Calibration Procedure

PXIe-4150 and PXIe-4151

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379060A-01

Instructions on how to complete the performance verification and adjustment of your instrument.

ni.com

This document contains the verification and adjustment procedures for the NI PXIe-4150 and PXIe-4151. 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

1. Icons

Refer to the following descriptions if one of these icons is marked on your product or used in this guide.

Icon	Description
	**Notice** — Take precautions to avoid data loss, loss of signal integrity, degradation of performance, or damage to the product.
	**Caution** — Take precautions to avoid injury. Consult the product documentation for cautionary statements when you see this icon printed on the product. Cautionary statements are localized into French for compliance with Canadian requirements.
	**Note** — Important information to assist with execution of procedure.
	**NI Calibration Executive Users** — Additional important information on running the automated procedure can be found in the help file.

2. 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 NI PXIe-4151 and PXIe-4150.
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.

3. Safety Guidelines

⚠ **CAUTION**

Observe all instructions and cautions in the user documentation. Using the product in a manner not specified can damage the product and compromise the built-in safety protection.

ATTENTION
Suivez toutes les instructions et respectez toutes les mises en garde de la documentation d'utilisation. L'utilisation du produit de toute autre façon que celle spécifiée risque de l'endommager et de compromettre la protection de sécurité intégrée.

⚠ **CAUTION**
The product is designed for nonhazardous, live signals. You must ensure that all signals connected to the product are isolated from hazardous, live circuits and no unsafe voltages are present at the inputs. Voltages that exceed the specifications could result in damage to the product or electric shock.

ATTENTION
Le produit est conçu pour les signaux en direct non dangereux. Vous devez vous assurer que tous les signaux connectés au produit sont isolés des circuits dangereux sous tension et qu'aucune tension dangereuse n'est présente aux entrées. Des tensions supérieures à celles mentionnées dans les spécifications peuvent endommager le produit ou provoquer un choc électrique

4. Calibration Overview

4.1. Safety Rated Current

101295A-01	1 A
101296A-01	0 A
101297A-01	20 A
101271A-01 (HI SENSE LO SENSE)	1 A
101271A-01 (HI LO)	40 A Total (20 A per Conductor)

4.2. Safety Rated Voltages

All Cable Assemblies and Connectors	60V DC

4.3. Calibration Information

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	
			PXIe-4150	PXIe-4151
Setup	3 minutes	2 Connections	—	
Warm Up	30 minutes	—	—	
Verify, Adjust, and Reverify	72 minutes	33 Connections	84 test points	80 test points
Verify Only	23 minutes	13 Connections	38 test points	36 test points
Adjust Only	26 minutes	7 Connections	8 test points	8 test points

Note
This DUT requires special considerations when calculating the total warm up time for the system. Refer to the Warmup section in this document for more information.

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

Note
Always refer to the specifications document for your device before connecting signals. Failure to observe the specified maximum signal ratings can cause shock, a fire hazard, or damage to the device connected to the DUT.

Note
Before using any probes or accessories, ensure that they meet applicable safety requirements for the signal levels you may encounter.

Environmental Conditions	Verification	Adjustment
Ambient temperature	23 °C ± 5 °C	23 °C ± 1 °C
Internal DUT temperature range[1]	Tcal ± 5 °C	Tcal ± 1 °C
Relative humidity	Between 10% and 90%, noncondensing	

4.4. 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, including front panel connections, and screws are secure.
- Allow adequate warm up time for all components of the calibration system.
- For maximum accuracy, perform the autocalibration (ACAL) function of the digital multimeter (DMM) prior to calibration if it has not been performed within the last 24 hours or when the multimeter's temperature changes by ± 1 °C from the last autocalibration. Always disconnect any input signals before performing autocalibration. Perform ACAL for all functions.

[1] The internal temperature of the DUT is greater than the ambient temperature.

- Configure the DMM to the following settings for all measurements:
    - Set the DMM NPLC to **100**.
    - Set digits of resolution to **8.5**.
    - Set the front panel Guard switch to **LO**.
- Ensure that properties or attributes for the device that are not specified in calibration procedures are set to their default values.
- Make all connections as shown in diagrams.
- 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.
- If a DUT fails reverification after adjustment, ensure that the Test Conditions have been met before returning the DUT to NI.
- Clean any oxidation from the spade connectors or banana plugs on the cables before connecting them into the binding posts. Oxidation tarnishes the copper plugs so that they appear dull rather than shiny and leads to greater thermal EMF.

