CALIBRATION PROCEDURE

RM-4339

Rack-Mount Accessory Universal Bridge

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ni.com/manuals

This document contains the verification procedures for the National Instruments RM-4339. For more information about calibration solutions, visit ni.com/calibration.

Contents

Software

Calibrating the NI RM-4339 requires the installation of NI-DAQmx on the calibration system. Driver support for the RM-4339 was first available in NI-DAQmx 14.5. For the list of devices supported by a specific release, refer to the NI-DAQmx Readme, available on the version-specific download page or installation media.

You can download NI-DAQmx from ni.com/downloads. NI-DAQmx supports numerous programming languages, including LabVIEW, LabWindows™/CVI™, C/C++, C#, and Visual Basic .NET. When you install NI-DAQmx, you only need to install support for the application software that you intend to use.

NATIONAL INSTRUMENTS™

Documentation

Consult the following documents for information about the RM-4339, NI-DAQmx, and your application software. All documents are available on `ni.com` and help files install with the software.

NI PXIe-4339 and RM-4339 User Guide and Terminal Block Specifications

NI-DAQmx installation, hardware setup, and RM-4339 specifications.

NI PXIe-4339 and TB-4339/B/C Installation Guide and Terminal Block Specifications

NI-DAQmx installation and hardware setup.

NIPXIe-4339 User Manual

NI PXIe-4339 specific information.

NI PXIe-4339 Specifications

NI PXIe-4339 specifications and calibration interval.

NI-DAQmx Readme

Operating system and application software support in NI-DAQmx.

NI DAQmx Help

Information about creating applications that use the NI-DAQmx driver.

LabVIEW Help

LabVIEW programming concepts and reference information about NI-DAQmx VIs and functions.

NI-DAQmx C Reference Help

Reference information for NI-DAQmx C functions and NI-DAQmx C properties.

NI-DAQmx .NET Help Support for Visual Studio

Reference information for NI-DAQmx .NET methods and NI-DAQmx .NET properties, key concepts, and a C enum to .NET enum mapping table.

Test Equipment

Table 1 lists the equipment recommended for the performance verification procedures. If the recommended equipment is not available, select a substitute using the requirements listed in Table 1.

Table 1. Recommended Equipment

Equipment	Recommended Model	Requirements
Calibrator	Fluke 5520A	If this instrument is unavailable, use a calibrator that can provide resistance values in the range of 120 Ω to 1 kΩ with 0.01 Ω resolution, and an accuracy of 90 ppm or better, and can sink 15 mA on the 120 Ω setting, 8 mA on the 350 Ω setting, and 3 mA on the 1 kΩ setting.
Ohm Meter	NI PXI-4070	If this instrument is unavailable, use a 6 ½ digit DMM with 2-wire resistance measurement capability and resistance accuracy of 80 ppm or better of reading +6 ppm of range for the 100 kΩ range.
8-Channel Universal-Bridge Input Module	NI PXIe-4339	—
Terminal Block Connection Accessory	TB-4339/B/C	—
PXI Express Chassis	NI PXIe-1062Q	—
Accessory Cable	SH96-96-2	The SH96-96-2 is available in 1 meter, 3 meter and 5 meter lengths. Any of these cable lengths can be used.
RJ50 to Pigtail Cable (8)	NI P/N: 195950-02	An RJ50 cable with a cable wire resistance < 0.2 Ω with better than 10% resistance mismatch between individual wires.

Connecting the Calibrator to the RM-4339

Caution Always have the NI PXI Express chassis powered off when inserting a module into the chassis.

Refer to the specific verification procedure section for information describing the required connections.

Note To minimize the number of verification connection changes, the connections for SCA shunt calibration resistance verification and quarter-bridge shunt calibration verification can be made simultaneously.

The RM-4339 provides support for up to three NI PXIe-4339 modules. The 96-pin DIN connectors used to connect the NI PXIe-4339 to the RM-4339 through the SH96-96-2 cable are located on the rear of the RM-4339 and are labeled A, B, and C. To fully verify the RM-4339, each of the verification procedures in this document must be conducted for each position A, B, and C. Refer to the *NI PXIe-4339 and RM-4339 User Guide and Terminal Block Specifications* for information about how to install and use the RM-4339.

Test Conditions

The following setup and environmental conditions are required to ensure the RM-4339 meets published specifications.

