

CALIBRATION PROCEDURE

NI PXIe-4304/4305

32 Ch, 24-bit, ± 42 V, 5 kS/s or 51.2 kS/s Simultaneous Filtered Data Acquisition Module

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This document contains the verification and adjustment procedure for the National Instruments PXIe-4304/4305 module.

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Software

Calibrating the NI PXIe-4304/4305 requires the installation of NI-DAQmx on the calibration system. Driver support for calibrating the PXIe-4304/4305 was first available in NI-DAQmx 15.1.1. For the list of devices supported by a specific release, refer to the *NI-DAQmx Readme*, available on the version-specific download page or installation media.

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 PXIe-4304/4305, NI-DAQmx, and your application software. All documents are available on ni.com, and help files install with the software.



NI PXIe-4304/4305 and TB-4304 User Guide and Terminal Block Specifications

NI-DAQmx driver software installation and hardware setup.



NI PXIe-4304/4305 User Manual

PXIe-4304/4305 usage and reference information.



NI PXIe-4304/4305 Specifications

PXIe-4304/4305 specifications and calibration interval.



NI-DAQmx Readme

Operating system and application software support in NI-DAQmx.



NI-DAQmx Help

Information about creating applications that use the NI-DAQmx driver.



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.

PXIe-4304/4305 Verification and Adjustment

This section provides information for verifying and adjusting the PXIe-4304/4305.

Test Equipment

Table 1 lists the equipment recommended for the performance verification and adjustment procedures of the PXIe-4304/4305. If the recommended equipment is not available, select a substitute using the requirements listed in Table 1.

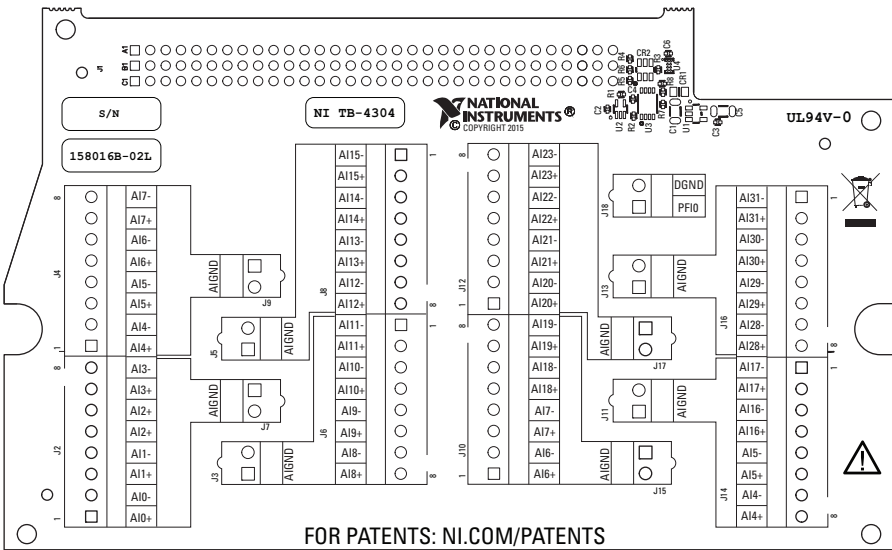
Table 1. Recommended Equipment for PXIe-4304/4305 Verification and Adjustment

Equipment	Recommended Model	Requirements
DMM	PXI-4071	Use a DMM that has an accuracy of 32 ppm or better when measuring voltages higher than 10 V and an accuracy of 2.1 μ V or better when measuring 0 V.
PXI Express Chassis	PXIe-1062Q	If this chassis is unavailable, use another PXI Express chassis, such as the PXIe-1082 or PXIe-1078.
Connection Accessory	TB-4304	—
SMU	PXIe-4139	Noise (0.1 Hz to 10 Hz, peak to peak) is 60 μ V or better when outputting voltages higher than 10 V. Noise (0.1 Hz to 10 Hz, peak to peak) is 2 μ V or better when outputting 0 V.

Connecting the TB-4304

The TB-4304 provides connections for the PXIe-4304/4305. Figure 1 shows the pin assignments of the TB-4304.

Figure 1. TB-4304 Circuit Board Parts Locator Diagram



Each channel consists of two terminal connections specific to that channel as shown in Table 2. You can verify or adjust the accuracy for any or all channels depending on the desired test coverage. Refer to Figure 2 and only connect the input channels required for verification or adjustment in parallel.