5. Calibration Resources

5.1. 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:

- LabVIEW version 2022 SPI Base/Full/Pro or later
- NI-DCPower instrument driver version 24.5.2 or greater

5.2. Recommended Documentation

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

- PXIe-4150 and PXIe-4151 User Manual
- PXIe-4150 and PXIe-4151 Specifications
- NI DCPower instrument driver help

5.3. 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.

Note
NI recommend installing the DUT in a chassis with slot cooling capacity ≥ 58 W for increased module capability. The usage of slot blockers in the chassis will also increase cooling capability for the DUT.

Standard	Recommended Model	Where Used	Functional Requirement(s)
Current Shunt[2]	Ohm-Labs CS-50	7.2 Current Programming and Measurement Accuracy Verification	Resistance Accuracy Requires additional Calibration Test Points
DMM	Keysight 3458A	All Procedures	Current and Voltage Functionality
PXIe-4150/4151 Calibration Cable Kit	NI 789107-01 Kit Includes: • Cal Cable – “Spade”, Qty 1 • Cal Cable – “Banana”, Qty 1 • Cal Connector – “Shorting”, Qty 1 • Spade Jumper, Qty 2 • Red Spade-Banana Jumper, Qty 2 • Black Spade-Banana Jumper, Qty 2	All Procedures	N/A
Auxiliary Power Supply	NI APS-4158 or NI APS-4159	All Procedures	N/A

6. Warm Up the DUT

Warm up time starts after the installed DUT is powered on in the chassis and power is applied through the 48 V auxiliary power supply. Warm up time resets after the DUT is power cycled or the auxiliary power supply is interrupted. This DUT requires 30 minutes to warm up prior to conducting

[2] Test Points should be included on the accredited calibration report for CS-50: 0.35 A, 1 A, 3 A, 5 A, 10 A, 20 A, 30 A, 40 A, and 50 A.

any tests. All cabling must be removed from the force and sense pins prior to running self-calibration. Self-calibration must be run after the DUT has sufficiently warmed up.

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

6.1. Perform Self-Calibration

Self-calibration adjusts the DUT for variations in the module environment. Self-calibration should be performed after the DUT has warmed up for the entire recommended time period. Self-calibration is NOT required to be repeated during the procedure unless more than 24 hours have passed, or the ambient temperature has changed by more than 5 °C, or the DUT has been power-cycled, or the auxiliary power supply has been interrupted when providing power to the DUT.

Complete the following steps to conduct self-calibration using Measurement & Automation Explorer (MAX).

Note
The only supported values for the `Self Calibration Persistence` property and the `NIDCPOWER_ATTR_SELF_CALIBRATION_PERSISTENCE` attribute are **Write to EEPROM** and `NIDCPOWER_ATTR_VAL_WRITE_TO_EEPROM`, respectively. This setting saves the calibration data to the onboard EEPROM, so the corrections survive power cycling and device resetting. Because EEPROM has a limited number of write cycles, NI recommends that you save your self-calibration data to EEPROM no more than once per day. Disconnect all external signals before beginning self-calibration.

1. Install the DUT and let it warm up for the recommended warm-up time.

Note
Warm up begins when the PXI chassis has been powered on, the operating system has completely loaded, and auxiliary power is supplied to the DUT.

2. Self-calibrate the DUT by clicking the **Self-Calibrate** button in MAX.
3. Launch Measurement Automation Explorer (MAX).
4. Select **My System»Devices and Interfaces»*[DUT model name]***.
5. Start self-calibration using one of the following methods:
6. Click **Self-Calibrate** in the upper right corner of MAX.
7. Right-click the name of the DUT in the MAX configuration tree and select **Self-Calibrate** from the drop-down menu.

Note
Low energy transients can appear at the output terminals of your DUT during certain situations, such as power-up, power-down, device driver loading, and self-calibration.

