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**NI-9221**

# CALIBRATION PROCEDURE

# NI 9201/9221

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[ni.com/manuals](http://ni.com/manuals)

This document contains the verification and adjustment procedures for the National Instruments 9201 and National Instruments 9221. In this document, the NI 9201 and the NI 9221 are referred to inclusively as the NI 9201/9221. For more information about calibration solutions, visit [ni.com/calibration](http://ni.com/calibration).

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## Software

Calibrating the NI 9201/9221 requires the installation of NI-DAQmx 9.2 or later on the calibration system. You can download NI-DAQmx from [ni.com/downloads](http://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

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Consult the following documents for information about the NI 9201/9221, NI-DAQmx, and your application software. All documents are available on [ni.com](http://ni.com) and help files install with the software.



## *NI cDAQ-9174/9178 Quick Start*

NI-DAQmx installation and hardware setup



## *NI 9201/9221 Operating Instructions and Specifications*

NI 9201/9221 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

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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 5700A	Use a high-precision voltage source with an output impedance of less than or equal to 50 $\Omega$ and an accuracy that meets the following requirement for your module:  <b>(NI 9201)</b> Use a high-precision voltage source with an accuracy of less than or equal to 15 ppm.  <b>(NI 9221)</b> Use a high-precision voltage source with an accuracy of less than or equal to 25 ppm.
Chassis	NI cDAQ-9178	—
DSUB Connection Accessory	NI 9934	—
Screw-Terminal Connection Accessory	NI 9932	—

## Test Conditions

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The following setup and environmental conditions are required to ensure the NI 9201/9221 meets published specifications.

- Keep connections to the NI 9201/9221 as short as possible. Long cables and wires act as antennae, picking up extra noise that can affect measurements.
- Verify that all connections to the NI 9201/9221 are secure.
- Use shielded copper wire for all cable connections to the NI 9201/9221. Use twisted-pairs wire to eliminate noise and thermal offsets.
- Maintain an ambient temperature of 23 °C  $\pm$ 5 °C. The NI 9201/9221 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 9201/9221 measurement circuitry is at a stable operating temperature.

# Initial Setup

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Complete the following steps to set up the NI 9201/9221.

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

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The following performance verification procedure describes the sequence of operation and test points required to check the NI 9201/9221 and assumes that adequate traceable uncertainties are available for the calibration references.

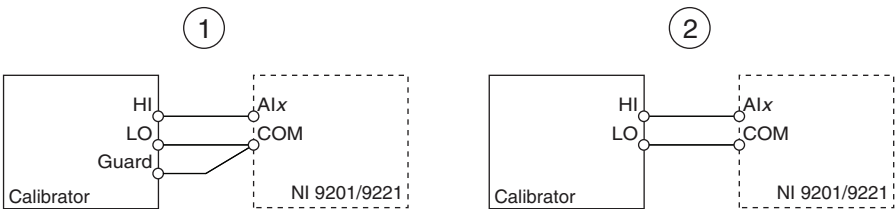
### Accuracy Verification

Complete the following procedure to determine the As-Found status of the NI 9201/9221.

1. Set the calibrator to Standby mode (STBY).
2. Connect the channel you want to verify on the NI 9201/9221 to the calibrator. Refer to Figure 1 for a connection diagram.

**Figure 1.** Accuracy Connections for the NI 9201/9221

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- 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 to Operate mode (OPR).
4. Set the calibrator voltage to a Test Point value indicated in Table 4 or Table 5.
5. Acquire and average samples.

- a. Create and configure an AI voltage channel according to Table 2.

**Table 2.** NI 9201/9221 AI Voltage Channel Configuration

Module	Input Range		Scaled Units	Terminal Configuration
	Min	Max		
NI 9201	-10	10	Volts	RSE
NI 9221	-60	60	Volts	RSE

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

**Table 3.** NI 9201/9221 Timing Configuration

Samples Per Channel	Acquisition Mode	Rate (S/s)
10k	Finite	25k

- c. Start the task.  
d. Read samples from the NI 9201/9221.  
e. Average the samples for each channel.  
f. Clear the task.
6. Compare the average sample for each channel to the test limits in Table 4 or Table 5.

**Table 4.** NI 9201 Voltage Test Limits

Range (V)		Test Point		1-Year Limits	
Min	Max	Location	Value (V)	Lower Limit (V)	Upper Limit (V)
-10.000	10.000	Max	9.500000	9.483250	9.516750
-10.000	10.000	Mid	0.000000	-0.012000	0.012000
-10.000	10.000	Min	-9.500000	-9.516750	-9.483250

**Table 5.** NI 9221 Voltage Test Limits

Range (V)		Test Point		1-Year Limits	
Min	Max	Location	Value (V)	Lower Limit (V)	Upper Limit (V)
-60.000	60.000	Max	57.000000	56.900500	57.099500
-60.000	60.000	Mid	0.000000	-0.071000	0.071000
-60.000	60.000	Min	-57.000000	-57.099500	-56.900500



**Note** The test limits listed in Tables 4 and 5 are derived using the values in Table 7.

7. Repeat steps 4 through 6 for each Test Point in Table 4 or Table 5.
8. Set the calibrator to Standby mode (STBY).
9. Disconnect the NI 9201/9221 from the calibrator.
10. Repeat steps 2 through 9 for each channel on the NI 9201/9221.

## Adjustment

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The following performance adjustment procedure describes the sequence of operation required to adjust the NI 9201/9221.

### Accuracy Adjustment

Complete the following procedure to adjust the accuracy performance of the NI 9201/9221.

1. Set the calibrator to Standby mode (STBY).
2. Connect the channel you want to adjust on the NI 9201/9221 to the calibrator. Refer to Figure 1 for a connection diagram.
3. Adjust the NI 9201/9221.
  - a. Initialize a calibration session on the NI 9201/9221. The default password is NI.
  - b. Input the external temperature in degrees Celsius.
  - c. Call the NI 9201 or NI 9221 get C Series adjustment points function to obtain an array of recommended calibration voltages for the NI 9201/9221.
  - 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 9201 or NI 9221 adjustment function according to Table 6.

**Table 6. Adjustment Configuration**

Physical Channel	Reference Value
cDAQMod8/aix	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 9201/9221 from the calibrator.
5. Repeat steps 2 through 4 for each channel on the NI 9201/9221.

# EEPROM Update

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When an adjustment procedure is completed, the NI 9201/9221 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.

## Re-Verification

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



**Note** If any test fails Re-Verification after performing an adjustment, verify that you have met the [Test Conditions](#) before returning your device to NI. Refer to [Where to Go for Support](#) for assistance in returning the device to NI.

## Accuracy Under Calibration Conditions

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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 9201/9221 installed in slot 8 of an NI cDAQ-9178 chassis
- Slots 1 through 7 of the NI cDAQ-9178 chassis are empty

**Table 7.** NI 9201/9221 Accuracy Under Calibration Conditions

Module	Gain Error	Offset Error
NI 9201	0.05%	12 mV
NI 9221	0.05%	71 mV



**Note** For operational specifications, refer to the most recent *NI 9201/9221 Operating Instructions and Specifications* online at [ni.com/manuals](http://ni.com/manuals).



# Where to Go for Support

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The National Instruments Web site is your complete resource for technical support. At [ni.com/support](http://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.

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world to help address your support needs. For telephone support in the United States, create your service request at [ni.com/support](http://ni.com/support) and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, visit the Worldwide Offices section of [ni.com/global](http://ni.com/global) to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

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