

NI 9215 Calibration Procedure

This document contains information about calibrating the National Instruments 9215 module using NI-DAQmx. In this document, the NI 9215 with screw terminal and NI 9215 with BNC are referred to inclusively as the NI 9215. This calibration procedure is intended for metrology labs.

This document does not discuss programming techniques or compiler configuration. The NI-DAQmx driver contains online help files that have compiler-specific instructions and detailed function explanations. You can install these help files when you install NI-DAQmx on the calibration computer.

The NI 9215 should be calibrated at a regular interval as defined by the measurement accuracy requirements of your application. National Instruments recommends that you routinely perform a complete calibration at least once every year. You can shorten this interval based on the accuracy demands of your application or requirements of your processes. Adjusting the calibration constants must be done by a factory calibration at NI.

Contents

Conventions	2
Software and Documentation Requirements.....	2
Software	2
Documentation	3
Calibration Requirements	3
Test Equipment	3
Test Conditions	4
Calibration Process	4
Calibration Process Overview	4
Initial Setup.....	4
Verification Procedure	5
Specifications	9
Device Test Limits	9
Using the Table	9
Range	9
Test Point	9
1-Year Limits	9
Where to Go for Support.....	10

Conventions

The following conventions appear in this manual:

»

The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.



This icon denotes a note, which alerts you to important information.

bold

Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names and hardware labels.

italic

Italic text denotes variables, emphasis, a cross-reference, or an introduction to a key concept. Italic text also denotes text that is a placeholder for a word or value that you must supply.

`monospace`

Monospace text denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions.

Software and Documentation Requirements

This section describes the software and documentation required for calibration.

Software

Install NI-DAQmx 8.1 or later on the calibration computer. NI-DAQmx includes high-level function calls to simplify the task of writing software to calibrate devices. You must have the proper device driver installed on the calibration system before calibrating the device.



Note NI recommends that you install the NI-DAQmx driver software before physically installing the NI 9215. NI-DAQmx, available at ni.com/downloads, configures and controls the NI 9215.

NI-DAQmx supports a number of programming languages, including LabVIEW, LabWindows™/CVI™, Microsoft Visual C++ 6.0, Microsoft Visual Basic 6.0, Microsoft .NET, and Borland C++.

You can access the NI-DAQmx header file, `NIDAQmx.h`, like any standard library. You can find examples of how to use the NI-DAQmx driver in the Program Files\National Instruments\NI-DAQ\Examples directory.

Documentation

You might find the following documentation helpful as you write the calibration procedure:

- *NI-DAQmx Help*—This help file contains general information about measurement concepts, key NI-DAQmx concepts, and common applications that apply to all programming environments. To access this help file, select **Start»All Programs»National Instruments»NI-DAQ»NI-DAQmx Help**.
- *NI-DAQmx C Reference Help*—This help file contains C reference and general information about measurement concepts. To access this help file, select **Start»All Programs»National Instruments»NI-DAQ»NI-DAQmx C Reference Help**.
- *DAQ Getting Started Guide* for NI-DAQ 8.0 or later—This guide describes how to install NI-DAQmx for Windows software and NI-DAQmx-supported DAQ devices, and how to confirm that your device is operating properly. To access this guide, select **Start»All Programs»National Instruments»NI-DAQ»DAQ Getting Started Guide**.



Note The documents above are installed with NI-DAQmx. You can also download the latest versions from the NI Web site at ni.com/manuals.

- *NI 9215 Operating Instructions*—This document contains information about specific device features. You can download the latest version of this document from the NI Web site at ni.com/manuals.

Calibration Requirements

Test Equipment

National Instruments recommends that you use the following equipment for calibrating the NI 9215:

- Fluke 5700A calibrator. If that instrument is unavailable, use a high-precision voltage source with an accuracy of at least 10 ppm and an output impedance of less than or equal to 50 Ω .
- NI cDAQ-9172 chassis.