- Keep connections to the RM-4339 as short as possible. Long cables and wires act as antennas, picking up extra noise that can affect measurements.
- Verify that all connections are secure.
- Shielded and twisted pair copper wire is recommended for all cable connections to help prevent external noise sources from coupling into the measurements.
- Maintain an ambient temperature of 23 °C ± 5 °C. The offset voltage verification procedure requires less than 1 °C of ambient temperature variation over the duration of the test. Refer to *Offset Voltage Verification* procedure for more details.
- Keep relative humidity below 80%.
- Allow a warm-up time for each of the instruments used in this procedure according to the specific instruments operating instructions.
- Ensure that the PXI Express chassis fan speed is set to HIGH, that the fan filters are clean, and that the empty slots contain filler panels. For more information, refer to the *Maintain Forced-Air Cooling Note to Users* document available at `ni.com/manuals`.

Initial Setup

Refer to the *NI PXIe-4339 and RM-4339 User Guide and Terminal Block Specifications* for information about how to install the software and hardware, and how to configure the device in Measurement & Automation Explorer (MAX).

Note When a device is configured with MAX, it is assigned a device identifier. Each function call uses this identifier to determine which DAQ device to verify, or verify and adjust. In this document, Dev1 was used for inputs that required a device identifier.

Verification

The following performance verification procedures describe the sequence of operation and provides test points required to verify the RM-4339. The verification procedures assume that adequate traceable uncertainties are available for the calibration references.

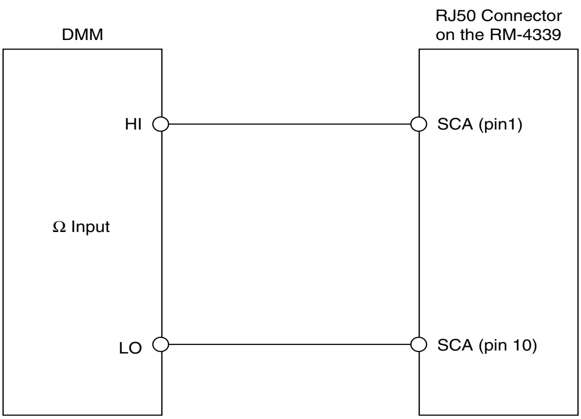
SCA Shunt Calibration Resistance Accuracy Verification

This section provides instructions for verifying the RM-4339 SCA shunt calibration resistance accuracy. Throughout the shunt calibration resistance accuracy verification, use Table 3 to determine if the RM-4339 is operating within its specified range.

Complete the following steps to test the accuracy of the RM-4339 SCA shunt calibration resistances:

1. **Plug an RJ50 cable into the RM-4339s RJ50 connector of the channel you want to verify.** Connect SCA (pin 1) of the RJ50 cable to the DMM HI input and connect SCA (pin 10) of the RJ50 cable to the DMM LO input as shown in Figure 1**.**

Figure 1. RJ50 to DMM Connections



2. Configure the DMM for a 2-wire resistance measurement.

3. Create a task to enable SCA shunt calibration.

   a. Create and configure an AI Bridge (V/V) measurement according to the values found in Table 2.

Table 2. AI Bridge Configuration

Configuration	Value
Channel Name	`Dev1/aix`, where *x* refers to the channel number.
Measurement Type	AI Bridge (V/V)
Voltage Excitation Source	Internal
Voltage Excitation Value	3.3
Maximum Value	0.01
Minimum Value	-0.01
Units	V/V
Bridge Configuration	Full
Sample Mode	Finite Samples
Sample Clock Rate	100
Samples per Channel	100

   b. Enable the SCA shunt calibration circuit using the following parameters:

      Property Node: DAQmx Channel

      AI.Bridge.ShuntCal.Select: A

      AI.Bridge.ShuntCalASrc: Built-In

      AI.Bridge.ShuntCal.ShuntCalAResistance: 100 k

      AI.Bridge.ShuntCal.Enable: True

Note These properties are located at **Analog Input»General Properties»Signal Conditioning»Bridge»Shunt Cal**.

   c. Commit the task by calling DAQmx Control Task with the following parameter:

      Action: Commit

4. Take a resistance measurement from the DMM and record the result.
5. Compare the result from step 4 to the Upper Limit and Lower Limit values in Table 3. If the result is between these values, the module passes the test.
6. Clear the task by calling DAQmx Clear Task.

7. Repeat steps 1 through 6 for each channel you want to verify.
8. Disconnect the DMM from the module.

Table 3. SCA Shunt Calibration Resistance Accuracy Limits

Nominal Value (Ω)	Lower Limit (Ω)	Upper Limit (Ω)
100,000	99,900	100,100

Offset Voltage Verification

The offset voltage verification uses the NI PXIe-4339 to measure the offset voltage of the RM-4339. Prior to measuring the offset voltage of the RM-4339, an offset characterization is performed on the NI PXIe-4339 using a TB-4339/B/C to provide an electrical short on the input of the NI PXIe-4339. The temperature variation of the environment should be kept within 1 °C between measurement of the offset error of the NI PXIe-4339 and the offset measurement of the RM-4339.

