

CALIBRATION PROCEDURE

NI TB-4353

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This document contains information about verifying National Instruments PXIe-4353 modules using NI-DAQmx 9.3 and later. It also contains information about verifying systems that include both the NI PXIe-4353 and TB-4353. For more information about calibration, visit ni.com/calibration.

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Software Requirements

Install NI-DAQmx 9.3 or later on the calibration computer. 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-4353. NI-DAQmx, available at ni.com/downloads, configures and controls the NI PXIe-4353.

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

You can access the NI-DAQmx header file, `NIDAQmx.h`, like any standard library. To find examples for using the NI-DAQmx driver, go to ni.com/info and enter the Info Code `NIDAQmxExLoc`. There you will find the topic *Where Can I Find NI-DAQmx Examples?* that provides example information.

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-4353 and TB-4353 Installation Guide and Terminal Block Specifications* provides instructions for installing and configuring the NI PXIe-4353 module and TB-4353 accessory.
- The *NI PXIe-4353 User Manual* describes how to use the NI PXIe-4353.
- The *NI PXIe-4353 Specifications* lists the specifications for the NI PXIe-4353.
- The *NI PXIe-4353 Calibration Procedure* provide calibration information for the NI PXIe-4353.
- The *CAL-4353 Specifications* lists the specifications for the CAL-4353.
- 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 TB-4353. 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 instruments in Table 1 for calibrating an NI PXIe-4353 module.

Table 1. Recommended Equipment

Equipment	Recommended Model	Requirements
Thermocouple Calibrator	Ectron 1140A	If this instrument is unavailable, use a high precision thermocouple source with an accuracy of at least 0.08 °C and an output impedance of $\leq 10 \Omega$.
Thermocouple Wire	TT-E-24-SLE-100	E-type SLE 24 AWG, 20 to 30 meters
Thermocouple Connector	Omega P/N: SMPW-E-M	E-type, must fit the output terminal of the thermocouple calibrator
Thermocouple Barrier Strips	Omega P/N: BS16A (x4)	32 channels
Thermocouple Barrier Strip Jackets	Omega P/N: BSJ-E (x6)	E-type, 32 channels
Thermocouple Spade Lugs	Omega P/N: SLCH-20 (x4), SLCO-20 (x4)	64 lugs of Chromel, 64 lugs of Constantan to match the E-type wires
Spade-Lug Crimping Tool	Omega P/N: CRIMPING TOOL-P	Must effectively crimp the spade lugs with the 24 AWG wire
PXI Express Chassis	NI PXIe-1062Q	—
Accessory	TB-4353	This accessory is used for system verification
Calibrated NI PXIe-4353 Module	NI PXIe-4353	The module must be verified to be within its specifications

Test Conditions

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

- Keep connections to the module 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 device are secure.
- Maintain an ambient temperature of $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. The module temperature will be greater than the ambient temperature.
- Keep relative humidity below 80%.
- Allow a warm-up time of 15 minutes to ensure that the measurement circuitry of the NI PXIe-4353 and TB-4353 are at a stable operating temperature.
- Use shielded wire for all cable connections to the module. Use twisted-pair wire to eliminate noise.
- 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.
- To correctly verify the TB-4353, the NI PXIe-4353 must be currently verified to be within the product specifications. If they are not, verify the NI PXIe-4353 before verifying the TB-4353. Refer to the *NI PXIe-4353 Calibration Procedure* to verify the NI PXIe-4353 as needed.

TB-4353 Calibration Procedure

This section provides instructions for verifying the performance of a TB-4353. The system-level calibration process consists of the following steps:

1. **Initial Setup**—Configure the NI PXIe-4353 and the TB-4353 in NI-DAQmx.
2. **Verifying Module Operating Temperature Changes**—Verify that the current module operating temperature will not cause you to incorrectly calibrate your module.
3. **Terminal Block Temperature Accuracy Verification**—Verify the existing operation of the NI PXIe-4353 with the TB-4353. This step confirms whether the module and terminal block are operating within the specified range or require adjustment.
4. **Adjustment**—If the system falls within the desired specifications, you can skip this step. If the NI PXIe-4353 does not fall within the desired specifications, verify that the NI PXIe-4353 passed verification in the *NI PXIe-4353 Calibration Procedure* document and that all test conditions are followed.
If the NI PXIe-4353 passed verification and the test conditions are valid, return the TB-4353 to the factory for analysis.
5. **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-4353 and TB-4353 Installation Guide and Terminal Block Specifications* for complete installation instructions.



