CALIBRATION PROCEDURE
# NI 9242/9244

4-Channel, 250 V$_{rms}$/400 V$_{rms}$ L-N or 800 V$_{rms}$ L-L, 24-Bit,
Simultaneous Analog Input Module

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| `ni.com/manuals` |

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This document contains the verification and adjustment procedures for the National Instruments
9242 and National Instruments 9244. In this document, the NI 9242 and NI 9244 are inclusively
referred to as NI 9242/9244. For more information about calibration solutions, visit ni.com/
calibration.

# Contents

# Software

Calibrating the NI 9242/9244 requires the installation of NI-DAQmx 9.9 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.

**NATIONAL INSTRUMENTS™**

# Documentation

Consult the following documents for information about the NI 9242/9244, 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 9242 User Manual and Specifications*

NI 9242 specific information, specifications, and calibration interval

*NI 9244 User Manual and Specifications*

NI 9244 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

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 | Requirements |
|---|---|---|
| Calibrator | Fluke 5500A | Use a high-precision voltage source with an accuracy ≤57 ppm and offset error <2 mV. |
| Connector Backshell | NI 9967 | Use the NI 9967 to ensure circuits connected to the NI 9242 are properly insulated from human contact. |
| | NI 9969 | Use the NI 9969 to ensure circuits connected to the NI 9244 are properly insulated from human contact. |
| Chassis | NI cDAQ-9178 | — |

# Test Conditions

The following setup and environmental conditions are required to ensure the NI 9242/9244 meets published specifications.

- Keep connections to the NI 9242/9244 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 9242/9244 are secure.
- Use shielded copper wire for all cable connections to the NI 9242/9244. Use twisted-pairs wire to eliminate noise and thermal offsets.
- Maintain an ambient temperature of 23 °C ± 5 °C. The NI 9242/9244 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 9242/9244 measurement circuitry is at a stable operating temperature.

# Initial Setup

Complete the following steps to set up the NI 9242/9244.

1.  Install NI-DAQmx.
2.  Make sure the NI cDAQ-9178 power source is not connected.
3.  Connect the NI cDAQ-9178 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 test points required to verify the NI 9242/9244 and assumes that adequate traceable uncertainties are available for the calibration references.

⚠️ **Caution** Verification requires that hazardous voltages be connected to the NI 9242/9244. Refer to the *NI 9242 User Manual and Specifications* or *NI 9244 User Manual and Specifications* for safety guidelines.

## Accuracy Verification

Complete the following procedure to determine the As-Found status of the NI 9242/9244.

1.  Set the calibrator to Standby mode (STBY).
2.  Connect the NI 9242/9244 to the calibrator as shown in Figure 1. Ensure that the chassis ground lug and the calibrator LO are connected to the same ground.

**Figure 1.** NI 9242/9244 Calibration Connections
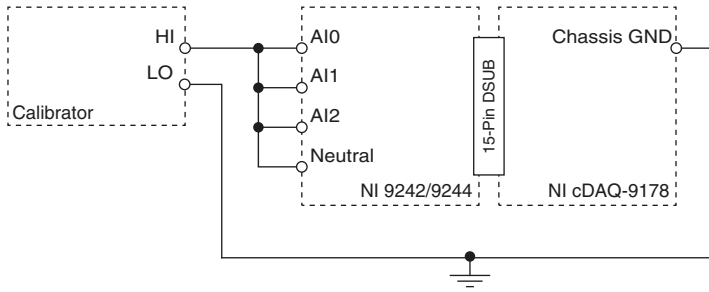


📝 **Note** The chassis ground lug connection to ground is the NI 9242/9244 ground connection.

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

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

**Table 2.** NI 9242/9244 AI Voltage Task Configuration

| Module | Minimum (V) | Maximum (V) | Physical Channels | Terminal Configuration |
|--------|-------------|-------------|-------------------|------------------------|
| NI 9242 | -500 | 500 | AI0:2 | NRSE |
| | | | Neutral | RSE |
| NI 9244 | -997.5 | 997.5 | AI0:2 | NRSE |
| | | | Neutral | RSE |

📝 **Note** The terminal configuration of NRSE for channels AI0:2 and RSE for Neutral is the default configuration for the NI 9242/9244.

   b. Configure the task timing according to Table 3.

