

CALIBRATION PROCEDURE

NI 9775

±10 V, 20 MS/s/ch, 14-Bit, 4-Channel C Series Digitizer Module

This document contains the verification and adjustment procedures for the NI 9775. For more information on calibration, visit ni.com/calibration.

Software

Calibrating the NI 9775 requires the installation of NI-DAQmx 17.6 or later. 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 9775, NI-DAQmx, and your application software. All documents are available on ni.com/manuals and help files install with the software.

- *NI cDAQ-9174/9178 USB Chassis Quick Start*
- *NI 9775 Datasheet*
- *NI 9775 Getting Started Guide*
- *NI-DAQmx Readme*
- *LabVIEW Help*
- *NI-DAQmx C Reference Help*
- *NI-DAQmx .NET Help Support for Visual Studio*

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.

Table 1. Recommended Equipment

Equipment	Recommended Model	Requirements
Calibrator	Fluke 5730A	DC gain error <500 ppm, DC offset error <100 μ V, AC gain error <0.2%
Chassis	cDAQ-9178	—

Test Conditions

The following setup and environmental conditions are required to ensure the NI 9775 meets published specifications.

- Keep connections to the NI 9775 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 NI 9775 are secure.
- Maintain an ambient temperature of $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 15 minutes to ensure that the NI 9775 measurement circuitry is at a stable operating temperature.

Initial Setup

Complete the following steps to set up the NI 9775.

1. Install NI-DAQmx.
2. Make sure the cDAQ-9178 power source is not connected.
3. Install the module in slot 8 of the cDAQ-9178 chassis. Leave slots 1 through 7 of the cDAQ-9178 chassis empty.
4. Connect the cDAQ-9178 chassis to your host computer.
5. Connect the power source to the cDAQ-9178 chassis.
6. Launch Measurement & Automation Explorer (MAX).
7. Right-click the device name and select **Self-Test** to ensure that the module is working properly.

Verification

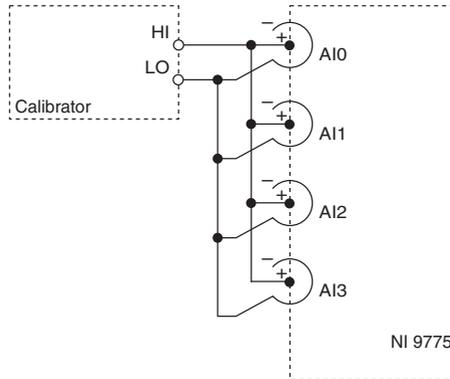
The following performance verification procedure describes the sequence of operation and test points required to verify the NI 9775 and assumes that adequate traceable uncertainties are available for the calibration references.

AC Accuracy Verification

Complete the following procedure to determine the As-Found Status of AC Accuracy of the NI 9775.

1. Set the calibrator to Standby mode (STBY).
2. Connect the NI 9775 to the calibrator as shown in the following figure.

Figure 1. Connections for DC and AC Accuracy Verification and Adjustment



3. Set the calibrator to generate AC voltage with settings shown in the following table.

Table 2. Calibrator Configuration for AC Accuracy Verification

Output Function	Amplitude (V RMS)	Frequency
AC Voltage	2.00	50 kHz

4. Set the calibrator to Operate mode (OPR).
5. Acquire samples from the NI 9775 and extract 50 kHz amplitude information.
 - a) Create and configure an AI voltage task on the NI 9775 according to the following table.

Table 3. NI 9775 AI Task Configuration for AC Accuracy Verification

Physical Channels	Min (V)	Max (V)	Terminal Configuration	Scaled Units
cDAQMod8/AI0:3	-10	10	RSE	Volts

- b) Configure the AI voltage task timing according to the following table.

Table 4. NI 9775 Timing Configuration for AC Accuracy Verification

Sample Mode	Samples per Channel	Rate
Finite Sample	40,000	20 MS/s

- c) Configure the channel properties according to the following table.

