CALIBRATION PROCEDURE
NI 9216/9226

8-Channel, 400 S/s Aggregate, 0 Ω to 400 Ω/4000 Ω,
PT100 RTD/PT1000 RTD C Series Temperature Input Module

This document contains the verification and adjustment procedures for the NI 9216 and NI 9226. In this document, the NI 9216 and NI 9226 are inclusively referred to as NI 9216/9226. For more information about calibration solutions, visit `ni.com/calibration`.

Contents

Software

Calibrating the NI 9216/9226 requires the installation of NI-DAQmx 14.5 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.

NATIONAL INSTRUMENTS™

Documentation

Consult the following documents for information about the NI 9216/9226, NI-DAQmx, and your application software. All documents are available on ni.com and help files install with the software.

NI cDAQ-9174/9178 Quick Start Guide

NI-DAQmx installation and hardware setup

NI 9216 Getting Started Guide

NI 9216 connection information

NI 9216 Datasheet

NI 9216 circuitry and specifications

NI 9226 Getting Started Guide

NI 9226 connection information

NI 9226 Datasheet

NI 9226 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

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 Models	Requirements
Calibrator	Fluke 5522A	Use a high-precision resistance source with gain accuracy ≤40 ppm and offset error ≤2 mΩ for the NI 9216 and offset error ≤20 mΩ for the NI 9226.
Chassis	cDAQ-9178	—

Test Conditions

The following setup and environmental conditions are required to ensure the NI 9216/9226 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 20 °C to 28 °C.
*   Keep relative humidity below 80%.
*   Allow a warm-up time of at least 10 minutes to ensure that the NI 9216/9226 measurement circuitry is at a stable operating temperature.

Initial Setup

Complete the following steps to set up the NI 9216/9226.

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

6. Connect the power source to the 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.
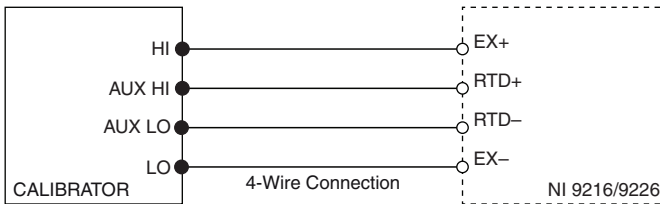
Verification

The following performance verification procedure describes the sequence of operation and test points required to verify the NI 9216/9226. 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 9216/9226.

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

2. Connect the desired channel of the NI 9216/9226 to the calibrator as shown in Figure 1. Connect only one channel at a time.

Figure 1. 4-Wire Resistance Connections

3. Set the calibrator as a resistance source to a Test Point value indicated in Table 2.

4. Set calibrator COMP to 4-wire.

Table 2. NI 9216/9226 Accuracy Verification Test Limits

Module	Range Minimum (Ω)	Range Maximum (Ω)	Test Point Value (Ω)	1-Year Limits Upper Limit (Ω)	1-Year Limits Lower Limit (Ω)
NI 9216	0	400	0	0.03	-0.03
			100	100.042	99.958
			320	320.0684	319.9316
NI 9226	0	4000	0	0.3	-0.3
			1000	1000.43	999.57
			3200	3200.72	3199.28

Note The limits are only based on the NI 9216/9226 accuracy. The uncertainty of calibration standard is not included.

Note The test limits listed in Table 2 are derived using the values in Table 6.

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

6. Acquire and average samples from one channel.

   a. Create and configure a 4-wire AI resistance task on the NI 9216/9226 according to Table 3.

   b. Configure the ADC Timing Mode to High Resolution.

Table 3. NI 9216/9226 Voltage Configuration

Module	Physical Channel	Range	
		Minimum (Ω)	Maximum (Ω)
NI 9216	AIx	0	400
NI 9226	AIx	0	4000

Note Use appropriate channel number in place of "x" in "AIx." For example, use AI3 for channel 3.

   c. Configure the task timing according to Table 4.

Table 4. NI 9216/9226 Task Timing Configuration

Sample Mode	Samples Per Channel	Rate (S/s)
Finite Samples	10	5

   d. Start the task.

   e. Read the samples from the NI 9216/9226.

   f. Average the samples.

   g. Stop and clear the task.

7. Compare the per-channel averages to the limits in Table 2.

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

9. Repeat steps 3 through 8 for each test point listed in Table 2.

10. Disconnect the NI 9216/9226 channel from the calibrator.

11. Repeat steps 2 through 10 for any other desired channel of NI 9216/9226.

Adjustments

The following performance adjustment procedure describes the sequence of operation required to adjust the NI 9216/9226.

Accuracy Adjustment

Complete the following procedure to adjust the accuracy performance of the NI 9216/9226.

1. Set the calibrator to Standby mode (STBY).
2. Connect the desired channel of the NI 9216/9226 to the calibrator as shown in Figure 1. Connect only one channel at a time.
3. Adjust the desired channel of the NI 9216/9226.

   a. Initialize a calibration session on the NI 9216/9226. The default password is NI.

   b. Input the external temperature in degrees Celsius.

   c. Call the DAQmx Get NI 9216/9226 Calibration Adjustment Points function to obtain an array of recommended calibration resistance values.

   d. Set the calibrator to a reference value determined by the array of recommended calibration voltages.

   e. Set calibrator COMP to 4-wire.

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

   g. Call and configure the NI 9216/9226 adjustment function according to Table 5.

Table 5. Gain Adjustment Configuration

Physical Channel	Reference Value
AIx	The reference resistance value from the array of adjustment points

Note Use appropriate channel number in place of "x" in "AIx." For example, use AI3 for channel 3.

Note The module acquisition is started each time the adjust function is called.

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

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

   j. Close the calibration session with action commit.

4. Disconnect the NI 9216/9226 channel from the calibrator.
5. Repeat steps 2 through 4 to calibrate any other desired channel of NI 9216/9226.

EEPROM Update

When an adjustment procedure is completed, the NI 9216/9226 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 coefficients, which are stored in the onboard EEPROM.

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

- Ambient temperature 20 °C to 28 °C
- NI 9216/9226 installed in slot 8 of an cDAQ-9178 chassis
- Slots 1 through 7 of the cDAQ-9178 chassis are empty

Table 6. NI 9216/9226 Accuracy Under Calibration Conditions

Module	Gain Error	Offset Error
NI 9216	±0.012%	±0.03 Ω
NI 9226	±0.013%	±0.3 Ω

Note For operational specifications, refer to the most recent *NI 9216 Datasheet* or *NI 9226 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 NI Factory Installation Services, repairs, extended warranty, and other services.

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 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.