Note You can also perform the self-test operation programmatically, using the DAQmx Self-Test Device VI or the equivalent C#.NET functionality.

1. Install the NI-DAQmx driver software.



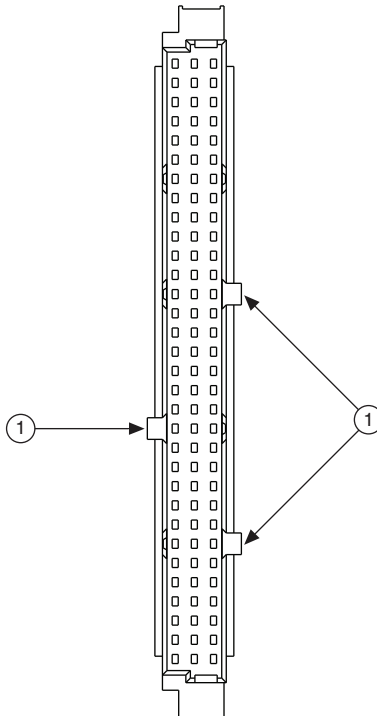
Caution Always have the PXI Express chassis powered off when inserting a module.

2. Insert the calibrated NI PXIe-4353 into an available slot in the PXI Express chassis.



Caution Make sure the TB-4353 has three keys installed in its connector and that none of the keys are loose. The keying locations are shown in Figure 1. If any of the three keys are missing or loose, refer to the [Where to Go for Support](#) section for assistance in returning the terminal block to NI.

Figure 1. TB-4353 Connector Key Locations



1 Key Locations

3. Attach the TB-4353 to the NI PXIe-4353.
4. Power on the chassis.
5. Launch MAX.
6. Expand **Devices and Interfaces** to confirm that MAX detects the module and terminal block. The terminal block should appear beneath its associated module.
7. Right-click **NI PXIe-4353** and select **Self-Test** to ensure that the module is working properly.

Verifying Module Operating Temperature Changes

A module operating temperature greater than ± 10 °C since the previous calibration adjustment can cause you to incorrectly calibrate your module. The onboard temperature sensor on the module can be used to verify that this condition does not exist. Complete the following steps to compare the current module temperature to the temperature measured during the last calibration.



Note You can also query the temperatures programmatically, using the DAQmx Calibration Info property node or the equivalent C/.NET functionality.

1. Launch MAX.
2. Select **My System»Devices and Interfaces»Chassis 1»NI PXIe-4353**.
3. Click the **Calibration** tab.

If the difference between the current operating temperature and the operating temperature from the last calibration adjustment is greater than 10 °C, the limits in the calibration tables are not valid.



Note The temperature reading returned by the module is an internal temperature. Typically, the internal temperature is approximately 10 °C warmer than the ambient temperature.

If the module temperature difference is outside the maximum range, you should change the system so that the operating temperature will be closer to the temperature recorded during the last calibration adjustment.

Terminal Block Temperature Accuracy Verification

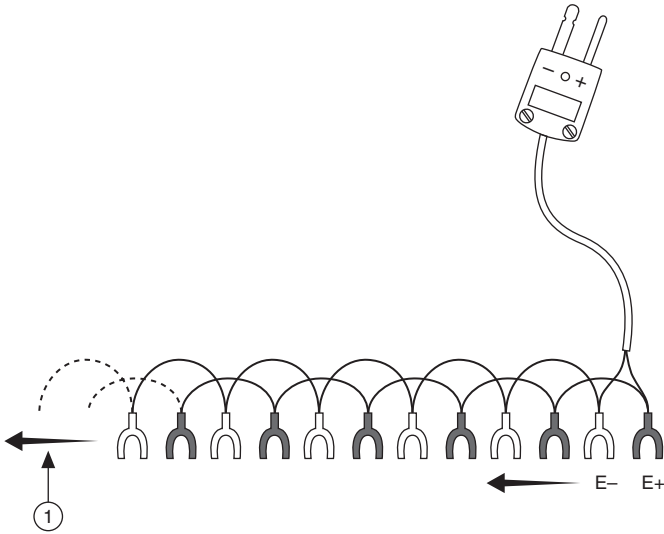
System-level verification determines how well the module and terminal block meet the temperature accuracy specifications. By completing the following procedure, you can determine the terminal block drift over time. Table 3, in the [Terminal Block Verification Test](#) section, shows the test points and test limits for the terminal block. Throughout the temperature accuracy verification process, use Table 3 to determine if the module is operating within its specified range.

