Calibration Procedure

TS-15110

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TS-15110 Calibration Procedure

This document contains the verification and adjustment procedures for the TS-15110. Use the procedures in this document to automate calibration or to conduct manual calibration. Review and become familiar with the entire procedure before beginning the calibration process.

Contents

Terms and Definitions

DUT	DUT is an acronym for Device Under Test and refers to the NI product being calibrated. For this procedure, DUT refers to the TS-15110.
As-Found Limits	These limits are derived from the published specifications for the DUT. NI uses these limits to determine if the DUT is performing within the

	recommended calibration interval specifications at the time of calibration and before any adjustment is performed.
As-Left Limits	These limits are derived from the published specifications for the DUT minus guardband to ensure a high probability that the DUT will meet its specifications over the next recommended calibration interval.
Functional Test	Functional Tests determine whether the DUT is operating correctly. Functional tests are not directly related to performance specifications.
Verification	Verification evaluates the measured calibration results against the defined As-Found Limits. The result of the evaluation is expressed as a Pass/Fail condition in the calibration certificate using an established evaluation formula.
Adjustment	Adjustment performs a set of operations on the DUT to optimize the measurement performance and conform it to the assigned calibrated values.
Reverification	Reverification evaluates the measured calibration results against the As-Left limits after adjustment. The As-Left limits may be tighter than the As-Found limits.
Recommended Calibration Interval	This interval indicates the recommended period between each round of verification and adjustment of the DUT. There is a high probability that, within this interval, the DUT will remain within the published warranted performance specifications. Some measurement DUTs have warranted specifications for different calibration intervals, for example: 24 hours, 90 days, 1 year, and 2 years. In this case, the specification depends on the calibration cycle chosen by the user.

Calibration Overview

Recommended Calibration Interval
2 years

Password
NI

Note
This is the default password for all password-protected operations. This password is site-specific.

Task	Estimated Test Time	Operator Connections	Test Points
Setup	15 minutes		—
Warm Up	10 minutes	—	—
Verify, Adjust, and Reverify	24 minutes	8	216
Verify Only	4 minutes	8	12
Adjust Only	20 minutes	8	204

Note
Estimated test times assume the user is conducting a manual calibration. For most procedures, automating the calibration significantly reduces test times.

Environmental Conditions	Verification	Adjustment
Ambient temperature	23°C ± 5 °C	23 °C ± 1 °C
Relative humidity	Below 80%, noncondensing	

Calibration Condition Guidelines

- Keep cabling as short as possible. Long cables act as antennas, picking up extra noise that can affect measurements.
- Ensure that all connections to the DUT are secure.
- Allow adequate warm up time for all components of the calibration system.
- Make all connections as shown in diagrams.
- Use shielded copper wire for all cable connections to the DUT.
- Use twisted-pair wires to eliminate noise and thermal offsets.
- If a DUT fails reverification after adjustment, ensure that the Test Conditions have been met before returning the DUT to NI.

Calibration Resources

Required Software

Note
Ensure that the most recent version of the required driver software is installed before conducting the calibration.

Install the following software on the calibration system:

- NI-DAQmx
- Supported application development environment (ADE) — LabVIEW or LabWindows™/CVI™
- Supported operating system — Windows

Recommended Documentation

Go to ni.com/docs to locate the following documentation for more information when performing this calibration:

- TS-15110 Feature Guide
- NI-DAQmx Readme
- NI-DAQmx Help
- LabVIEW Help
- NI-DAQmx C Reference Help
- NI-DAQmx .NET Help Support for Visual Studio

Test Equipment

This section details the equipment NI recommends for each test performed as part of this calibration procedure.

NI Calibration Executive Users
Refer to the Calibration Executive Help to find an updated list of test equipment for this calibration procedure.