Complete the following steps to verify the offset voltage:

1. Make the following connections:
   a. On the TB-4339/B/C, short the AI+ and AI- of all the channels to AIGND.

   Note Refer to the *NI PXIe-4339 and TB-4339/B/C Installation Guide and Terminal Block Specifications* for the pin assignments and signal names.

   b. Connect the female end of the SH96-96-2 cable to the NI PXIe-4339.
   c. Connect the TB-4339/B/C to the male end of the SH96-96-2 cable.

2. Acquire voltage measurements from all channels with the NI PXIe-4339.
    a. Create and configure an AI voltage measurement according to the values found in Table 4.

Table 4. AI Voltage Mode Setup

Configuration	Value
Channel Name	`Dev1/ai0:7`
Measurement Type	AI Voltage
Maximum Value	0.01
Minimum Value	-0.01
Units	Volts
Input Terminal Configuration	Default
Sample Mode	Finite Samples
Sample Clock Rate	100
Samples per Channel	100

    b. Start the task by calling DAQmx Start Task.
    c. Average the readings that you acquired and record the vales as *VoffsetPXIe-4339Chx*, where *x* is the channel number.
    d. Clear the task by calling DAQmx Clear Task.
3. Remove the TB-4339/B/C from the SH96-96-2 cable and connect the SH96-96-2 cable to the 96-pin connector on the back of the RM-4339.
4. Connect an RJ50 cable to each channel with AI+ (pin 2) and AI- (pin 3) connected to T- (pin 9).
5. Acquire voltage measurements from all channels with the NI PXIe-4339.
    a. Create and configure an AI voltage measurement according to the values found in Table 4.
    b. Start the task by calling DAQmx Start Task.
    c. Average the readings that you acquired and subtract *VoffsetPXIe-4339Chx* from the average values for each channel.

d. Compare the values obtained in step c with those in Table 5.

e. Clear the task by calling DAQmx Clear Task.

Table 5. Offset Voltage Accuracy Limits

Range (V)		Test Point (V)	Lower Limit (V)	Upper Limit (V)
Minimum	Maximum			
-0.1	0.1	0	-0.000010	0.000010

Quarter-Bridge Shunt Calibration Accuracy Verification

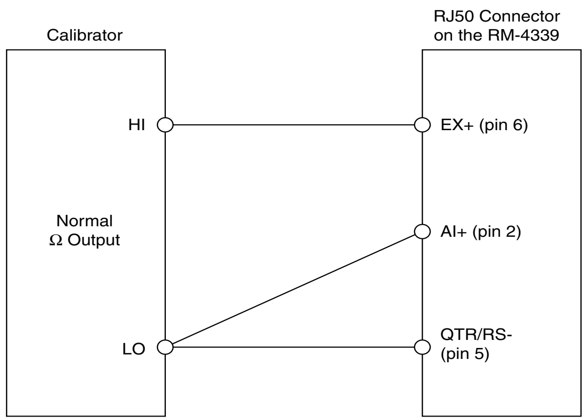
Complete the following procedure to verify the quarter-bridge shunt calibration accuracy of the RM-4339:

1. Set the calibrator to standby mode (STBY).
2. Using an RJ50 cable connect the calibrator to the channel of the RM-4339 you want to verify.

Note Only one channel can be connected to the calibrator at a time.

a. Connect EX+ (pin 6) to Ω HI, connect QTR (pin 5) to Ω LO and connect AI+ (pin 2) to Ω LO as shown in Figure 2.

Figure 2. RJ50 to Calibrator Connections



b. QTR and AI+ must be connected together at the calibrator. The EX+ lead wire and the QTR lead wire must be the same length.

3. Set the calibrator output to 120 Ω, 350 Ω, or 1000 Ω depending on the quarter-bridge configuration you want to verify. This must match the configuration setting made in step 6 a.
4. Set the calibrator output for compensation off (COMP off).
5. Set the calibrator to operate mode (OPR) to enable the output.

6. Acquire an AI Bridge (V/V) measurement with shunt calibration disabled.
   a. Create and configure an AI Bridge (V/V) channel according to the values found in Table 6.

