
61-GP_PORT[7]	62-GND	63-GP_PORT[11]	64-GP_PORT[10]	65-GND	66-5V
67-GND	68-GP_PORT[13]	69-GP_PORT[12]	70-GND	71-GP_PORT[17]	72-5V
73-GP_PORT[15]	74-GP_PORT[14]	75-GND	76-GP_PORT[19]	77-GP_PORT[18]	78-GND
79-GP_PORT[16]	80-GND	81-GP_PORT[21]	82-GP_PORT[20]	83-GND	84-RESERVED
85-GND	86-RESERVED	87-GP_PORT[22]	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-FPGA_CONF	240-FPGA_VIO

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RMC Connector Power Requirements

Use the following voltage pins to power the RMC:

- 5 V rail (pins 54, 60, 66, and 72), which provides a primary power source to the RMC
- 3.3 V_AUX (pin 48), which provides an auxiliary power source to the RMC
- PROC_VIO (pin 42) and FPGA_VIO (pins 234 and 240), which supply I/O power and determine I/O levels for the GP_PORT I/O and FPGA I/O pins

Table 6 lists the requirements for each rail on an RMC connector.

Table 6. RMC Rail Requirements

Rail	Voltage Tolerance	Max Current	Max Ripple and Noise
5 V	± 5%	1.5 A	50 mV
3.3V_AUX	± 5%	0.25 A	50 mV
PROC_VIO (3.3 V)	± 5%	0.25 A	50 mV
FPGA_VIO (3.3 V)	± 5%	0.33 A	50 mV

Caution RMCs should not source any current onto any of the power pins and should be able to tolerate 5 V, PROC_VIO, and FPGA_VIO coming up in any order.

RMC Connector Electrical Characteristics

Each pin in an RMC connector conforms to a particular I/O standard. On the NI sbRIO-9605/9606/9623/9626, the $LVTTL_{3.3V}$, $OD_LVTTL_{3.3V}$, $PROC_{3.3V}$, and $FPGA_{3.3V}$ I/O standards meet the input and output logic levels defined in the *3.3 V Digital I/O on RMC Connector* section of the *Specifications* section of this document.

RMCs with $PROC_{3.3V}$ I/O pins or $FPGA_{3.3V}$ I/O pins that require an explicit pull-up or pull-down should use the values listed in Table 7.

Table 7. RMC Connector I/O Pin Pull-up and Pull-down Values

I/O Pin	Requirement	Max Value	Min Value
$PROC_{3.3V}$	Explicit pull-up	3.675 kΩ	1 kΩ
	Explicit pull-down	2 kΩ	1 kΩ
$FPGA_{3.3V}$	Explicit pull-up	14.7 kΩ	1 kΩ
	Explicit pull-down	8 kΩ	1 kΩ

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RMC VBAT

The NI sbRIO device implements an onboard real-time clock (RTC) to keep track of absolute time. The RMC connector provides a VBAT pin 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# pin indicates that power provided through the RMC Connector is valid. The signal goes to 3.3 V if the power is valid when the board powers up or receives a reset command. The signal asserts to 0 V for at least 1 ms before returning to 3.3 V. There should be no more than 30 pF on the RST# pin of a RIO Mezzanine Card. This includes the RMC Connector, traces, vias, and device pins. Refer to *3.3 V Digital I/O on RMC Connector* in the *Specifications* section for output logic levels.

FPGA_CONF

The FPGA_CONF pin asserts high when the FPGA has been programmed. When the FPGA is not configured the signal is floating. A pull-down resistor is required when using this signal to ensure it returns to ground.

RMC Connector General Purpose Port Pin Implementations

The RMC connector provides 23 general purpose port pins that connect to the processor of the NI sbRIO device. Table 8 describes all currently defined interfaces for the pins.

Note You must use EEPROM to define the specific use of the pins. Refer to the *Identifying RMC Connectors with EEPROM* section of this document for more information about EEPROM. Refer to the RMC EEPROM Image Programmer example program, located in the `labVIEW\examples\CompactRIO\RMC Specific\EEPROM Image Programmer` directory for NI-RIO Device Drivers 13.1 or later, for a demonstration of programming and configuring the EEPROM to define the specific use of general purpose pins.

Note Many of the interfaces for the general purpose pins have overlapping pins. If an interface overlaps with another interface, the interfaces cannot exist within the same design.

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Key:	Output (to RMC connector)	Input (to processor)	Bidirectional

Table 8. Defined Interfaces for RMC Connector General Purpose Pins

Pin	CAN	SPI Master 1	SPI Master 2	MII	RMII	SDHC
GP_PORT[0]	TX					
GP_PORT[1]	RS					
GP_PORT[2]						Lock
GP_PORT[3]				COL		CardPresent
GP_PORT[4]		MOSI		MDC	MDC	
GP_PORT[5]	RX					
GP_PORT[6]				MDIO	MDIO	
GP_PORT[7]				CRS		D2
GP_PORT[8]			MISO	RXCLK		
GP_PORT[9]			IRQ#	TXEN	TXEN	
GP_PORT[10]			MOSI	TXCLK	REF_CLK	
GP_PORT[11]				RXDV	CRS_DV	
GP_PORT[12]		IRQ#		IRQ#	IRQ#	
GP_PORT[13]			CS#	TXD0	TXD0	
GP_PORT[14]		CS#		TXD1	TXD1	
GP_PORT[15]				TXD2		CLK
GP_PORT[16]				TXD3		CMD
GP_PORT[17]			SCLK	RXD0	RXD0	
GP_PORT[18]		SCLK		RXD1	RXD1	
GP_PORT[19]				RXD2		D0
GP_PORT[20]				RXD3		D1_IRQ
GP_PORT[21]		MISO		RXER	RXER	
GP_PORT[22]				TXER		D3_CD

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Identifying RMC Connectors with EEPROM

If you want to enable serial, CAN, Ethernet, or SDHC peripherals on an RMC, you must have EEPROM on the RMC for general purpose port pin configuration and mapping. Software uses EEPROM to determine what expansion card is connected to the host system, and the host system can then configure the general purpose pins. An example of a recommended EEPROM device is Atmels 2K EEPROM (part number AT34C02CN-SH-T). RMCs must comply with the *SMBus Module Requirements* in the ExpressCard Standard Release 1.2 for the SMBDATA and SMBCLK signals.

Table 9 describes the required fields in EEPROM:

Table 9. Required Fields in RMC Connector EEPROM

Byte Number	Byte Length	Comments
3-0	4	Vendor ID
4-7	4	Product ID
8-11	4	Hardware revision
12-15	4	Serial number
16-19	4	ROM format revision (0x00000001)
20-42	23	GP_PORT[22..0] pin listing. GP_PORT[0] corresponds to byte 20.
43-58	16	Reserved
59-74	16	
75-90	16	
91-106	16	
107-122	16	
123-138	16	
139	1	
140-253	112	Additional Configuration List. Refer to the *Additional Configuration List Definitions* section of this document for more information about the Additional Configuration List.
254-255	2	16-bit checksum

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EEPROM contains one byte for each GP_PORT[*x*] pin listed in the *RMC Connector Pin Listing by Location* section of this document. Each byte represents an ID that indicates what function the corresponding pin has, as Table 10 describes.

