

CALIBRATION PROCEDURE

NI PXIe-4357

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This document contains information about calibrating National Instruments PXIe-4357 SC Express modules using NI-DAQmx. For more information about calibration, visit ni.com/calibration.

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Software Requirements

Install NI-DAQmx 9.5 or later on the calibration computer. NI-DAQmx includes high-level function calls to simplify the task of writing software to calibrate modules. You must have the proper module driver installed on the calibration system before calibrating the module.



Note NI recommends that you install the NI-DAQmx driver software before physically installing the NI PXIe-4357. NI-DAQmx, available at ni.com/downloads, configures and controls the NI PXIe-4357.

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

Documentation Requirements

The following documents are your primary references for writing your calibration utility with NI-DAQmx. You can download the latest version of these documents from the NI Web site at ni.com/manuals.

- The *NI PXIe-4357 and TB-4357 Installation Guide and Terminal Block Specifications* provides instructions for installing and configuring the NI PXIe-4357 module and TB-4357 accessory. This document also contains TB-4357 specifications.
- The *NI PXIe-4357 User Manual* describes how to use the NI PXIe-4357.
- The *NI PXIe-4357 Specifications* lists the specifications for the NI PXIe-4357.
- The *NI-DAQmx Help* includes information about creating applications that use the NI-DAQmx driver.
- The *NI-DAQmx C Reference Help* includes information about the functions in the driver.

Calibration Interval

National Instruments recommends a calibration interval of one year for the NI PXIe-4357. You should adjust the recommended calibration interval based on the measurement accuracy demands of your application.

Test Equipment

National Instruments recommends that you use the equipment in Table 1 for calibrating an NI PXIe-4357 module.

Table 1. Recommended Equipment

Equipment	Recommended Model(s)	Requirements
Calibrator	Fluke 5520A	If this instrument is unavailable, use a calibrator that can provide resistance values in the range of 0 Ω to 400 Ω with 0.01 Ω resolution, an accuracy of 90 ppm or better, and automatic lead-wire compensation.
PXI Express chassis	NI PXIe-1062Q	—
Connection accessory	TB-4357 terminal block	Screw terminal accessory for the NI PXIe-4357.

Test Conditions

The following setup and environmental conditions are required to ensure the device meets published specifications:

- Keep connections to the module 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 module. Use twisted-pair wire to eliminate noise and thermal offsets.
- 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 measurement circuitry of the module is at a stable operating temperature.
- Ensure that the PXI Express chassis fan speed is set to HIGH, that the fan filters are clean, and that the empty slots contain filler panels. For more information, refer to the *Maintain Forced-Air Cooling Note to Users* document available at ni.com/manuals.

Calibration Procedure

This section provides instructions for verifying the performance of the NI PXIe-4357. The calibration process consists of the following steps:

1. *Initial Setup*—Install the module and configure it in Measurement & Automation Explorer (MAX).
2. *Verification*—Verify the existing operation of the module. This step confirms whether the module is operating within the published specifications prior to adjustment.
3. *Adjustment Procedure*—If necessary, perform an external calibration that adjusts the module calibration constants with respect to a known calibration source.
4. *Reverification*—Repeat the verification procedure to ensure that the module is operating within the published specifications after adjustment.

Initial Setup

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

Complete the following steps to configure a module in MAX. Refer to the *NI PXIe-4357 and TB-4357 Installation Guide and Terminal Block Specifications* for complete installation instructions.

1. Install the NI-DAQmx driver software.



Caution Always have the PXI Express chassis turned off when inserting a module.

2. Insert the module into an available slot in the PXI Express chassis.
3. Install the terminal block.
4. Power on the chassis.

5. Launch MAX.
6. Expand **Devices and Interfaces** to confirm that MAX detects the module.
7. Right-click the module name and select **Self-Test** to ensure that the module is working properly.



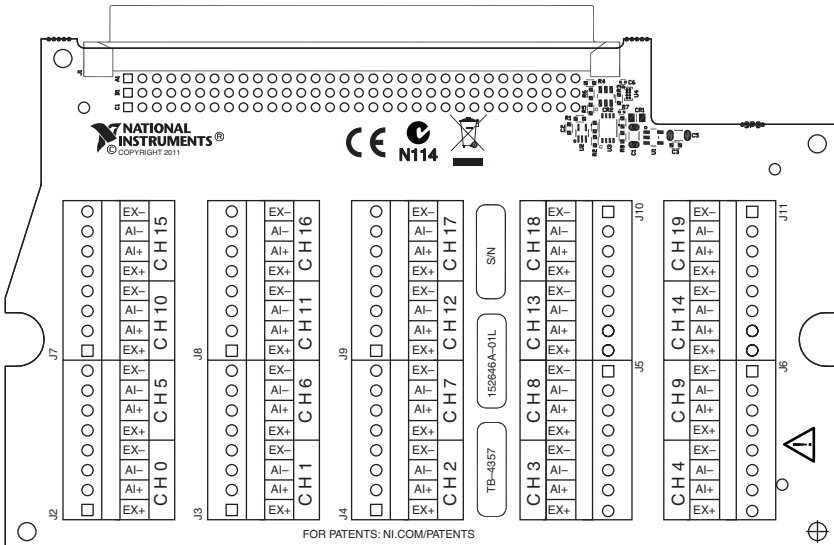
Note When a module is configured with MAX, it is assigned a module name. Each function call uses this module name to determine which DAQ module to calibrate. This document uses Dev1 to refer to the module name. In the following procedures, use the module name as it appears in MAX.

