

## CALIBRATION PROCEDURE

# NI 9224

8 AI,  $\pm 10$  V, 24 Bit, 1 kS/s/ch Simultaneous

This document contains the verification and adjustment procedures for NI 9224. For more information about calibration solutions, visit [ni.com/calibration](http://ni.com/calibration).

## Contents

---

Software.....	1
Documentation.....	1
Test Equipment.....	2
Test Conditions.....	3
Initial Setup.....	3
Verification.....	3
Accuracy Verification.....	3
Adjustment.....	5
Accuracy Adjustment.....	5
EEPROM Update.....	6
Reverification.....	6
Accuracy under Calibration Conditions.....	6
Revision History.....	7
Worldwide Support and Services.....	7

## Software

---

Calibrating the NI 9224 requires the installation of NI-DAQmx 18.1 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™, 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 9224, 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 USB Chassis Quick Start*

NI-DAQmx installation and hardware setup



*NI 9224 Getting Started Guide*

NI 9224 connection information



*NI 9224 Datasheet*

NI 9224 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	Use a high-precision voltage source with gain error of $\leq 50$ ppm and offset error $< 50 \mu\text{V}$ .
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  $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ . The device temperature will be greater than the ambient temperature.
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 15 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 9224.

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 9224. The verification procedure assumes that adequate traceable uncertainties are available for the calibration references.

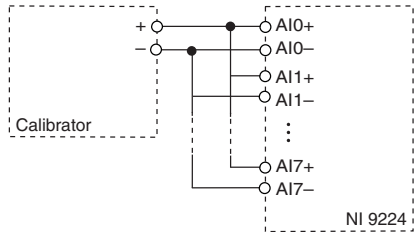
### Accuracy Verification

Complete the following procedure to determine the As-Found status of the NI 9224.

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

- Connect the NI 9224 to the calibrator as shown in the following figure.

**Figure 1. Accuracy Verification Connections**



**Note** The chassis ground lug connection to ground is the NI 9224 ground connection.

- Set the calibrator voltage to a Test Point value indicated in the *NI 9224 Verification Test Limits* table.
- Set the calibrator to Operate mode (OPR).
- Acquire and average samples for each channel.
  - Create and configure an AI voltage task according to the following *NI 9224 Accuracy Verification Configuration* table.

**Table 2. NI 9224 Accuracy Verification Configuration**

Minimum (V)	Maximum (V)	Scaled Units	Physical Channels	Channel Configuration
-10	10	Volts	cDAQ1Mod8/AI0:AI7	Differential

- Configure the task timing according to the following *NI 9224 Timing Configuration* table.

**Table 3. NI 9224 Timing Configuration**

Sample Mode	Samples Per Channel	Rate (kS/s)
Finite Samples	100	1

- Start the task.
  - Read the samples from the NI 9224.
  - Average the samples for each AI channel and record the average.
  - Stop and clear the task.
- Set the calibrator to Standby mode (STBY).
  - Compare the averaged samples to the limits in the *NI 9224 Verification Test Limits* table to verify the input accuracy. If the value is within these limits, the device passes the test.
  - Repeat steps 3 through 7 for each test point in the *NI 9224 Verification Test Limits* table.
  - Disconnect the calibrator from the device.

**Table 4.** NI 9224 Verification Test Limits

Test Points		2-Year Limits	
Location	Value	Lower Limit (VDC)	Upper Limit (VDC)
Positive full-scale	9.5	9.485	9.515
Mid	0	-0.00116	0.00116
Negative full-scale	-9.5	-9.515	-9.485



**Note** The test limits listed in the *NI 9224 Verification Test Limits* table are derived using values from the *NI 9224 Accuracy Under Calibration Conditions* table.

## Adjustment

The following performance adjustment procedure describes the sequence of operation required to adjust the NI 9224.

### Accuracy Adjustment

Complete the following procedure to adjust the accuracy performance of the NI 9224.

1. Set the calibrator to Standby mode (STBY).
2. Connect the NI 9224 to the calibrator as shown in the *Accuracy Verification* section.
3. Adjust the NI 9224.
  - a) Initialize a calibration session on the NI 9224. The default password is NI.
  - b) Input the external temperature in degrees Celsius.
  - c) Call the NI 9224 get C Series adjustment points function to obtain an array of recommended calibration voltages for the NI 9224.
  - 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 9224 adjustment function according to *NI 9224 Adjustment Configuration* table.

**Table 5.** NI 9224 Adjustment Configuration

Physical Channel	Reference Value
cDAQ1Mod8/AI0:7	A reference value from the array of adjustment points

- 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.
  - j) Close and commit the calibration session.
4. Disconnect the NI 9224 from the calibrator.

# EEPROM Update

When an adjustment procedure is completed, the NI 9224 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  $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$
- NI 9224 installed in slot 8 of a NI cDAQ-9178 chassis
- Slots 1 through 7 of the NI cDAQ-9178 chassis are empty

**Table 6.** NI 9224 Accuracy under Calibration Conditions

Device	Percent of Reading (Gain Error)	Percentage of Range (Offset Error) <sup>1</sup>
NI 9224	0.141%	0.011%



**Note** For operational specifications, refer to the most recent *NI 9224 Datasheet* online at [ni.com/manuals](http://ni.com/manuals).

<sup>1</sup> Range equals 10.54 V.

# Revision History

---

Part Number	Edition Date	Section	Changes
376504C-01	June 2020	Test Equipment	Corrected the required gain error for recommended calibrator
		Verification	Updated the verification test limits table

# Worldwide Support and Services

---

The NI website is your complete resource for technical support. At [ni.com/support](https://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](https://ni.com/services) for information about the services NI offers.

Visit [ni.com/register](https://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, USA. For up-to-date contact information for your location, visit [ni.com/contact](https://ni.com/contact).

Information is subject to change without notice. Refer to the *NI Trademarks and Logo Guidelines* at [ni.com/trademarks](http://ni.com/trademarks) for information on NI trademarks. Other product and company names mentioned herein are trademarks or trade names of their respective companies. For patents covering NI products/technology, refer to the appropriate location: **Help»Patents** in your software, the `patents.txt` file on your media, or the *National Instruments Patent Notice* at [ni.com/patents](http://ni.com/patents). You can find information about end-user license agreements (EULAs) and third-party legal notices in the readme file for your NI product. Refer to the *Export Compliance Information* at [ni.com/legal/export-compliance](http://ni.com/legal/export-compliance) for the NI global trade compliance policy and how to obtain relevant HTS codes, ECCNs, and other import/export data. NI MAKES NO EXPRESS OR IMPLIED WARRANTIES AS TO THE ACCURACY OF THE INFORMATION CONTAINED HEREIN AND SHALL NOT BE LIABLE FOR ANY ERRORS. U.S. Government Customers: The data contained in this manual was developed at private expense and is subject to the applicable limited rights and restricted data rights as set forth in FAR 52.227-14, DFAR 252.227-7014, and DFAR 252.227-7015.

© 2017—2020 National Instruments Corporation. All rights reserved.

376504C-01 July 1, 2020