CALIBRATION PROCEDURE
NI 9209

16-Channel Differential/32-Channel Single-Ended, ±10 V, 24-Bit
Analog Input Module

This document contains the verification and adjustment procedures for the NI 9209. For more information about calibration solutions, visit `ni.com/calibration`.

Contents

Software

Calibrating the NI 9209 requires the installation of NI-DAQmx 15.1 or later on the calibration system. You can download NI-DAQmx from `ni.com/downloads`. NI-DAQmx supports 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.

Documentation

Consult the following documents for information about the NI 9209, 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 9209 Getting Started Guide

NI 9209 specific information.

NI 9209 Datasheet

NI 9209 specifications and calibration interval.

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 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	Minimum Requirements
Source	Fluke 5500A	Use a source with gain error ≤260 ppm and an offset error ≤70 uV.
cDAQ Chassis	NI cDAQ-9178	—
Connection Accessory	NI 9923	—

Test Conditions

The following setup and environmental conditions are required to ensure the NI 9209 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 device are secure.
- 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 ± 5 °C. The device temperature will be greater than the ambient temperature.
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 10 minutes to ensure that the NI 9209 measurement circuitry is at a stable operating temperature.

Initial Setup

Complete the following steps to set up the NI 9209.

1. Install NI-DAQmx.
2. Make sure the NI cDAQ-9178 power source is not connected.
3. Install the module in slot 8 of the NI cDAQ-9178 chassis. Leave slots 1 through 7 of the NI cDAQ-9178 chassis empty.
4. Connect the NI cDAQ-9178 chassis to your host computer.
5. Connect the power source to the NI cDAQ-9178 chassis.

6. Launch Measurement & Automation Explorer (MAX).

7. Right-click the device name and select **Self-Test** to ensure that the module is working properly.

Verification

The following performance verification procedures describe the sequence of operation and test points required to verify the NI 9209 and assumes that adequate traceable uncertainties are available for the calibration references.

Differential Voltage Accuracy Verification

Complete the following procedure to determine the As-Found status of the NI 9209.

1. Set the calibrator to Standby mode (STBY).

2. Connect the NI 9209 to the calibrator as shown in Figure 1.

Figure 1. Differential Voltage Accuracy Connections
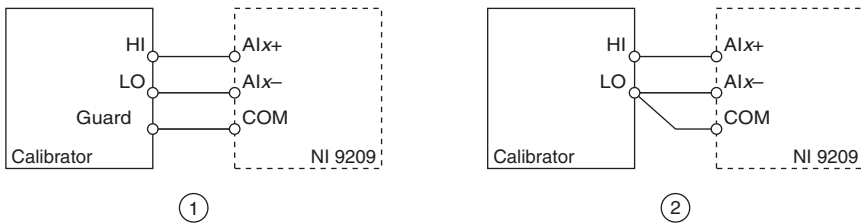
1 Connections when using a calibrator with a guard connection.
2 Connections when using a calibrator with no guard connection.

> **Note** If the calibrator outputs are truly floating, connect the negative output to a quiet earth ground as well as COM to give the entire system a ground reference.

3. Set the calibrator voltage to a Test Point value indicated in Table 4.

4. Set the calibrator to Operate mode (OPR).

5. Acquire and average samples.

   a. Create and configure an AI voltage task on the NI 9209 according to Table 2.

Table 2. NI 9209 Configuration for Voltage Accuracy Verification

Input Range		Scaled Units	Terminal Configuration
Min	**Max**		
-10	10	Volts	Differential

b. Configure the AI voltage task according to Table 3. Set the ADC timing mode to high-resolution.

Table 3. NI 9209 Voltage Timing Configuration

ADC Timing Mode	Sample Mode	Samples to Read	Sample Rate
High-Resolution	N Samples	5	19 S/s
High-Speed	N Samples	75	500 S/s

c. Start the task.

d. Average the readings.

e. Stop and clear the task.

6. Compare the average to the limits in Table 4.

Table 4. NI 9209 Verification Test Limits for Differential Voltage Accuracy

Range (V)		Test Point		2-Year Limits	
Minimum	Maximum	Location	Value (V)	Lower Limit (V)	Upper Limit (V)
-10.00000	10.00000	Pos FS	10.00000	9.98972	10.01028
-10.00000	10.00000	Mid	0.00000	-0.00058	0.00058
-10.00000	10.00000	Neg FS	-10.00000	-10.01028	-9.98972

Note The test limits listed in Table 4 are derived using the values in Table 8.

**Note** The uncertainty of the calibration standard is not included in these limits.

7. Repeat step 5 and 6 with the ADC timing mode on the NI 9209 set to high-speed.

8. Set the calibrator to Standby mode (STBY).

9. Repeat steps 3 through 8 for each test point listed in Table 4.

10. Disconnect the calibrator from the device.

11. Repeat steps 1 through 10 for each voltage channel on the NI 9209.

Single-Ended Voltage Accuracy Verification

Complete the following procedure to determine the As-Found status of the NI 9209.