Refer to Table 2 for the analog signal names of the TB-4304.

Table 2. TB-4304 Analog Signal Names

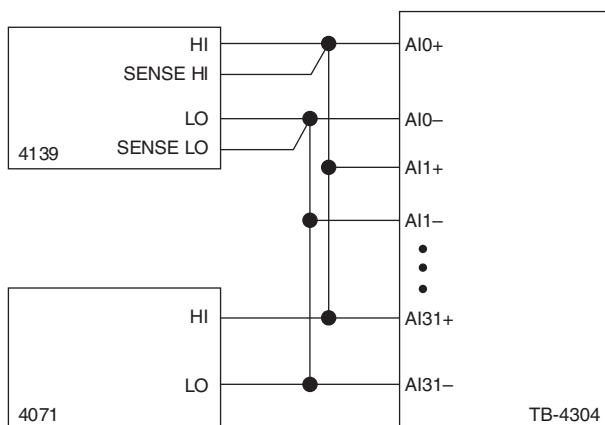
Signal Name	Signal Description
AI+	Positive input voltage terminal
AI-	Negative input voltage terminal
AIGND	Analog ground input

Complete the following steps to connect the TB-4304.

1. Install the PXIe-4304/4305 and the TB-4304 in the PXI Express chassis according to the instructions in the *NI PXIe-4304/4305 and TB-4304 User Guide and Terminal Block Specifications*.
2. Configure the PXIe-4139 to voltage output mode and enable remote sensing. Connect the PXIe-4139 output to the TB-4304 as shown in Figure 2.

- Connect the PXI-4071 to measure the differential voltage across the TB-4304 AI+ and AI- terminals. A detailed wiring diagram is shown in Figure 2.

Figure 2. Connecting the TB-4304



Test Conditions

The following setup and environmental conditions are required to ensure the PXIe-4304/4305 meets published specifications.

- Keep connections to the PXIe-4304/4305 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 TB-4304 are secure.
- Use shielded copper wire for all cable connections to the TB-4304. Use twisted-pair wire to eliminate noise and thermal offsets.
- Maintain an ambient temperature of $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. The PXIe-4304/4305 temperature will be greater than the ambient temperature. Maintain an internal device temperature range of $T_{cal} \pm 5\text{ }^{\circ}\text{C}$ for the PXI-4071.¹
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 15 minutes to ensure that the PXIe-4304/4305 measurement circuitry is at a stable operating temperature.
- Ensure that the PXI/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.

¹ T_{cal} is the internal device temperature recorded by the PXI-4071 at the completion of the last self-calibration.

Initial Setup

Refer to the *NI PXIe-4304/4305 and TB-4304 Installation Guide and Terminal Block Specifications* for information about how to install the software and hardware and how to configure the device in NI Measurement & Automation Explorer (MAX).



Note When a device is configured in MAX, it is assigned a device identifier. Each function call uses this identifier to determine which DAQ device to verify or to verify and adjust. This document uses `Dev1` to refer to the device name. In the following procedures, use the device name as it appears in MAX.



Note If you are using the PXIe-4139 as a source, no self-calibration is required.

Accuracy Verification

The following performance verification procedures describe the sequence of operations and provides the test points required to verify the PXIe-4304/4305. The verification procedures assume that adequate traceable uncertainties are available for the calibration references.

The PXIe-4304/4305 has 32 independent analog input channels. You can verify the accuracy of any or all of the channels depending upon your desired test coverage.

Complete the following steps to verify the voltage mode accuracy of the PXIe-4304/4305.

1. Set the PXIe-4139 voltage output to zero volts.
2. Connect the PXIe-4139 and PXI-4071 to the TB-4304 as shown in Figure 2.
3. Use Table 3 to configure the PXIe-4139 to output a Test Point value for the appropriate range shown in Table 6, beginning with the values in the first row.

Table 3. PXIe-4139 Voltage Output Setup

Configuration	Value
Function	Voltage output
Sense	Remote
Range	600 mV range for test points of 0 V
	60 V range for all other test points
Current Limit	20 mA
Current Limit Range	200 mA

4. Refer to Table 4 to configure the PXI-4071 and acquire a voltage measurement.

Table 4. PXI-4071 Voltage Measurement Setup

Configuration	Value
Function	DC measurement
Range	1 V range for test points of 0 V.
	100 V range for all other test points.
Digital Resolution	7.5 digits
Aperture Time	100 ms
Autozero	On
ADC Calibration	On
Input Impedance	10 M Ω
DC Noise Rejection	High Order
Number of Averages	1
Power Line Frequency	Dependent upon the local power line characteristics.