1. Use the single thermocouple wire, the spade lugs, the spade-lug crimping tool, and the mini-thermocouple connector to make a wire with a compensated mini-thermocouple connector on one end and multiple spade-lug leads on the other end as shown in Figure 2.



Note Compensated spade-lug colors in Figures 2, 3, and 5 are for illustration purposes only and are used to easily differentiate + and –.

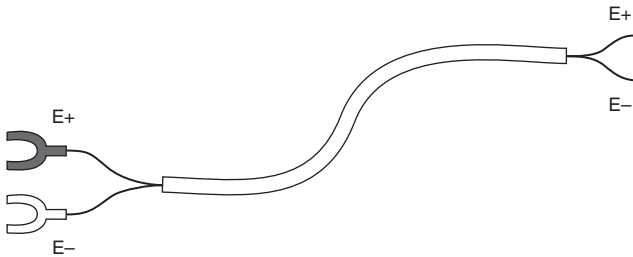
Figure 2. Mini-Thermocouple Connector to Compensated Spade-Lug Assembly



1 Total of 32 Terminals

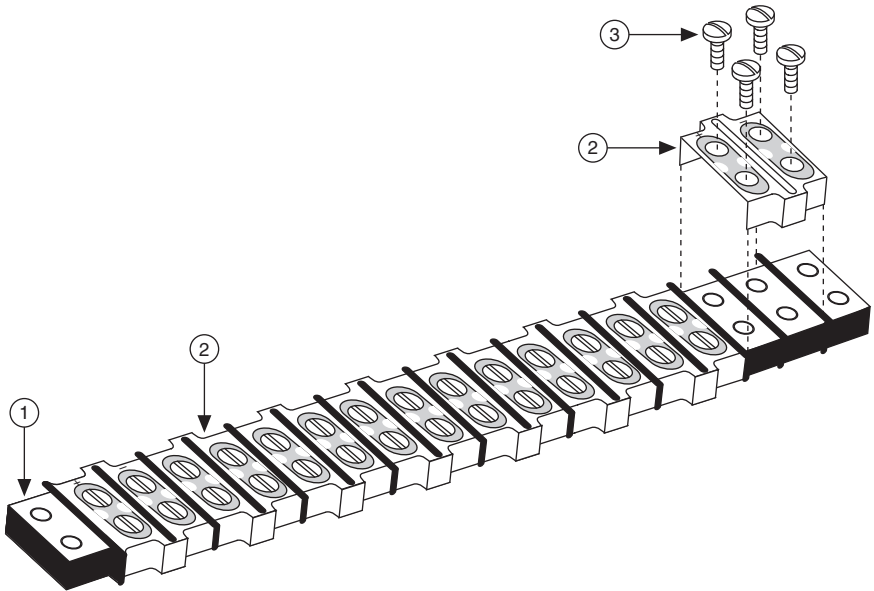
- Using the thermocouple wire and the remaining spade lugs, make 32 cables with bare leads on one end and the compensated spade lugs on the other end as shown in Figure 3.