Table 10. EEPROM Function IDs

Interface	Function ID
MII (Ethernet)	x4
RMII (Ethernet)	x5
SDHC	x7
CAN	x8
SPI Master 1 (Serial Interface 1)	xB
SPI Master 2 (Serial Interface 2)	xC

Additional Configuration List Definitions

Some GP_PORT[*x*] configurations, such as SPI Master 1, SPI Master 2, MII, and RMII, require that you set some additional parameters starting at byte 140 of the EEPROM. For example, all Ethernet devices have a unique MAC address, which you can define for a particular MII or RMII port by specifying an additional parameter with the MAC address value.

You must set the starting and ending flags described in Table 11 for the Additional Configuration List.

Table 11. Starting and Ending Flags for the Additional Configuration List

Flag	Description	Value
Start new GP_PORT configuration	Indicates that an Additional Configuration List item relates to one or more GP_PORT pins.	0x01
End of Additional Configuration List	Indicates the end of the Additional Configuration List.	0x00

When you configure the SPI Master 1 or SPI Master 2 interface, you must specify the required additional configurations by setting the bytes described in Table 12.

Table 12. SPI Master Interface Type Field Definition

Byte Index	Byte Count	Description
0	1	Additional Configuration List flag, **Start new GP_PORT configuration**
1	1	GP_PORT configuration type, **SPI Master**, fixed to 0x02

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Table 12. SPI Master Interface Type Field Definition (Continued)

Byte Index	Byte Count	Description
2	1	Function ID from SPI device supported by software. Occupies 0x0B for SPI Master 1 or 0x0C for SPI Master 2.
3	1	Type ID specified in Table 13. This ID defines the SPI device connected to this SPI port.

Table 13 lists the values you can specify for an SPI Master interface type ID in the EEPROM. The values correspond to modes of a SCDual SPI UART device, SC16IS762, with which software can communicate.

Table 13. Dual SPI UART Device Modes and Type IDs

Port 1 Mode	Port 2 Mode	Type ID
RS-232	RS-232	0x01
RS-232	RS-485/422	0x02
RS-485/422	RS-485/422	0x03
RS-485	RS-485	0x04

When you configure the MII or RMII interface, you must specify the required additional configurations by setting the bytes described in Table 14.

Table 14. MII or RMII Interface MAC Address Field Definition

Byte Index	Byte Count	Description
0	1	Additional Configuration List flag, **Start new GP_PORT configuration**
1	1	GP_PORT configuration type, **MAC Address**, fixed to 0x01
2	1	Function ID from Table 10, fixed to 0x04 for MII or to 0x05 for RMII
3-8	6	MAC address

SMBus Module Requirements

Refer to the *SMBus on RMC Connector* section of the *Specifications* section of this document for information about SMBus technical requirements.

Visit `ni.com/info` and enter the Info Code `sbRIORefDesigns` for reference designs, such as example schematics for SMBus EEPROM, serial, CAN, Ethernet, and SDHC implementations.

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Reserved SMBus Addresses

Table 15 lists the addresses the SMBus specification reserves. Any device on the SMBus cannot use any of these addresses.

Table 15. Reserved SMBus Addresses

Slave Address Bits 7-1	R/W# Bit 0	Description
0000 000	0	General call address
0000 000	1	START byte
0000 001	X	C-Bus address
0000 010	X	Reserved for different bus format
0000 011	X	Reserved for future use
0000 1XX	X	Reserved for future use
0101 000	X	Reserved for ACCESS.bus host
0110 111	X	Reserved for ACCESS.bus default address
1111 0XX	X	10-bit slave addressing
1111 1XX	X	Reserved for future use
0001 000	X	SMBus host
0001 100	X	SMBus alert response address
1100 001	X	SMBus device default address

Table 16 lists the addresses that host system devices reserve. Any device on the expansion card SMBus cannot use any of these addresses.

Table 16. Reserved Host System SMBus Addresses

Slave Address Bits 7-1	R/W# Bit 0	Description
1101 000	X	Reserved for host system watchdog timer

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Required Components for General Purpose Port Implementations

Table 17 describes the recommended components to enable NI sbRIO device driver compatibility for different general purpose implementations.

Table 17. Required Components for RMC General Purpose Port Implementations

Implementation	Description	Manufacturer, Part Number
RS-232/RS-485 via Master SPI	Dual-channel UART controller	NXP, SC16IS762IBS*
CAN	CAN controller interface	NXP, PCA82C251T/N3
MII Ethernet	Ethernet transceiver	Cortina, LXT971ABE
RMII Ethernet	Ethernet transceiver	SMSC, LAN8720A
* The NXP, SC16IS762IBS is required due to SPI rates used to communicate with the device through the NI Serial driver. Additionally, use a crystal or oscillator with a 14.7456 MHz frequency with the NXP, SC16IS762IBS.		

3.3 V Digital I/O

The NI sbRIO device provides 3.3 V digital I/O via the RMC connector and the 50-pin IDC headers.

Figure 19 shows the circuitry of one 3.3 V DIO channel on the RMC connector.

Figure 19. Circuitry of One 3.3 V DIO Channel on the RMC Connector

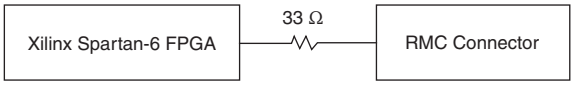
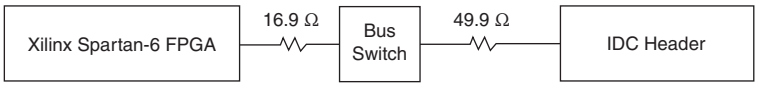


Figure 20 shows the circuitry of one 3.3 V DIO channel on the J502 or J503 IDC header.

Figure 20. Circuitry of One 3.3 V DIO Channel on the J502 or J503 IDC Header



The NI sbRIO device is tested with all DIO channels driving ±3 mA DC loads. DIO signals are tristated (floating) before and during FPGA configuration. After FPGA configuration completes, unused DIO signals remain tristated. To ensure startup values, place pull-up or pull-down resistors on an RMC. The DIO channels on the NI sbRIO device are routed with a 55 Ω characteristic trace impedance. Route all RMCs with a similar impedance to ensure the best signal quality. Refer to *3.3 V Digital I/O on RMC Connector* and *3.3 V Digital I/O on 50-Pin IDC Connector* in the *Specifications* section for the logic levels.