7. Perform Verification

7.1. Voltage Programming and Measurement Accuracy Verification

7.1.1. Test Limits

Table 1: Test Points/Limits for Voltage Programming and Measurement Accuracy Verification Test

DUT Range	Test Point	DUT Model	Sense Configuration	As-Found Test Limit	
				Lower Limit	Upper Limit
6 V	100 mV	PXIe-4150/4151	Local & Remote	– 0.522 mV	0.522 mV

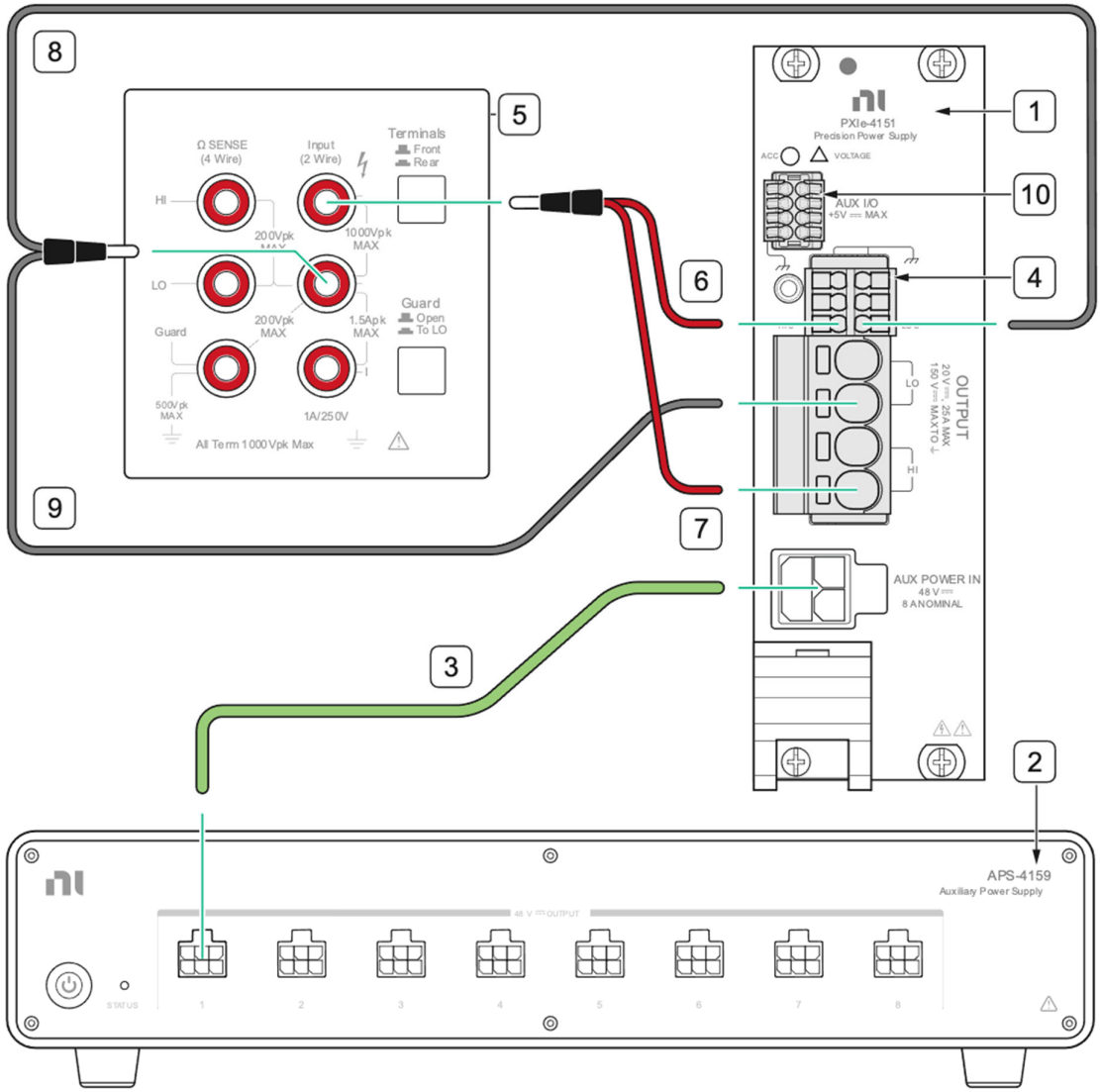
6 V	1.5 V	PXIe-4150/4151	Local & Remote	– 0.83 mV	0.83 mV
6 V	3 V	PXIe-4150/4151	Local & Remote	– 1.16 mV	1.16 mV
6 V	6 V	PXIe-4150/4151	Local & Remote	– 1.82 mV	1.82 mV
60 V	100 mV	PXIe-4150	Local & Remote	– 5.02 mV	5.02 mV
60 V	5 V	PXIe-4150	Local & Remote	– 6.20 mV	6.20 mV
60 V	10 V	PXIe-4150	Local & Remote	– 7.40 mV	7.40 mV
60 V	20 V	PXIe-4150	Local & Remote	– 9.80 mV	9.80 mV
60 V	40 V	PXIe-4150	Local & Remote	– 14.60 mV	14.60 mV
60 V	60 V	PXIe-4150	Local & Remote	– 19.40 mV	19.40 mV
20 V	100 mV	PXIe-4151	Local & Remote	– 2.02 mV	2.02 mV
20 V	5 V	PXIe-4151	Local & Remote	– 3.20 mV	3.20 mV
20 V	10 V	PXIe-4151	Local & Remote	– 4.40 mV	4.40 mV
20 V	20 V	PXIe-4151	Local & Remote	– 6.80 mV	6.80 mV

