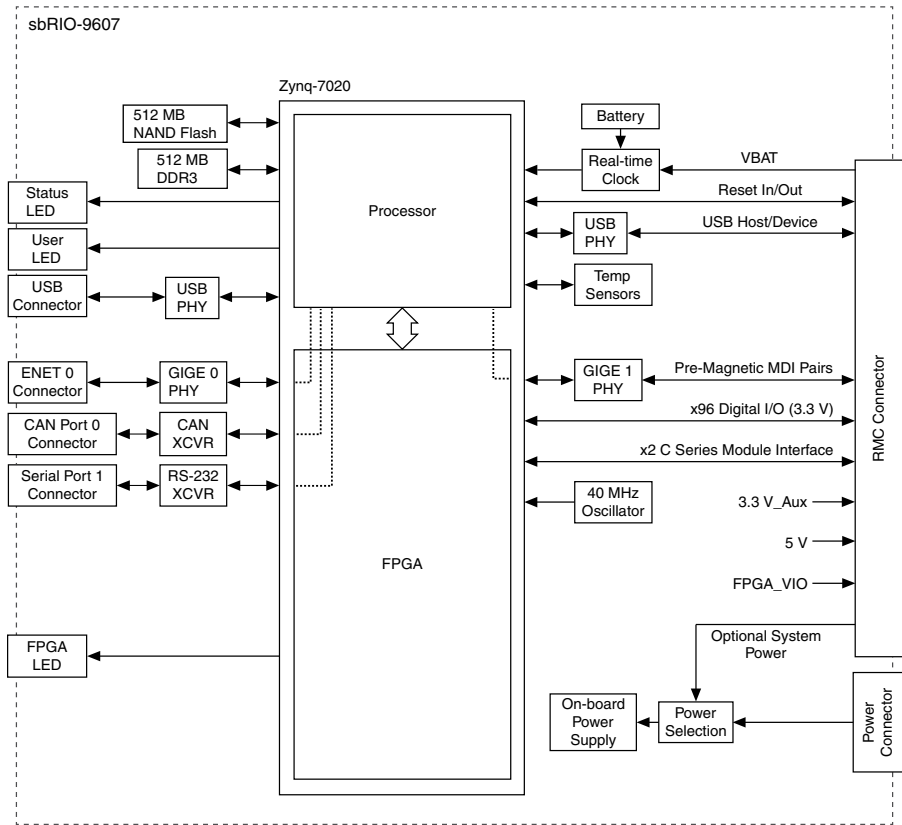


# NI sbRIO-9607

## Single-Board RIO OEM Devices

This document describes the features of the NI sbRIO-9607 and contains information about operating the device.

**Figure 1. NI sbRIO-9607 Block Diagram**



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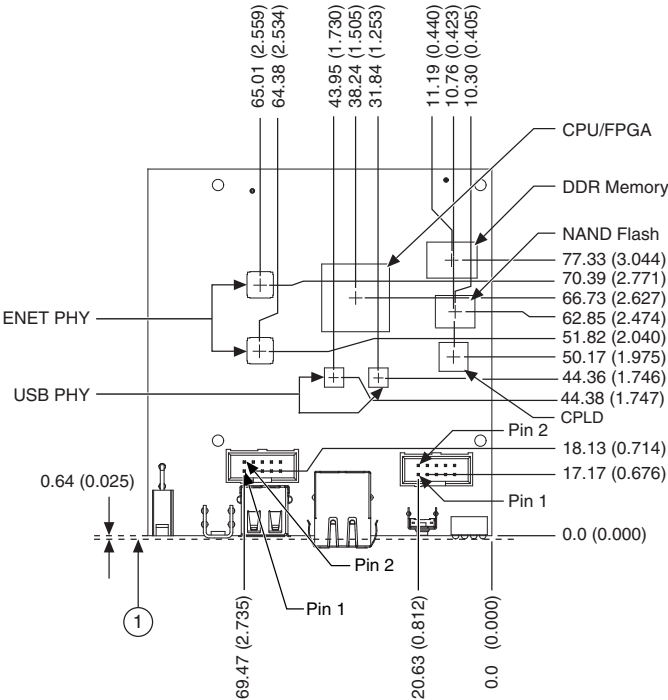
# Mechanical Considerations

Proper mechanical design is critical for rugged environments in which the NI sbRIO device may be subjected to extreme temperatures, shock, vibration, and other factors. In particular, pay special attention to thermal performance to ensure that your application meets the NI sbRIO device operating requirements.

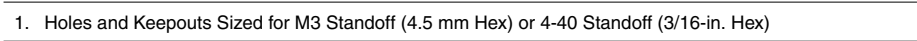
## Dimensions

The following figures specify dimensions for the sbRIO-9607.

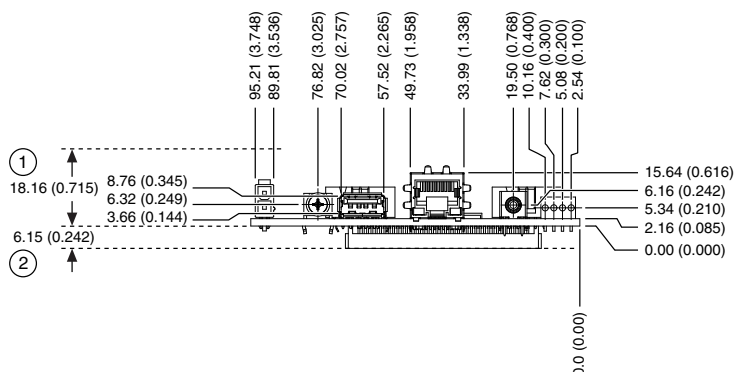
**Figure 2. Primary-Side Dimensions in mm (in.)**



1. Back of Front Panel



**Figure 4. Front Dimensions in mm (in.)**



1. Minimum Clearance for Latch on Mating Power Connector



**Tip** For two-dimensional drawings and three-dimensional models of the sbRIO-9607, visit [ni.com/dimensions](https://ni.com/dimensions) and search by model number.

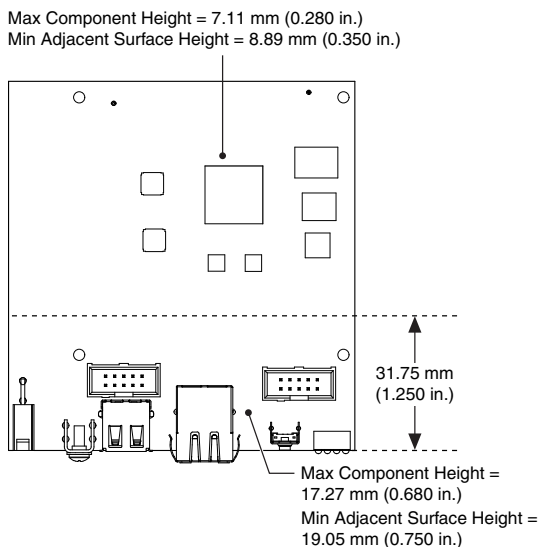
## Maximum Component Heights

The primary side of the sbRIO-9607 is the top side of the PCB populated with the power and Ethernet connectors. The secondary side is the bottom side of the PCB populated with the RMC connector. The following figures show the maximum component heights for the different regions of the primary and secondary sides.

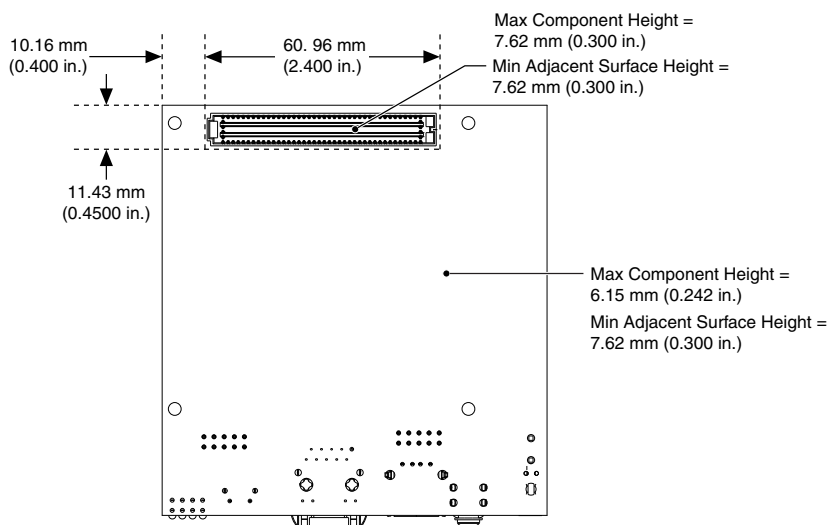


**Note** In addition to the maximum component heights, you must also observe minimum keepaway distances for adjacent PCBs and surfaces.

**Figure 5. Maximum Component Height of Primary Side**



**Figure 6. Maximum Component Height of Secondary Side**



## Mounting

You can mount the NI sbRIO device in a variety of ways in order to maximize system performance. Some mounting methods might require custom fasteners or unique assembly

techniques to maintain required connector stack heights and enable improved thermal and structural design for rugged environments.

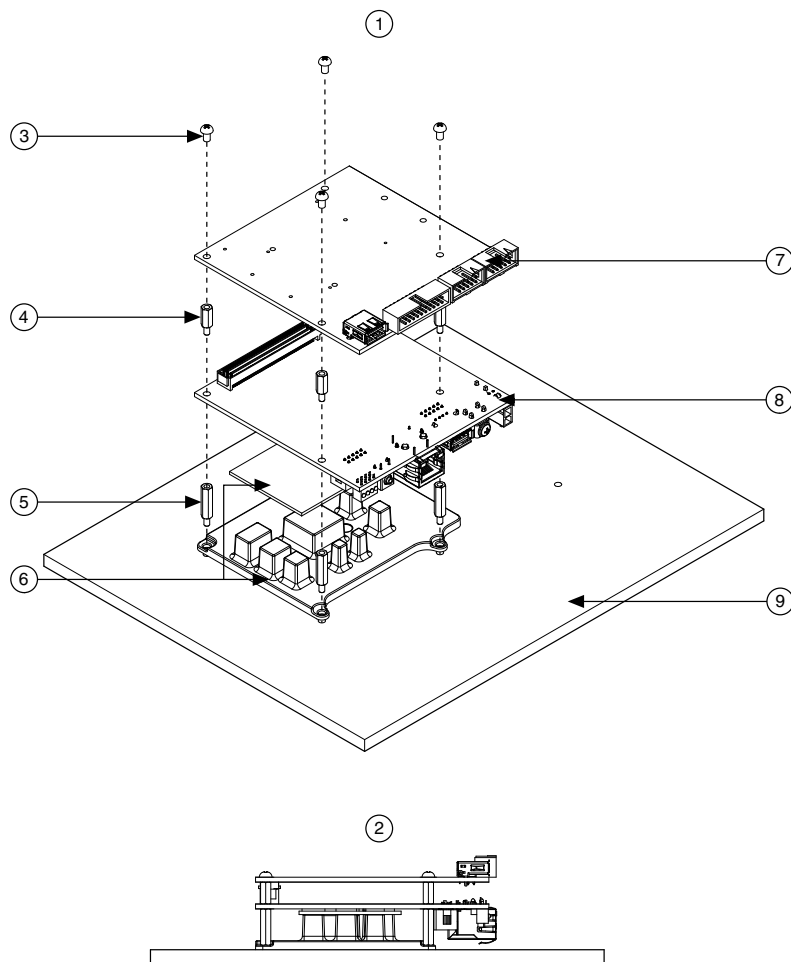
## Mounting Direction Options

The sbRIO-9607, Thermal Kit for NI sbRIO-9607/9627/9637 (153901-02), and certain RMC accessories are designed to allow traditional M-F standoff threads to pass through and stack in either direction. The following figures show possible mounting configurations and associated fastener types.