**Table 3.** NI 9242/9244 Voltage Task Timing Configuration

| Sample Mode | Samples Per Channel | Rate (kS/s) |
|-------------|---------------------|-------------|
| Finite Samples | 5000 | 50 |

   c. Start the task.
   d. Read samples from the NI 9242/9244.
   e. Average the samples per AI channel and Neutral.

f. Perform the following calculation using the average for each AI channel.

$$AIx_{Measurement} = AIx_{Average} + Neutral_{Average}$$

g. Clear the task.

6. Compare the $Neutral_{Average}$ and the $AIx_{Measurement}$ for each AI channel to the limits in Table 4 or Table 5.

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

8. Repeat steps 3 through 7 for each test point in Table 4 or Table 5.

9. Disconnect the calibrator from the device.

**Table 4.** NI 9242 Verification Test Limits

| Test Point | | 1-Year Limits | |
|---|---|---|---|
| Location | Value (V) | Lower Limit ($V_{DC}$) | Upper Limit ($V_{DC}$) |
| Min | -450 | -450.5447 | -449.4553 |
| Mid | 0 | -0.0825 | 0.0828 |
| Max | 450 | 449.4553 | 450.5447 |

**Table 5.** NI 9244 Verification Test Limits

| Test Point | | 1-Year Limits | |
|---|---|---|---|
| Location | Value (V) | Lower Limit ($V_{DC}$) | Upper Limit ($V_{DC}$) |
| Min | -950 | -950.9026 | -949.0974 |
| Mid | 0 | -0.0571 | 0.0571 |
| Max | 950 | 949.0974 | 950.9026 |

**Note**   The test limits listed in Table 4 and Table 5 are derived using the values in Table 8.

# Adjustment

The following performance adjustment procedure describes the sequence of operation required to adjust the NI 9242/9244.

**Caution**   Adjustment requires that hazardous voltages be connected to the NI 9242/9244. Refer to the *NI 9242 User Manual and Specifications* or *NI 9244 User Manual and Specifications* for safety guidelines.

# Accuracy Adjustment

Complete the following procedure to adjust the accuracy performance of the NI 9242/9244.

1. Set the calibrator to Standby mode (STBY).
2. Connect the NI 9242/9244 to the calibrator as shown in Figure 1.
3. Adjust the NI 9242/9244.

   a. Initialize a calibration session on the NI 9242/9244. The default password is NI.

   b. Input the external temperature in degrees Celsius.

   c. Call the NI 9242/9244 get C Series adjustment points function to obtain an array of recommended calibration voltages for the NI 9242/9244.

   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 9242/9244 setup function according to Table 6.

**Table 6.** Setup Configuration

| Physical Channel | Adjustment Point |
|---|---|
| cDAQMod8/AI0:2, cDAQMod8/Neutral | The recommended calibration voltage |

📝 **Note** The NI 9242/9244 acquisition starts each time the setup function is called.

   g. Call and configure the NI 9242/9244 adjustment function according to Table 7.

**Table 7.** Adjustment Configuration

| Physical Channel | Reference Value |
|---|---|
| cDAQMod8/AI0:2, cDAQMod8/Neutral | The actual value of the voltage output of the calibrator |

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

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

   j. Close the calibration session.

4. Disconnect the NI 9242/9244 from the calibrator.

# EEPROM Update

When an adjustment procedure is completed, the NI 9242/9244 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 23 °C ± 5 °C
- NI 9242/9244 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 9242/9244 Accuracy Under Calibration Conditions

| Module | Percent of Reading (Gain Error) | Percent of Range* (Offset Error) |
|---|---|---|
| NI 9242 | ±0.103% | ±0.023% |
| NI 9244 | ±0.089% | ±0.01% |
| * Range equals 354 V for the NI 9242 and 565.7 V for the NI 9244. | | |

📝 **Note** For operational specifications, refer to the most recent *NI 9242 User Manual and Specifications* or *NI 9244 User Manual and Specifications* 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.

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