7.1.2. Initial Test Connection

Caution
Always refer to the specifications document for your device before connecting signals. Failure to observe the specified maximum signal ratings can cause a fire hazard or damage to the device connected to the DUT.

Caution
Before using any probes or accessories, ensure that they meet applicable safety requirements for the signal levels you may encounter.

Figure 1. Connections for Voltage Programming and Measurement Accuracy Verification



1. DUT
2. Auxiliary Power Supply
3. Auxiliary Power Supply Cable
4. Cal Cable – "Banana" (NI 101295A-01)
5. DMM
6. HI Sense signal cable
7. HI signal cable from DUT (Positive polarity defined as voltage measured on NI > LO)
8. LO Sense signal cable
9. LO single wire from DUT (Positive polarity defined as voltage measured on NI > LO)
10. AUX I/O Connector for DUT

Note
Before operating the programmable power supply, short pin 4 to pin 5 on the AUX I/O connector. For more information, refer to *Installing the Input and AUX I/O Connector on the PXIe-4151.*

7.1.3. Verification Procedure

1. Reset the DUT.
2. Ensure that the warm-up time is observed for the DUT as well as all the instruments.
3. Perform self-calibration on the DUT, if required. Follow instructions identified in this procedure regarding self-calibration.
4. Ensure DUT is not generating any signals, and the output is turned off prior to making any connections.
5. Set the DUT function to **DC Voltage**.
6. Connect all test equipment as shown in **Figure 1**.

Note
Before using any probes or accessories, ensure that they meet applicable safety requirements for the signal levels you may encounter.

Repeat 2 times, once for each sense configuration.

7. Set the level range, limit range, and limit on the DUT.
   a. Set current limit to **100 mA**.
   b. Set current range to **100 mA**.
8. Set the DUT sense attribute according to **Table 1**.
9. First iteration of loop should be **local**.

10. Second iteration of loop should be **remote**.
11. Set the DUT to **2 PLC** for measurement.
12. Commit all settings to DUT.
13. Configure the DMM
    a. Set the DMM NPLC to **100**.
    b. Set digits of resolution to **8.5**.
    c. Set function to **DC Voltage**.

Note
Recommended to start with smallest signal level and iterate through test points according to increasing signal level.

Repeat 10 times, once for each output Voltage (PXIe-4150).
Repeat 8 times, once for each output Voltage (PXIe-4151).

14. Set the DMM to the voltage range according to **Table 2**.
15. Set the level of the DUT to the test point according to **Table 2**.

Note
Recommended to start with smallest signal level and iterate through test points according to increasing signal level.