## Mounting on a Panel or Plate with Conduction Path

If possible, NI recommends that you mount the sbRIO-9607 on a panel or plate, such that a thermal solution provides a conduction path from the primary side components and is secured to or made from the panel or plate, as shown in the following figure.

**Figure 7. Mounting on a Panel or Plate with Conduction Path**

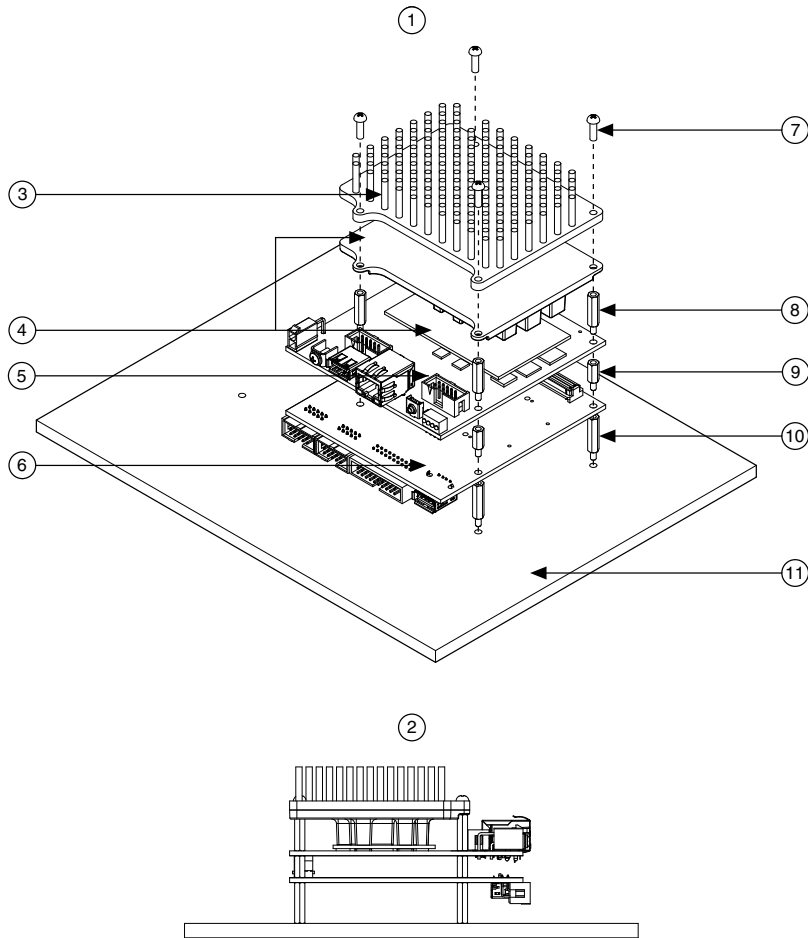


- |                                             |                                                        |
|---------------------------------------------|--------------------------------------------------------|
| 1. Exploded view of all mounting components | 6. Thermal Kit for NI sbRIO-9607/9627/9637 (153901-02) |
| 2. Complete assembled and mounted view      | 7. RMC board                                           |
| 3. Mounting screws                          | 8. NI sbRIO-9607                                       |
| 4. Standoff, 9.65 mm (0.38 in.)             | 9. Mounting surface                                    |
| 5. Standoff, 16.00 mm (0.63 in.)            |                                                        |

# Mounting on a Panel or Plate with Convection Path

Alternatively, the thermal solution can be used for convection to natural or forced air flow or used in conjunction with a heat sink optimized for the environment.

**Figure 8.** Mounting on a Panel or Plate

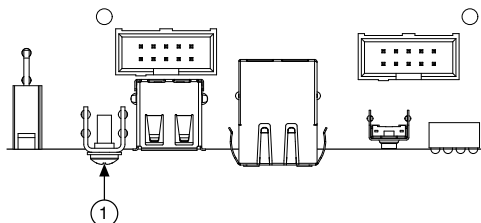


- |                                                        |                                  |
|--------------------------------------------------------|----------------------------------|
| 1. Exploded view of all mounting components            | 7. Mounting screws               |
| 2. Complete assembled and mounted view                 | 8. Standoff, 16.00 mm (0.63 in.) |
| 3. Heatsink                                            | 9. Standoff, 9.65 mm (0.38 in.)  |
| 4. Thermal Kit for NI sbRIO-9607/9627/9637 (153901-02) | 10. Standoff                     |
| 5. NI sbRIO-9607                                       | 11. Mounting surface             |
| 6. RMC board                                           |                                  |

## Chassis Grounding Connections

The sbRIO-9607 provides a multi-function bracket that can be used with the supplied 4-40 grounding screw for directly attaching ground connections or for attaching to and grounding a front panel as shown in the following figure.

**Figure 9.** sbRIO-9607 Chassis Grounding Screw



### 1. Chassis Grounding Screw

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 each of the IO connectors. 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.

## Managing Thermal Conditions

Due to the small size of the sbRIO-9607, it is very important to appropriately dissipate the heat generated during operation. You must plan for the thermal conditions of your application throughout development and validation. This section provides design recommendations and validation tools and methods for maximizing the thermal performance of the system.

### Designing a Suitable Enclosure

NI sbRIO devices operate as components in a higher-level system and may require an enclosure to protect the internal circuit card assemblies and dissipate heat. For the sbRIO-9607, the system integrator is responsible for designing an enclosure that meets the thermal requirements of your specific application.

NI sbRIO devices integrated into an enclosure or system with proper thermal dissipation can be deployed in high- and low-temperature environments. However, the 85 °C local ambient operating temperature rating of the sbRIO-9607 does not mean that the external temperature of the natural convection environment such as a room or larger enclosure can be 85 °C. In this

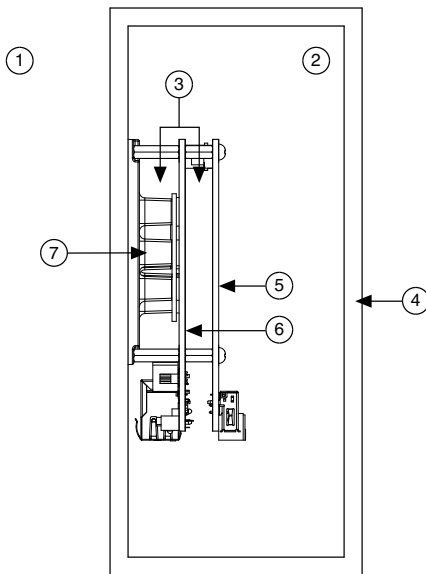
way, properly designed NI sbRIO devices may still require an external ambient temperature of 70 °C or less and may still require specific mounting requirements to ensure that the local ambient and thermally-relevant component maximum operating temperatures are within specification.

## Understanding Thermal Specifications

A deployed system has several temperature measurement locations that indicate the thermal performance of the system and the devices the system contains. For example, in a natural convection system, the temperature of a critical component will be higher than the temperature of the air in the immediate vicinity of the component. This local air temperature will also be higher inside an enclosure than in the room ambient that surrounds the enclosure.

The following figure identifies these types of ambient temperatures.

**Figure 10. Ambient Temperatures**



- |                                           |                                                        |
|-------------------------------------------|--------------------------------------------------------|
| 1. External ambient temperature           | 5. RMC board                                           |
| 2. Internal/enclosure ambient temperature | 6. NI sbRIO-9607                                       |
| 3. Local ambient temperature              | 7. Thermal Kit for NI sbRIO-9607/9627/9637 (153901-02) |
| 4. Enclosure                              |                                                        |

- External ambient—The maximum air temperature of the room or installation location that surrounds the system.
- Internal/enclosure ambient—The maximum air temperature inside the enclosure. This can be measured at various locations within the enclosure and is highly influenced by the proximity and dissipation of devices inside the enclosure.
- Local ambient—The maximum air temperature as specified directly adjacent to the NI sbRIO device. This is measured on all sides of a device that has exposed circuitry.

Because the system integrator may use any number of enclosure sizes, materials, thermal solutions, and room conditions when designing an enclosure for a specific application, NI sbRIO devices are specified in a manner that removes most of these external variables. Therefore, the sbRIO-9607 thermal performance is not determined by measuring the external ambient or internal/enclosure ambient temperatures, but by measuring the local ambient and specific component temperatures. NI provides digitally reported temperatures to help you accurately measure these critical temperatures.

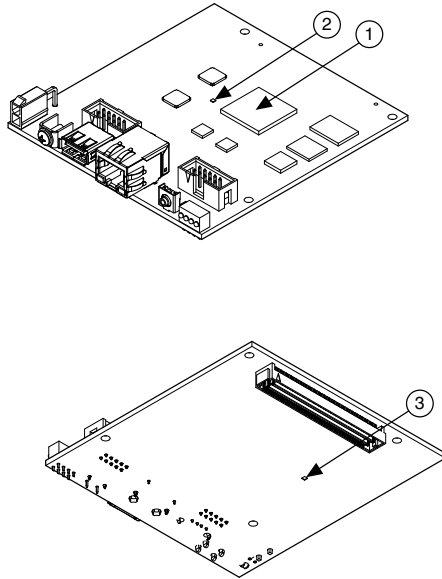
## Validating the System

NI recommends that you use a validation system for an extended period of time in a test environment with the same thermal, environmental, and functional utilization characteristics as the target deployment environment. You are responsible for final validation of your application.