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Integrated Analog Input

This section applies only to the following NI sbRIO devices:

- NI sbRIO-9623
- NI sbRIO-9626
- NI sbRIO-9633
- NI sbRIO-9636

Each NI sbRIO-9623/9633 device has 16 multiplexed, 0-5 V, single-ended, 12-bit analog input (AI) channels. Each NI sbRIO-9626/9636 device has 16 multiplexed, ±10 V, single-ended or eight differential, 16-bit AI channels. Connector J503, the MIO connector, provides connections for analog inputs, outputs, and grounds. Refer to Figure 17 for a pinout of connector J503.

Figure 21 shows the circuitry for one AI channel on the NI sbRIO-9623/9633.

Figure 21. Single-Ended Analog Input on the NI sbRIO-9623/9633

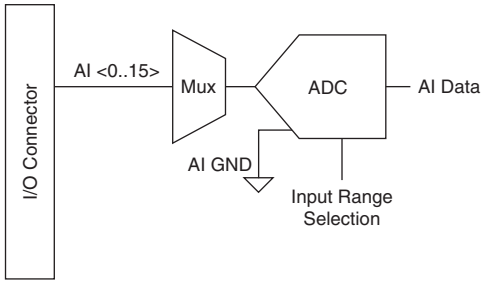
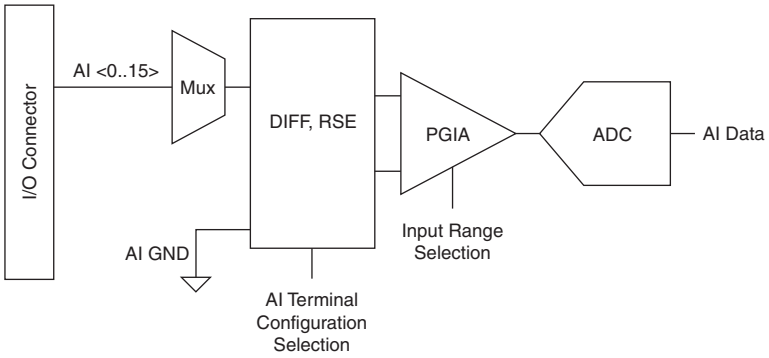


Figure 22 shows the circuitry for one AI channel on the NI sbRIO-9626/9636.

Figure 22. Single-Ended Analog Input on the NI sbRIO-9626/9636



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Analog Input Range

An input range is a set of input voltages that an analog input channel can digitize with the specified accuracy. NI sbRIO devices with selectable input ranges have a programmable gain instrumentation amplifier (PGIA), which amplifies or attenuates the AI signal depending on the input range. You can program the input range for each AI channel independently on the NI sbRIO 9626/9636.

The ADC converts analog inputs into discrete digital values. For a 12-bit ADC there are 2^{12} (4,096) possible values, and for a 16-bit ADC there are 2^{16} (65,536) possible values. These values are spread evenly across the input range, and the voltage difference between values is proportional to the input range selected for the channel. The voltage difference between values is the *size of the least significant bit* (LSB size) for the channel. Equation 1 shows how to calculate the LSB size for a channel set to the -10 V to 10 V input range, with a 16-bit ADC.

$$\frac{10\text{V} - (-10\text{V})}{65,536} = 35\mu\text{V} \quad (1)$$

The NI sbRIO-9626/9636 uses a scaling method that requires some codes (typically about 5% of the codes) to lie outside the specified range. This method improves absolute accuracy, but it increases the LSB size by about 5% over the calculated value.

Choose an input range that matches the expected range of your input signal. A large input range accommodates large variations in signals but results in a larger LSB and, therefore, lower resolution. A smaller input range improves the resolution, but large input signals may go out of range.

For more information about selecting ranges, refer to the *LabVIEW Help*.

Table 18 shows the input ranges and resulting LSB sizes for AI channels on each NI sbRIO device.

Table 18. NI sbRIO Device Input Range and Resolutions

Device	Input Range	Bit Resolution	LSB Size
NI sbRIO 9623/9633	0 V to 5 V	12-bit	1.22 mV
NI sbRIO 9626/9636	-10 V to 10 V	16-bit	320 µV*
	-5 V to 5 V		160 µV*
	-2 V to 2 V		64 µV*
	-1 V to 1 V		32 µV*

* Includes 5% overranging.

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Working Voltage Range

The PGIA on NI sbRIO devices operates normally by amplifying signals of interest while rejecting common-mode signals under the following three conditions:

- The common-mode voltage (V_{cm}), which is equivalent to subtracting AIGND from AI-, must be less than ±10 V. V_{cm} is a constant for all range selections.
- The signal voltage (V_s), which is equivalent to subtracting AI+ from AI-, must be less than or equal to the range selection of the given channel. If V_s is greater than the range selected, the signal clips and information is lost.
- The total working voltage of the positive input, which is equivalent to ($V_{cm} + V_s$), or subtracting AIGND from AI+, must be less than the maximum working voltage specified for that range. Refer to the *NI sbRIO-9626/9636 Input* section for the maximum working voltage for each range.

If any of these conditions are exceeded, the input voltage is clamped until the fault condition is removed.

Best Practices for Scanning Multiple Channels

NI sbRIO devices can scan multiple channels at high rates and digitize the signals accurately. If your application scans multiple channels, settling error can affect the accuracy of your measurements. Settling error is a difference between the input value and the value that the ADC digitizes, and is the result of switching between multiplexed input channels. National Instruments defines settling error as the difference between a single-channel measurement of a signal and a multiple-channel measurement of the same signal. Settling errors are directly proportional to channel-to-channel voltage step size and the time between acquisitions. NI sbRIO devices scan at a fixed rate equal to the maximum aggregate rate.

To ensure the lowest possible settling errors, design your application according to the following best practices:

- **Use low-impedance sources**—Ensure that the impedance of signal sources is less than 1 kΩ. High-impedance sources increase settling errors and decrease accuracy at fast scanning rates. You can reduce impedance by connecting a voltage-follower circuit between the signal source and the AI pin of the channel. For more information about reducing impedance, visit `ni.com/info` and entering the Info Code `rdbbis`.
- **Use short, high-quality cabling**—Using short, high-quality cables can minimize several effects that degrade accuracy, including crosstalk, transmission line effects, and noise. The capacitance of the cable can also increase the settling error. National Instruments recommends using individually shielded twisted-pair wires shorter than 2 m to connect AI signals to the device. Refer to the *Connecting Analog Input Signals* section for more information.
- **Minimize voltage step between adjacent channels**—Settling error increases with the voltage step between channels. If you know the expected input ranges of your signals, you can group signals with similar expected ranges together on adjacent channels.

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Note When you program your I/O node with a scan list, the NI sbRIO device scans channels in numerical order at a fixed rate. Calling a second I/O node adds an extra delay before the first channel but does not reduce settling error.

