NI 9203 Calibration Procedure

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This document contains information about calibrating National Instruments 9203 modules using NI-DAQmx. 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.

Contents

NATIONAL INSTRUMENTS

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.
`monospace italic`	Italic text in this font denotes text that is a placeholder for a word or value that you must supply.

Software

Install NI-DAQmx 8.5 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 9203. NI-DAQmx, available at `ni.com/downloads`, configures and controls the NI 9203.

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 9203 Operating Instructions and Specifications*—This document describes how to use the NI 9203 and includes specifications and terminal assignments for the NI 9203. The limits you use to verify the accuracy of the device are based on the specifications found in this document. You can download the latest version of this document from the NI Web site at `ni.com/manuals`.

Calibration Interval

The NI 9203 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.

Test Equipment

National Instruments recommends that you use the following equipment for calibrating the NI 9203.

Table 1. Recommended Equipment

Equipment	Recommended Model	Requirements
Calibrator	Fluke 5700A	If this instrument is unavailable, use a high-precision current source with an accuracy of at least 100 ppm.
Chassis	NI cDAQ-9172	—

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 ±5 °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 Procedure

This section provides instructions for verifying the performance of the NI 9203.

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 is operating within its specified range and whether it needs adjustment.

3. *Adjustment*—If the device does not fall within the desired specifications, submit the device to NI for a factory calibration to adjust the calibration constants.
4. *Verification Procedure*—Perform another verification to ensure that the device operates within its specifications after adjustment.

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. Tables 3 and 4 in the *Test Limits* section show all acceptable settings for the device type. Throughout the verification process, use Tables 3 and 4 to determine if the device is operating within its specified range. Because the NI 9203 has two different input ranges, you should verify measurements for each available range on the module.

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

1. Connect the calibrator to the channel you want to verify. Connect the LO output of the calibrator to COM, then connect the HI output of the calibrator to the AI channel. If the calibrator has a separate guard terminal not tied to the LO output, connect the guard terminal and the LO output to the COM of the NI 9203. Refer to Figure 1 for the terminal assignments of the NI 9203.

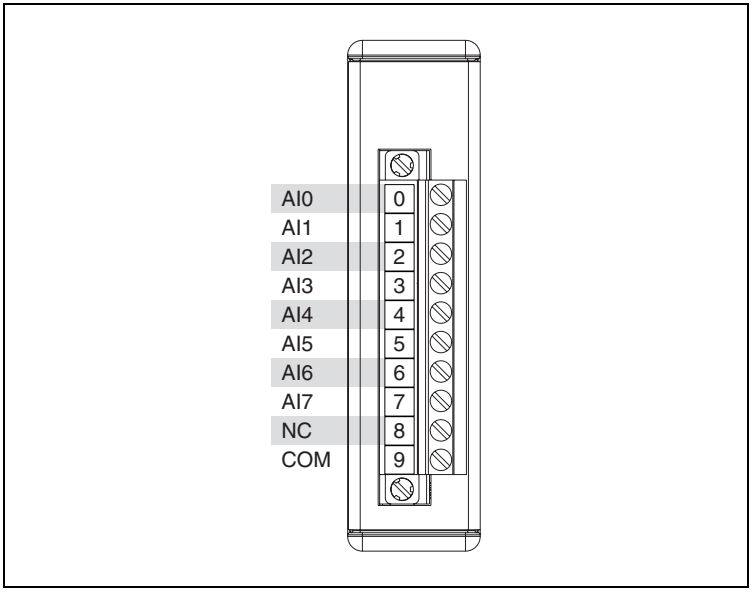


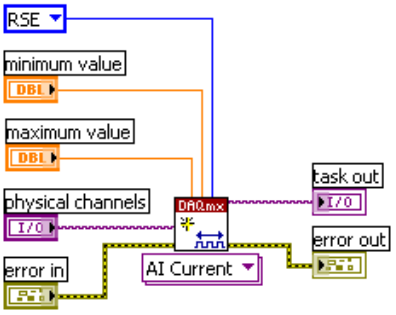
Figure 1. NI 9203 Terminal Assignments

2. Set the calibrator current to a Test Point value indicated in Table 3 or 4.
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.

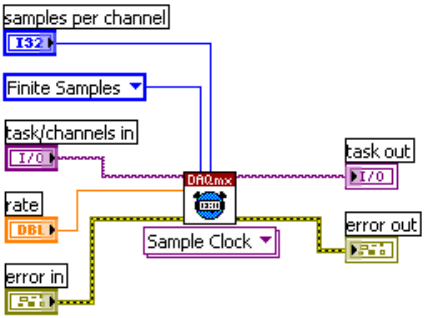
LabVIEW Block Diagram	NI-DAQmx Function Call
LabVIEW does not require this step.	Call `DAQmxCreateTask` with the following parameters: **taskName**: *`AIVerificationTask`* **taskHandle**: `&taskHandle`

4. Create and configure an AI current channel using the DAQmx Create Virtual Channel VI, as shown in the following table.