### Validating Temperature Measurements Digitally

To meet the thermal specifications of the sbRIO-9607, you must satisfy the requirements of either the digital or analog thermal validation approach as described in the *NI sbRIO-9607 Specifications* on [ni.com/manuals](http://ni.com/manuals). The sbRIO-9607 includes three onboard temperature-monitoring sensors to simplify validation of a thermal solution. The sensors provide an indication of thermal performance and are used to validate the system digitally.

**Figure 11. Onboard Temperature-Monitoring Sensors**



1. CPU/FPGA sensor
2. Primary System sensor
3. Secondary System sensor

- CPU/FPGA sensor—Digitally reports the die junction temperature of the Xilinx Zynq SoC.
- Primary System sensor—Digitally reports the temperature on the Xilinx Zynq SoC side of the circuit card assembly. This value is a conservative approximation of the local ambient temperature on that side of the circuit card assembly.
- Secondary System sensor—Digitally reports the temperature on the SEARAY side of the circuit card assembly. This value is a conservative approximation of the local ambient temperature on that side of the circuit card assembly.

In addition to being useful for system validation, digitally reported temperatures also provide feedback about system health and can be used as triggers or set points.

NI recommends that you monitor the digitally reported temperatures on deployed systems, especially if the temperatures approach the maximum thermal specifications during system validation testing. Monitoring allows individual systems to identify adverse thermal changes caused by differences in environmental, operating, or process conditions.

For more information about how to access and use the digitally reported temperature sensor measurements, visit [ni.com/info](https://ni.com/info) and enter the Info Code `sbriosensors`.

## Managing Power and Feature Utilization

An NI sbRIO device that heavily utilizes all of its performance and features consumes and dissipates substantially more power than an idle device.

Consider the following options for reducing the die junction temperature.

- Design for additional thermal cooling that can appropriately dissipate power
- Reduce device feature utilization



**Note** Your final validation must consider software and hardware utilization that is representative of the final deployment conditions.



**Note** Refer to the *Power Requirements* section of the *NI sbRIO-9607 Specifications* on [ni.com/manuals](http://ni.com/manuals) for specifications that approximate the maximum power requirement for each input rail on the sbRIO device with worst-case silicon manufacturing process and maximum junction temperatures. For a more accurate estimate of the power consumption for a specific application, NI recommends that you directly measure the power the sbRIO device consumes when running your application in an environment that is representative of the intended use case.

## Mounting Recommendations for Maximizing Thermal Performance

Thermal performance of the NI sbRIO device can be maximized by implementing the following recommendations.

- Directly mount a thermal solution such as the Thermal Kit for NI sbRIO-9607/9627/9637 (153901-02) to a thermally conductive surface such as a metal enclosure wall or plate, as shown in the [Mounting on a Panel or Plate with Conduction Path](#) section. An interface material such as thermal grease should be used to maximize the heat transfer from the heat spreader to the enclosure or plate.

If design limitations prevent this solution, you can alternatively attach a heat sink or other thermal solution as shown in the [Mounting on a Panel or Plate with Convection Path](#) section. This solution takes advantage of natural convection or forced cooling provided by a fan.

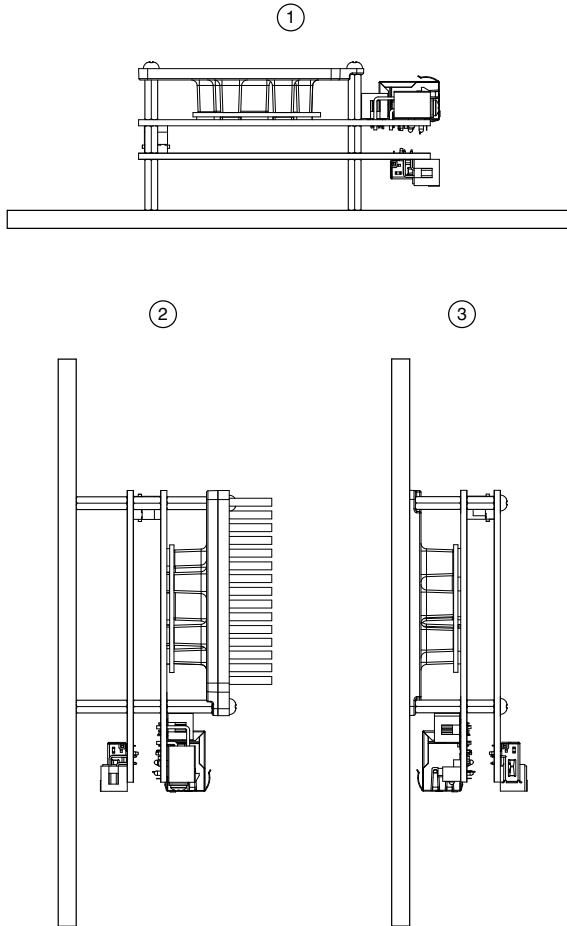
- Mount the NI sbRIO device vertically with respect to gravity to take advantage of natural convection cooling.
- Mount the NI sbRIO device below and away from other heat-dissipating components.



**Note** Placing the NI sbRIO device within a system or enclosure will also influence thermal performance.

The following figure shows good, better, and best thermal mounting solutions for the sbRIO-9607.

**Figure 12. Thermal Mounting Solutions Comparison**

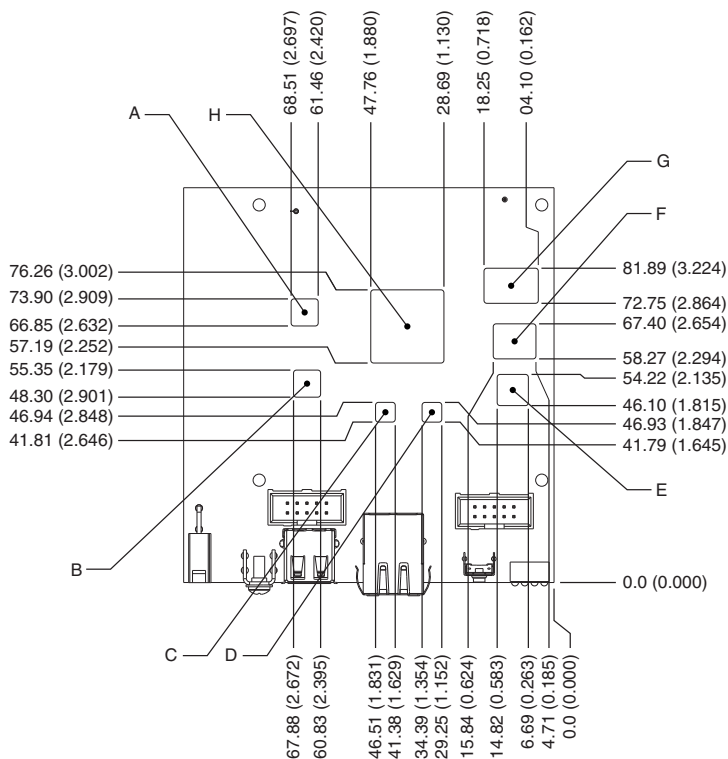


1. Good—Horizontal mounting with no additional thermal provisions
2. Better—Vertical mounting with an attached heat sink
3. Best—Vertical mounting directly to a thermally-conductive wall or plate

## Designing A Thermal Solution

If the Thermal Kit for NI sbRIO-9607/9627/9637 (153901-02) does not satisfy your design requirements, NI recommends replicating the features of the heat spreader into your own thermal solution. Use the pedestal dimensions shown in the following figure and a Bergquist GPVOUS-0.060 thermal gap pad with a fastener assembly rate of 4.23 mm/s (10 in./min.) to prevent damage to the critical components during assembly. NI recommends that you replicate each of the pedestals and not just the pedestal for the CPU/FPGA.

**Figure 13. sbRIO-9607 Pedestal Dimensions in mm (in.)**



The following table provides the pedestal height from board surface for each corresponding component shown in the previous figure.

**Table 1. Pedestal Height from Board Surface**

| Designation | Pedestal Corresponding Component | Pedestal Height from Board Surface |
|-------------|----------------------------------|------------------------------------|
| A, B        | ENET PHY                         | 2.05 mm (0.081 in.)                |
| C, D        | USB PHY                          | 2.00 mm (0.079 in.)                |
| E           | CPLD                             | 2.20 mm (0.087 in.)                |
| F           | NAND Flash                       | 2.16 mm (0.085 in.)                |
| G           | DDR Memory                       | 2.32 mm (0.091 in.)                |
| H           | CPU/FPGA                         | 2.51 mm (0.099 in.)                |



**Note** Pedestals of the same dimensions are allowed to violate the primary side maximum component height keepaway restrictions.



**Note** Gap-filling thermal interface materials between the components and pedestals confined to within the indicated region are allowed to violate the primary side maximum component height keepaway restrictions.



**Note** Pedestals of the same dimensions are allowed to have 0.5 mm (0.02 in.) rounds and 2° draft angles.

## Additional Resources for Managing Thermal Conditions

Visit [ni.com/info](https://ni.com/info) and enter the Info Code `sbriocooling` for the following additional information to help you manage thermal conditions:

- Examples regarding the effect of the design factors discussed in this chapter
- Case study examples to help you estimate the achievable external ambient temperature for a representative system

## Shock and Vibration

The mounting method you use, components you select, and assembly techniques you use influence the ability of the system to resist fretting corrosion and other damage caused by exposure to shock and vibration. Consider the following factors when designing your sbRIO-9607 system to account for shock and vibration:

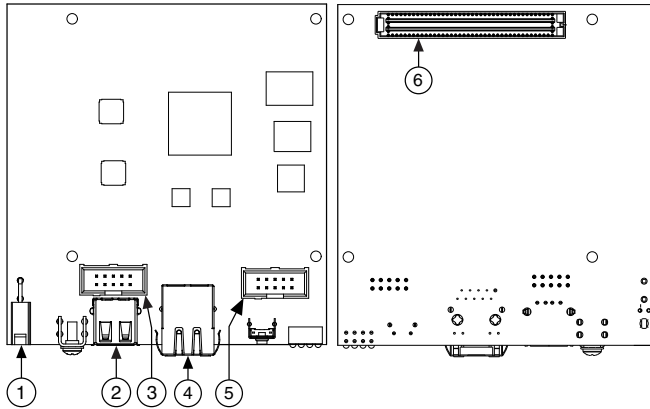
- In general, shorter SEARAY stack heights perform better than taller stack heights.
- Directly mounting the thermal solution to a rigid surface provides the best performance. If this method is not feasible for your design, minimize the amount of extra mass that only the sbRIO-9607 supports, such as a heat sink or other thermal solution, that is fastened to the four standoffs. If you require substantial thermal solutions, provide additional structural support.
- NI recommends that you use connectors that provide the following benefits:
  - Positive locking
  - Provisions for strain relief
  - Substantial gold plating on pins
- The sbRIO-9607 has been tested to industry specifications for rugged environments.
- NI offers a variety of cable assemblies and other connectivity accessories to complete your system design. Typically, these accessories include the best available designs, materials, and plating to maximize performance and longevity in rugged environments.