Differential Measurement Configurations

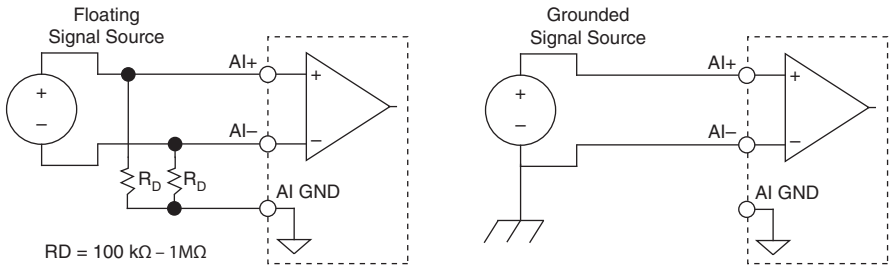
To attain more accurate measurements and less noise on NI sbRIO-9626/9636 devices, use a differential measurement configuration. A differential measurement configuration requires two inputs for each measurement, reducing the number of available channels from 16 to eight. Table 19 shows the signal pairs that are valid for differential connection configurations.

Table 19. Differential Analog Input Signals on the NI sbRIO-9626/9636

Channel	Signal +	Signal -
0	AI0	AI8
1	AI1	AI9
2	AI2	AI10
3	AI3	AI11
4	AI4	AI12
5	AI5	AI13
6	AI6	AI14
7	AI7	AI15

Figure 23 shows how to make a differential connection for a floating signal and for a ground-referenced signal.

Figure 23. Differential Connections with Floating and Grounded Signal Sources

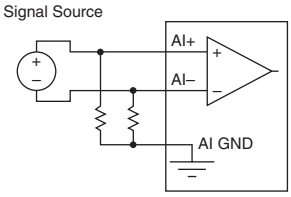
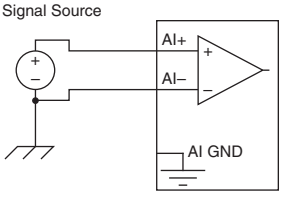
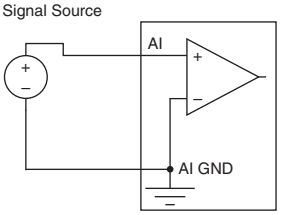
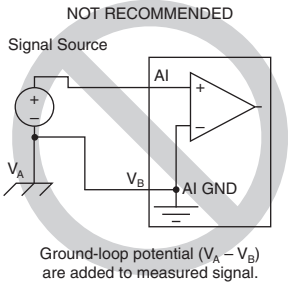


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Connecting Analog Input Signals

Table 20 summarizes the recommended input configuration for both types of signal sources.

Table 20. NI sbRIO Analog Input Configuration

AI Ground-Reference Setting	Floating Signal Sources (Not Connected to Building Ground) Examples: • Ungrounded thermocouples • Signal conditioning with isolated outputs • Battery devices	Ground-Referenced Signal Sources Example: • Plug-in instruments with non-isolated outputs
Differential		
Referenced Single-Ended (RSE)		

Connecting Floating Signal Sources

A floating signal source is not connected to the building ground system, but has an isolated ground-reference point. Some examples of floating signal sources are outputs of transformers, thermocouples, battery-powered devices, optical isolators, and isolation amplifiers. An instrument or device that has an isolated output is a floating signal source.

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When to Use Differential Connections with Floating Signal Sources

Use DIFF input connections for any channel that meets any of the following conditions:

- The input signal is low level (less than 1 V).
- The leads connecting the signal to the device are greater than 3 m (10 ft).
- The input signal requires a separate ground-reference point or return signal.
- The signal leads travel through noisy environments.
- Two analog input channels, AI+ and AI-, are available for the signal.

DIFF signal connections reduce noise pickup and increase common-mode noise rejection. DIFF signal connections also allow input signals to float within the common-mode limits of the PGIA.

Refer to the *Connecting Floating Signal Sources* section for more information about differential connections.

When to Use Referenced Single-Ended (RSE) Connections with Floating Signal Sources

Only use RSE input connections if the input signal meets the following conditions:

- The input signal can share a common reference point, AI GND, with other signals that use RSE.
- The input signal is high-level (greater than 1 V).
- The leads connecting the signal to the device are less than 3 m (10 ft).

DIFF input connections are recommended for greater signal integrity for any input signal that does not meet the preceding conditions.

In the single-ended modes, more electrostatic and magnetic noise couples into the signal connections than in DIFF configurations. The coupling is the result of differences in the signal path. Magnetic coupling is proportional to the area between the two signal conductors. Electrical coupling is a function of how much the electric field differs between the two conductors.

With this type of connection, the NI sbRIO device rejects both the common-mode noise in the signal and the ground potential difference between the signal source and the device ground.

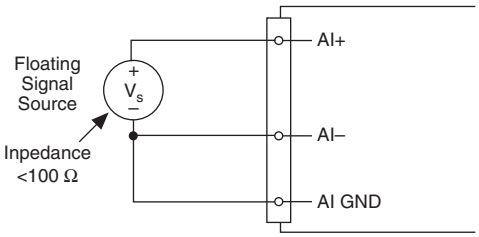
Using Differential Connections for Floating Signal Sources

It is important to connect the negative lead of a floating source to AI GND (either directly or through a bias resistor). Otherwise, the source may float out of the maximum working voltage range of the PGIA device and return erroneous data.

The easiest way to reference the source to AI GND is to connect the positive side of the signal to AI+ and connect the negative side of the signal to AI GND as well as to AI- without using resistors, as shown in Figure 24. This connection works well for DC-coupled sources with low source impedance (less than 100 Ω).

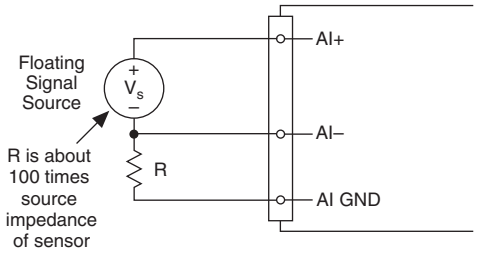
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Figure 24. Differential Connections for Floating Signal Sources without Bias Resistors



However, for larger source impedances, this connection leaves the DIFF signal path significantly off balance. Noise that couples electrostatically onto the positive signal does not couple onto the negative signal because it is connected to ground. This noise appears as a differential mode signal instead of a common-mode signal, and thus appears in your data. In this case, instead of directly connecting the negative signal to AI GND, connect the negative signal to AI GND through a resistor that is about 100 times the equivalent source impedance, as shown in Figure 25. The resistor puts the signal path nearly in balance, so that about the same amount of noise couples onto both connections, yielding better rejection of electrostatically coupled noise. This configuration does not load down the source (other than the very high input impedance of the PGIA).