Table 5. NI 9775 Channel Properties Configuration for AC Accuracy Verification

AI.ADCTimingMode	AI.Lowpass.Enable
High Speed	False

- d) Start the task.
- e) Read the samples from the NI 9775.
- f) Extract the amplitude of the 50 kHz signal from each channel. This can be done using the "Extract Single Tone Information.vi". The output of the "Extract Single Tone Information.vi" is in Vpk. To obtain AC amplitude error in units of dB, use the following equation:

$$AC \text{ Amplitude Error (dB)} = 20 \times \log_{10} \left(\frac{V_{pk}}{\sqrt{2} \times 2.0V} \right)$$

- g) Clear the task.
6. Compare the amplitude error to the limits in the following table

Table 6. NI 9775 Verification Limits for AC Accuracy

Test Point		1-Year Limits	
Frequency	Amplitude (V RMS)	Upper Limit	Lower Limit
50 kHz	2.00	0.12 dB	-0.12 dB



Note The test limits listed in this table are derived using the values in the *NI 9775 Accuracy Under Calibration Conditions* table.



Note The uncertainty of the calibration standard is not included in these limits.

7. Set the calibrator to Standby mode (STBY).
8. Disconnect the NI 9775 from the calibrator.

DC Accuracy Verification

Complete the following procedure to determine the As-Found status of DC Accuracy of the NI 9775.

1. Set the calibrator to Standby mode (STBY).
2. Connect the NI 9775 to the calibrator as shown in the *AC Accuracy Verification* section.
3. Set the calibrator voltage to a Test Point value indicated in the *NI 9775 Verification Limits for DC Accuracy* table.
4. Set the calibrator to Operate mode (OPR).
5. Acquire and average samples.
 - a) Create and configure an AI voltage task on the NI 9775 according to the following table.

Table 7. NI 9775 Configuration for DC Accuracy Verification

Physical Channels	Min (V)	Max (V)	Terminal Configuration	Scaled Units
cDAQMod8/AI0:3	-10	10	RSE	Volts

b) Configure the AI voltage task timing according to the following table.

Table 8. NI 9775 Timing Configuration for DC Accuracy Verification

Sample Mode	Samples per Channel	Rate
Finite Sample	10,000	20 MS/s

c) Configure each test point according to the channel property settings in the following table.

Table 9. NI 9775 Channel Properties Configuration for DC Accuracy Verification

AI.ADCTimingMode	AI.Lowpass Enable
High Speed	False
High Speed	True
High Resolution	True

d) Start the task.

e) Read the samples from the NI 9775.

f) Average the readings.

g) Stop and clear the task.

6. Compare the per-channel averages to the limits in the following table.

Table 10. NI 9775 Verification Limits for DC Accuracy

Channel Property Settings		Test Point		1-Year Limits (V)	
ADC Timing Mode	Analog Lowpass Filter	Location	Value	Upper Limit	Lower Limit
High Speed	Disabled	Min	-10.000	-9.931	-10.069
		Mid	0.000	0.015	-0.015
		Max	10.000	10.069	9.931
High Speed	Enabled	Min	-10.000	-9.931	-10.069
		Mid	0.000	0.015	-0.015
		Max	10.000	10.069	9.931

Table 10. NI 9775 Verification Limits for DC Accuracy (Continued)

Channel Property Settings		Test Point		1-Year Limits (V)	
ADC Timing Mode	Analog Lowpass Filter	Location	Value	Upper Limit	Lower Limit
High Resolution	Enabled	Min	-10.000	-9.931	-10.069
		Mid	0.000	0.015	-0.015
		Max	10.000	10.069	9.931



Note The test limits in this table are derived using the values in the *NI 9775 Accuracy Under Calibration Conditions* table.



Note The uncertainty of the calibration standard is not included in these limits.

7. Set the calibrator to Standby mode (STBY).
8. Repeat steps 3 through 7 for each test point in the *NI 9775 Verification Limits for DC Accuracy* table.
9. Repeat steps 3 through 8 for each channel configuration in the *NI 9775 Channel Properties Configuration for DC Accuracy Verification* table.
10. Disconnect the NI 9775 from the calibrator.

Adjustment

The following performance adjustment procedure describes the sequence of operation required to adjust the NI 9775.

AC Accuracy Adjustment

Complete the following procedure to adjust the AC accuracy performance of the NI 9775.