Standard	Recommended Model	Where Used	Functional Requirement(s)
DMM	PXIe-4081	All Tests	DC Voltage Input Voltage Range: up to 10 V
TestScale Backplane and Core Module Calibration Kit	NI 788650-02	All Tests	
37-Pin DSUB Terminal Block	NI-9923	All Tests	
37-Pin DSUB to 37-Pin DSUB cable	778621-01	All Tests	
Banana Plugs (x2)	Multicomp Pro PE000038 (Red) Multicomp Pro PE000037 (Black)	All Tests	
Twisted-pair wire			

Warm Up the DUT

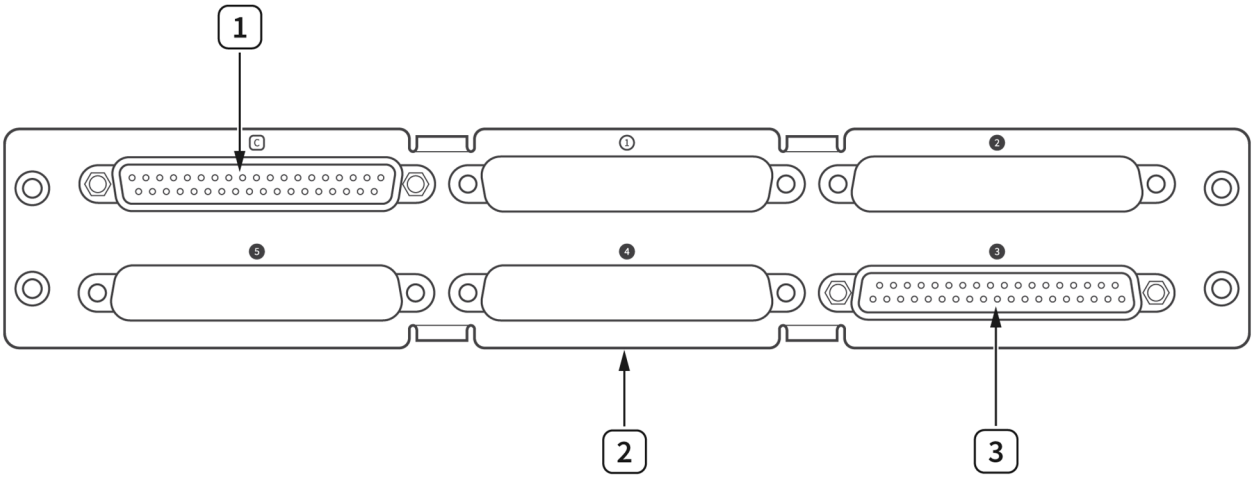
Warm up time starts after the installed DUT is powered on in the chassis. Warm up time resets after the DUT is removed from the chassis. This DUT requires 10 minutes to warm up prior to conducting any tests.

Note
Observe adequate warm up time for all components of the calibration system.

Initial Setup

Note
The core module (TS-15050) will be installed in slot labeled “C”. Ensure that the DUT is installed in slot 3 of the TS-15000/15010.

Figure 1. Initial Setup



1. TS-15050 (Core Module)
2. TS-15000/15010 Backplane
3. DUT

Perform Verification

AO Voltage Verification

Test Limits

Note
The limits in **Table 1** are derived using the values in **Table 7** and **Table 8** using the following equation:

$$Accuracy = Gain\ Error * Reading + Offset\ Error + INL$$

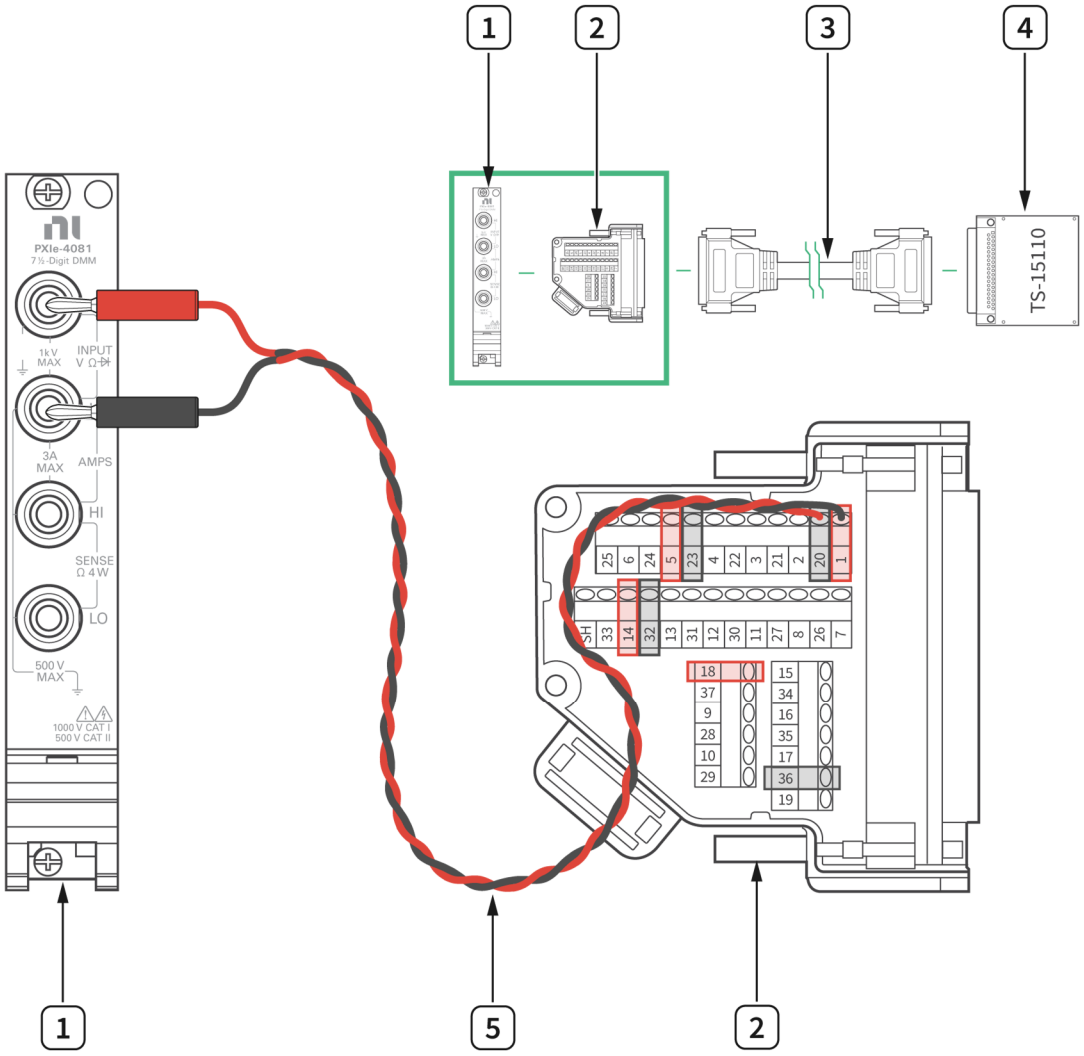
Table 1: AO Voltage Verification Limits

Range	Test Point (V)	As-Found Test Limit		As-Left Test Limit	
		Lower Limit (V)	Upper Limit (V)	Lower Limit (V)	Upper Limit (V)
±10	9.500000	9.485440	9.514560	9.487720	9.512280
±10	0.000000	-0.007150	0.007150	-0.007149	0.007149
±10	-9.500000	-9.514560	-9.485440	-9.512280	-9.487720

Initial Test Connection

Note
Connect the positive input to the DMM to AO 0 (pin 1) and the negative input to COM (pin 20). For this connection, solder each end of the twisted-pair wires to their respective banana plugs; and on the other end, insert each wire from the twisted-pair to the screw terminal on the NI-9923.

Figure 2. Initial Connection for this Test



1. DMM
2. NI-9923
3. 37-Pin DSUB to 37-Pin DSUB Cable
4. TS-15110
5. Twisted-Pair Wire

Table 2. Channel Configurations

DUT Channel	TB-9923 Positive Pin (to INPUT HI)	TB-9923 Negative Pin (to INPUT LO)
AO 0	1	20
AO 1	5	23
AO 2	14	32
AO 3	18	36

Verification Procedure

Complete the following procedure to verify the AO accuracy.

Repeat 4 times, once for each channel.

1. Connect the AO channel under test to the DMM as shown in **Figure 2**.

Repeat 3 times, once for each test point.