Test Conditions

Follow these guidelines to optimize the connections and the environment:

- Keep connections to the device as short as possible. Long cables and wires act as antennae, picking up extra noise that can affect measurements.
- Use shielded copper wire for all cable connections to the device. Use twisted-pair wire to eliminate noise and thermal offsets.
- Maintain an ambient temperature of 23 ± 10 °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 measurement circuitry is at a stable operating temperature.

Calibration Process

This section provides instructions for verifying the NI 9215.

Calibration Process Overview

The calibration process consists of the following steps:

1. *Initial Setup*—Configure the device in NI-DAQmx.
2. *Verification Procedure*—Verify the existing operation of the device. This step confirms whether the device was operating within its specified range prior to calibration.
3. *Adjustment*—Submit the device to NI for a factory calibration to adjust the calibration constants.

The first two steps are explained in the following sections.

Initial Setup

You must configure the device in Measurement & Automation Explorer (MAX) to communicate with NI-DAQmx.

Complete the following steps to configure a device in MAX:

1. Install the NI-DAQmx driver software.
2. Make sure that no power is connected to the module terminals. If the system is in a nonhazardous location, the chassis power can be on when you install the module.
3. Insert the module into an available slot in the cDAQ-9172 chassis.

4. Launch MAX.
5. Right-click the device name and select **Self-Test** to ensure that the device is working properly.



Note When a device is configured with MAX, it is assigned a device name. Each function call uses this device name to determine which DAQ device to calibrate. This document uses `dev1` to refer to the device name. In the following procedures, use the device name as it appears in MAX.

Verification Procedure

Verification determines how well the device is meeting its specifications. By completing this procedure, you can see how the device has drifted over time, which helps you determine the appropriate calibration interval for your application. Table 3 in the *Device Test Limits* section shows all acceptable settings for the device type. Throughout the verification process, use Table 3 to determine if the device is operating within its specified range prior to calibration. You must perform verification on all analog input channels.

Complete the following steps to test the performance of the device:

1. Refer to Table 1 for a list of the NI connection accessories for the NI 9215 and instructions on connecting the calibrator to the device.

Table 1. NI Connection Accessories

Device	Connection Accessory	Connection Instructions
NI 9215	NI 9932 Strain relief and high voltage screw terminal connector	Connect the positive output of the calibrator to all positive terminals (pins 0, 2, 4, and 6) and the negative output of the calibrator to all negative terminals (pins 1, 3, 5, and 7) and COM (pin 9). If the calibrator has a guard connection, connect that terminal to COM instead of connecting COM to the negative output.
NI 9215 with BNC	N/A	Connect the positive output of the calibrator to all positive terminals (pins AI0+, AI1+, AI2+, and AI3+) and the negative output of the calibrator to all negative terminals (pins AI0-, AI1-, AI2-, and AI3-). If the calibrator has a guard connection, connect that terminal to all negative terminals (pins AI0-, AI1-, AI2-, and AI3-).

2. Set the calibrator voltage to a Test Point value indicated in Table 3. NI recommends that you verify all values, although you can save time by verifying only the values used in your application.

3. If you use C function calls, create a task using DAQmxCreateTask, as shown in the following table. If you use LabVIEW, skip this step. The task is created in step 4 in LabVIEW.

NI-DAQmx Function Call	LabVIEW Block Diagram
Call DAQmxCreateTask with the following parameters: taskName: <i>AIVerificationTask</i> taskHandle: &taskHandle	LabVIEW does not require this step.

4. Create and configure an AI voltage channel through NI-DAQmx using DAQmxCreateAIVoltageChan (DAQmx Create Virtual Channel VI), as shown in the following table. Use Table 3 to determine the minimum and maximum values for the device.

NI-DAQmx Function Call	LabVIEW Block Diagram
Call DAQmxCreateAIVoltageChan with the following parameters: taskHandle: taskHandle physicalChannels: dev1/ai0 nameToAssignToChannel: <i>myVoltageChannel</i> terminalConfig: <i>DAQmx_Val_Cfg_Default</i> minVal: -10.0 maxVal: 10.0 units: DAQmx_Val_Volts customScaleName: NULL	

5. Configure the timing properties for the voltage acquisition using DAQmxCfgSampClkTiming (DAQmx Timing VI), as shown in the following table.

