

CALIBRATION PROCEDURE

NI TC-4353

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ni.com/manuals

This document contains the verification procedure for the National Instruments TC-4353. For more information about calibration solutions, visit ni.com/calibration.

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Software

Calibrating the NI PXIe-4353 and TC-4353 requires the installation of NI-DAQmx 9.6 or later on the calibration system. You can download NI-DAQmx from ni.com/downloads. NI-DAQmx supports a number of programming languages, including 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 PXIe-4353 and TC-4353, NI-DAQmx, and your application software. All documents are available on ni.com and help files install with the software.



NI PXIe-4353 and TC-4353 Installation Guide and Terminal Block Specifications

Contains: NI-DAQmx installation and hardware setup



NI PXIe-4353 User Manual

Contains: NI PXIe-4353 specific information



NI PXIe-4353 Specifications

Contains: NI PXIe-4353 specifications and calibration interval



NI-DAQmx Readme

Contains: Operating system and application software support in NI-DAQmx



NI-DAQmx Help

Contains: information about creating applications that use the NI-DAQmx driver



LabVIEW Help

Contains: LabVIEW programming concepts and reference information about NI-DAQmx VIs and functions



NI-DAQmx C Reference Help

Contains: Reference information for NI-DAQmx C functions and NI-DAQmx C properties



NI-DAQmx .NET Help Support for Visual Studio

Contains: Reference information for NI-DAQmx .NET methods and NI-DAQmx .NET properties, key concepts, and a C enum to .NET enum mapping table

Test Equipment

Table 1 lists the equipment recommended for the performance verification procedures. If the recommended equipment is not available, select a substitute using the requirements listed in Table 1.

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 0.07 °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 Connector | Omega P/N: SMPW-E-M (x33) | E-type, mini-thermocouple connector to fit the terminals of the TC-4353 |
| 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 | — |
| Calibrated NI PXIe-4353 Module | NI PXIe-4353 | The module must be verified to be within its specifications |

Building and Connecting the TC-4353 Verification Assemblies

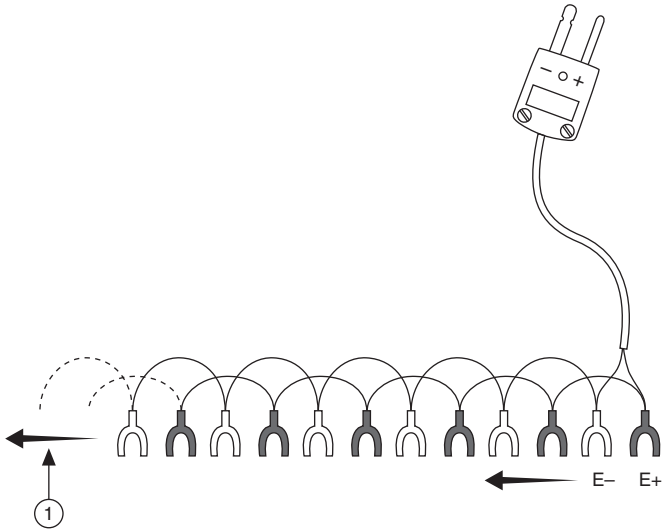
Complete the following steps to build and connect the TC-4353 verification assemblies:

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 1.



Note Compensated spade-lug colors in Figures 1, 2, and 4 are for illustration purposes only and are used to easily differentiate + and -.

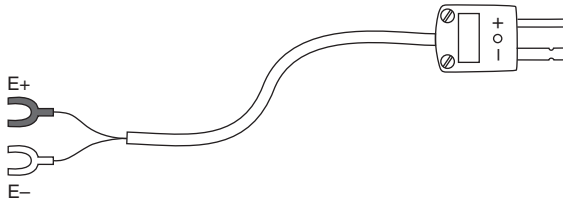
Figure 1. Mini-Thermocouple Connector to Compensated Spade-Lug Assembly



1 Total of 32 Terminals

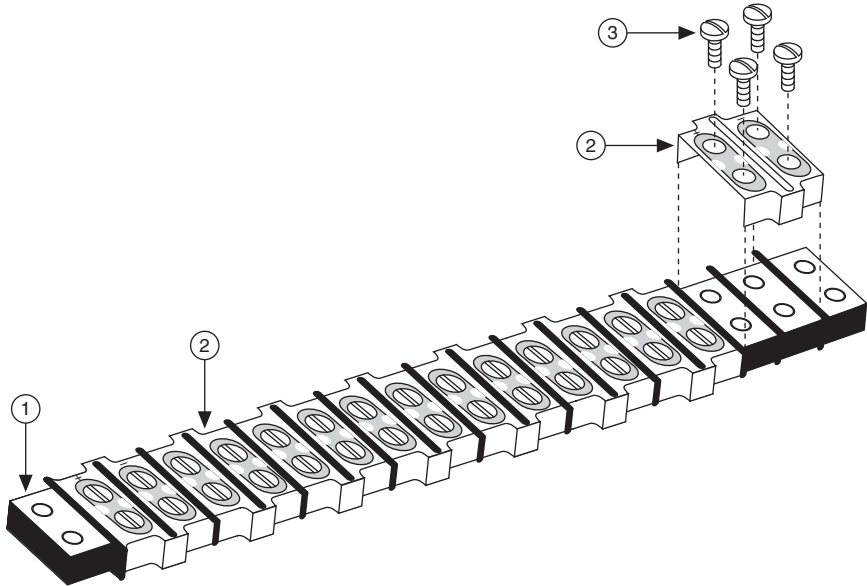
- Using a mini-thermocouple connector and the remaining spade lugs, make 32 cables with a mini-thermocouple connector on one end and the compensated spade lugs on the other end as shown in Figure 2.