Table 2: Voltage Test Point Configuration

DUT Range	Test Point	DMM Range	DUT Model
6 V	100 mV	100 mV	PXIe-4150/4151
6 V	1.5 V	10 V	PXIe-4150/4151
6 V	3 V	10 V	PXIe-4150/4151
6 V	6 V	10 V	PXIe-4150/4151
20 V	100 mV	100 mV	PXIe-4151
20 V	5 V	10 V	PXIe-4151

20 V	10 V	10 V	PXIe-4151
20 V	20 V	100 V	PXIe-4151
60 V	100 mV	100 mV	PXIe-4150
60 V	5 V	10 V	PXIe-4150
60 V	10 V	10 V	PXIe-4150
60 V	20 V	100 V	PXIe-4150
60 V	40 V	100 V	PXIe-4150
60 V	60 V	100 V	PXIe-4150

16. Wait 2 seconds to ensure the system has adequate time to settle.
17. An additional 4 minute wait is required when the DMM has changed either function of range.

Note
The additional 4 minute wait is to reduce thermal EMF and a requirement of using the DMM identified in this procedure.

18. Take a voltage measurement using the DMM.
19. Calculate the measurement accuracy.

$$Voltage_{accuracy} = DMM_{measurement} - Test\ Point$$

20. Verify the accuracy measurement against the test limits in **Table 1**.

7.2. Current Programming and Measurement Accuracy Verification

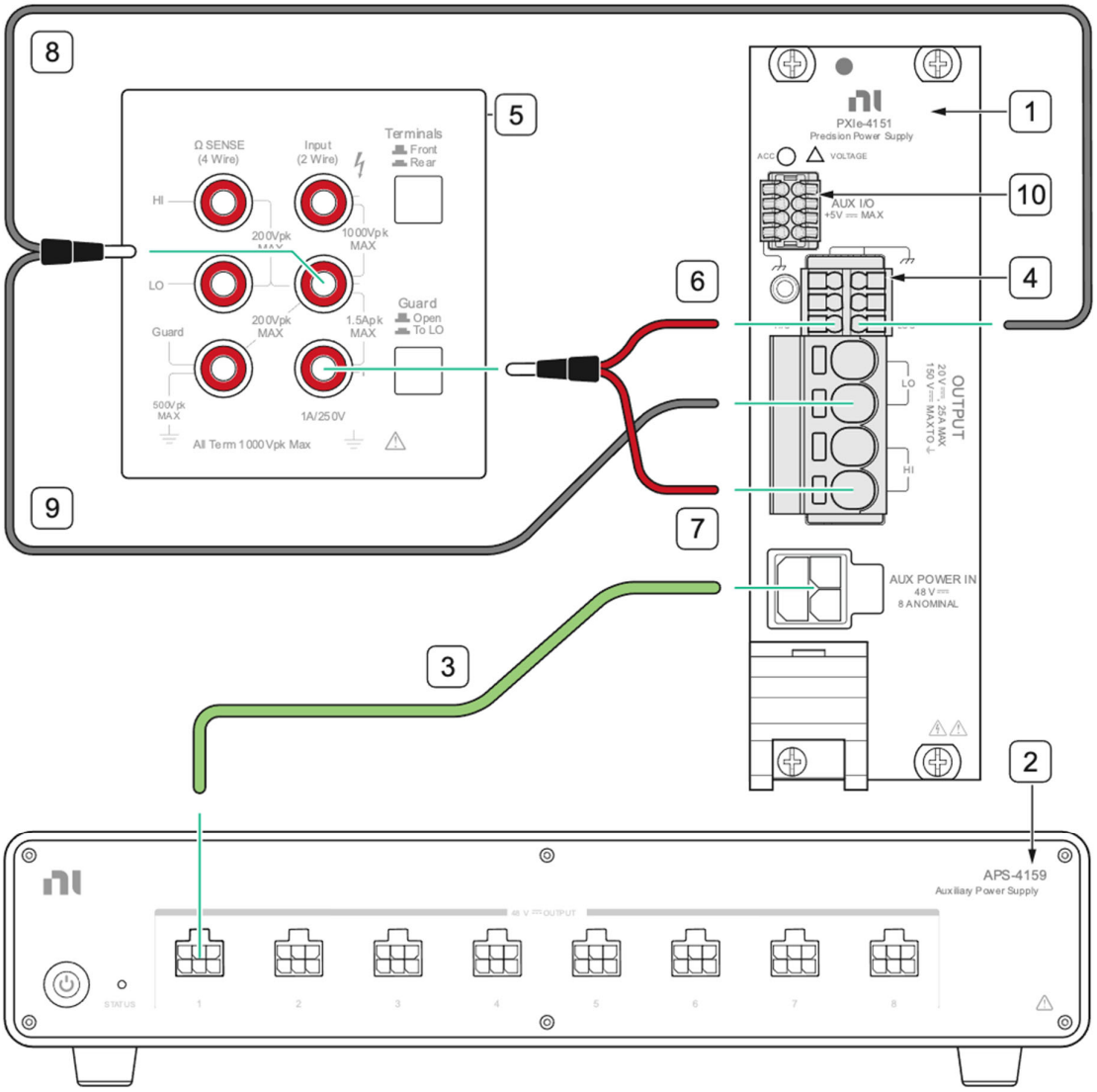
7.2.1. Test Limits

Table 3: Test Points/Limits for Current Programming and Measurement Accuracy Verification Test

DUT Range	Test Point	DUT Model	As-Found Test Limit	
			Lower Limit	Upper Limit
100 mA	25 mA	PXIe-4150/4151	– 37.5 µA	37.5 µA
100 mA	50 mA	PXIe-4150/4151	– 45.0 µA	45.0 µA
100 mA	100 mA	PXIe-4150/4151	– 60.0 µA	60.0 µA
1 A	250 mA	PXIe-4150/4151	– 375 µA	375 µA
1 A	500 mA	PXIe-4150/4151	– 450 µA	450 µA
1 A	1 A	PXIe-4150/4151	– 600 µA	600 µA
10 A	2.5 A	PXIe-4150	– 3.87 mA	3.87 mA
10 A	5 A	PXIe-4150	– 5.75 mA	5.75 mA
10 A	10 A	PXIe-4150	– 9.5 mA	9.5 mA
25 A	2.5 A	PXIe-4151	– 3.6 mA	3.6 mA
25 A	5 A	PXIe-4151	– 5.3 mA	5.3 mA
25 A	10 A	PXIe-4151	– 8.5 mA	8.5 mA
25 A	25 A	PXIe-4151	– 18.3 mA	18.3 mA

7.2.2. Initial Test Connection

Figure 2. Initial Direct Connection to DMM for Current Programming and Measurement Accuracy Verification



1. DUT
2. Auxiliary Power Supply
3. Auxiliary Power Supply Cable
