

CALIBRATION PROCEDURE

NI 9229/9239

4-Channel, ± 60 V/ ± 10 V, 24-Bit Simultaneous, Channel-to-Channel Isolated Analog Input Modules

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This document contains the verification and adjustment procedures for the National Instruments 9229/9239. For more information about calibration solutions, visit ni.com/calibration.

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Software

Calibrating the NI 9229/9239 requires the installation of NI-DAQmx 9.5 or later on the calibration system. You can download NI-DAQmx from ni.com/downloads. NI-DAQmx supports LabVIEW, LabWindows™/CVI™, ANSI C, Microsoft Visual C++, Microsoft Visual Basic .NET, and Microsoft Visual C#. When you install NI-DAQmx you only need to install support for the application software that you intend to use.

Documentation

Consult the following documents for information about the NI 9229/9239, NI-DAQmx, and your application software. All documents are available on ni.com and help files install with the software.



NI cDAQ-9174/9178 USB Chassis Quick Start

NI-DAQmx installation and hardware setup



NI 9229/9239 Operating Instructions and Specifications

NI 9229/9239 specific information, specifications, and calibration interval



NI-DAQmx README

Operating system and application software support in NI-DAQmx



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 and adjustment 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	Parameter Measured	Requirements
Calibrator	Fluke 5700A	Accuracy, Adjustment	Use a high-precision voltage source with an accuracy ≤ 100 ppm and an output impedance $\leq 50 \Omega$.
Function Generator	NI 4461	Gain Matching, Phase Matching	Use a function generator capable of sourcing both 1 kHz and 20 kHz $\pm 10 V_{pk}$ AC sinusoidal signals with amplitude uncertainty of $\pm 10\%$.
Chassis	NI cDAQ-9178	All	—

Test Conditions

The following setup and environmental conditions are required to ensure the NI 9229/9239 meets published specifications.

- Keep connections to the device as short as possible. Long cables and wires act as antennas, picking up extra noise that can affect measurements.
- Verify that all connections to the NI 9229/9239 are secure.
- **(NI 9229/9239 with screw-terminal)** Use shielded copper wire for all cable connections to the device.
- Use twisted-pairs wire to eliminate noise and thermal offsets.
- Maintain an ambient temperature of $23 \text{ }^\circ\text{C} \pm 5 \text{ }^\circ\text{C}$.
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 10 minutes to ensure that the NI 9229/9239 measurement circuitry is at a stable operating temperature.

Initial Setup

Complete the following steps to set up the NI 9229/9239.

1. Install the NI-DAQmx driver software.
2. Make sure the NI cDAQ-9178 power source is not connected.

3. Connect the NI cDAQ-9178 to the system safety ground.
 - a. Attach a ring lug to a 14 AWG (1.6 mm) wire.
 - b. Connect the ring lug to the ground terminal on the side of the NI cDAQ-9178 using the ground screw.
 - c. Attach the other end of the wire to the system safety ground.
4. Install the NI 9229/9239 in slot 8 of the NI cDAQ-9178 chassis. Leave slots 1 through 7 of the NI cDAQ-9178 chassis empty.
5. Connect the NI cDAQ-9178 chassis to your host computer.
6. Connect the power source to the NI cDAQ-9178 chassis.
7. Launch Measurements & Automation Explorer (MAX).
8. Right-click the device name and select **Self-Test** to ensure that the device is working properly.