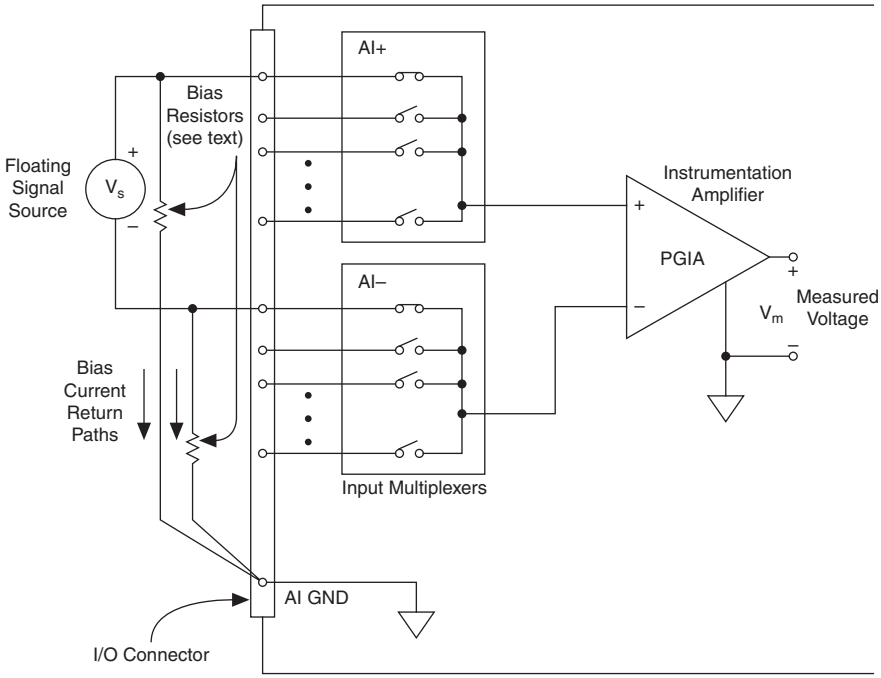
Figure 25. Differential Connections for Floating Signal Sources with Single Bias Resistor



You can fully balance the signal path by connecting another resistor of the same value between the positive input and AI GND, as shown in Figure 26. This fully balanced configuration offers slightly better noise rejection, but has the disadvantage of loading the source down with the series combination (sum) of the two resistors. If, for example, the source impedance is 2 kΩ and each of the two resistors is 100 kΩ, the resistors load down the source with 200 kΩ and produce a -1% gain error.

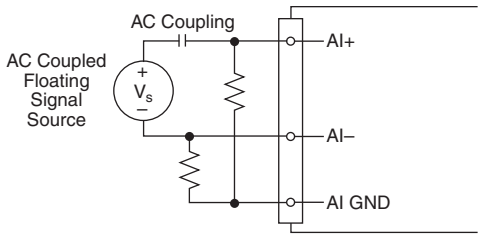
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Figure 26. Differential Connections for Floating Signal Sources with Balanced Bias Resistors



Both inputs of the PGIA require a DC path to ground in order for the PGIA to work. If the source is AC coupled (capacitively coupled), the PGIA needs a resistor between the positive input and AI GND. If the source has low-impedance, choose a resistor that is large enough not to significantly load the source but small enough not to produce significant input offset voltage as a result of input bias current (typically 100 kΩ to 1 MΩ). In this case, connect the negative input directly to AI GND. If the source has high output impedance, balance the signal path as previously described using the same value resistor on both the positive and negative inputs; be aware that there is some gain error from loading down the source, as shown in Figure 27.

Figure 27. Differential Connections for AC Coupled Floating Sources with Balanced Bias Resistors



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Integrated Analog Output

This section applies only to the following NI sbRIO devices:

- NI sbRIO-9623
- NI sbRIO-9626
- NI sbRIO-9633
- NI sbRIO-9636

The NI sbRIO-9623/9633 each have four 12-bit analog output (AO) channels capable of driving 0 V to 5 V. The NI sbRIO-9626-9636 each have four 16-bit AO channels capable of driving ±10 V. All AO channels are ground-referenced. Connector J503 provides connections for analog inputs, outputs, and grounds. Refer to Figure 17 for a pinout of connector J503.

Figure 28 shows an AO channel on the NI sbRIO-9623/9633.

Figure 28. Analog Output Channel on NI sbRIO-9623/9633

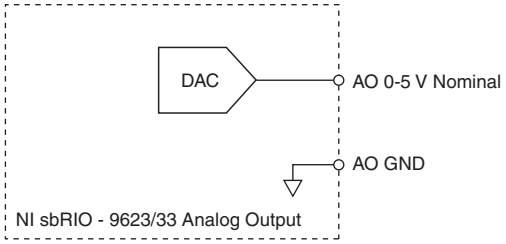
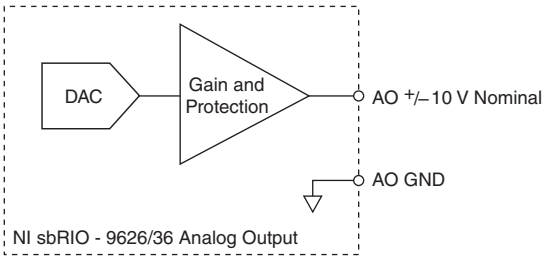


Figure 29 shows an AO channel on the NI sbRIO-9626/9636.

Figure 29. Analog Output Channel on NI sbRIO-9626/9636



Analog Output Startup and Initialization

The analog output on the NI sbRIO device does not get powered until the first time the FPGA is loaded after applying board power. The analog output is initialized (made active and set to 0 V) the first time the FPGA is loaded with a bitfile in which either AI or AO functionality of the board is used. The AO is re-initialized to 0 V every time the FPGA is loaded with a bitfile containing AI or AO functionality.

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Powering the NI sbRIO Device

The NI sbRIO device requires an external power supply that meets the specifications in the *Power Requirements* section. The NI sbRIO device filters and regulates the supplied power and provides power for RMCs.

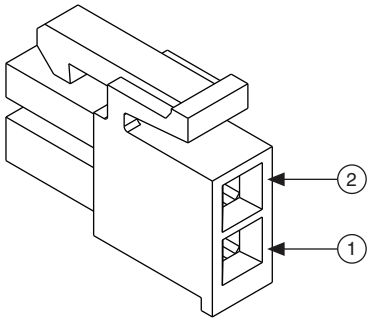
Note Refer to the *Power Requirements* section for formulas and examples for calculating power requirements for different configurations and application types.

Complete the following steps to connect a power supply to the device.

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 plug, as shown in Figure 30.