4. Cal cable – "Banana" (NI 101295A-01)
5. DMM
6. HI Sense signal cable
7. HI signal cable from DUT (Positive polarity defined as voltage measured on NI > LO)
8. LO Sense signal cable
9. LO single wire from DUT (Positive polarity defined as voltage measured on NI > LO)
10. AUX I/O Connector for DUT

Note
Before operating the programmable power supply, short pin 4 to pin 5 on the AUX I/O connector. For more information, refer to *Installing the Input and AUX I/O Connector on the PXIe-4151.*

7.2.3. Verification Procedure Direct to DMM

1. Reset the DUT.
2. Ensure that the warm-up time is observed for the DUT as well as all the instruments.
3. Perform self-calibration on the DUT, if required. Follow instructions identified in this procedure regarding self-calibration.
4. Ensure DUT is not generating any signals, and the output is turned off prior to making any connections.
5. Set the DUT to **DC Current** function.
6. Connect all test equipment as shown in **Figure 2**.

Caution
Before using any probes or accessories, ensure that they meet applicable safety requirements for the signal levels you may encounter.

Repeat 3 times, once for each output Current value.

7. Set the level range, limit range, and limit on the DUT.
   a. Set voltage limit to **6 V**.
   b. Set voltage range to **6 V**.
8. Set the DUT sense attribute according to **Table 3**.
9. Set the sense configuration to **local**.
10. Set the DUT to **2 PLC** for measurement.

11. Commit all settings to DUT.
12. Configure the DMM
    a. Set the DMM NPLC to **100**.
    b. Set digits of resolution to **8.5**.
    c. Set function to **DC Current**.

Note
Recommended to start with smallest signal level and iterate through test points according to increasing signal level.

13. Set the DMM to the current range according to **Table 4**.
14. Set the level of the DUT to the test point according to **Table 4**.

Note
Recommended to start with smallest signal level and iterate through test points according to increasing signal level.