Verification

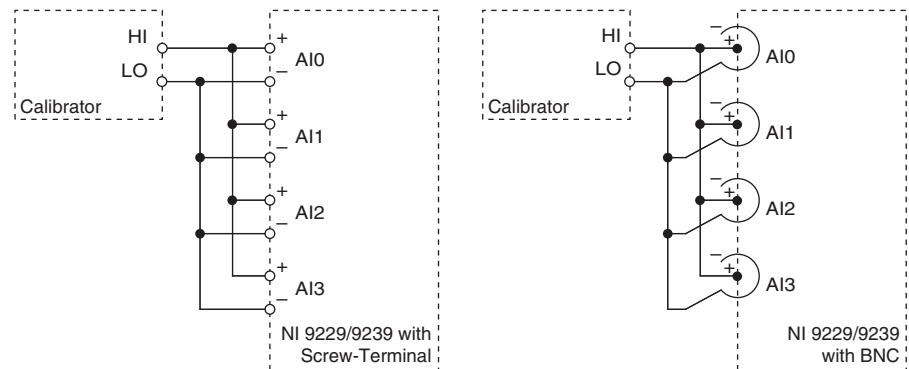
The following performance verification procedures describe the sequence of operation and provide test points required to verify the NI 9229/9239. The verification procedures assume that adequate traceable uncertainties are available for the calibration references.

Accuracy Verification

Complete the following procedure to determine the As-Found status of the NI 9229/9239.

1. Set the calibrator to Standby mode (STBY).
2. Connect the NI 9229/9239 to the calibrator as shown in Figure 1.

Figure 1. Accuracy Verification Connections



3. Set the calibrator voltage to a Test Point value indicated in Tables 4 or 5.
4. Set the calibrator to Operate mode (OPR).

5. Acquire and average samples.
 - a. Create and configure an AI voltage task on the NI 9229/9239 according to Table 2.

Table 2. NI 9229/9239 Configuration for Accuracy Verification

Module	Physical Channels	Min (V)	Max (V)	Scaled Units	Terminal Configuration
9229	AI0:3	-60	60	Volts	Differential
9239	AI0:3	-10	10	Volts	Differential

- b. Configure the AI voltage task timing according to Table 3.

Table 3. NI 9229/9239 Timing Configuration

Sample Mode	Samples Per Channel	Rate
Finite Samples	2000	8330

- c. Start the task.
 - d. Read samples from the NI 9229/9239.
 - e. Average the samples per channel.
 - f. Clear the task.
6. Compare the per channel average to the limits in Table 4 or Table 5.

Table 4. NI 9229 Verification Test Limits for Accuracy

Range		Test Point		1-Year Limits	
Min (V)	Max (V)	Location	Value (V)	Lower Limit (V)	Upper Limit (V)
-60	60	Max	57.00000	56.9695	57.0304
		Mid	0.00	-0.00766	0.00766
		Min	-57.00000	-57.0304	-56.9695

Table 5. NI 9239 Verification Test Limits for Accuracy

Range		Test Point		1-Year Limits	
Min (V)	Max (V)	Location	Value (V)	Lower Limit (V)	Upper Limit (V)
-10	10	Max	9.50000	9.4948	9.50515
		Mid	0.00	-0.00135	0.00135
		Min	-9.50000	-9.50515	-9.4948



Note The test limits listed in Table 4 and 5 are derived using the values in Table 14.

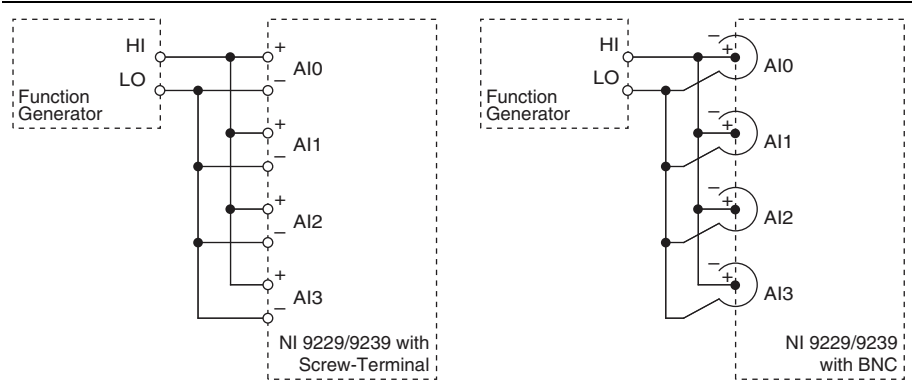
7. Set the calibrator to Standby mode (STBY).
8. Repeat steps 3 through 7 for each test point in Table 4.
9. Disconnect the calibrator from the device.