Table 6. AI Bridge (V/V) Mode Setup

Configuration	Value
Channel Name	`Dev1/aix`, where *x* refers to the channel number
Measurement Type	AI Bridge (V/V)
Bridge Configuration	Quarter
Nominal Bridge Resistance	120 Ω, 350 Ω, 1000 Ω*
Voltage Excitation Source	Internal
Voltage Excitation Value	3.3 V for 120 Ω configuration, 5 V for 350 Ω and 1 kΩ configurations
Maximum Value	0.01
Minimum Value	-0.01
Units	V/V
Sample Mode	Finite Samples
Sample Clock Rate	100
Samples per Channel	100

* Use the bridge resistance value that corresponds to the configuration being verified.

   b. Disable the SCB shunt calibration circuit using the following parameters:

      Property Node: DAQmx Channel

      AI.Bridge.ShuntCal.Enable: False

   c. Commit the task by calling DAQmx Control Task with the following parameter:

      Action: Commit

   d. Wait 5 seconds to allow the circuitry to stabilize. If the calibrator requires more than a 5 second wait time, use the wait time required by the calibrator.
   e. Start the task by calling DAQmx Start Task.
   f. Average the readings that you acquired and record the values as $Result_{SCD}$.
   g. Clear the task by calling DAQmx Clear Task.
7. Acquire an AI Bridge (V/V) measurement with shunt calibration enabled.
   a. Create a task.
   b. Create and configure an AI Bridge (V/V) channel according to the values found in Table 6.

c. Enable the SCB shunt calibration circuit using the following parameters:

   Property Node: DAQmx Channel

   AI.Bridge.ShuntCal.Select: B

   AI.Bridge.ShuntCal.ShuntCalBResistance: 50k for 120 Ω, 100k for 350 Ω and 1 kΩ

   AI.Bridge.ShuntCal.Enable: True

d. Start the task by calling DAQmx Start Task.

e. Average the readings that you acquired and record the values as $Result_{SCE}$.

f. Clear the task by calling DAQmx Clear Task.

8. Calculate the shunt calibration scaling factor as follows:

$$SCalScaleFactor = SCalExp/(Result_{SCE} - Result_{SCD})$$

where

SCalExp is the expected shunt calibration deflection, given in the following, for each of the supported quarter-bridge completion values.

SCalExp = -0.00059928 for 120 Ω

SCalExp = -0.00087347 for 350 Ω

SCalExp = -0.00248756 for 1 kΩ

For reference, the calculation for the expected shunt calibration deflection is given by the following equation:

$$SCalExp = \frac{R_{eq}}{R_{eq} + R_{qtr}} - 0.5$$

where

R_{eq} is the equivalent parallel resistance of the quarter-bridge and shunt calibration resistors.

R_{qtr} is the resistance of the quarter-bridge completion resistor.

9. Set the calibrator output to the value of the Calibrator Output indicated in Table 7 for the quarter-bridge configuration that is being verified.

10. Acquire an AI Bridge (V/V) measurement.

    a. Create a task.

    b. Create and configure an AI Bridge (V/V) channel according to the values found in Table 6.

    c. Disable the SCB shunt calibration circuit using the following parameters:

       Property Node: DAQmx Channel

       AI.Bridge.ShuntCal.Enable: False

    d. Start the task by calling DAQmx Start Task.

    e. Average the readings that you acquired, subtract $Result_{SCD}$ from the averaged result, and record the values as $Unscaled_{OffsetComp}$.

f. Multiply $Unscaled_{OffsetComp}$ by *SCalScaleFactor* that was calculated in step 8 and record the value as $Scaled_{OffsetComp}$.

g. Compare $Scaled_{OffsetComp}$ to the Upper and Lower Limits from Table 7 for the quarter-bridge configuration that is being verified. If the results are within the Upper and Lower Limits the device passes the verification test.

h. Clear the task by calling DAQmx Clear Task.

11. Repeat steps 3 through 10 for each quarter-bridge configuration.
12. Repeat steps 1 through 11 for each channel.
13. Set the calibrator to standby mode (STBY).
14. Disconnect the calibrator from the device.

Table 7. Quarter-Bridge Shunt Calibration Accuracy Limits

Quarter-Bridge Completion (Ω)	Calibrator Output (Ω)	Nominal Value (V/V)	Lower Limit (V/V)	Upper Limit (V/V)
120	116.0	0.0084746	0.0084449	0.0085042
350	338.4	0.0084253	0.0084043	0.0084464
1000	966.8	0.0084401	0.0084190	0.0084612

Note Test limits in this document are based upon the March 2015 edition of the *NI PXIe-4339 and RM-4339 User Guide and Terminal Block Specifications*. Refer to the most recent *NI PXIe-4339 and RM-4339 User Guide and Terminal Block Specifications* online at `ni.com/manuals`.

If the device is not operating within the specified values, refer to the *World Wide Support and Services* section for assistance in returning the device to NI.

Specifications

Refer to the *NI PXIe-4339 and RM-4339 User Guide and Terminal Block Specifications* for detailed specification information.

World Wide Support and Services

The National Instruments website is your complete resource for technical support. At ni.com/support you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

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