5. Acquire a voltage measurement with the PXIe-4304/4305.
 - a. Create a DAQmx task.
 - b. Create and configure the AI channel according to the values shown in Table 5.

Table 5. AI Voltage Mode Setup

Configuration	Value
Channel Name	Dev1/aiX, where X refers to the channel number
Task	AI voltage
Sample Mode	Finite samples
Sample Clock Rate	5000
Samples per Channel	5000
Maximum Value	Appropriate maximum range value from Table 6
Minimum Value	Appropriate minimum range value from Table 6
Units	Volts

- c. Start the task.
- d. Average the readings that you acquired.

- e. Clear the task.
- f. Compare the resulting average to the *Lower Limit* and *Upper Limit* values in Table 6. If the result is between these values, the device passes the test.

Table 6. Voltage Measurement Accuracy Limits

Range (V)		Test Point (V)	Lower Limit (V)	Upper Limit (V)
Minimum	Maximum			
-42	42	-39.9	DMM Reading - 0.019263 V	DMM Reading + 0.019263 V
-42	42	0	DMM Reading - 0.0045 V	DMM Reading + 0.0045 V
-42	42	39.9	DMM Reading - 0.019263 V	DMM Reading + 0.019263 V

6. For each value in Table 6, repeat steps 3 through 5 for all channels.
7. Set the PXIe-4139 output to be zero volts.
8. Disconnect the PXIe-4139 and PXI-4071 from the TB-4304.

Adjustment

The following performance adjustment procedure describes the sequence of operations required to adjust the PXIe-4304/4205.

Complete the following steps to adjust the accuracy of the PXIe-4304/4205.

1. Set the PXIe-4139 output to be zero volts.
2. Connect the PXIe-4139 and PXI-4071 to the TB-4304 as shown in Figure 2.
3. Call the DAQmx Initialize External Calibration function with the following parameters:
 - Device In:** Dev1
 - Password¹:** NI
4. Call the 4304/4305 instance of the DAQmx Setup SC Express Calibration function with the following parameters:
 - calhandle in:** calhandle output from DAQmx Initialize External Calibration
 - rangeMax:** Appropriate Range Max starting with the first Test Point value in Table 7
 - rangeMin:** Appropriate Range Min starting with the first Test Point value in Table 7
 - physical channels:** dev1/ai0:31

¹ The default password is NI, which can be changed. Refer to the *NI-DAQmx Help* for details.

Table 7. Voltage Mode Adjustment Test Points

Range (V)		Test Points (V)
Max	Min	
42	-42	-37.8
		-25.2
		-12.6
		0
		12.6
		25.2
		37.8

5. Refer to Table 3 to configure the PXIe-4139. Set the PXIe-4139 output equal to the first Test Point for the corresponding range in Table 7 that was configured in step 4.
6. Enable the PXIe-4139 output.
7. Refer to Table 4 to configure the PXI-4071 and acquire a voltage measurement.
8. Call the 4304/4305 instance of the DAQmx Adjust SC Express Calibration function with the following parameters:
 - calhandle in:** calhandle output from DAQmx Initialize External Calibration reference
 - voltage:** DMM measurement value from step 7
9. Repeat steps 5 through 8 for the remaining Test Point values from Table 7 for the corresponding range that was configured in step 4.
10. Repeat steps 4 through 9 for the remaining ranges from Table 7.
11. Call the 4304/4305 instance of the DAQmx Adjust SC Express Calibration function with the following parameters:
 - calhandle in:** calhandle output from DAQmx Initialize External Calibration
 - action:** commit

EEPROM Update

When an adjustment procedure is completed, the PXIe-4304/4305 internal calibration memory (EEPROM) is immediately updated.

If you do not want to perform an adjustment, you can update the calibration date without making any adjustments by initializing an external calibration and closing the external calibration.

Reverification

Repeat the [Accuracy 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 [World Wide Support and Services](#) for assistance in returning the device to NI.

Specifications

Refer to the *NI PXIe-4304/4305 Specifications* document for detailed PXIe-4304/4305 specification information.

World Wide 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.

Visit ni.com/register to register your National Instruments product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

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