Gain Matching Verification

Complete the following procedure to determine the As-Found status of the NI 9229/9239.

1. Connect the NI 9229/9239 to the function generator as shown in Figure 2.

Figure 2. Gain Matching Verification Connections



2. Configure function generator according to Table 6.

Table 6. Function Generator Configuration for Gain Matching Verification

Signal Type	Amplitude (V_{pk})	Frequency (kHz)
Sinewave	9	20

3. Acquire and average samples.
 - a. Create and configure an AI voltage task on the NI 9229/9239 according to Table 7.

Table 7. NI 9229/9239 Configuration for Gain Matching Verification

Module	Physical Channels	Min (V)	Max (V)	Scaled Units	Terminal Configuration
9229	AI0:3	-60	60	Volts	Differential
9239	AI0:3	-10	10	Volts	Differential

- b. Configure the AI voltage task timing according to Table 3.

Table 8. NI 9229/9239 Timing Configuration

Sample Mode	Samples Per Channel	Rate
Finite Samples	25000	50000

- c. Enable the function generator.
 - d. Start the task and wait for it to complete.
 - e. Calculate the amplitude for each reading and record the result as $Amplitude_{Acq}$.
 - f. Disable the function generator.
 - g. Clear the task.
4. Perform the following calculation using the $Amplitude_{Acq}$ value.

$$Amplitude(dB) = \left(20 \times \log_{10} \left(\frac{Amplitude_{Acq}}{9V} \right) \right)$$

- 5. Repeat step 4 for each channel.
- 6. Compare the channel-to-channel gain difference to the maximum limit of ± 0.22 dB.

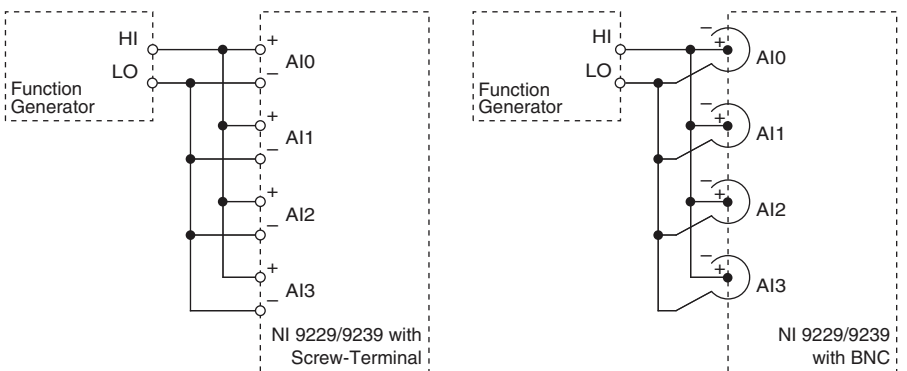
If the Gain Matching verification procedure determines that the NI 9229/9239 is outside of the limits, refer to [Worldwide Support and Services](#) for assistance in returning the device to NI.

Phase Matching Verification

Complete the following procedure to determine the As-Found status of the NI 9229/9239.

- 1. Connect the NI 9229/9239 to the function generator as shown in Figure 3.

Figure 3. Phase Matching Verification Connections



2. Configure function generator according to Table 9.

Table 9. Function Generator Configuration for Phase Matching Verification

Signal Type	Amplitude (V_{pk})
Sinewave	9

3. Set the function generator frequency to a value indicated in Table 12.
4. Acquire and average samples.
 - a. Create and configure an AI voltage task on the NI 9229/9239 according to Table 10.

Table 10. NI 9229/9239 Configuration for Phase Matching Verification

Module	Physical Channels	Min (V)	Max (V)	Scaled Units	Terminal Configuration
9229	AI0:3	-60	60	Volts	Differential
9239	AI0:3	-10	10	Volts	Differential

- b. Configure the AI voltage task timing according to Table 3.