Table 4: Current Test Point Configuration

DUT Range	Test Point	DMM Range	DUT Model
100 mA	25 mA	100 mA	PXIe-4150/4151
100 mA	50 mA	100 mA	PXIe-4150/4151
100 mA	100 mA	100 mA	PXIe-4150/4151

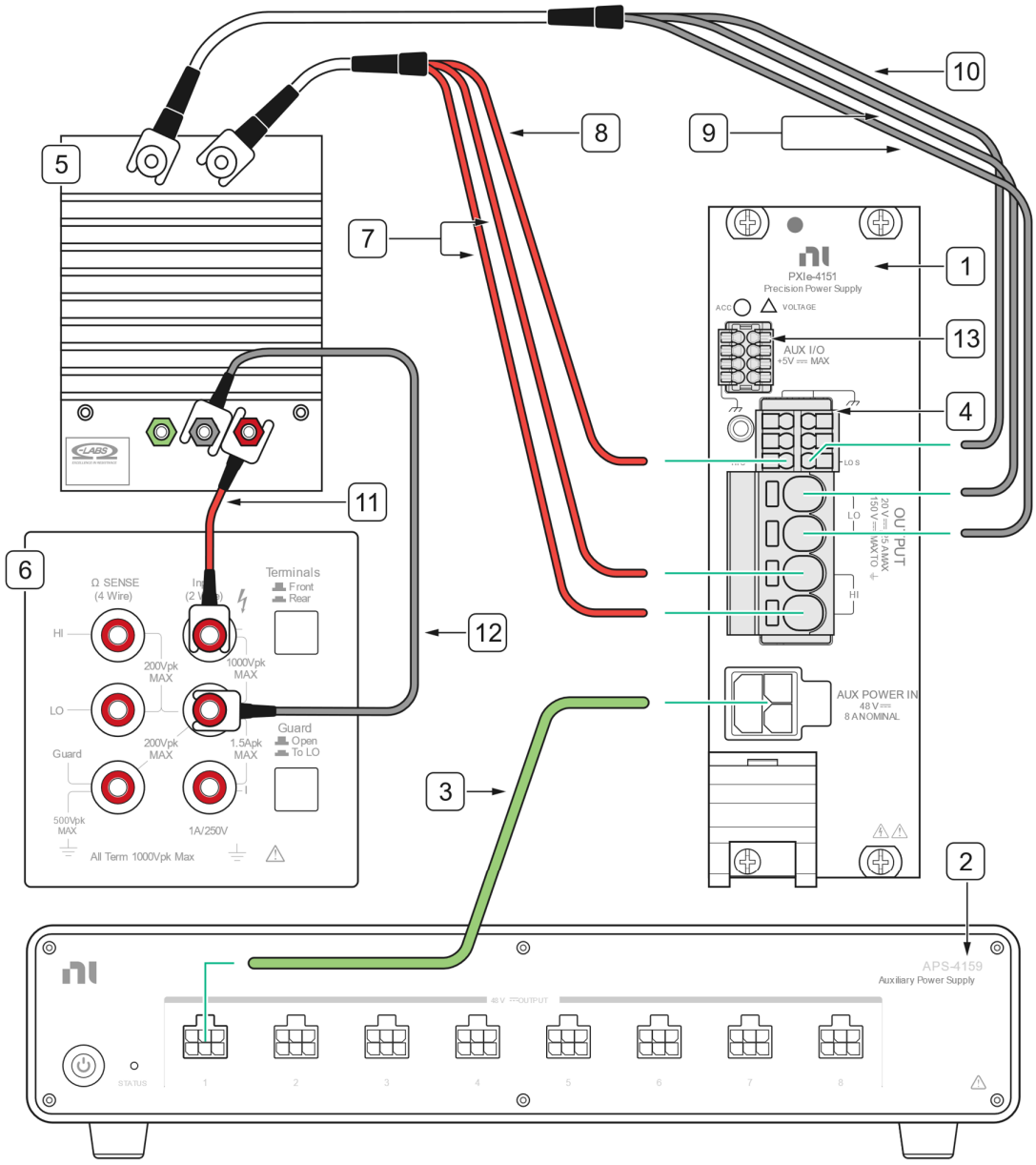
15. Wait 2 seconds to ensure the system has adequate time to settle.
16. An additional 30 second wait is required when the DMM has changed either function of range.
17. Take a current measurement using the DMM.
18. Calculate the measurement accuracy.