Figure 30. NI sbRIO Device Power Connector



1	V Terminal	2	C Terminal

3. Connect the C lead of the power supply to position 2 of the 2-position power connector plug.
4. Insert the power connector plug into the power connector receptacle of the NI sbRIO device 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 NI Measurement & Automation Explorer (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 *Measurement & Automation Explorer 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

Table 21 lists the reset options available on NI sbRIO devices for determining how the FPGA behaves when the device is reset in various conditions. Use the RIO Device Setup utility, which you can launch in the following ways, to select reset options:

- **(Windows 8)** Click the **NI Launcher** tile on the Start screen and select **NI-RIO» RIO Device Setup**.
- **(Windows 7 or earlier)** Select **Start»All Programs»National Instruments»NI-RIO» RIO Device Setup**.

Table 21. 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.

Running a VI When Loaded to the FPGA

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**.

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3. In the **General** category of the **FPGA Target Properties** dialog box, enable the **Run when loaded to FPGA** option.
4. Compile the FPGA VI.

Connecting the NI sbRIO Device to a Network

Use a standard Category 5 (CAT-5) or better shielded, twisted-pair Ethernet cable to connect the RJ-45 Ethernet port on the device to an Ethernet hub, or use an Ethernet crossover cable to connect the device 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 device, it attempts to initiate a DHCP network connection. If the device 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 the device is powered up, you must install software on the device and configure the network settings in MAX.

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

Connecting Serial Devices

NI sbRIO devices populated with RS-232 and RS-485 serial ports can connect to 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

NI sbRIO devices populated with one IDC header provide connections to a CAN bus. CAN-enabled NI sbRIO devices have 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.

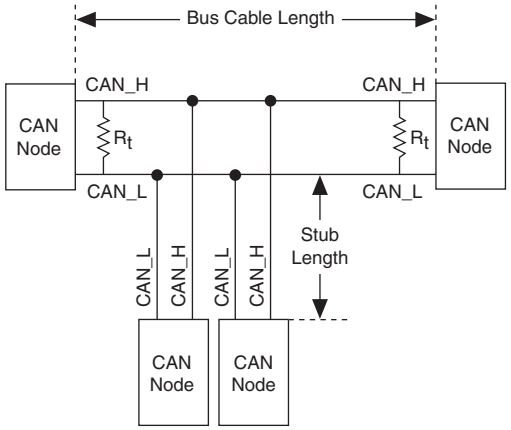
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CAN Bus Topology and Termination

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.

Figure 31 shows a simplified diagram of a CAN bus with multiple CAN nodes and proper termination resistor (Rt) locations.

Figure 31. CAN Bus Topology and Termination Resistor Locations



Cable Specifications

Cables should meet the physical medium requirements specified in ISO 11898, shown in Table 22. Belden cable (3084A) meets all these requirements and is suitable for most applications.

Table 22. 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

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Termination Resistors

The termination resistors (Rt) should match the nominal impedance of the CAN cable and therefore comply with the values in Table 23.

Table 23. Termination Resistor Specification

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

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.

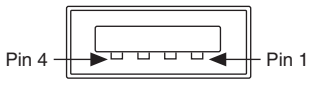
USB Port

This section applies only to the following NI sbRIO devices:

- NI sbRIO-9606
- NI sbRIO-9626
- NI sbRIO-9633
- NI sbRIO-9636

The NI sbRIO devices populated with USB ports support 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 32 and Table 24 for USB pin locations and signal descriptions.

Figure 32. USB Port Pin Locations



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Table 24. 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

Using the System Clock to Provide Data Timestamps

At startup, the system clock of the NI sbRIO-9605/9606 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, visit `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.

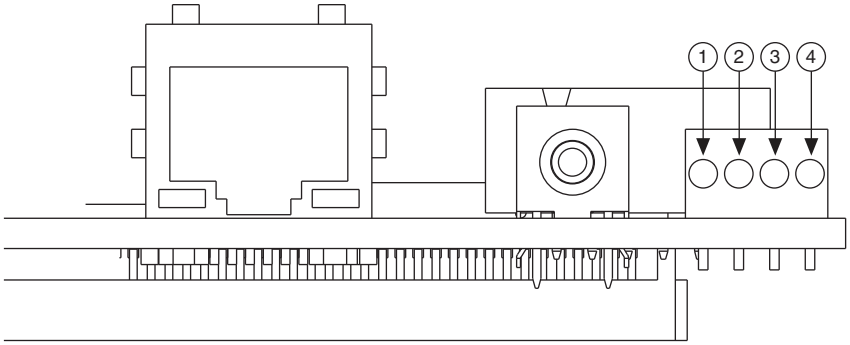
Note To force the device into safe mode, hold the reset button down for 5 seconds, then release. The device will be in safe mode with output from the COM1 serial port enabled.

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Understanding LED Indications

Figure 33 shows the LED indicators on the sbRIO device.

Figure 33. NI sbRIO Device LEDs



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

Power LED

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

Status LED

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

Table 25. Status LED Indications

Number of Flashes	Indication
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.

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Table 25. Status LED Indications (Continued)

Number of Flashes	Indication
4	The device software has crashed twice without rebooting or cycling power between crashes. This usually occurs when the device runs out of memory. Review your RT VI and check the device memory usage. Modify the VI as necessary to solve the memory usage issue.
Continuous flashing or solid	The device has detected an unrecoverable error. Format the hard drive on the device. If the problem persists, contact National Instruments.

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. In the *LabVIEW Help*, refer to the **Real-Time Module» Real-Time VIs»RT Utilities VIs»RT LEDs** section for more information about the RT LEDs VI.

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. In the *LabVIEW Help*, refer to the **Real-Time Module» Real-Time VIs»RT Utilities VIs»RT LEDs** section for information about programming this LED.

Troubleshooting Network Communication

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

1. Hold the Reset button down for 5 seconds, 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 COM1 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 device 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 85 °C for the NI sbRIO device.

Processor Speed

NI sbRIO-9605/9606/9623/9626/
9633/9636 ..... 400 MHz

Memory

NI sbRIO-9605/9623/9633

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

NI sbRIO-9606/9626/9636

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



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

FPGA

NI sbRIO-9605/9623/9633

- FPGA type ..... Xilinx Spartan-6 LX25
- Number of flip-flops 30,064
- Number of 6-input LUTs 15,032
- Number of DSP48s 38
- Available block RAM ..... 936 kbits
- Number of DMA channels 5

NI sbRIO-9606/9626/9636

- 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

RS-485 Serial Port

Maximum baud rate ..... 460,800 bps

Data bits 5, 6, 7, 8

Stop bits 1, 1.5, 2

Parity ..... Odd, Even, Mark, Space, None

Flow control ..... XON/XOFF

Wire Mode ..... 4-wire, 2-wire, 2-wire auto

Isolation Voltage,
port to earth ground ..... None

Embedded CAN

Transceiver ..... NXP PCA82C251T

Maximum baud rate ..... 1 Mbps

Minimum baud rate ..... 10 kbps

USB Port

Compatibility ..... USB 2.0 High Speed

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

Maximum current ..... 500 mA

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Internal RTC

Accuracy ..... 200 ppm; 35 ppm at 25 °C

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

SD Port

SD card support ..... SD and SDHC standards

3.3 V Digital I/O on RMC Connector

Number of DIO channels 96

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

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

Note The performance of the RMC DIO pins is bounded by the FPGA, signal integrity, the application 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, visit `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 ..... 2.4 V min; 3.465 V max
- Output low voltage, V_{OL}
  sinking 3 mA ..... 0.0 V min; 0.4 V max

SMBus on RMC Connector

Max signal capacitance

- SMBDATA ..... 150 pF
- SMBCLK ..... 150 pF

Note The max signal capacitance value includes the expansion connector, traces, vias, and device pins.