## Ports and Connectors

---

The sbRIO-9607 provides the following ports and connectors.

**Figure 14.** sbRIO-9607 Ports and Connectors



- |                        |                                     |
|------------------------|-------------------------------------|
| 1. J9, Power Connector | 4. J7, RJ-45 Ethernet Port          |
| 2. J10, USB Host Port  | 5. W2, RS-232 (ASRL1)               |
| 3. W1, CAN (CAN0)      | 6. J1, RIO Mezzanine Card Connector |



**Note** Ethernet, CAN, RS-232, RS-485, and RMC processor peripherals created using the CLIP generator are all routed through the FPGA. These peripherals will be temporarily unavailable when the FPGA is reconfigured. Downloading your FPGA application to the flash of the sbRIO-9607 ensures that the FPGA is configured before the driver can access a given peripheral. Refer to the [Configuring FPGA Startup App](#) section in this document for more information.

## Connector Descriptions

The following table lists 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.

**Table 2. NI sbRIO Connector Descriptions**

| Connector             | Description                                                  | Manufacturer, Part Number          | Recommended Mating Connector       | NI Solution                          |
|-----------------------|--------------------------------------------------------------|------------------------------------|------------------------------------|--------------------------------------|
| Power                 | 2-position, mini-fit JR, H = 10.439 mm (0.411 in.)           | Molex, 46999-0144                  | Molex, 50-36-1673 w/ 0457501211    | NI, Power Plug Assembly, 152834-01   |
| RS-232/CAN IDC Header | 10-pin, 0.100 in. CT, shrouded, H = 9.398 mm (0.370 in.)     | Samtec, TST-105-01-L-D             | Tyco, 1658622-1                    | NI, 10-pin to 9-pin D-SUB, 153158-10 |
| RMC Connector         | 240-pin, 40 × 6 position, 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 | —                                    |

Samtec SEAM connectors come in multiple heights, indicated in millimeters 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 (0.006 in.) 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 (0.006 in.).

The following table provides an example standoff height calculation using a Samtec SEAM-40-03.0-S-06-2-A-K-TR mating connector.

**Table 3. Example Connector Configuration and Calculated Standoff Height**

| Component        | Manufacturer, Part Number         | Height              |
|------------------|-----------------------------------|---------------------|
| RMC connector    | Samtec SEAF-40-06.5-S-06-2-A-K-TR | 6.50 mm (0.256 in.) |
| Mating connector | Samtec SEAM-40-03.0-S-06-2-A-K-TR | 3.00 mm (0.118 in.) |

**Table 3.** Example Connector Configuration and Calculated Standoff Height (Continued)

| Component                           | Manufacturer, Part Number | Height              |
|-------------------------------------|---------------------------|---------------------|
| Required additional standoff height | —                         | 0.15 mm (0.006 in.) |
| Total calculated standoff height    | —                         | 9.65 mm (0.380 in.) |

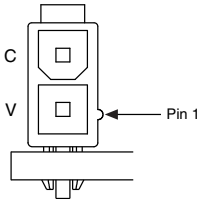
Consult Samtec for alternative heights and options. You must observe keepaways and maximum heights with all RMC and mating connector combinations.

Refer to the [RIO Mezzanine Card Connector](#) section of this document for more information about connecting an RMC.

## Power Connector

The sbRIO-9607 has a power connector to which you can connect a power supply. The following table shows the pinout for the power connector.

**Table 4.** Power Connector Pinout

| Pinout                                                                            | Pin | Description |
|-----------------------------------------------------------------------------------|-----|-------------|
|  | C   | Common      |
|                                                                                   | V   | Power input |

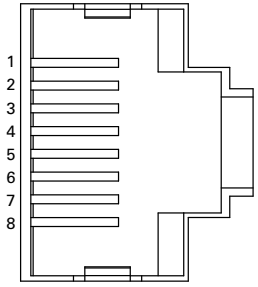
The sbRIO-9607 has reverse-voltage protection.

## RJ-45 Gigabit Ethernet Port

The sbRIO-9607 has a tri-speed RJ-45 Gigabit Ethernet port. By default, the Ethernet port is enabled and configured to obtain an IP address automatically. The Ethernet port can be configured in MAX.

The following table shows the pinout for the RJ-45 Gigabit Ethernet port.

**Table 5. RJ-45 Gigabit Ethernet Port Pinout**

| Fast Ethernet Signal | Gigabit Ethernet Signal | Pin | Pinout                                                                            |
|----------------------|-------------------------|-----|-----------------------------------------------------------------------------------|
| TX+                  | TX_A+                   | 1   |  |
| TX-                  | TX_A-                   | 2   |                                                                                   |
| RX+                  | RX_B+                   | 3   |                                                                                   |
| No Connect           | TX_C+                   | 4   |                                                                                   |
| No Connect           | TX_C-                   | 5   |                                                                                   |
| RX-                  | RX_B-                   | 6   |                                                                                   |
| No Connect           | RX_D+                   | 7   |                                                                                   |
| No Connect           | RX_D-                   | 8   |                                                                                   |



**Note** Both Ethernet ports perform automatic crossover configuration so you do not need to use a crossover cable to connect to a host computer.

The following NI Ethernet cables are available for the sbRIO-9607.

**Table 6. RJ-45 Gigabit Ethernet Cables**

| Cables                          | Length | Part Number |
|---------------------------------|--------|-------------|
| CAT-5E Ethernet Cable, shielded | 2 m    | 151733-02   |
|                                 | 5 m    | 151733-05   |
|                                 | 10 m   | 151733-10   |

## RS-232 Serial Port

The sbRIO-9607 has an RS-232 serial port that is implemented with a shrouded header, 10-position modular jack 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. Refer to the *LabVIEW Help* for information about the Serial VIs.

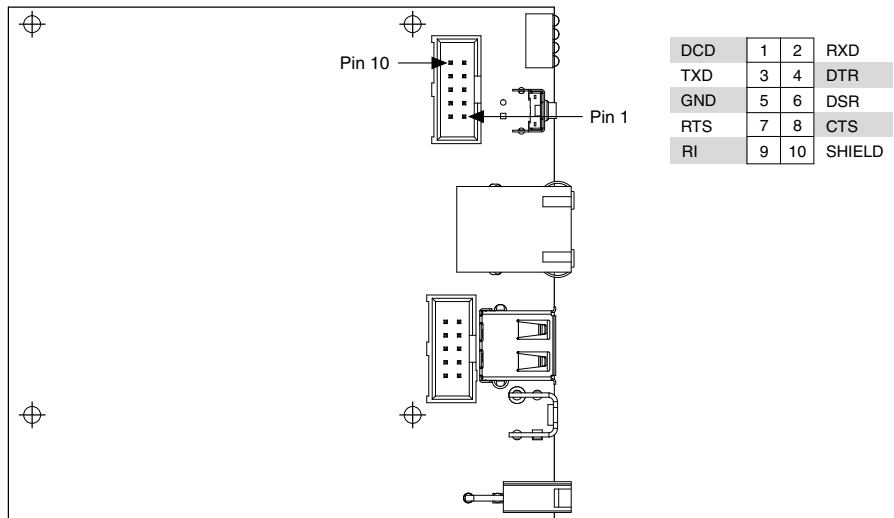
Find examples on how to use NI-Serial or NI-VISA to perform serial communication in the NI Example Finder. Select **Help»Find Examples** in LabVIEW to launch the NI Example Finder.



**Note** The ASRL1 RS-232 serial port cannot be accessed by the user application when the Console Out startup option is enabled.

The following figure shows the pinout for the RS-232 serial port.

**Figure 15. RS-232 Serial Port Pinout**



The following accessories are available to connect the RS-232 serial port.

**Table 7. RS-232 Serial Port Accessories**

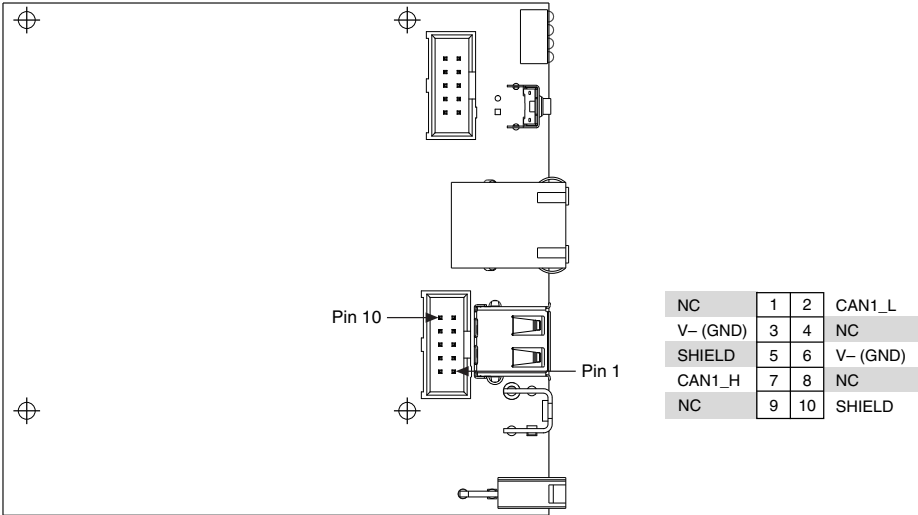
| Accessory                                        | Part Number |
|--------------------------------------------------|-------------|
| NI Single-Board RIO 10-pin header to 9-pin D-SUB | 153158-10   |

## CAN Port

The sbRIO-9607 has a CAN port that is implemented with a shrouded header, 10-position modular jack to provide connections to a CAN bus.

The following figure shows the pinout for the CAN port.

Figure 16. CAN Port Pinout



The following accessories are available to connect the CAN port.