Note Adjust AC accuracy first, then DC accuracy. Always adjust DC accuracy whenever you adjust AC accuracy.

1. Set the calibrator to Standby mode (STBY).
2. Connect the NI 9775 to the calibrator as shown in the *AC Accuracy Verification* section.
3. Adjust the NI 9775.
 - a) Initialize a calibration session on the NI 9775. The default password is NI.
 - b) Input the external temperature in degrees Celsius with the DAQmx Set Temperature C Series Function.
 - c) Call the NI 9775 get C Series adjustment points function with coupling mode set to AC to obtain an array of recommended calibration frequency points for the NI 9775 Accuracy Adjustment.
 - d) Set the calibrator to a frequency value determined by the array or recommended calibration frequency points. The AC voltage amplitude should be the value as shown in the following table.

Table 11. Calibrator Configuration for AC Accuracy Adjustment

Output Function	Amplitude (V RMS)
AC Voltage	2.00

- e) Wait for one second to allow the output amplitude of the calibrator to settle.
- f) Call and configure the NI 9775 adjustment function according to the following table.

Table 12. NI 9775 AC Adjustment Configuration

Physical Channel	Coupling Mode	Reference Value
cDAQMod8/AI0:3	AC	The output frequency setting of the calibrator in Hz

- g) Repeat steps d through f for each point in the adjustment points array obtained in step c.
 - h) Close and commit the calibration session.
 - i) Clear the task.
4. Set the calibrator to Standby mode (STBY).
 5. Disconnect the NI 9775 from the calibrator.

DC Accuracy Adjustment

Complete the following procedure to adjust the DC accuracy performance of the NI 9775.

1. Set the calibrator to Standby mode (STBY).
2. Connect the NI 9775 to the calibrator as shown in the *AC Accuracy Verification* section.
3. Adjust the NI 9775.
 - a) Initialize a calibration session on the NI 9775. The default password is NI.
 - b) Input the external temperature in degrees Celsius.
 - c) Call the NI 9775 get C Series adjustment points function with coupling mode set to DC to obtain an array of recommended calibration voltages for the NI 9775.
 - 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 9775 adjustment function according to the following table.

Table 13. NI 9775 DC Adjustment Configuration

Physical Channel	Coupling Mode	Reference Value
cDAQMod8/AI0:3	DC	The output voltage setting of the calibrator

- g) Set the calibrator to Standby mode (STBY).
 - h) Repeat steps d through g for each calibration voltage in the array.
 - i) Close and commit the calibration session.
 - j) Clear the task.
4. Disconnect the NI 9775 from the calibrator.

EEPROM Update

When an adjustment procedure is completed, the NI 9775 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 You must remove and re-insert the module from the chassis before running verification.



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 $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$
- NI 9775 installed in slot 8 of an cDAQ-9178 chassis
- Slots 1 through 7 of the cDAQ-9178 chassis are empty



Note The test limits listed in *NI 9775 Verification Limits for DC Accuracy* table are derived using the values in the following table.

Table 14. NI 9775 Accuracy Under Calibration Conditions

Accuracy Type	Gain Error	Offset Error (mV)
AC	$\pm 1.39\%$	—
DC	$\pm 0.54\%$	$\pm 15\text{ mV}$



Note For operational specifications, refer to the *NI 9775 Datasheet* online at ni.com/manuals.

Worldwide Support and Services

The NI 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 NI product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

A Declaration of Conformity (DoC) is our claim of compliance with the Council of the European Communities using the manufacturer's declaration of conformity. This system affords the user protection for electromagnetic compatibility (EMC) and product safety. You can obtain the DoC for your product by visiting ni.com/certification. If your product supports calibration, you can obtain the calibration certificate for your product at ni.com/calibration.

NI corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. NI also has offices located around the world. For telephone support in the United States, create your service request at ni.com/support or dial 1 866 ASK MYNI (275 6964). For telephone support outside the United States, visit the *Worldwide Offices* section of ni.com/niglobal to access the branch office websites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

Information is subject to change without notice. Refer to the *NI Trademarks and Logo Guidelines* at 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. 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 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.

© 2018 National Instruments. All rights reserved.

376632A-01 February 28, 2018