Figure 2. Thermocouple Compensated Spade-Lug Assembly



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

Figure 3. Barrier Strip Jacket Installation



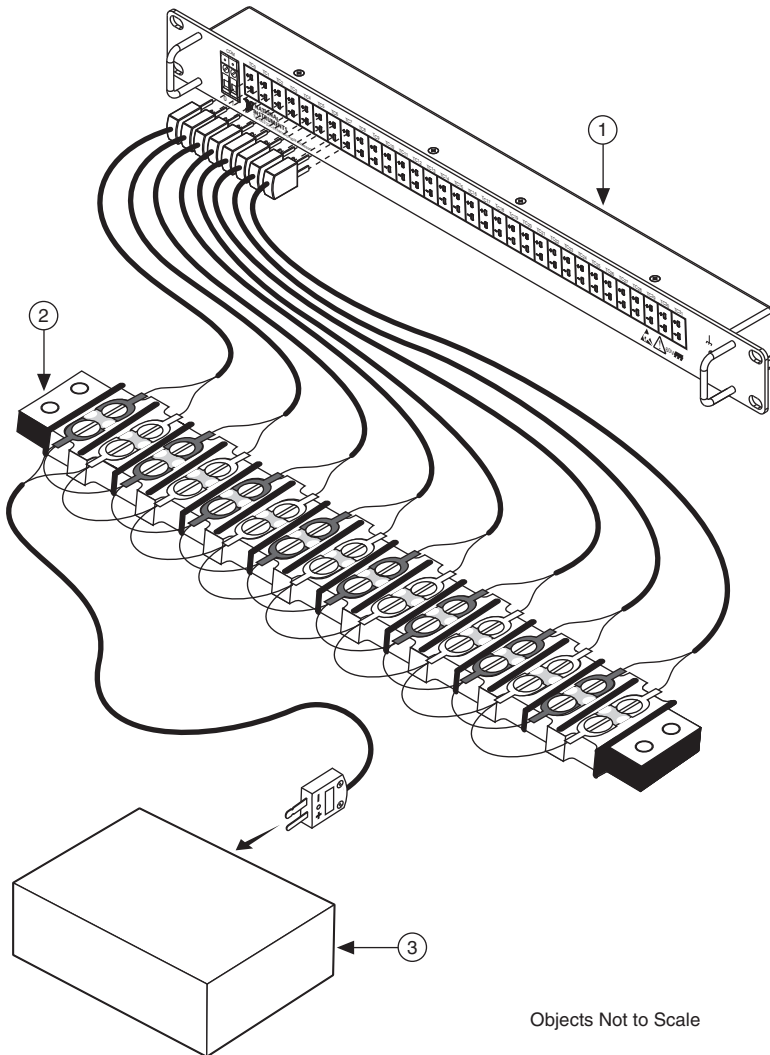
1 Barrier Strip 2 Barrier Strip Jacket 3 Terminal Screws

4. Using the assembled barrier strips and cables from steps 1 through 3, make the connections shown in Figure 4 between the thermocouple calibrator and the 32 channels of the TC-4353.



Note Figure 4 shows wiring for eight channels. Make similar connections for the 24 remaining channels.

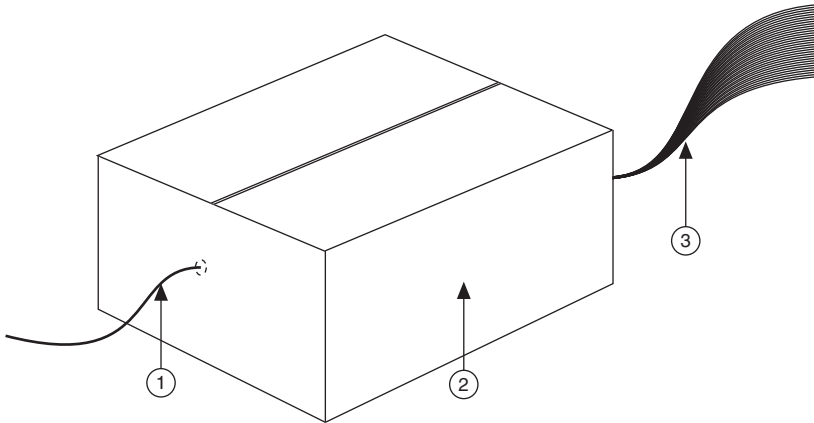
Figure 4. Thermocouple Calibrator to TC-4353 Connections



1 TC-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 5. This setup isolates the barrier strip from air currents and rapid temperature transients. Refer to Figure 5.