1. Set the calibrator to Standby mode (STBY).
2. Connect the NI 9209 to the calibrator as shown in Figure 2.

Figure 2. Single-Ended Voltage Accuracy Connections
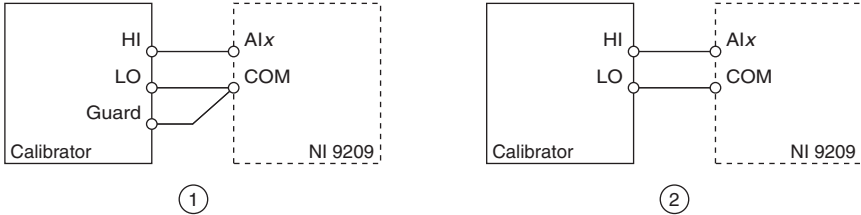
1	Connections when using a calibrator with a guard connection.
2	Connections when using a calibrator with no guard connection.

> **Note** If the calibrator outputs are truly floating, connect the negative output to a quiet earth ground as well as COM to give the entire system a ground reference.

3. Set the calibrator voltage to a Test Point value indicated in Table 6.
4. Set the calibrator to Operate mode (OPR).
5. Acquire and average samples.
   a. Create and configure an AI voltage task on the NI 9209 according to Table 5.

Table 5. NI 9209 Configuration for Voltage Accuracy Verification

Input Range		Scaled Units	Terminal Configuration
Min	**Max**		
-10	10	Volts	Single-Ended/RSE

   b. Configure the AI voltage task according to Table 3 on page 5. Set the ADC timing mode to high-resolution.
   c. Start the task.
   d. Average the readings.
   e. Clear the task.

6. Compare the average to the limits in Table 6.

Table 6. NI 9209 Verification Test Limits for Single-Ended Voltage Accuracy

Range (V)		Test Point		2-Year Limits	
Minimum	Maximum	Location	Value (V)	Lower Limit (V)	Upper Limit (V)
-10.00000	10.00000	Pos FS	10.00000	9.99014	10.00986
-10.00000	10.00000	Mid	0.00000	-0.00056	0.00056
-10.00000	10.00000	Neg FS	-10.00000	-10.00986	-9.99014

📝 **Note** The test limits listed in Table 6 are derived using the values in Table 8.

📝 **Note** The uncertainty of the calibration standard is not included in these limits.

7. Repeat step 5 and 6 with the ADC timing mode on the NI 9209 set to high-speed.
8. Set the calibrator to Standby mode (STBY).
9. Repeat steps 3 through 8 for each test point listed in Table 6.
10. Disconnect the calibrator from the device.
11. Repeat steps 1 through 10 for each voltage channel on the NI 9209.

Adjustments

The following performance adjustment procedures describe the sequence of operation required to adjust the NI 9209.

Voltage Accuracy Adjustment

Complete the following procedure to adjust the voltage accuracy performance of the NI 9209.

1. Set the calibrator to Standby mode (STBY).
2. Connect the NI 9209 to the calibrator as shown in Figure 1.
3. Adjust the NI 9209 voltage accuracy.
    a. Initialize a calibration session on the NI 9209. The default password is NI.
    b. Input the external temperature in degrees Celsius.
    c. Call the DAQmx Get 9209 Calibration Adjustment Points function to obtain an array of recommended calibration voltages for the NI 9209.
    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 9209 gain instance of the adjustment function according to Table 7 with the input terminal configuration set to Differential.

Table 7. Gain Adjustment Configuration

Physical Channel	Reference Value
cDAQMod8/ai*x*	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. Repeat steps d through h for each channel.

j. Repeat steps d through i with the input terminal configuration set to Single-Ended/RSE as shown in Figure 2.

k. Disconnect the calibrator from the NI 9209.

l. Short the voltage channels to the NI 9209 AIGND.

m. Call the DAQmx Adjust 9209 Offset Calibration for the physical channel(s) adjusted in the RSE and Differential sections. For example, if you adjusted all the channels, then the physical channels should be cDAQ1Mod8/ai0:31.

> **Note** If adjusting the channel(s) in differential and single-ended mode, the physical channel(s) should be a union of the channels specified in both configurations.

n. Close and commit the calibration session.

4. Remove the connections from the NI 9209.

EEPROM Update

When an adjustment procedure is completed, the NI 9209 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 values in the following table are based on calibrated scaling coefficents, which are stored in the onboard EEPROM.

The following accuracy table is valid for calibration under the following conditions:

- Ambient temperature 23 °C ± 5 °C
- NI 9209 installed in slot 8 of an NI cDAQ-9178 chassis
- Slots 1 through 7 of the NI cDAQ-9178 chassis are empty

Table 8. NI 9209 Accuracy Under Calibration Conditions

Input Channels	Percentage of Reading	Percentage of Range[*]
Differential	0.097%	0.0055%
Single-Ended	0.093%	0.0053%
[*] Range equals 10.4 V for voltage.		

Note For operational specifications, refer to the most recent *NI 9209 Datasheet* online at `ni.com/manuals`.

Worldwide 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.

Visit `ni.com/services` for NI Factory Installation Services, repairs, extended warranty, and other services.

Visit `ni.com/register` to register your National Instruments product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world. For telephone support in the United States, create your service request at `ni.com/support` or dial 1 866 ASK MYNI (275 6964). For telephone support outside the United States, visit the Worldwide Offices section of `ni.com/niglobal` to access the branch office websites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.