



NI-9227

Calibration Procedure



Provided by:

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CALIBRATION PROCEDURE

NI 9227

This document contains the verification and adjustment procedures for the National Instruments 9227. For more information about calibration solutions, visit ni.com/calibration.

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Software

Calibrating the NI 9227 requires the installation of NI-DAQmx 9.3 or later on the calibration system. You can download NI-DAQmx from 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

Consult the following documents for information about the NI 9227, NI-DAQmx, and your application software. All documents are available on ni.com and help files install with the software.



NI cDAQ-9174/9178 USB Chassis Quick Start

NI-DAQmx installation and hardware setup



NI 9227 Operating Instructions and Specifications

NI 9227 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	Where Used	Requirements
Calibrator	Fluke 5522A	Accuracy, Adjustment	Use a high-precision current source with an accuracy ± 500 ppm of output + 500 μ A.
Function Generator	NI 5421	Gain Matching, Phase Matching	Use a function generator with an output impedance of 50 Ω capable of sourcing both 1 kHz and 20 kHz ± 10 VPK AC sinusoidal signals with amplitude uncertainty of $\pm 10\%$ to a 50 Ω load.
Termination Resistor	—	Gain Matching, Phase Matching	50 Ω , 1 W, $\pm 5\%$
Chassis	NI cDAQ-9178	All	—

Test Conditions

The following setup and environmental conditions are required to ensure the NI 9227 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 23 $^{\circ}$ C \pm 5 $^{\circ}$ 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 NI 9227 measurement circuitry is at a stable operating temperature.

Initial Setup

Complete the following steps to set up the NI 9227.

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 procedures describes the sequence of operation and test points required to verify the NI 9227 and assumes that adequate traceable uncertainties are available for the calibration references.

Accuracy Verification

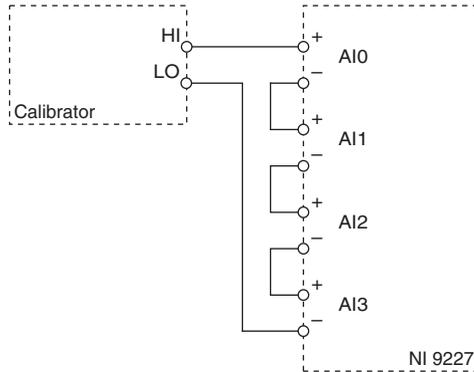
Complete the following procedure to determine the As-Found status of the NI 9227.



Note Completing the Accuracy verification procedure verifies both the 5 A_{rms} and 10 A_{rms} accuracy specifications listed in the *NI 9227 Operating Instructions and Specifications*.

1. Set the calibrator to Standby mode (STBY).
2. Connect the NI 9227 to the calibrator as shown in Figure 1.

Figure 1. Accuracy Verification Connections



3. Set the calibrator current to a Test Point value indicated in Table 4.
4. Set the calibrator to Operate mode (OPR).
5. Acquire and average samples.
 - a. Create and configure an AI current task according to Table 2.

Table 2. NI 9227 Configuration for Accuracy Verification

Physical Channels	Minimum (A_{rms})	Maximum (A_{rms})	Terminal Configuration
AI0:3	-5.0	5.0	Differential

- b. Configure the task timing according to Table 3.

Table 3. NI 9227 Timing Configuration for Accuracy Verification

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

- c. Start the task.

- d. Read samples from the NI 9227.
 - e. Average the samples.
 - f. Stop and clear the task.
6. Compare the per-channel averages to the limits in Table 4.
 7. Set the calibrator to Standby mode (STBY).
 8. Repeat steps 3 through 7 for each test point in Table 4.
 9. Disconnect the calibrator from the device.

Table 4. NI 9227 Verification Test Limits for Accuracy

Range		Test Point		1-Year Limits	
Min (A_{rms})	Max (A_{rms})	Location	Value (A_{DC})	Lower Limit (A_{DC})	Upper Limit (A_{DC})
-5	5	Max	5.00	4.990758	5.009242
		Mid	0.00	-0.004242	0.004242
		Min	-5.00	-5.009242	-4.990758



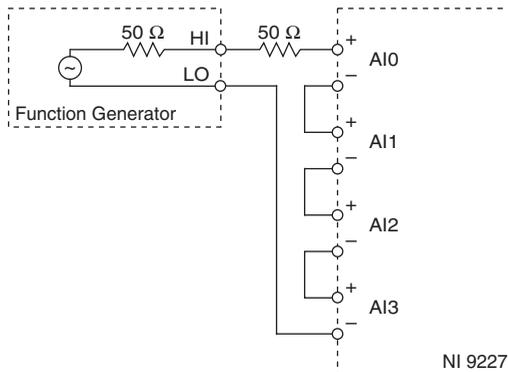
Note The test limits listed in Table 4 are derived using the values in Table 13.

Gain Matching Verification

Complete the following procedure to determine the As-Found status of the NI 9227.

1. Connect the NI 9227 to the function generator as shown in Figure 2.

Figure 2. Gain Matching Verification Connections



2. Configure function generator according to Table 5.

Table 5. Function Generator Configuration for Gain Matching Verification

Signal Type	Amplitude (VPK)	Frequency (kHz)
Sinewave	9	20

3. Enable the function generator.
4. Acquire samples.
 - a. Create and configure an AI current task according to Table 6.

Table 6. NI 9227 Configuration for Gain Matching Verification

Physical Channels	Terminal Configuration
AI0:3	Differential

- b. Configure the task timing according to Table 7.