2. Configure the DMM to read DC voltage as shown in **Table 3**.

Table 3: DMM Configuration

Configuration	Value
Function	DC Volts
Range	Fixed: 10 V for ±9.5 V test points Fixed: 100 mV for 0 V test point
Auto Zero	Enabled
ADC Calibration	Enabled
Offset Nulling	Enabled

3. Create and configure an AO voltage task as shown in **Table 4**.

Table 4: AO Voltage Channel Configuration

Parameter	Value
Physical channels	*TSxMod3/aox*
Terminal Configuration	Single Ended
Scaled Units	Volts
Input Range	±10 V

4. Start the task.
5. Configure the timing properties for the voltage output as shown in **Table 5**.

Table 5: AO Voltage Channel Timing Configuration

Parameter	Value
Timeout	10.0
Samples per Channel	1
Data	Test point from **Table 1**

6. Wait for the reading to settle, then record the value from the DMM.
7. Stop and clear the task.
8. Compare the value to the limits in **Table 1**.
9. Set the DMM to Standby mode (STBY) before moving to the next channel.

Perform Adjustment

AO Voltage Adjustment

Perform an adjustment at least once within the calibration interval. Adjustment automatically updates the calibration constants, the date, and the temperature in the DUT EEPROM. If the DUT passes the verification procedures within the As-Left test limits, an adjustment is not required. Proceed to the *Update the Onboard Calibration Information* section.

Note
Initial test connection is the same as AO Voltage Verification, as shown in **Figure 2**.

Adjustment Procedure

Repeat 4 times, once for each channel.

1. Open a calibration session.
   - Call DAQmxInitExtCal to initialize the adjustment.
2. Call DAQmxTSSeriesSetTemp and set the external temperature in degrees Celsius.
3. Call the TS-15110 get TestScale adjustment points function to obtain an array of recommended calibration voltages.
4. Configure the DMM to read the voltage from Step 3.
5. Call and configure the TS-15110 setup calibration function to output voltage points from Step 3. Select the AO*x* channel.
6. Perform an external adjustment using DAQmxTSSeriesCalAdjust, as shown in **Table 6**.

Table 6: Adjustment Configuration

Parameter	Value
Physical Channel	TSMod3/aox
Reference Value	Voltage from Step 3

7. Save the adjustment to the EEPROM using DAQmxCloseExtCal by choosing the “commit” action. This function also saves the date, time, and temperature of the adjustment to the onboard memory.
8. Set the DMM to Standby (STBY) and disconnect the DUT.

Perform Reverification

Perform all tests in the Verification section after completing Adjustment. This verification compares the As-Left limits with measurement data collected after the DUT adjustment. The As-Left limits are tighter than the As-Found limits.

Update the Onboard Calibration Information

When the adjustment procedure is completed, the DUT internal calibration memory (EEPROM) is immediately updated.

If an adjustment is not needed, update the calibration date and onboard calibration temperature without making any adjustments by initializing an external calibration session, setting the calibration temperature, and closing the external calibration session.

Accuracy Under Calibration Conditions

The following accuracy tables are valid for calibration under the following conditions:

- Ambient temperature 23°C ± 5 °C
- DUT installed in slot 3 of the TS-15000/15010 backplane
- Slots 1, 2, 4, and 5 are empty

Note

The test limits in **Table 1** are derived using the values in **Table 7** and **Table 8** using the following equation:

$$Accuracy = Gain\ Error * Reading + Offset\ Error + INL$$

Table 7: TS-15110 Accuracy Under Calibration Conditions

Range	As-Found		As-Left	
	Gain Error (%)	Offset Error (mV)	Gain Error (%)	Offset Error (mV)
±10	0.078	3.23	0.054	3.23

Table 8: Additional Accuracy Information

Range	INL[1]
10 V	12 LSB

[1]Scaling Coefficient: 326.7 µV/LSB

Revision History

Revision	Section	Changes
378822A-01 October 2022	—	This is the initial release version of the TS-15110 Calibration Procedure.

NI Services

Visit ni.com/support to find support resources including documentation, downloads, and troubleshooting and application development self-help such as tutorials and examples.

Visit ni.com/services to learn about NI service offerings such as calibration options, repair, and replacement.

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

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