Figure 3. Thermocouple Compensated Spade-Lug Assembly



3. Assemble the barrier strips and barrier strip jackets as indicated by the manufacturer while referring to Figure 4.

Figure 4. Barrier Strip Jacket Installation



1 Barrier Strip

2 Barrier Strip Jacket

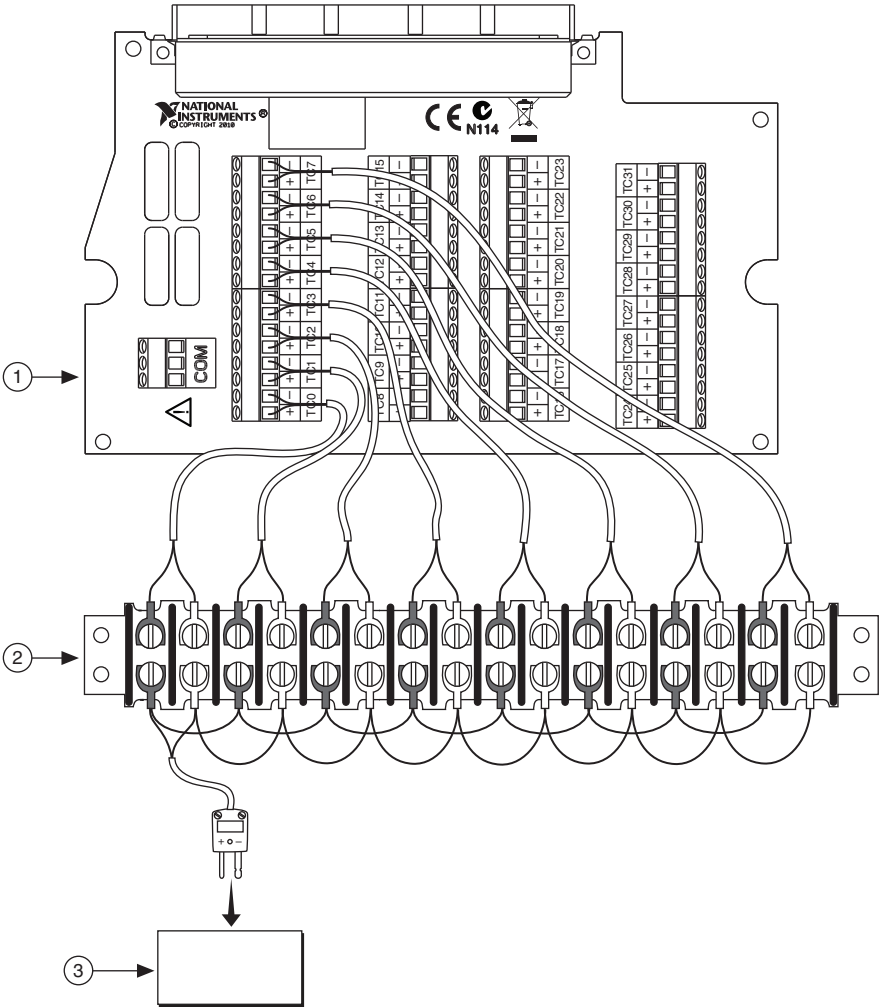
3 Terminal Screws

- Using the assembled barrier strips and cables from steps 1 through 3, make the connections shown in Figure 5 between the thermocouple calibrator and the 32 channels of the TB-4353.



Note Figure 5 shows wiring for eight channels. Make similar connections for the 24 remaining channels.