3.3 V Digital I/O on 50-Pin IDC Connector

Number of DIO channels

- NI sbRIO-9623/9626 4
- NI sbRIO-9633/9636 28

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

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Max total current, all pins

NI sbRIO-9623/9626 ..... 12 mA

NI sbRIO-9633/9636 ..... 84 mA

Input logic levels

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

Input high voltage, V_{IH} ..... 2.0 V min; 5.25 V max

Output logic levels

Output high voltage, V_{OH}
sourcing 3 mA ..... 2.4 V min; 3.465 V max

Output low voltage, V_{OL}
sinking 3 mA ..... 0.0 V min; 0.4 V max

Analog Input Characteristics

NI sbRIO-9623/9633 Input

Number of channels ..... 16 single-ended

ADC Resolution ..... 12 bits

Maximum aggregate sampling rate ..... 500 kS/s

Input range ..... 0-5 V nominal

Input impedance

Powered on, idle ..... 250 MΩ

Acquiring 500 kS/s ..... 325 kΩ

Powered off/overload ..... 1 kΩ

Overvoltage protection ..... None

AI accuracy

Measurement Conditions	Percent of Reading (Gain Error)	Percent of Range* (Offset Error)
Typical (25 °C, ±5 °C)	0.11%	0.03%
Max (-40 to 85 °C)	0.55%	0.16%
* Range = 5 V		

Note For information about measuring the local ambient temperature, refer to the *Environmental* section.

INL ..... ±0.024% of range

DNL ..... ±0.024% of range

Input bandwidth (-3 dB) ..... 6 MHz

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NI sbRIO-9626/9636 Input

Number of channels ..... 16 single-ended or 8 differential

ADC Resolution ..... 16 bits

Maximum aggregate sampling rate ..... 200 kS/s

Input range ..... ±10 V, ±5 V, ±2 V, ±1 V

Maximum working voltage (signal + common mode)

Range	Working voltage
10 V	±11 V
5 V	± 10.5 V
2 V	± 9 V
1 V	± 8.5 V

Input impedance

Powered on ..... > 1 GW in parallel with 100 pF

Powered off/overload ..... 2.3 kW min

Overvoltage protection

Powered on ..... ±25 V, for up to 2 AI pins

Powered off ..... ±15V

AI accuracy

Measurement Conditions	Range	Percent of Reading (Gain Error)	Percent of Range (Offset Error)
Typical (25 °C, ±5 °C)	1 V	0.042%	0.007%
	2 V		0.007%
	5 V		0.007%
	10 V		0.008%
Max (-40 to 85 °C)	1 V	0.380%	0.179%
	2 V	0.360%	0.138%
	5 V	0.348%	0.113%
	10 V	0.344%	0.105%

Gain drift ..... 12 ppm of reading/°C

Offset drift ..... 4 ppm of range/°C

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AI Noise

Range	Working voltage
10 V	200 µVRMS
5 V	105 µVRMS
2 V	45 µVRMS
1 V	30 µVRMS

INL..... ±64 ppm of range, max

DNL .....No missing codes guaranteed

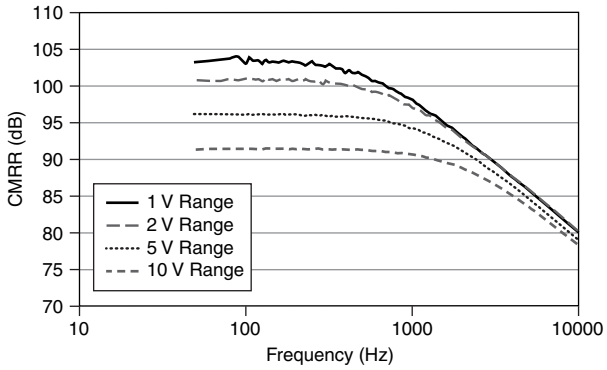
CMRR, DC to 60 Hz..... -80 dB

Input bandwidth (-3 dB) .....600 kHz, typical

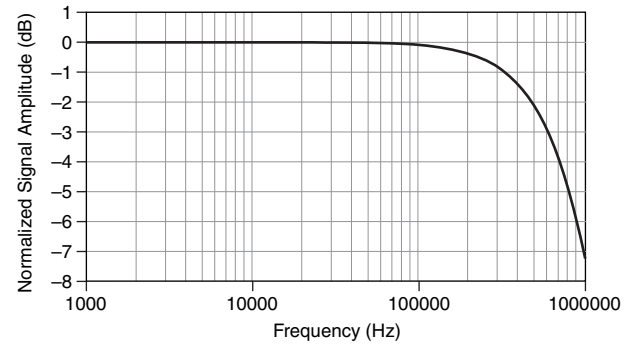
Settling error (multichannel scanning) .....±60 ppm step size, typical

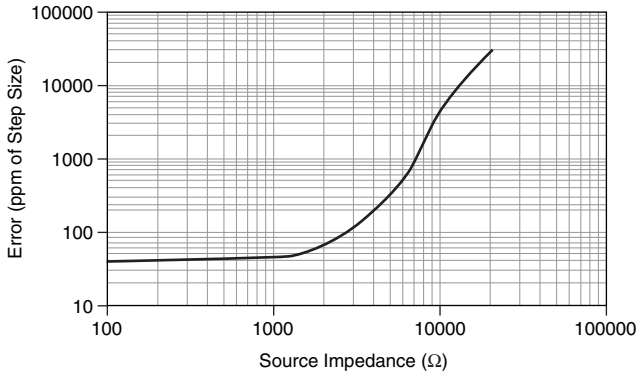
Crosstalk (10 kHz)..... -70 dB

Typical performance graphs



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Analog Output Characteristics

NI sbRIO-9623/9633 Output

Number of channels 4

DAC resolution ..... 12 bits

Max update rate[1] ..... 336 kS/s

Range ..... 0-5 V

Output impedance ..... 13 Ω typical, 27 Ω max

Current drive ..... ±1 mA / channel max.