Table 8. CAN Port Accessories

| Accessory                                        | Part Number |
|--------------------------------------------------|-------------|
| NI Single-Board RIO 10-pin header to 9-pin D-SUB | 153158-10   |

## USB Host Ports

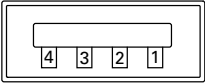
The USB host ports on the sbRIO-9607 support common USB mass-storage devices such as USB Flash drives and USB-to-IDE adapters formatted with FAT16 and FAT32 file systems. The sbRIO-9607 USB host port supports Web cameras that conform to the USB Video Device Class (UVC) protocol as well as machine vision cameras that conform to the USB3 Vision standard and are USB 2.0-compatible.



**Caution** Do not hot-swap USB devices while the sbRIO-9607 is in a hazardous location or connected to high voltages. If the sbRIO-9607 is not in a hazardous location, you can connect and disconnect USB devices without affecting operation.

The sbRIO-9607 provides a multi-function bracket that can be used in conjunction with a 1 mm (0.039 in.) thick front panel and a 6.35 mm (0.250 in.) length 4-40 M-F standoff to provide retention for the USB connector. The following table shows the pinout for the USB host ports.

**Table 9.** USB Host Port Pinout

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

The following NI cable is available for the sbRIO-9607.

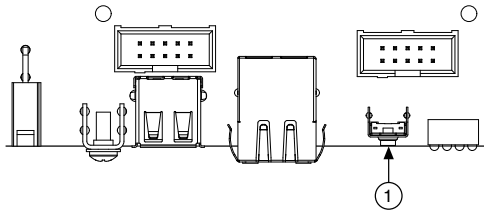
**Table 10.** USB Host Port Cable

| Cable                                           | Length | Part Number |
|-------------------------------------------------|--------|-------------|
| USB Extension with Retention, Type A Connectors | 0.5 m  | 152166-0R5  |
|                                                 | 2 m    | 152166-02   |

# RESET Button

Press the RESET button to reset the processor in a similar manner as cycling power.

**Figure 17.** RESET button

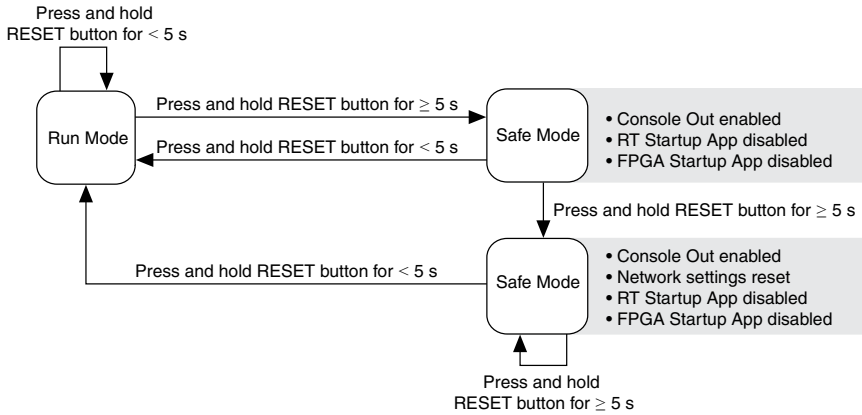


1. RESET button

# System Reset

The following figure shows the reset behavior of the sbRIO-9607.

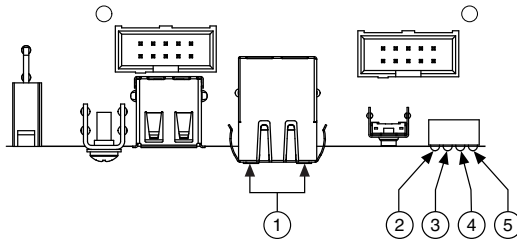
**Figure 18. Reset Button Behavior**



## LEDs

The sbRIO-9607 provides the following LEDs.

**Figure 19. sbRIO-9607 LEDs**



- |                          |                   |
|--------------------------|-------------------|
| 1. Gigabit Ethernet LEDs | 4. USER1 LED      |
| 2. POWER LED             | 5. USER FPGA1 LED |
| 3. STATUS LED            |                   |

## POWER LED Indicators

The following table lists the POWER LED indicators.

**Table 11. POWER LED Indicators**

| LED Color | LED Pattern | Indication                     |
|-----------|-------------|--------------------------------|
| Green     | Solid       | The sbRIO-9607 is powered ON.  |
| —         | Off         | The sbRIO-9607 is powered OFF. |

# STATUS LED Indicators

The following table lists the STATUS LED indicators.

**Table 12. STATUS LED Indicators**

| LED Pattern                   | Indication                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Blinks twice and pauses       | <p>The sbRIO-9607 is in safe mode. Software is not installed, which is the factory default state, or software has been improperly installed on the sbRIO-9607.</p> <p>An error can occur when an attempt to upgrade the software is interrupted. Reinstall software on the sbRIO-9607. Refer to the <i>Measurement &amp; Automation Explorer (MAX) Help</i> for information about installing software on the sbRIO-9607.</p>                            |
| Blinks three times and pauses | <p>The sbRIO-9607 is in user-directed safe mode, or the sbRIO-9607 is in install mode to indicate that software is currently being installed.</p> <p>This pattern may also indicate that the user has forced the sbRIO-9607 to boot into safe mode by pressing the reset button for longer than five seconds or by enabling safe mode in MAX. Refer to the <i>Measurement &amp; Automation Explorer (MAX) Help</i> for information about safe mode.</p> |
| Blinks four times and pauses  | <p>The sbRIO-9607 is in safe mode. The software has crashed twice without rebooting or cycling power between crashes.</p>                                                                                                                                                                                                                                                                                                                               |
| Continuously blinks           | <p>The sbRIO-9607 has not booted into NI Linux Real-Time. The sbRIO-9607 either booted into an unsupported operating system, was interrupted during the boot process, or detected an unrecoverable software error.</p>                                                                                                                                                                                                                                  |
| On momentarily                | <p>The sbRIO-9607 is booting. No action required.</p>                                                                                                                                                                                                                                                                                                                                                                                                   |
| Off                           | <p>The sbRIO-9607 is in run mode. Software is installed and the operating system is running.</p>                                                                                                                                                                                                                                                                                                                                                        |

## User LEDs

You can define the USER1 and USER FPGA1 LEDs to meet the needs of your application. The following table lists the USER1 and USER FPGA1 LED indicators.

**Table 13. User LEDs**

| LED           | LED Color | Description                                                                                                                                                                                                                                                     |
|---------------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| USER1         | Green     | Use LabVIEW Real-Time to define the USER1 LED with the RT LEDs VI. For more information about the RT LEDs VI, refer to the <i>LabVIEW Help</i> .                                                                                                                |
| USER<br>FPGA1 | Green     | Use the LabVIEW FPGA Module and NI-RIO Device Drivers software to define the USER FPGA1 LED. Use the USER FPGA1 LED to help debug your application or retrieve application status. Refer to the <i>LabVIEW Help</i> for information about programming this LED. |

## Ethernet LED Indicators

The following table lists the Ethernet LED indicators.

**Table 14. Ethernet LED Indicators**

| LED         | LED Color | LED Pattern | Indication                      |
|-------------|-----------|-------------|---------------------------------|
| ACT/LINK    | —         | Off         | LAN link not established        |
|             | Green     | Solid       | LAN link established            |
|             |           | Flashing    | Activity on LAN                 |
| 10/100/1000 | Yellow    | Solid       | 1,000 Mbit/s data rate selected |
|             | Green     | Solid       | 100 Mbit/s data rate selected   |
|             | —         | Off         | 10 Mbit/s data rate selected    |

## Real-Time Clock (RTC) Battery

The sbRIO-9607 contains an RTC battery, which is a lithium cell battery that stores the system clock information when the sbRIO-9607 is powered off. Only a slight drain on the RTC battery occurs when power is applied to the sbRIO-9607 power connector. The rate at which the RTC battery drains when power is disconnected depends on the ambient storage temperature. For longer battery life, store the sbRIO-9607 at a cooler temperature and apply power to the power connector. Refer to the device specifications on [ni.com/manuals](https://ni.com/manuals) for the expected battery lifetime.

If longer battery life is needed, attach an RTC battery on the RMC and connect it to the VBAT pin. Refer to the [RMC VBAT](#) section in this document for more information.

The battery is user-replaceable. The sbRIO-9607 ships with an industrial-rated BR1225 battery from RAYOVAC.

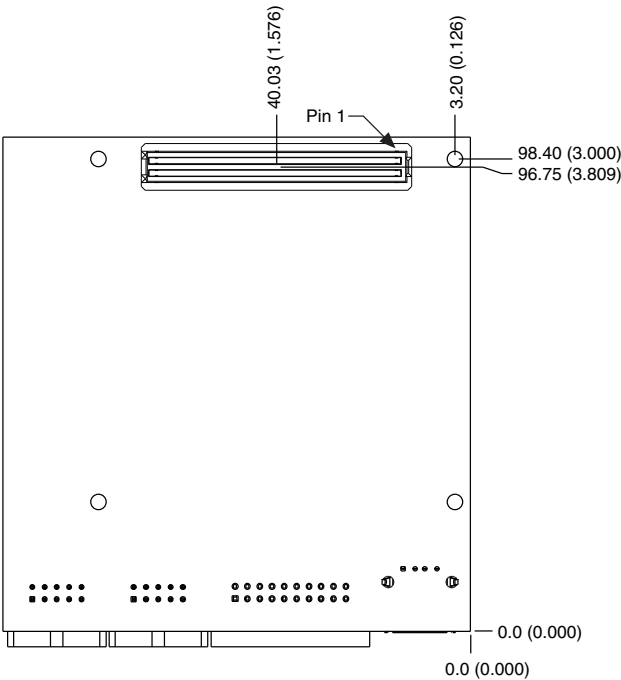
# Internal Real-Time Clock (RTC)

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

## RIO Mezzanine Card Connector

The following figure shows the dimensions of an example RMC and the locations for connecting to the NI sbRIO device.

**Figure 20.** RMC Connector Location and Dimensions on Example RMC



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

# RMC Connector Pins

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

- Pins with dedicated functions.
- General purpose digital I/O pins.
- Pins reserved for future use.