Connecting the Calibrator to the Module

Refer to the specific verification or calibration procedure section for information describing the required module connections. Each channel consists of a group of four pins specific to that channel. Before connecting or disconnecting the calibrator from the module, always set the calibrator to standby mode (STBY).

Refer to Figure 1 for the pin assignments of the TB-4357.

Figure 1. TB-4357 Pin Assignments



Refer to Table 2 for the analog signal names of the TB-4357.

Table 2. TB-4357 Analog Signal Names

Signal Names	Signal Descriptions
EX-	Excitation current return
EX+	Positive excitation current output
AI-	Negative analog input
AI+	Positive analog input

Verification

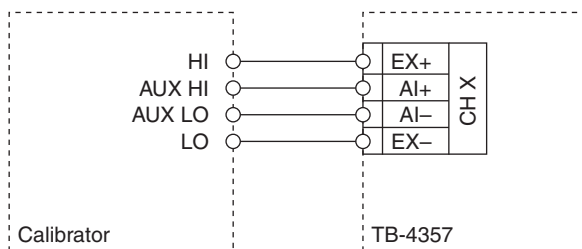
Verification determines how well the module is meeting its specifications. By completing this procedure, you can see how the module has drifted over time, which helps you determine the appropriate calibration interval for your application. The NI PXIe-4357 has 20 independent analog input channels. You can conduct verification on any or all of them, depending upon your desired test coverage.

4-Wire Accuracy Verification

Complete the following steps to test the 4-wire accuracy of the module.

1. Set the calibrator to standby mode (STBY).
2. Make the following connections to the TB-4357 for the channel you want to verify. Refer to Figure 2 for visual reference. Refer to the [Connecting the Calibrator to the Module](#) section for the pin assignments and signal names of the TB-4357.

Figure 2. 4-Wire Accuracy Verification Connections



3. Zero the calibrator with the ohms-only zero (OHMS ZERO) operation. Refer to the calibrator documentation for more information about zeroing the calibrator.
4. Set the calibrator output for 4-wire compensation (COMP 4-wire).
5. Set the calibrator resistance output to a 0 Ω .
6. Set the calibrator to operate mode (OPR).
7. Create a task.

8. Create and configure an AI Resistance channel according to the values in Table 3.

Table 3. 4-Wire Configuration Values

Configuration	Value
Channel Name	Dev1/aix, where x refers to the channel number
Min Input Limit	0
Max Input Limit	400
Units	Ohms
Resistance Configuration	4-wire
Current Excitation Source	Internal
Current Excitation Value	0.0009
Sample Clock Rate (Hz)	10
Sample Mode	Finite Samples
Samples to Read	10

9. Configure the timing properties for the task.
10. Start the task.
11. Acquire 10 points of data.
12. Average the readings that you acquired and record the result.
13. Clear the task.
14. Repeat steps 5 through 13 for all calibrator output values listed in Table 4. NI recommends that you verify all values, although you can save time by verifying only the values used in your application.
15. Compare the measured result for each value to the *Upper Limit (Ω)* and *Lower Limit (Ω)* values in Table 4. If the results are all between these values, the module passes the test.
16. Set the calibrator to standby mode (STBY).
17. Disconnect the calibrator from the module.
18. Repeat steps 2 through 17 for every channel you want to verify.

Table 4. 4-Wire Mode Accuracy Test Limits

Test Point (Ω)	Lower Limit (Ω)	Upper Limit (Ω)
0	-0.034	0.034
50	49.946	50.054
100	99.926	100.074
150	149.906	150.094
200	199.886	200.114
250	249.866	250.134
300	299.846	300.154
350	349.826	350.174
400	399.806	400.194

Adjustment Procedure

Use the adjustment procedure to adjust the gain and offset calibration constants for each channel. At the end of each calibration procedure, these new constants are stored in the external calibration area of the EEPROM. These values are password-protected, which prevents the accidental access or modification of any calibration constants adjusted by the metrology laboratory. The default password is NI. You can calibrate as many or as few channel and excitation configurations as desired. The calibration routine for the NI PXIe-4357 uses a two-point calibration to determine the gain and offset adjustment calibration constants.

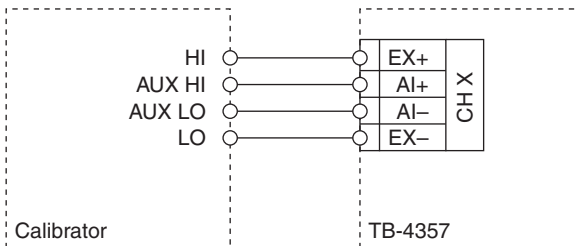
Complete the following steps to test the accuracy of the module.