Figure 5. Rapid Temperature Transient Isolation Box



1 One Channel In

2 Empty Box Containing Barrier Strip

3 32 Channels Out

Test Conditions

The following setup and environmental conditions are required to ensure the NI PXIe-4353 meets published specifications.

- Keep connections to the NI PXIe-4353 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 PXIe-4353 are secure.
- Maintain an ambient temperature of $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. The NI PXIe-4353 temperature will be greater than the ambient temperature.
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 15 minutes to ensure that the NI PXIe-4353 and TC-4353 measurement circuitry are 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.
- To correctly verify the TC-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 TC-4353. Refer to the *NI PXIe-4353 Calibration Procedure* to verify the NI PXIe-4353 as needed.
- Maintain the TC-4353 in Configuration A, by placing it on a desk a few feet from the PXIe chassis and protect the TC-4353 from any nearby air currents. Do *not* place the TC-4353 in a rack with the NI PXIe-4353. Refer to the *NI PXIe-4353 and TC-4353 Installation Guide and Terminal Block Specifications* and Info Code TC4353CONFIGURATIONS for additional information.

Initial Setup

Refer to the *NI PXIe-4353 and TC-4353 Installation Guide and Terminal Block Specifications* for information about how to install the software and hardware and how to configure the device in Measurement & Automation Explorer (MAX).

Complete the following steps to configure a module in MAX. Refer to the *NI PXIe-4353 and TC-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.



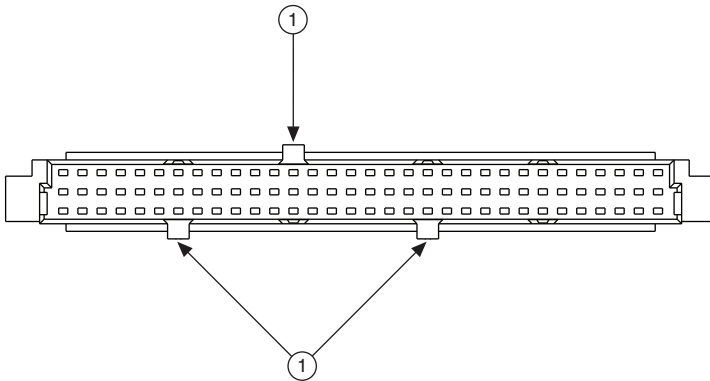
Caution Always have the PXI Express chassis powered off when inserting a module.

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



Caution Make sure the TC-4353 has three keys installed in its connector and that none of the keys are loose. The keying locations are shown in Figure 6. 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 6. TC-4353 Connector Key Locations



1 Key Locations

3. Screw the two standoffs into the NI PXIe-4353 module.
4. Connect the TC-4353 to the NI PXIe-4353 using the SH96-96-1 cable.
5. Power on the chassis.
6. Launch MAX.

7. Expand **Devices and Interfaces** to confirm that MAX detects the module and terminal block. The terminal block should appear beneath its associated module.
8. Right-click **NI PXIe-4353** and select **Self-Test** to ensure that the module is working properly.

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 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. Power on the thermocouple calibrator and set the thermocouple type to E-type.
2. Wait the warm-up time required by the thermocouple calibrator or 15 minutes, whichever is longer.
3. Acquire a CJC temp0 value.
 - a. Set the timing mode to 1 (High Resolution).
 - b. Configure the timing properties for a finite acquisition with a sample clock rate of 1 S/s and 30 samples per channel.
 - c. Start the task.
 - d. Average the temperature data and record this value as `cjc_temp0`.
4. 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.
5. Acquire and average data and determine the error.
 - a. For every sample, enable autozero and disable open thermocouple detection for the NI PXIe-4353.
 - b. Configure the temperature acquisition according to Table 2.



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. Start the acquisition.

- c. Start the task.



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.

- d. Determine the temperature error using the formula found below:

$$\text{Temperature_error_Ch_}x = \text{Temperature_Ch_}x - \text{CJC_temp}0$$

where

Temperature_error_Ch_x is the error in °C for channel *x*

Temperature_Ch_x is the average of measured temperature for channel *x*

CJC_temp0 is the temperature of the CJC and the temperature output of the calibrator

x is the number of a particular channel.

- e. Record the difference as *Temperature_error_Ch_x* (where *x* is the number of the particular channel).
6. 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.
7. Clear the task.

If the verification procedure determines that the TC-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 |
| Timing Mode | 1 (High resolution) |
| 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 Type | E |
| CJC Source | Built-in |
| CJC Value | 0.0 |

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 | -0.28 | 0.28 |

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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