Protection ..... Short-circuit to ground

Power-on state[2] ..... 0 V

[1] This is the maximum update rate when running one AO channel in a loop with the FPGA top-level clock set to 40 MHz.

[2] When power is applied, the analog outputs remain high impedance until the FPGA loads for the first time. When the FPGA loads, the analog outputs become low-impedance sources driving 0 V. During the transition from high to low impedance, the outputs typically glitch for about 60 µs. The magnitude of the glitch is inversely proportional to the load capacitance. With a 300 pF load, the peak is typically 0.25 V.

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AO accuracy

Measurement Conditions	Percent of Reading (Gain Error)	Percent of Range* (Offset Error)
Typical (25 °C, ±5 °C)	0.12%	0.02%
Max (-40 to 85 °C)	0.80%	0.12%
* Range is 5 V		

Note For information about measuring the local ambient temperature, refer to the *Environmental* section.

INL ..... ±0.018% of range, max

Capacitive drive ..... 1 nF, typical

Slew rate ..... 0.75 V/µsec, typical

NI sbRIO-9626/9636 Output

Number of channels 4

DAC resolution ..... 16 bits

Max update rate[1] ..... 336 kS/s

Range ..... ±10 V

Overrange operating voltage

- Minimum ..... 10.3 V
- Typical ..... 10.6 V
- Max ..... 10.9 V

Output impedance ..... 0.4 Ω typical

Current drive ..... ±3 mA/channel max.

Protection ..... Short-circuit to ground

Power-on state[2] ..... 0 V

[1] This is the maximum update rate when running one AO channel in a loop with the FPGA top-level clock set to 40 MHz.

[2] When the analog output initializes, a glitch occurs for about 20 µs, peaking at 1.3 V, typical.

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AO accuracy

Measurement Conditions	Percent of Reading (Gain Error)	Percent of Range* (Offset Error)
Typical (25 °C, ±5 °C)	0.09%	0.02%
Max (-40 to 85 °C)	0.50%	0.20%
* Range is 10 V		

Gain drift..... 23 ppm of reading/°C

Offset drift ..... 5.4 ppm of range/°C

INL..... ±194 ppm of range, max

DNL ..... ±16 ppm of range, max

Capacitive drive ..... 1.5 nF, typical

Slew rate ..... 3.7 V / µsec, typical

Settling time (100 pF load to 320 µV)

FS step ..... 50 µs

2 V step..... 12 µs

0.2 V step..... 9 µs

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 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]

Reversed-voltage protection ..... 30 VDC

[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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Total power requirement = $P_{int} + P_{DIO} + P_{5V} + P_{USB} + P_{SD} + P_{AO}$

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 pins across the RMC, MIO, or DIO connectors

P_{5V} is the power consumption by the 5 V voltage output across the RMC or DIO connectors

$P_{3.3V}$ 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

P_{SD} is the power consumption of an SD card plugged into the SD slot

P_{AO} is the power consumption of the Analog output across the MIO connector

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

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

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

$$h_{AO} = 50\%$$

P_{AO} is the power consumption of the Analog output across the MIO connector

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

Maximum P_{int} ..... Refer to Table 26.

Maximum P_{DIO} ..... Total DIO current × 3.3 V/0.8

Maximum P_{5V} ..... Total 5 V current × 5 V/0.9

Maximum $P_{3.3V}$ ..... Total 3.3 V current × 3.3 V/0.8

Maximum P_{USB} ..... Total USB current × 5 V/0.9

Maximum P_{SD}[1] ..... Total SD current × 3.3 V/0.8

[1] The SD specification allows 200 mA maximum current draw for an SD card. If your SD card does not specify maximum current draw, assume 200 mA.

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Maximum P_{AO}

NI sbRIO-9623/9633 ..... Total AO current × 5 V/0.5

NI sbRIO-9626/9636 ..... Total AO current × 15 V/0.5

Table 26. NI sbRIO Device Maximum Power Levels

Model	P_{int}	P_{DIO}	P_{5V}	$P_{3.3V}$	P_{USB}	P_{SD}	P_{AO}
NI sbRIO-9605	5.66 W	1.79 W	8.33 W	1.36 W	N/A	N/A	N/A
NI sbRIO-9606	8.10 W				2.78 W		
NI sbRIO-9623	7.50 W				N/A		0.04 W
NI sbRIO-9626	11.86 W				2.78 W	0.83 W	0.3 W
NI sbRIO-9633	9.04 W	0.41 W		N/A			0.04 W
NI sbRIO-9636	11.86 W						0.3 W

NI sbRIO-9605

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

NI sbRIO-9606

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

NI sbRIO-9623

Power consumption while sourcing RMC..... 21.7 W Max

NI sbRIO-9626

Power consumption while sourcing RMC..... 29.9 W Max

NI sbRIO-9633

Power consumption ..... 21.9 W Max

NI sbRIO-9636

Power consumption ..... 24.7 W Max

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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 device system. For a more accurate estimate of the power consumption of a specific application, National Instruments recommends that you directly measure a board running the application in an environment representative of the intended use case.

Environmental

The NI sbRIO device is intended for indoor use only.

Local ambient temperature near device
(IEC 60068-2-1, IEC 60068-2-2)

NI sbRIO-960*x*.....-40 to 85 °C
NI sbRIO-962*x*.....-40 to 85 °C
NI sbRIO-963*x*.....-40 to 85 °C

Note Measure the local 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 near board edges, which can cause inaccurate temperature measurements. In addition to the local ambient temperature, the case temperature of the components should not exceed the recommended maximum case temperature.

Component maximum case temperature

Component*	Manufacturer	Max Case Temp.
FPGA	Xilinx	93 °C
Processor	Freescale	107 °C

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Component*	Manufacturer	Max Case Temp.
DDR memory	Micron	97 °C
NAND flash	Micron	90 °C
* Refer to Figure 2 for component locations		

Note Some systems may require a heat sink or air flow to remain within the maximum allowed temperature ranges. You can mount the NI 9695 (part number 153901-01) heat spreader on the NI sbRIO device.

Note For information about and examples of environmental and design factors that can affect the thermal performance of NI sbRIO systems, visit `ni.com/info` and enter the Info Code `sbriocooling`.

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

Physical Characteristics

Weight

Model	Weight (g)	Weight (oz)
NI sbRIO-9605	85	2.998
NI sbRIO-9606	89	3.139
NI sbRIO-9623	123	4.24
NI sbRIO-9626	133	4.69
NI sbRIO-9633	131	4.62
NI sbRIO-9636	132	4.66

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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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NI is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial to the environment and to NI customers.

For additional environmental information, refer to the *NI and the Environment* web page at `ni.com/environment`. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)

EU Customers At the end of the product life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers, National Instruments WEEE initiatives, and compliance with WEEE Directive 2002/96/EC on Waste and Electronic Equipment, visit `ni.com/environment/weee`.

Battery Replacement and Disposal

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

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