**Note** Leave reserved and unused pins disconnected on RMCs.

# Pins with Dedicated Functions

**Table 15.** 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.                                                                                                                                                                                     |
|           | FPGA_VIO     | O                            | —            | I/O voltage for the FPGA <sub>3.3V</sub> pins.                                                                                                                                                                              |
|           | VIN_FILTERED | I                            | —            | 9 V to 30 V input to power the device through the RMC connector rather than through the front panel connector.                                                                                                              |
|           | VBAT         | I                            | —            | This pin may be used to connect a longer life battery to the RTC on the host system. The RTC will track absolute time as long as either the main system battery or RMC battery through VBAT pin contains sufficient charge. |

**Table 15. RMC Connector Pins with Dedicated Functions (Continued)**

| Pin Group    | Pin Name                                                                                                                                                            | Direction (from Host System) | I/O Standard                                                           | Description                                                                                                                                                                                                        |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| C Series DIO | ID_SELECT#[x]<br>OSCLK_DIO0[x]<br>TRIG_DIO1[x]<br>DONE#_DIO2[x]<br>CVRT#_DIO3[x]<br>SPIFUNC_DIO4[x]<br>SPICS#_DIO5[x]<br>MISO_DIO6[x]<br>MOSI_DIO7[x]<br>SPI_CLK[x] | I/O                          | LVTTL <sub>3.3V</sub><br><br>LVTTL <sub>5V</sub><br><br>tolerant input | Signal conditioned C Series DIO.<br><br>Refer to the <i>NI sbRIO-9607/9627 RMC Design Guide</i> for more information about how to use these signals to connect up to two board-level C Series modules to your RMC. |
|              | SLEEP<br>5V C Series                                                                                                                                                | O                            | 5 V                                                                    |                                                                                                                                                                                                                    |
| Resets       | RST#                                                                                                                                                                | O                            | LVTTL <sub>3.3V</sub>                                                  | Reset that indicates that the main power is not ideal, or that the RMC connector host system has been reset.                                                                                                       |
|              | SYS_RST#                                                                                                                                                            | I                            | LVTTL <sub>3.3V</sub>                                                  | System reset used to reset the RMC connector host system. Asserting this pin causes the RST# pin to also assert.                                                                                                   |

**Table 15. RMC Connector Pins with Dedicated Functions (Continued)**

| Pin Group                  | Pin Name                                                                                             | Direction (from Host System) | I/O Standard                          | Description                                                                                                                                     |
|----------------------------|------------------------------------------------------------------------------------------------------|------------------------------|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| GBE (after PHY)            | GBE_MDI0+<br>GBE_MDI0-<br>GBE_MDI1+<br>GBE_MDI1-<br>GBE_MDI2+<br>GBE_MDI2-<br>GBE_MDI3+<br>GBE_MDI3- | I/O                          | Defined by Ethernet PHY specification | Pre-magnetic Gigabit Ethernet data pairs.                                                                                                       |
|                            | GBE_SPEED_LEDg<br>GBE_SPEED_LEDy                                                                     | O                            | LVTTL <sub>3.3V</sub>                 | Speed LED signals.                                                                                                                              |
|                            | GBE_ACT_LEDg                                                                                         | O                            | LVTTL <sub>3.3V</sub>                 | Activity/link LED signal.                                                                                                                       |
| High speed USB (after PHY) | USB_D+<br>USB_D-                                                                                     | I/O                          | Defined by USB                        | Port for hi-speed differential USB.                                                                                                             |
|                            | USB_MODE                                                                                             | I                            | —                                     | Connect to digital ground or leave disconnected to configure the USB port as Host.<br><br>Connect to +3.3V to configure the USB port as Device. |
|                            | USB_CPEN                                                                                             | O                            | LVTTL <sub>3.3V</sub>                 | Refer to the <i>sbRIO-9607/9627 RMC Design Guide</i> for more information about these signals.                                                  |
|                            | USB_VBUS                                                                                             | I                            | —                                     |                                                                                                                                                 |

# General Purpose Digital I/O Pins

**Table 16.** RMC Connector General Purpose Digital I/O Pins

| Pin Group                        | Pin Name   | Direction (from Host System) | I/O Standard          | Description                                                                                                                     |
|----------------------------------|------------|------------------------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------|
| General purpose digital I/O pins | DIO[0..95] | I/O                          | LVTTL <sub>3.3V</sub> | Pins for connecting directly to the FPGA through a series resistor and for enabling serial, CAN, or SDHC peripherals on an RMC. |

## RMC Connector Pin Listing by Location

The following table lists the pinout for the RMC connector and indicates the pin number and corresponding function.

**Figure 21. RMC Connector Pin Listing**

|                     |                    |                    |                    |                      |                 |
|---------------------|--------------------|--------------------|--------------------|----------------------|-----------------|
| 1 - VIN_Filtered    | 2 - GND            | 3 - GBE_MDIO+      | 4 - GND            | 5 - GBE_MDIO2+       | 6 - GND         |
| 7 - VIN_Filtered    | 8 - GND            | 9 - GBE_MDIO-      | 10 - GND           | 11 - GBE_MDIO2-      | 12 - GND        |
| 13 - GND            | 14 - VIN_Filtered  | 15 - GND           | 16 - GBE_MDIO1+    | 17 - GND             | 18 - GBE_MDIO3+ |
| 19 - GND            | 20 - VIN_Filtered  | 21 - GND           | 22 - GBE_MDIO1-    | 23 - GND             | 24 - GBE_MDIO3- |
| 25 - RESERVED       | 26 - GND           | 27 - RESERVED      | 28 - GND           | 29 - USB_D+          | 30 - GND        |
| 31 - GBE_SPEED_LEDy | 32 - GBE_ACT_LEDg  | 33 - USB_CPEN      | 34 - USB_MODE      | 35 - USB_D-          | 36 - GND        |
| 37 - GBE_SPEED_LEDg | 38 - RST#          | 39 - GND           | 40 - ID_SELECT#[1] | 41 - GND             | 42 - RESERVED   |
| 43 - SYS_RST#       | 44 - GND           | 45 - SLEEP[1]      | 46 - CVRT#_DIO3[1] | 47 - GND             | 48 - 3.3V_AUX   |
| 49 - GND            | 50 - DONE#_DIO2[1] | 51 - SLEEP[2]      | 52 - GND           | 53 - SPIFUNC_DIO4[1] | 54 - 5V         |
| 55 - SPICS#_DIO5[1] | 56 - MOSI_DIO7[1]  | 57 - GND           | 58 - OSCLK_DIO0[1] | 59 - RESERVED        | 60 - 5V         |
| 61 - SPI_CLK[1]     | 62 - GND           | 63 - ID_SELECT#[2] | 64 - TRIG_DIO1[1]  | 65 - GND             | 66 - 5V         |
| 67 - GND            | 68 - DONE#_DIO2[2] | 69 - CVRT#_DIO3[2] | 70 - GND           | 71 - MISO_DIO6[1]    | 72 - 5V         |
| 73 - SPICS#_DIO5[2] | 74 - MOSI_DIO7[2]  | 75 - GND           | 76 - OSCLK_DIO0[2] | 77 - SPIFUNC_DIO4[2] | 78 - GND        |
| 79 - SPI_CLK[2]     | 80 - GND           | 81 - MISO_DIO6[2]  | 82 - TRIG_DIO1[2]  | 83 - GND             | 84 - USB_VBUS   |
| 85 - GND            | 86 - 5V C Series   | 87 - RESERVED      | 88 - GND           | 89 - DIO47           | 90 - DIO15      |
| 91 - 5V C Series    | 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  |

 Power

 GND

 Differential IO

 Singled Ended IO

 Reserved

 Routed to FPGA Global Clock Resources on the Host System

Use the following table to determine if a previously designed RMC is compatible with the new RMC pinout and as guidance on how to design an RMC for compatibility with future generations of the RMC.

**Table 17. RMC Connector Feature Set Compatibility**

| <b>Feature Set</b>                                               | <b>sbRIO-9605/06/23/26</b> | <b>sbRIO-9607</b> | <b>Future Design Compatibility</b> |
|------------------------------------------------------------------|----------------------------|-------------------|------------------------------------|
| DIO[0..63]                                                       | Yes                        | Yes               | Yes                                |
| DIO[64..95]                                                      | Yes                        | Yes               | Not guaranteed                     |
| FPGA_CONF                                                        | Yes                        | Yes               | Yes                                |
| USB_D+/-                                                         | Yes                        | Yes               | Yes                                |
| RST#                                                             | Yes                        | Yes               | Yes                                |
| SYS_RST#                                                         | Yes                        | Yes               | Yes                                |
| 5V                                                               | Yes                        | Yes               | Yes                                |
| 3.3V_AUX                                                         | Yes                        | Yes               | Yes                                |
| FPGA_VIO                                                         | Yes                        | Yes               | Yes                                |
| PROC_VIO                                                         | Yes                        | No <sup>1</sup>   | Not guaranteed                     |
| VBAT                                                             | Yes                        | Yes               | Yes                                |
| GP_PORT<br>CAN<br>RS-232<br>RS-485<br>Secondary Ethernet<br>SDHC | Yes                        | No                | Not guaranteed                     |
| Processor I/O via DIO[0..95]<br>CAN<br>RS-232<br>RS-485<br>SDHC  | No                         | Yes               | Not guaranteed                     |

<sup>1</sup> Pin 42 - RESERVED of the RMC connector provides 3.3 V to the RMC in order to maintain compatibility with the sbRIO-9605/06/23/26 RMC pinout. This pin is not recommended for use with new designs.

**Table 17. RMC Connector Feature Set Compatibility (Continued)**

| Feature Set                  | sbRIO-9605/06/23/26 | sbRIO-9607 | Future Design Compatibility |
|------------------------------|---------------------|------------|-----------------------------|
| GBE_MDI[0..3+/-]             | No                  | Yes        | Not guaranteed              |
| USB_MODE, USB_CPEN, USB_VBUS | No                  | Yes        | Not guaranteed              |
| Dedicated C Series DIO       | No <sup>2</sup>     | Yes        | Not guaranteed              |
| VIN_FILTERED                 | No                  | Yes        | Yes                         |

## 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
- FPGA\_VIO (pins 234 and 240), which provides I/O power for the FPGA I/O pins

The following table lists the requirements for each rail on an RMC connector.

| Rail             | Voltage Tolerance | Maximum Current | Maximum Ripple and Noise |
|------------------|-------------------|-----------------|--------------------------|
| 5 V              | ± 5%              | 1.5 A           | 50 mV                    |
| 3.3V_AUX         | ± 5%              | 0.33 A          | 50 mV                    |
| FPGA_VIO (3.3 V) | ± 5%              | 0.33 A          | 50 mV                    |



**Caution** Ensure that your RMC does not source any current onto any of the power pins and can tolerate 5 V 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 sbRIO-9607, the LVTTTL<sub>3.3V</sub> I/O standard meets the input and output logic levels defined in the *NI sbRIO-9607 Specifications* on [ni.com/manuals](https://ni.com/manuals).

RMCs with FPGA I/O pins that require an explicit pull-up or pull-down should use the values listed in the following table.

<sup>2</sup> The sbRIO-9605/06/23/26 supports C Series I/O using the NI 9693.