NI-DAQmx Function Call	LabVIEW Block Diagram
Call DAQmxCfgSampClkTiming with the following parameters: taskHandle: taskHandle source: NULL rate: 100k activeEdge: DAQmx_Val_Rising sampleMode: DAQmx_Val_FiniteSamps sampsPerCha: 10k	

6. Start the acquisition using DAQmxStartTask (DAQmx Start Task VI), as shown in the following table.

NI-DAQmx Function Call	LabVIEW Block Diagram
Call DAQmxStartTask with the following parameter: taskHandle: taskHandle	

7. Acquire 10,000 points of voltage data using DAQmxReadAnalogF64 (DAQmx Read VI), as shown in the following table.

NI-DAQmx Function Call	LabVIEW Block Diagram
Call DAQmxReadAnalogF64 with the following parameters: taskHandle: taskHandle numSampsPerChan: -1 timeout: 10.0 fillMode: DAQmx_Val_GroupByChannel readArray: data arraySizeInSamples: 10000 sampsPerChanRead: &read reserved: NULL	

8. Average the voltage values that you acquired for each channel. Compare the resulting average to the Upper Limit and Lower Limit values listed in Table 3 per channel. If the result is between these values, the device passes the test.
9. Clear the acquisition using DAQmxClearTask (DAQmx Clear Task VI), as shown in the following table.

NI-DAQmx Function Call	LabVIEW Block Diagram
Call DAQmxClearTask with the following parameter: taskHandle: taskHandle	

10. Repeat steps 3 through 9 for all channels and all values.
11. Disconnect the calibrator from the device.

Specifications

The values in the following table are based on calibrated scaling coefficients, which are stored in the onboard EEPROM. The following calibration specifications are for 23 ± 10 °C.

Table 2. NI 9215 Accuracy

Gain Error	Offset Error
0.04%	1.5 mV

Device Test Limits

Table 3 lists the specifications that the NI 9215 meets if it has been one year between calibrations.

Using the Table

The following definitions describe how to use the information from Table 3.

Range

Range refers to the minimum or maximum voltage range of an input signal.

Test Point

The *Test Point* is the voltage value that is input or output for verification purposes. This value is broken down into two columns—*Location* and *Value*. *Location* refers to where the test value fits within the test range. *Value* refers to the voltage value to be verified. *Max* refers to maximum value, *Min* refers to minimum value, and *Mid* refers to mid-scale.

1-Year Limits

The *1-Year Limits* column contains the *Upper Limits* and *Lower Limits* for the test point value. That is, when the device is within its 1-year calibration interval, the test point value should fall between these upper and lower limit values.

Table 3. NI 9215 Analog Input Values

Range (V)		Test Point		1-Year Limits	
Minimum	Maximum	Location	Value (V)	Lower Limit (V)	Upper Limit (V)
-10.000	10.000	Max	9.500000	9.494700	9.505300
-10.000	10.000	Mid	0.000000	-0.001500	0.001500
-10.000	10.000	Min	-9.500000	-9.505300	-9.494700

Where to Go for Support

The National Instruments Web site 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.

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 and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 1800 300 800, Austria 43 0 662 45 79 90 0,
 Belgium 32 0 2 757 00 20, Brazil 55 11 3262 3599,
 Canada 800 433 3488, China 86 21 6555 7838,
 Czech Republic 420 224 235 774, Denmark 45 45 76 26 00,
 Finland 385 0 9 725 725 11, France 33 0 1 48 14 24 24,
 Germany 49 0 89 741 31 30, India 91 80 41190000,
 Israel 972 0 3 6393737, Italy 39 02 413091, Japan 81 3 5472 2970,
 Korea 82 02 3451 3400, Lebanon 961 0 1 33 28 28,
 Malaysia 1800 887710, Mexico 01 800 010 0793,
 Netherlands 31 0 348 433 466, New Zealand 0800 553 322,
 Norway 47 0 66 90 76 60, Poland 48 22 3390150,
 Portugal 351 210 311 210, Russia 7 095 783 68 51,
 Singapore 1800 226 5886, Slovenia 386 3 425 4200,
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