Table 11. NI 9229/9239 Timing Configuration

Sample Mode	Samples Per Channel	Rate
Finite Samples	25000	50000

- c. Enable the function generator.
 - d. Start the task.
 - e. Read samples.
 - f. Disable the function generator.
 - g. Clear the task.
5. Calculate the phase for each channel on the NI 9229/9239. NI recommends using the Extract Single Tone Information VI to calculate phase.

6. Compare the channel-to-channel phase difference to the limits in Table 12.
7. Repeat steps 2 through 6 for each test point in Table 12.

Table 12. NI 9229/9239 Verification Test Limits for Phase Matching

Module	Generator Frequency (kHz)	Phase Matching Channel-to-Channel Limit
NI 9229	1	$\pm 0.045^\circ$
	20	$\pm 0.900^\circ$
NI 9239	1	$\pm 0.075^\circ$
	20	$\pm 1.500^\circ$

If the Phase Matching verification procedure determines that the NI 9229/9239 is outside of the limits, refer to [Worldwide Support and Services](#) for assistance in returning the device to NI.

Adjustment

The following performance adjustment procedure describes the sequence of operation required to adjust the NI 9229/9239.

Accuracy Adjustment

Complete the following procedure to adjust the accuracy performance of the NI 9229/9239.

1. Set the calibrator to Standby mode (STBY).
2. Connect the NI 9229/9239 to the calibrator as shown in Figure 1.



Note If the calibrator outputs are truly floating, the negative output must be connected to a quiet earth ground as well as AI- to give the entire system a ground reference.

3. Adjust the NI 9229/9239.
 - a. Initialize a calibration session on the NI 9229/9239. The default password is NI.
 - b. Input the external temperature in degrees Celsius.
 - c. Call the NI 9229/9239 get C Series adjustment points function to obtain an array of recommended calibration voltages for the NI 9229/9239.
 - d. Set the calibrator to a reference value determined by the array of recommended calibration voltages.
 - e. Set the calibrator to Operate mode (OPR).
 - f. Call and configure the NI 9229/9239 adjustment function according to Table 13.

Table 13. Adjustment Configuration

Physical Channel	Reference Value
cDAQMod8/air	The reference value from the array of adjustment points

- g. Set the calibrator to Standby mode (STBY).
 - h. Repeat steps d through g for each calibration voltage in the array.
 - i. Close the calibration session.
4. Disconnect the NI 9229/9239 from the calibrator.

EEPROM Update

When an adjustment procedure is completed, the NI 9229/9239 internal calibration memory (EEPROM) is immediately updated.

If you do not want to perform an adjustment, you can update the calibration date and onboard calibration temperature without making any adjustments by initializing an external calibration, setting the C Series calibration temperature, and closing the external calibration.

Reverification

Repeat the [Verification](#) section to determine the As-Left status of the device.



Note If any test fails Reverification after performing an adjustment, verify that you have met the [Test Conditions](#) before returning your device to NI. Refer to [Worldwide Support and Services](#) for assistance in returning the device to NI.

Accuracy Under Calibration Conditions

The following calibration specifications are valid under the following conditions:

- Ambient temperature 23 ± 5 °C
- NI 9229/9239 installed in slot 8 of an NI cDAQ-9178 chassis
- Slots 1 through 7 of the NI cDAQ-9178 chassis are empty



Note The test limits listed in Table 4 are derived using the values in Table 14.

Table 14. NI 9229/9239 Accuracy Under Calibration Conditions

Module	Gain Error	Offset Error
NI 9229	$\pm 0.04\%$	± 7.66 mV
NI 9239	$\pm 0.04\%$	± 1.35 mV



Note For operational specifications, refer to the most recent *NI 9229/9239 Operating Instructions and Specifications* online at ni.com/manuals.

Worldwide Support and Services

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