**Table 18. Explicit Pull-up/-down Values**

| Requirement        | Maximum Value   | Minimum Value |
|--------------------|-----------------|---------------|
| Explicit pull-up   | 14.7 k $\Omega$ | 1 k $\Omega$  |
| Explicit pull-down | 8 k $\Omega$    | 1 k $\Omega$  |

## VIN\_Filtered

The sbRIO-9607 may alternatively be powered over the RMC connector via the VIN\_Filtered pins. These input pins are 9 V to 30 V. These power pins must contain appropriate filtering on them to ensure reliable operation of the sbRIO-9607. Refer to the *sbRIO-9607/9627 RMC Design Guide* on [ni.com/manuals](http://ni.com/manuals) for further information.



**Note** If simultaneously connected to multiple power sources, the sbRIO-9607 draws power from the terminal with the higher voltage. Ensure that the preferred power supply is 500 mV higher than the alternative power supply.

## RMC VBAT

The NI sbRIO device implements an onboard RTC to keep track of absolute time. The RMC connector provides a VBAT pin to power the RTC. The sbRIO-9607 also has an onboard battery that powers the RTC. The following table lists the VBAT power specifications.

**Table 19. VBAT Power Specifications**

| Specification                     | Minimum | Typical             | Maximum             |
|-----------------------------------|---------|---------------------|---------------------|
| VBAT input voltage                | 2.875 V | 3.0 V               | 5.5 V               |
| sbRIO-9607 powered VBAT current   | —       | 25 nA               | 100 nA              |
| sbRIO-9607 unpowered VBAT current | —       | 2.6 $\mu$ A average | 4.2 $\mu$ A average |

## USB Support

The USB interface supports both host mode and device mode USB. The USB pairs connect to either a USB connector or to a USB device on the RMC board. The *NI sbRIO-9607/9627 RMC Design Guide* on [ni.com/manuals](http://ni.com/manuals) provides design guidelines, requirements for routing signals, and recommendations for an appropriate connector. The following specifications depend on a suitable RMC design that follows these guidelines and requirements.

Number of RMC USB ports

|                   |                        |
|-------------------|------------------------|
| Host/Device       | 1                      |
| USB interface     | USB 2.0, Hi-Speed      |
| Maximum data rate | 480 Mb/s per interface |

# RMC Ethernet Support

You must connect this interface to voltage-mode-PHY-compatible Ethernet magnetics. The *NI sbRIO-9607/9627 RMC Design Guide* on [ni.com/manuals](https://ni.com/manuals) provides design guidelines, requirements for routing signals, and recommendations for appropriate magnetics and connectors. The following specifications depend on a suitable RMC board design that follows these guidelines and requirements.

|                     |                                                                  |
|---------------------|------------------------------------------------------------------|
| Network interface   | 10Base-T, 100Base-TX, 1000Base-T Ethernet                        |
| Compatibility       | IEEE 802.3                                                       |
| Communication rates | 10 Mbps, 100 Mbps, 1,000 Mbps auto-negotiated, half-/full-duplex |

## RMC Ethernet LED Behavior

The RMC connector provides signals for implementing Ethernet LEDs on an RMC.

The GBE\_ACT\_LEDg signal indicates the link status and activity of the Ethernet connection, as described in the following table.

**Table 20.** Ethernet Link Activity LED Behavior

| Link State            | GBE_ACT_LEDg Behavior |
|-----------------------|-----------------------|
| No link               | Low                   |
| Link, but no activity | High                  |
| Link with activity    | Toggling              |

The GBE\_SPEED\_LEDg and GBE\_SPEED\_LEDy signals indicate the link speed of the Ethernet connection, as described in the following table.

**Table 21.** Ethernet Speed LED Behavior

| Link Speed | GBE_SPEED_LEDg | GBE_SPEED_LEDy |
|------------|----------------|----------------|
| No link    | Low            | Low            |
| 10Base-T   | Low            | Low            |
| 100Base-TX | High           | Low            |
| 1000Base-T | Low            | High           |

## C Series DIO

The C Series DIO lines provides up to two slots of C Series support on the RMC. All lines can be connected directly to the 15-pin DSUB connector except for the 5 V power. The 5 V power

has specific filtering requirements. The *NI sbRIO-9607/9627 RMC Design Guide* on [ni.com/manuals](https://ni.com/manuals) provides design guidelines, requirements for routing signals, requirements for the 5 V filtering, and recommendations for an appropriate connector.

## RMC RST#

The RST# pin indicates that power provided through the RMC Connector is valid or that the sbRIO-9607 is in reset. The signal goes to 3.3 V if the power is valid when the board powers up or when coming out of reset. The signal asserts to 0 V for at least 1 ms before returning to 3.3 V when going into reset. This includes the RMC Connector, traces, vias, and device pins. Refer to the *NI sbRIO-9607 Specifications* on [ni.com/manuals](https://ni.com/manuals) for output logic levels.

## SYS\_RST#

The SYS\_RST# signal is a system reset signal for resetting the sbRIO-9607 processor and FPGA. Asserting this signal causes the RMC RST# signal to also assert. The SYS\_RST# signal asserts low.

The amount of time for which you assert this signal determines the specific reset behavior. This behavior is the same as shown in the [Reset Button Behavior](#) section of this document.

You can assert the SYS\_RST# signal before you apply power to the sbRIO-9607. The sbRIO-9607 remains in reset until the SYS\_RST# signal de-asserts. If you assert the SYS\_RST# signal before power is applied, then you must de-assert the SYS\_RST# signal within five seconds.

## FPGA\_CONF

The FPGA\_CONF pin asserts high when the FPGA has been programmed. When the FPGA is not configured the signal may be either floating or driven low. A pull-down resistor is required when using this signal to ensure it returns to ground.

## User-Defined FPGA Signals

The RMC connector provides FPGA Digital I/O (DIO) pins that you configure for purposes specific to your application. You can use these signals to implement the following interfaces:

- FPGA DIO
- Additional UART (4 RS-232 and 2 RS-485) Support
- CAN Support
- SDIO Support

Use one of the following methods to access the user-defined FPGA signals in LabVIEW:

- Right-click your **FPGA Target** and select **New»RIO Mezzanine Card...** to choose a generic Digital RMC and access all 96 DIO lines with digital I/O nodes.



**Note** This methodology does not allow you to configure the DIO lines as processor peripherals such as CAN, SDIO, or Serial.

- 1. Right click your **FPGA Target** and select **Launch sbRIO CLIP Generator...** to launch the NI Single-Board RIO CLIP Generator application, which you can use to create a socketed component-level IP (CLIP) that defines the FPGA signals or processor peripherals to use in your application.
- 2. After you create a CLIP, return to LabVIEW and right-click an **RMC Socket** under the **FPGA Target** and select **Properties**.
- 3. In the Socket Properties dialog box, select your CLIP and click OK. The I/O appears under the socket, or the I/O is connected directly to the RT processor.



**Note** For a given FPGA target, you must use either the digital I/O method or the socketed CLIP method for all 96 DIO lines.

## FPGA DIO

**Figure 22.** Circuitry of One 3.3 V DIO Channel on the RMC Connector



The RMC has a total of 96 DIO channels. The NI sbRIO device is tested with all DIO channels driving  $\pm 3$  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  $55\ \Omega$  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* section in the *NI sbRIO-9607 Specifications* on [ni.com/manuals](https://ni.com/manuals) for the logic levels.



**Note** Refer to the *NI sbRIO-9607/9627 RMC Design Guide* on [ni.com/manuals](https://ni.com/manuals) for information about FPGA DIO best practices.

## FPGA DIO Clock Capabilities

- Single-region clock capable (SRCC)—These pins provide a direct connection to the global clock distribution buffers in the FPGA. The pins also connect to the regional buffers on a specific bank of pins. Each SRCC pin has an `_SRCC` suffix in the pin name.
- Multi-region clock capable (MRCC)—These pins provide a direct connection to the global clock distribution buffers in the FPGA. The pins also connect to the regional and

multi-regional buffers on a specific bank of pins. Each MRCC pin has an `_MRCC` suffix in the pin name.



**Tip** FPGA DIO pins through the RMC may be used to import or export clocks. Use the CLIP generation wizard to configure DIO lines for this capability. NI recommends that you use the SRCC or MRCC pins when you import a clock into LabVIEW FPGA.

## Additional UART (4 RS-232 and 2 RS-485) Support

You must connect each of these interfaces to an appropriate RS-232 or RS-485 serial transceiver on your RMC design. The *NI sbRIO-9607/9627 RMC Design Guide* on [ni.com/manuals](https://ni.com/manuals) provides design guidelines, requirements for routing signals, and recommendations for a serial transceiver. The specifications depend on a suitable RMC design that follows these guidelines, requirements, and recommended or equivalent transceivers. Refer to *RS-232 (DTE) Serial Port* and *RS-485 Serial Port* section in the *NI sbRIO-9607 Specifications* on [ni.com/manuals](https://ni.com/manuals) for the specifications.

## CAN Support

You must connect this interface to an appropriate CAN transceiver on your RMC design. The *NI sbRIO-9607/9627 RMC Design Guide* on [ni.com/manuals](https://ni.com/manuals) provides design guidelines, requirements for routing signals, and recommendations for a CAN transceiver. The specifications depend on a suitable RMC design that follows these guidelines and requirements and utilizes the recommended or an equivalent transceiver. Refer to *Embedded CAN* section in the *NI sbRIO-9607 Specifications* on [ni.com/manuals](https://ni.com/manuals) for the specifications.

## SDIO Support

The sbRIO-9607 RMC provides a Secure Digital (SD) Card interface. The *NI sbRIO-9607/9627 RMC Design Guide* on [ni.com/manuals](https://ni.com/manuals) provides design guidelines, requirements for routing signals, requirements for pull-up resistors, and recommendations for an appropriate connector. Refer to *SD Card Slot* in the *NI sbRIO-9607 Specifications* on [ni.com/manuals](https://ni.com/manuals) for the specifications.

## Power Requirements

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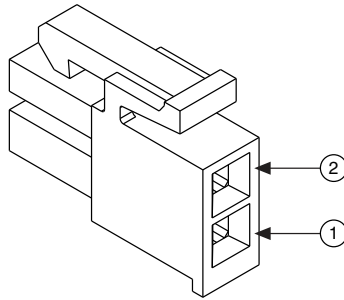
The NI sbRIO device requires a 9 VDC to 30 VDC external power supply.

The NI sbRIO device filters and regulates the supplied power and provides power for RMCs.

## Wiring the Power Supply Connector

Wire the power supply connector as shown in the following figure.