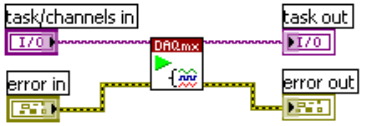
Note Throughout the procedure, refer to the NI-DAQmx function parameters for the LabVIEW input values. Refer to the block diagram images for the correct instance to use for polymorphic VIs.

LabVIEW Block Diagram	NI-DAQmx Function Call
	Call `DAQmxCreateAICurrentChan` with the following parameters: **taskHandle**: `taskHandle` **physicalChannel**: `dev1/aiX`* **nameToAssignToChannel**: *`myCurrentChannel`* **terminalConfig**: `DAQmx_Val_Cfg_Default` **minVal**: `0.000` (unipolar), `-0.020` (bipolar) **maxVal**: `0.020` **units**: `DAQmx_Val_Amps` **customScaleName**: `NULL`
* *X* refers to the channel number.	

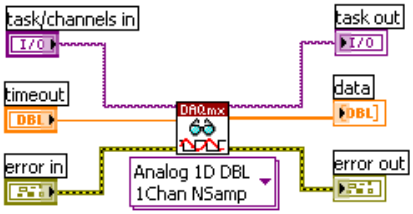
5. Configure the timing properties for the current acquisition using the DAQmx Timing VI, as shown in the following table.

LabVIEW Block Diagram	NI-DAQmx Function Call
	Call `DAQmxCfgSampClkTiming` with the following parameters: **taskHandle**: `taskHandle` **source**: `NULL` **rate**: `200000.0` **activeEdge**: `DAQmx_Val_Rising` **sampleMode**: `DAQmx_Val_FiniteSamps` **sampsPerChan**: `10000`

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

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

7. Acquire 10,000 points of current data using the DAQmx Read VI, as shown in the following table.

LabVIEW Block Diagram	NI-DAQmx Function Call
	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 current values that you acquired. Compare the resulting average to the Upper Limit and Lower Limit values in Table 3 or 4. If the result is between these values, the device passes the test.
9. Clear the acquisition using the DAQmx Clear Task VI, as shown in the following table.

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

10. Repeat steps 2 through 9 for all Test Point values. NI recommends that you verify all values, although you can save time by verifying only the values used in your application.
11. Repeat steps 1 through 10 for all channels.
12. 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 ±5 °C.

Table 2. NI 9203 Accuracy

Input Range	Percent of Reading (Gain Error)	Percent of Range* (Offset Error)
Unipolar	0.080% max	0.019%† max
Bipolar	0.082% max	0.033% max

* Range equals 21.5 mA for Unipolar and 43 mA (±21.5 mA) for Bipolar

† This specification is lower than the Percent of Range typical specification in the *NI 9203 Operating Instructions and Specifications* because the typical specification shows digits only to the hundredth place.

Test Limits

Tables 3 and 4 list the specifications that the NI 9203 should meet if it has been one year between calibrations. The following definitions describe how to use the information from Tables 3 and 4.

Range

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

Test Point

The *Test Point* is the current 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 current 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 9203 Verification Test Limits (Unipolar)

Range (A)		Test Point		1-Year Limits	
Minimum	**Maximum**	**Location**	**Value (A)**	**Lower Limit (A)**	**Upper Limit (A)**
0.000	0.020	Max	0.020000	0.019980	0.020020
0.000	0.020	Mid	0.010000	0.009988	0.010012
0.000	0.020	Min	0.000000	–0.000004	0.000004

Table 4. NI 9203 Verification Test Limits (Bipolar)

Range (A)		Test Point		1-Year Limits	
Minimum	**Maximum**	**Location**	**Value (A)**	**Lower Limit (A)**	**Upper Limit (A)**
–0.020	0.020	Max	0.020000	0.019969	0.020031
–0.020	0.020	Mid	0.000000	–0.000014	0.000014
–0.020	0.020	Min	–0.020000	–0.020031	–0.019969

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 43 662 457990-0,
Belgium 32 (0) 2 757 0020, Brazil 55 11 3262 3599,
Canada 800 433 3488, China 86 21 5050 9800,
Czech Republic 420 224 235 774, Denmark 45 45 76 26 00,
Finland 358 (0) 9 725 72511, France 01 57 66 24 24,
Germany 49 89 7413130, India 91 80 41190000, Israel 972 3 6393737,
Italy 39 02 41309277, Japan 0120-527196, 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 22 328 90 10, Portugal 351 210 311 210,
Russia 7 495 783 6851, Singapore 1800 226 5886,
Slovenia 386 3 425 42 00, South Africa 27 0 11 805 8197,
Spain 34 91 640 0085, Sweden 46 (0) 8 587 895 00,
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