Table 7. NI 9227 Configuration for Gain Matching Verification

Sample Mode	Samples Per Channel	Rate (kS/s)
Finite Samples	25000	50

- c. Start the task.
 - d. Read samples from the NI 9227. Record the amplitude of the waveform as $Amplitude_{Acq}$ for each channel.
 - e. Clear the task.
5. Perform the following calculation for each channel using the $Amplitude_{Acq}$ value to calculate the gain for each channel.

$$Amplitude(dB) = \left(20 \times \log_{10} \left(\frac{Amplitude_{Acq}}{90mA} \right) \right)$$

6. Compare the channel-to-channel gain difference to the maximum limit of ± 0.13 dB.
7. Disable the function generator.
8. Disconnect the calibrator from the device.

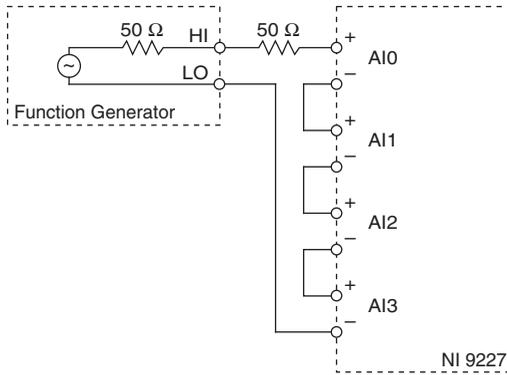
If the Gain Matching verification procedure determines that the NI 9227 is outside of the limits, refer to [Worldwide Support and Services](#) for assistance in returning the device to NI.

Phase Matching Verification

Complete the following procedure to determine the As-Found status of the NI 9227.

1. Connect the NI 9227 to the function generator as shown in Figure 3.

Figure 3. Phase Matching Verification Connections



2. Configure function generator according to Table 8.

Table 8. Function Generator Configuration for Phase Matching Verification

Signal Type	Amplitude (V _{PK})	Frequency (kHz)
Sinewave	9	20

3. Set the function generator frequency to a value indicated in Table 11.
4. Enable the function generator.
5. Acquire samples.
 - a. Create and configure an AI current task according to Table 9.

Table 9. NI 9227 Configuration for Phase Matching Verification

Physical Channels	Channel Configuration
AI0:3	DC Coupled

- b. Configure the task timing according to Table 10.

Table 10. NI 9227 Configuration for Phase Matching Verification

Sample Mode	Samples Per Channel	Rate (kS/s)
Finite Samples	25000	50

- c. Start the task.

- d. Read samples from the NI 9227. Record this measurement for each channel.
 - e. Clear the task.
6. Calculate the phase for each channel on the NI 9227. NI recommends using the Extract Single Tone Information VI to calculate phase.
 7. Compare the channel-to-channel phase difference to the limits in Table 11.
 8. Repeat steps 2 through 7 for each test point in Table 11.

Table 11. NI 9227 Verification Test Limits for Phase Matching

Generator Frequency (kHz)	Phase Matching Channel-to-Channel Limit
1	$\pm 0.100^\circ$
20	$\pm 2.000^\circ$

9. Disable the function generator.
10. Disconnect the function generator from the device.

If the Phase Matching verification procedure determines that the NI 9227 is outside of the limits, refer to [Worldwide Support and Services](#) for assistance in returning the device to NI.

Adjustment

The following performance adjustment procedure describes the sequence of operation required to adjust the NI 9227.

Accuracy Adjustment

Complete the following procedure to adjust the accuracy performance of the NI 9227.



Note Completing the Accuracy adjustment procedure adjusts the NI 9227 to meet both the 5 A_{rms} and 10 A_{rms} accuracy specifications listed in the *NI 9227 Operating Instructions and Specifications*.

1. Set the calibrator to Standby mode (STBY).
2. Connect the NI 9227 to the calibrator as shown in Figure 1.
3. Adjust the NI 9227.
 - a. Initialize a calibration session on the NI 9227. The default password is NI.
 - b. Input the external temperature in degrees Celsius.
 - c. Call the NI 9227 get C Series adjustment points function to obtain an array of recommended calibration currents for the NI 9227.
 - d. Set the calibrator to a reference value determined by the array of recommended calibration currents.

- e. Set the calibrator to Operate mode (OPR).
- f. Call and configure the NI 9227 adjustment function according to Table 12.

Table 12. Adjustment Configuration

Physical Channel	Reference Value
cDAQMod8/aix	The actual value of the current output of the calibrator

- g. Set the calibrator to Standby mode (STBY).
 - h. Repeat steps d through g for each calibration current in the array.
 - i. Close the calibration session.
4. Disconnect the NI 9227 from the calibrator.

EEPROM Update

When an adjustment procedure is completed, the NI 9227 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 following calibration specifications are valid under the following conditions:

- Ambient temperature $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$
- NI 9227 installed in slot 8 of an NI cDAQ-9178 chassis
- Slots 1 through 7 of the NI cDAQ-9178 chassis are empty



Note The test limits listed in Table 4 are derived using the values in Table 13.

Table 13. NI 9227 Accuracy Under Calibration Conditions

Percent of Reading (Gain Error)	Percent of Range* (Offset Error)
0.1% max	0.06% max
* Range equals $5 A_{\text{rms}}$ (7.07 APK)	



Note For operational specifications, refer to the most recent *NI 9227 Operating Instructions 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.

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