**Figure 23. NI sbRIO Device Power Connector**



1. Connect V lead of the power supply.
2. Connect C lead of the power supply.



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

## 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 [STATUS LED Indicators](#) section of this document to help you troubleshoot the issue.

## Calculating the Power Requirement



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

Total power requirement =  $P_{\text{int}} + P_{\text{DIO}} + P_{5V} + P_{3.3V} + P_{\text{USB}}$ , where

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

$P_{\text{DIO}}$  is the power consumption by the 3.3 V DIO pins across the RMC 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

$P_{\text{USB}}$  is the power consumption of a device plugged into the USB port

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

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

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



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

**Table 22.** Approximate Maximum Power Requirement

| Power              | Values and Calculations                  |
|--------------------|------------------------------------------|
| Maximum $P_{int}$  | 11.36 W                                  |
| Maximum $P_{DIO}$  | Total DIO current $\times$ 3.3 V / 0.8   |
| Maximum $P_{5V}$   | Total 5 V current $\times$ 5 V / 0.9     |
| Maximum $P_{3.3V}$ | Total 3.3 V current $\times$ 3.3 V / 0.8 |
| Maximum $P_{USB}$  | Total USB current $\times$ 5 V / 0.9     |



**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, NI recommends that you directly measure a board running the application in an environment representative of the intended use case.

## Configuring the sbRIO-9607

You can connect the sbRIO-9607 to a host computer or network and configure the startup options using the RJ-45 Gigabit Ethernet port. If a RIO Mezzanine Card is designed with a device USB connector, the target can also be configured using the device USB port.



**Tip** Refer to the *NI sbRIO-9607 Getting Started Guide* on [ni.com/manuals](https://ni.com/manuals) for basic configuration instructions and information about connecting to a host computer using the RJ-45 Gigabit Ethernet port.



**Tip** Refer to the *NI sbRIO-9607/9627 RMC Design Guide* on [ni.com/manuals](https://ni.com/manuals) for basic configuration instructions and information about connecting to a host computer using the device USB port.

# Connecting the sbRIO-9607 to the Host Computer

Complete the following steps to connect the sbRIO-9607 to the host computer using the RJ-45 Ethernet port.

1. Power on the host computer.
2. Connect the sbRIO-9607 to the host computer using a standard Category 5 (CAT-5) or better shielded, twisted-pair Ethernet cable.



**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 has 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](http://ni.com/info) and enter the Info Code `ipconfigerio`.

## Finding the sbRIO-9607 on the Network (DHCP)

Complete the following steps to find the sbRIO-9607 on a network using DHCP.

1. Disable secondary network interfaces on the host computer, such as a wireless access card on a laptop.
2. Ensure that any anti-virus and firewall software running on the host computer allows connections to the host computer.



**Note** MAX uses UDP 44525. Refer to the documentation of your firewall software for information about configuring the firewall to allow communication through the UDP 44525.

3. Launch MAX on the host computer.
4. Expand **Remote Systems** in the configuration tree and locate your system.



**Tip** MAX lists the system under the model number followed by the serial number, such as NI-sbRIO-9607-#####.

## Finding the sbRIO-9607 on the Network (Static IP)

Complete the following steps to find the sbRIO-9607 on the network if the host computer is using a static IP address. The following instructions are for host computers running Microsoft Windows 7. For more information about performing the network configuration steps in this section, visit [www.microsoft.com](http://www.microsoft.com) and search for `change tcp/ip settings`.

1. Obtain IP settings from the host computer.
  - a) Click **Start»Control Panel»Network and Sharing Center**.
  - b) Select the primary network connection, which may appear as **Local Area Connection** or something similar.

- c) In the dialog box that appears, click **Properties**.
- d) Select **Internet Protocol Version 4 (TCP/IPv4)**.
- e) Click **Properties**.
- f) Record the **IP address**, **Subnet mask**, and **Default gateway** address. You need these settings to configure the network settings of the sbRIO-9607 and to restore the network settings of the host computer.



**Tip** You can also access these settings by opening the Start menu, entering `cmd.exe`, and entering `ipconfig` in the command window that launches.

- g) Wait at least one minute.

## 2. Configure IP Settings on the controller in MAX.

- a) Launch MAX on the host computer.
- b) Expand **Remote Systems** in the configuration tree and locate your system.



**Tip** MAX lists the system under the model number followed by the serial number, such as NI-sbRIO-9607-#####.

- c) Select the **Network Settings** tab near the bottom of the window.
- d) Select **Static** on the **Configure IPv4 Address** control.
- e) Enter values for **IPv4 Address**, **Subnet Mask**, **Gateway**, and **DNS Server** based on the information you recorded. Be sure to enter a value for **IPv4 Address** that is not used by another device on the network. For example, do not use the IP address usually assigned to the host computer.
- f) Click **Save** and let MAX restart the sbRIO-9607. The sbRIO-9607 disappears from under **Remote Systems** and does not reappear until you restore the original network settings to the host computer.
- g) Restore the original network settings to the host computer.
- h) Return to MAX and refresh **Remote Systems**.

## Configuring Startup Options

Complete the following steps to configure the sbRIO-9607 startup options in MAX.

1. In MAX, expand your system under Remote Systems.
2. Select the **Startup Settings** tab to configure the startup settings.

### sbRIO-9607 Startup Options

You can configure the following sbRIO-9607 startup options.

**Table 23. sbRIO-9607 Startup Options**

| Startup Option                   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Force Safe Mode                  | Rebooting the sbRIO-9607 with this setting on starts the sbRIO-9607 without launching LabVIEW Real-Time or any startup applications. In safe mode, the sbRIO-9607 launches only the services necessary for updating configuration and installing software.                                                                                                                                                                                                                                                                                                      |
| Enable Console Out               | Rebooting the sbRIO-9607 with this setting on redirects the console output to the RS-232 serial port. You can use a serial-port terminal program to read the IP address and firmware version of the sbRIO-9607. Use a null-modem cable to connect the RS-232 serial port to a computer. Make sure that the serial-port terminal program is configured to the following settings: <ul style="list-style-type: none"> <li>• 115,200 bits per second</li> <li>• Eight data bits</li> <li>• No parity</li> <li>• One stop bit</li> <li>• No flow control</li> </ul> |
| Disable RT Startup App           | Rebooting the sbRIO-9607 with this setting on prevents any LabVIEW startup applications from running.                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Disable FPGA Startup App         | Rebooting the sbRIO-9607 with this setting on prevents autoloading of any FPGA application.                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Enable Secure Shell (SSH) Logins | Rebooting the sbRIO-9607 with this setting on starts sshd on the sbRIO-9607. Starting sshd enables logins over SSH, an encrypted communication protocol. <div>  <b>Note</b> Visit <a href="https://ni.com/info">ni.com/info</a> and enter the Info Code <code>openssh</code> for more information about SSH. </div>                                                                                                                                                          |
| LabVIEW Project Access           | Rebooting the sbRIO-9607 with this setting on enables you to add the target to a LabVIEW project.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

## Configuring FPGA Startup App

Use the RIO Device Setup utility, which you can launch in the following ways, to select an FPGA startup application:

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

# Connecting CAN Networks

The sbRIO-9607 is populated with one IDC header to provide connections to a CAN bus. This connector 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.

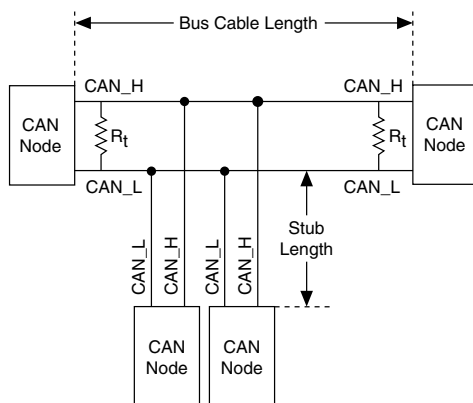
The port has two common pins (GND) that serve as the reference ground for CAN\_H and CAN\_L. You can connect the CAN bus reference ground (sometimes referred to as CAN\_V-) to one or both COM pins. The port also has an optional shield pin (SHLD) that can connect to a shielded CAN cable. Connecting SHLD 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. However, only the two nodes at the far end of the cable, not every node on the bus, require termination resistors.

The following figure shows a simplified diagram of a CAN bus with multiple CAN nodes and proper termination resistor ( $R_t$ ) locations.

**Figure 24.** CAN Bus Topology and Termination Resistor Locations



## Cable Specifications

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

**Table 24.** ISO 11898 Specifications for Characteristics of a CAN\_H and CAN\_L Pair of Wires

| Characteristic            | Value                                                           |
|---------------------------|-----------------------------------------------------------------|
| Impedance                 | 95 $\Omega$ minimum, 120 $\Omega$ nominal, 140 $\Omega$ maximum |
| Length-related resistance | 70 m $\Omega$ /m nominal                                        |
| Specific line delay       | 5 ns/m nominal                                                  |

## Termination Resistors

The termination resistors ( $R_t$ ) must match the nominal impedance of the CAN cable and therefore comply with the values in the following table.

**Table 25.** Termination Resistor Specification

| Characteristic              | Value                                                    | Condition                         |
|-----------------------------|----------------------------------------------------------|-----------------------------------|
| Termination resistor, $R_t$ | 100 $\Omega$ min, 120 $\Omega$ nominal, 130 $\Omega$ 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 NI recommends that you analyze each node 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.

## File System

LabVIEW mounts USB devices to the directory and creates symbolic links `/u`, `/v`, `/w`, or `/x` to the media mount point, starting with `/u` if it is available. To prevent any file corruption to external storage devices, verify that any file I/O operations with the specific drive finish before removing the device. Refer to the *LabVIEW Help* for more information.

The file system of the sbRIO-9607 follows conventions established for UNIX-style operating systems. Other LabVIEW Real-Time targets follow Microsoft Windows-style conventions. In

order to facilitate the porting of applications from those targets, this target supports the Windows-style `/C` home directory. This path is bound to the UNIX-style directory `/home/lvuser`.

Various LabVIEW Real-Time system files which would be accessible from `C:` (or `/C`) on other LabVIEW Real-Time targets are found in different locations on this target.

UNIX-style file systems support the concept of a symbolic link, which allows access to a file using an alternative file path. For example, it is possible to link `/C/ni-rt/system`, where dynamic libraries are deployed on other LabVIEW Real-Time targets, to `/usr/local/lib`, where they are stored on the sbRIO-9607, if the application requires this.

For more information, visit [ni.com/info](http://ni.com/info) and enter the Info Code `RT_Paths`.

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