Figure 5. Thermocouple Calibrator to TB-4353 Connections



Not to Scale

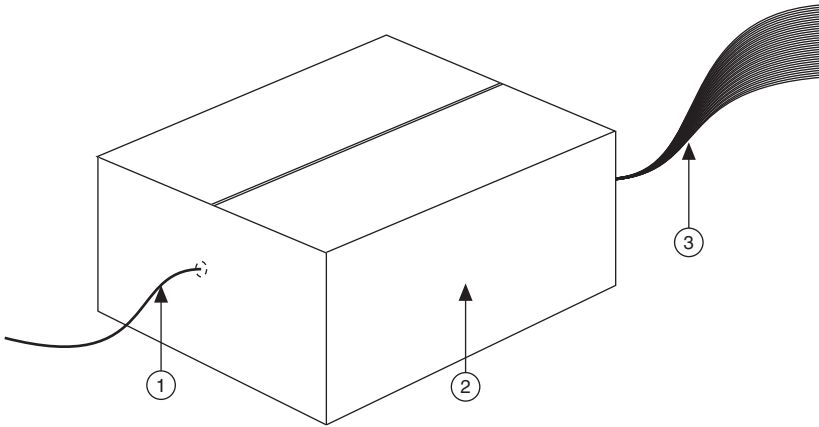
1 TB-4353

2 Barrier Strip Assembly

3 Thermocouple Calibrator

5. Place the barrier strip section into an otherwise empty box. Close the lid and leave only a small opening for the wires to enter and exit the box as shown in Figure 6. This setup isolates the barrier strip from air currents and rapid temperature transients. Refer to Figure 6.

Figure 6. Rapid Temperature Transient Isolation Box



1	One Channel In	2	Empty Box Containing Barrier Strip	3	32 Channels Out
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6. Power on the thermocouple calibrator and set the thermocouple type to E-type.
7. Ensure that the cover is installed properly on the terminal block.
8. Wait the warm-up time required by the thermocouple calibrator or 15 minutes, whichever is longer.
9. Create and configure an AI Temp Built-In Sensor channel for CJC channel `_cjc_temp0` on the NI PXIe-4353.
10. Set the timing mode to 1 (High Resolution).
11. Configure the timing properties for a finite acquisition with a sample clock rate of 1 S/s and 30 samples per channel.
12. Start the temperature acquisition.
13. Average the temperature data and record this value as `cjc_temp0`.
14. Set the thermocouple calibrator output to `CJC_temp0`. This ensures that during the thermocouple measurements, the input channel measures very close to 0 V, which eliminates gain errors in the NI PXIe-4353.
15. Create and configure an AI Temp TC channel for the NI PXIe-4353 for all 32 channels.
16. For every sample, enable autozero and disable open thermocouple detection for the NI PXIe-4353.
17. Set the timing mode to 1 (High Resolution).
18. Configure the timing properties for the temperature acquisition according to Table 2.
19. Start the acquisition.

20. Acquire the temperature data.



Note Make sure the thermocouple calibrator and NI PXIe-4353 are completely settled at the desired temperature setting before acquiring data. When using the Ectron 1140A, wait at least 300 ms for the system to settle before issuing the start task function to the NI PXIe-4353.

21. Average the temperature values separately for each channel that you acquired and record the average as *Temperature_Ch_x* (where *x* is the number of the particular channel). Subtract *CJC_temp0* from each average. Record the difference as *Temperature_error_Ch_x* (where *x* is the number of the particular channel). Compare the resulting errors for each channel to the *Upper Limit* and *Lower Limit* values in Table 3. If the result is between these values for each channel, the terminal block passes.

22. Clear the acquisition.

If the verification procedure determines that the TB-4353 is outside of the specifications, refer to the [Where to Go for Support](#) section for assistance in returning the terminal block to NI.

Table 2. Configuration Values

Configuration	Value (TC)
Physical Channel Name	Dev1/ai0:31
Sample Mode	Finite samples
Sample Clock Rate	1 S/s
Samples per Channel	30
Measurement Type	Thermocouple
Max Input Limit	100.0
Min Input Limit	0.0
Units	°C
Thermocouple Configuration	N/A
Thermocouple Type	E
CJC Source	Built-in
CJC Value	0.0

Limits

Table 3 lists the specifications that the NI PXIe 4353 and TB 4353 system should meet if it has been one year between calibrations. The following definitions describe how to use the information from Table 3:

- **Test Point**—The temperature value that is input for verification purposes.
- **1-Year Limits**—Contains the *Upper Limits* and *Lower Limits* for the test point value. That is, when the module is within its 1-year calibration interval, the test point value should fall between these upper and lower limit values.

Terminal Block Verification Test

Table 3 contains the terminal block verification test limits.

Table 3. Terminal Block Verification Test Limits with Autozero Enabled
(Timing Mode 1, High Resolution)

TC Type	Range (°C)		Test Point Value (°C)	1-Year Limits (°C)	
	Minimum	Maximum		Lower Limit	Upper Limit
E	-270	1000	CJC_temp0	-0.33	0.33

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/niglobal 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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