1. Set the calibrator to standby mode (STBY).
2. Make the following connections to the TB-4357 for the channel you want to adjust. Refer to Figure 3 for visual reference. Refer to the [Connecting the Calibrator to the Module](#) section for the pin assignments and signal names of the TB-4357.

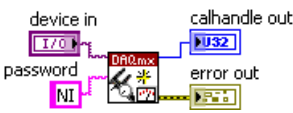


Note All connections shown in Figure 3 must be made using discrete connections.

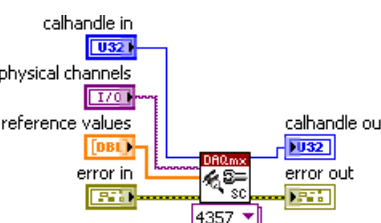
Figure 3. Adjustment Connections



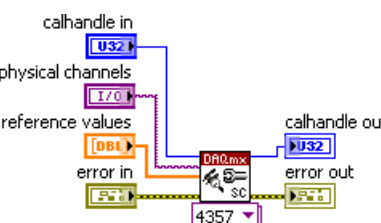
3. Zero the calibrator with the ohms-only zero (OHMS ZERO) operation. Refer to the calibrator documentation for more information about zeroing the calibrator. This step can be skipped if an OHMS ZERO has already been executed on the calibrator as required by the calibrator for the specified accuracy.
4. Set the calibrator output for 4-wire compensation (COMP 4-wire).
5. Set the calibrator resistance output to 100 Ω . This is the first calibration point.
6. Set the calibrator to operate mode (OPR).
7. Open a calibration session on your module using the DAQmx Initialize External Calibration VI. The default password is NI.

LabVIEW Block Diagram	NI-DAQmx Function Call
 <p>The diagram shows a DAQmx Init Ext Cal block. It has three inputs: 'device in' (I70), 'password' (NI), and 'calhandle out' (U32). It has two outputs: 'error out' (E7) and 'calhandle out' (U32).</p>	<p>Call DAQmxInitExtCal with the following parameters:</p> <p>deviceName: Dev1 password: NI calHandle: &calHandle</p>

8. Call the DAQmx Adjust 4357 Calibration VI.

LabVIEW Block Diagram	NI-DAQmx Function Call
 <p>The diagram shows a DAQmx Adjust 4357 Cal block. It has four inputs: 'calhandle in' (U32), 'physical channels' (I70), 'reference values' (DB1), and 'error in' (E7). It has two outputs: 'calhandle out' (U32) and 'error out' (E7). A dropdown menu is set to '4357'.</p>	<p>Call DAQmxAdjust4357Cal with the following parameters:</p> <p>calHandle: calHandle physicalChannel: Dev1/aix, where x refers to the channel number. refValues: [100] numRefValues: 1</p>

9. Set the calibrator to output a resistance of 350 Ω . This is the second calibration point.
10. Call the DAQmx Adjust 4357 Calibration VI.

LabVIEW Block Diagram	NI-DAQmx Function Call
 <p>The diagram shows a DAQmx Adjust 4357 Cal block. It has four inputs: 'calhandle in' (U32), 'physical channels' (I70), 'reference values' (DB1), and 'error in' (E7). It has two outputs: 'calhandle out' (U32) and 'error out' (E7). A dropdown menu is set to '4357'.</p>	<p>Call DAQmxAdjust4357Cal with the following parameters:</p> <p>calHandle: calHandle physicalChannel: Dev1/aix, where x refers to the channel number. refValues: [350] numRefValues: 1</p>

- Save the adjustment to the EEPROM, using the DAQmx Close External Calibration VI. This VI also saves the date, time, and temperature of the adjustment to the onboard memory.



Note If an error occurs during adjustment, no constants will be written to the EEPROM.

LabVIEW Block Diagram	NI-DAQmx Function Call
	<p>Call <code>DAQmxCloseExtCal</code> with the following parameters:</p> <p>calHandle: calHandle action: DAQmx_Val_Action_Commit</p>

- Repeat steps 1 through 11 for each channel to be adjusted.
- Set the calibrator to standby mode (STBY).
- Disconnect the calibrator from the module.

The module is now calibrated with respect to your external source. After calibrating the module, you must reverify the accuracy of the module. To do this, repeat the [Verification](#) section.

Specifications

The specifications in Table 5 are provided for reference only, refer to the *NI PXIe-4357 Specifications* and *NI PXIe-4357 User Manual* for detailed specification and application information. The values in Table 5 are based on calibrated scaling coefficients, which are stored in the onboard EEPROM. The following calibration specifications are for 23 °C ±5 °C.

Table 5. NI PXIe-4357 Measurement Accuracy, 1 Year, 23 °C ±5 °C Max, 4-Wire Mode

Offset Error (Ω)	Gain Error (% of Reading)
0.034	0.04

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, visit the Worldwide Offices section of ni.com/global to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

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