CALIBRATION PROCEDURE

NI 9231

8 AI, ±5 V, 24 Bit, 51.2 kS/s/ch Simultaneous, AC/DC Coupling, IEPE AC Coupling

This document contains the verification and adjustment procedures for NI 9231. For more information about calibration solutions, visit *ni.com/calibration*.

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Software

Calibrating the NI 9231 requires the installation of NI-DAQmx 18.1 or later on the calibration system.

You can download NI-DAQmx from *ni.com/downloads*. NI-DAQmx supports LabVIEW, LabWindows™/CVI™, ANSI C, and .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 9231, NI-DAQmx, and your application software. All documents are available on *ni.com* and help files install with the software.

NATIONAL INSTRUMENTS

NI cDAQ-9174/9178 USB Chassis Quick Start

NI-DAQmx installation and hardware setup

NI 9231 Getting Started Guide

NI 9231 connection information

NI 9231 Datasheet

NI 9231 circuitry and specifications

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

The following table 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.

Table 1. Recommended Equipment

Equipment	Recommended Model	Requirements
Calibrator	Fluke 5502A, Fluke 5522A, Fluke 5730A	Use a high-precision voltage source with gain error of <100 ppm and offset error <0.1 mV.
BNC (F) to Banana Adapter	Pomona Electronics 1270	—

Table 1. Recommended Equipment (Continued)

Equipment	Recommended Model	Requirements
10-32 (M) to BNC (F) Coupler	769416-01	Characteristic impedance: 50 Ω
Chassis	NI cDAQ-9178	—

Test Conditions

The following setup and environmental conditions are required to ensure the device 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.
- Maintain an ambient temperature of 23 °C ± 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 device measurement circuitry is at a stable operating temperature.

Initial Setup

Complete the following steps to set up the NI 9231.

1. Install NI-DAQmx.
2. Make sure that the NI cDAQ-9178 power source is not connected to the chassis.
3. Connect the NI cDAQ-9178 chassis 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 module 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 Measurement & Automation Explorer (MAX).
8. Right-click the device name and select **Self-Test** to ensure that the module is working properly.

Verification

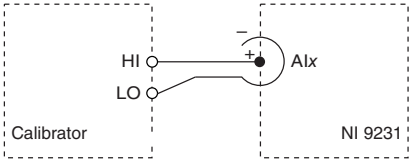
The following performance verification procedure describes the sequence of operation and provides test points required to verify the NI 9231. The verification procedure assumes that adequate traceable uncertainties are available for the calibration references.

Accuracy Verification

Complete the following procedure to determine the As-Found status of the NI 9231.

1. Set the calibrator to Standby mode (STBY).
2. Connect channel 0 of the NI 9231 to the calibrator as shown in the following figure.

Figure 1. Analog Input Verification Connections



Note The chassis ground lug connection to ground is the NI 9231 ground connection.

3. Set the calibrator voltage to a Test Point value indicated in the *NI 9231 Verification Test Limits* table.
4. Set the calibrator to Operate mode (OPR).
5. Acquire and average samples for each channel.
   a) Create and configure an AI voltage task according to the following *NI 9231 AI Voltage Task Configuration* table.

Table 2. NI 9231 AI Voltage Task Configuration

Minimum (V)	Maximum (V)	Scaled Units	Physical Channels	Channel Configuration
-5	5	Volts	AI*x*	DC Coupled

   b) Configure the task timing according to the following *NI 9231 Timing Configuration* table.

Table 3. NI 9231 Timing Configuration

Sample Mode	Samples Per Channel	Rate (kS/s)
Finite Samples	5120	51.2

   c) Start the task.
   d) Read the samples from the NI 9231.
   e) Average the samples for each AI channel.
   f) Clear the task.

6. Compare the averaged samples to the limits in the *NI 9231 Verification Test Limits* table to verify the input accuracy. If the value is within these limits, the device passes the test.
7. Repeat steps 3 through 7 for each test point in the *NI 9231 Verification Test Limits* table.
8. Set the calibrator to Standby mode (STBY).
9. Repeat steps 1 through 8 for each channel on the NI 9231.

Table 4. NI 9231 Verification Test Limits

Test Point		2-Year Limits	
Location	**Value (V)**	**Lower Limit (VDC)**	**Upper Limit (VDC)**
Minimum	-4.9	-4.907121	-4.892879
Mid-scale	0	-0.001565	0.001565
Maximum	4.9	4.892879	4.907121

Note The test limits listed in the *NI 9231 Verification Test Limits* table are derived using values from the *NI 9231 Accuracy Under Calibration Conditions* table.

Adjustment

The following performance adjustment procedure describes the sequence of operation required to adjust the NI 9231.

Accuracy Adjustment

Complete the following procedure to adjust the accuracy performance of the NI 9231.

1. Set the calibrator to Standby mode (STBY).
2. Connect channel 0 of the NI 9231 to the calibrator as shown in the *Accuracy Verification* section.
3. Adjust the NI 9231.
   a) Initialize a calibration session on the NI 9231. The default password is `NI`.
   b) Input the external temperature in degrees Celsius.
   c) Call the NI 9231 get C Series adjustment points function to obtain an array of recommended calibration voltages for the NI 9231.
   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 9231 adjustment function according to *NI 9231 Adjustment Configuration* table.

Table 5. NI 9231 Adjustment Configuration

Physical Channel	Reference Value
cDAQ1Mod8/AI*x*	The actual value of the voltage output of the calibrator

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

h) Repeat steps d through g for each point in the array.

i) Close the calibration session.

4. Disconnect the NI 9231 from the calibrator.
5. Repeat steps 1 through 4 for each channel on the NI 9231.

EEPROM Update

When an adjustment procedure is completed, the NI 9231 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 the *Worldwide Support and Services* section for assistance in returning the device to NI.

Accuracy under Calibration Conditions

The values in the following table are based on calibrated scaling coefficients, 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 9231 installed in slot 8 of an NI cDAQ-9178 chassis
- Slots 1 through 7 of the NI cDAQ-9178 chassis are empty

Table 6. NI 9231 Accuracy under Calibration Conditions

Device	Percent of Reading (Gain Error)	Percentage of Range (Offset Error)[1]
NI 9231	±0.1134%	±0.0313%

Note For operational specifications, refer to the most recent *NI 9231 Datasheet* online at *ni.com/manuals*.

Worldwide Support and Services

The NI 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 information about the services NI offers.

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

NI corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. NI also has offices located around the world. For support in the United States, create your service request at *ni.com/support* or dial 1 866 ASK MYNI (275 6964). For 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.

[1] Range equals 5 V.

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