$$Current_{accuracy} = DMM_{measurement} - Test\ Point$$

19. Verify the accuracy measurement against the test limits in **Table 3**.

7.2.4. Test Connection with Shunt

Figure 3. Connection with Shunt for Current Programming and Measurement Accuracy Verification



1. DUT
2. Auxiliary Power Supply
3. Auxiliary Power Supply Cable
4. Cal cable – "Spade" (NI 101271A-01)
5. 50 A Shunt (0.01 Ω)
6. DMM
7. HI signal cable from DUT (Positive polarity defined as voltage measured on NI > LO) connected to Shunt HI current terminal
8. HI Sense signal cable connected to Shunt HI current terminal
9. LO single wire from DUT (Positive polarity defined as voltage measured on NI > LO) connected to Shunt LO current terminal
10. LO Sense signal cable connected to Shunt LO current terminal
11. Shunt HI Sense signal cable: Spade-Banana red (Pomona 5295-36-2)
12. Shunt LO Sense signal cable: Spade-Banana black (Pomona 5295-36-0)
13. AUX I/O Connector for DUT

Note
Before operating the programmable power supply, short pin 4 to pin 5 on the AUX I/O connector. For more information, refer to *Installing the Input and AUX I/O Connector on the PXIe-4151.*

7.2.5. Verification Procedure with Shunt

1. Reset the DUT.
2. Ensure that the warm-up time is observed for the DUT as well as all the instruments.
3. Perform self-calibration on the DUT, if required. Follow instructions identified in this procedure regarding self-calibration.
4. Ensure DUT is not generating any signals, and the output is turned off prior to making any connections.
5. Set the DUT to **DC Current** function.
6. Connect all test equipment as shown in **Figure 3**.

Caution
Before using any probes or accessories, ensure that they meet applicable safety requirements for the signal levels you may encounter.

Repeat 6 times, once for each output Current (PXIe-4150).
Repeat 7 times, once for each output Current (PXIe-4151).

7. Set the level range, limit range, and limit on the DUT.
   a. Set voltage limit to **6 V**.
   b. Set voltage range to **6 V**.
8. Set the DUT sense attribute according to **Table 3**.
9. Set the sense configuration to **local**.
10. Set the DUT to **2 PLC** for measurement.
11. Commit all settings to DUT.
12. Configure the DMM
    a. Set the DMM NPLC to **100**.
    b. Set digits of resolution to **8.5**.
    c. Set function to **DC Current**.

Note
Recommended to start with smallest signal level and iterate through test points according to increasing signal level.

13. Set the DMM to the voltage range according to **Table 5**.
14. Set the level of the DUT to the test point according to **Table 5**.

Note
Recommended to start with smallest signal level and iterate through test points according to increasing signal level.

Table 5: Current Test Point Configuration

DUT Range	Test Point	Expected DMM Reading	DMM Range	DUT Model
1 A	250 mA	2.5 mV	100 mV	PXIe-4150/4151
1 A	500 mA	5 mV	100 mV	PXIe-4150/4151
1 A	1 A	10 mV	100 mV	PXIe-4150/4151
10 A	2.5 A	25 mV	100 mV	PXIe-4150
10 A	5 A	50 mV	100 mV	PXIe-4150
10 A	10 A	100 mV	100 mV	PXIe-4150
25 A	2.5 A	25 mV	100 mV	PXIe-4151
25 A	5 A	50 mV	100 mV	PXIe-4151
25 A	10 A	100 mV	100 mV	PXIe-4151
25 A	25 A	250 mV	1 V	PXIe-4151

15. Wait 2 seconds to ensure the system has adequate time to settle.
16. An additional 4 minute wait is required when the DMM has changed either function of range.

Note
The additional 4 minute wait is to reduce thermal EMF and a requirement of using the DMM identified in this procedure.

17. Take a voltage measurement using the DMM.
18. Calculate the measurement accuracy.

$$Current_{accuracy} = \frac{DMM_{measurement}}{Shunt_{resistance}} - Test\ Point$$

19. Verify the accuracy measurement against the test limits in **Table 3**.

7.3. Voltage Load Regulation Verification

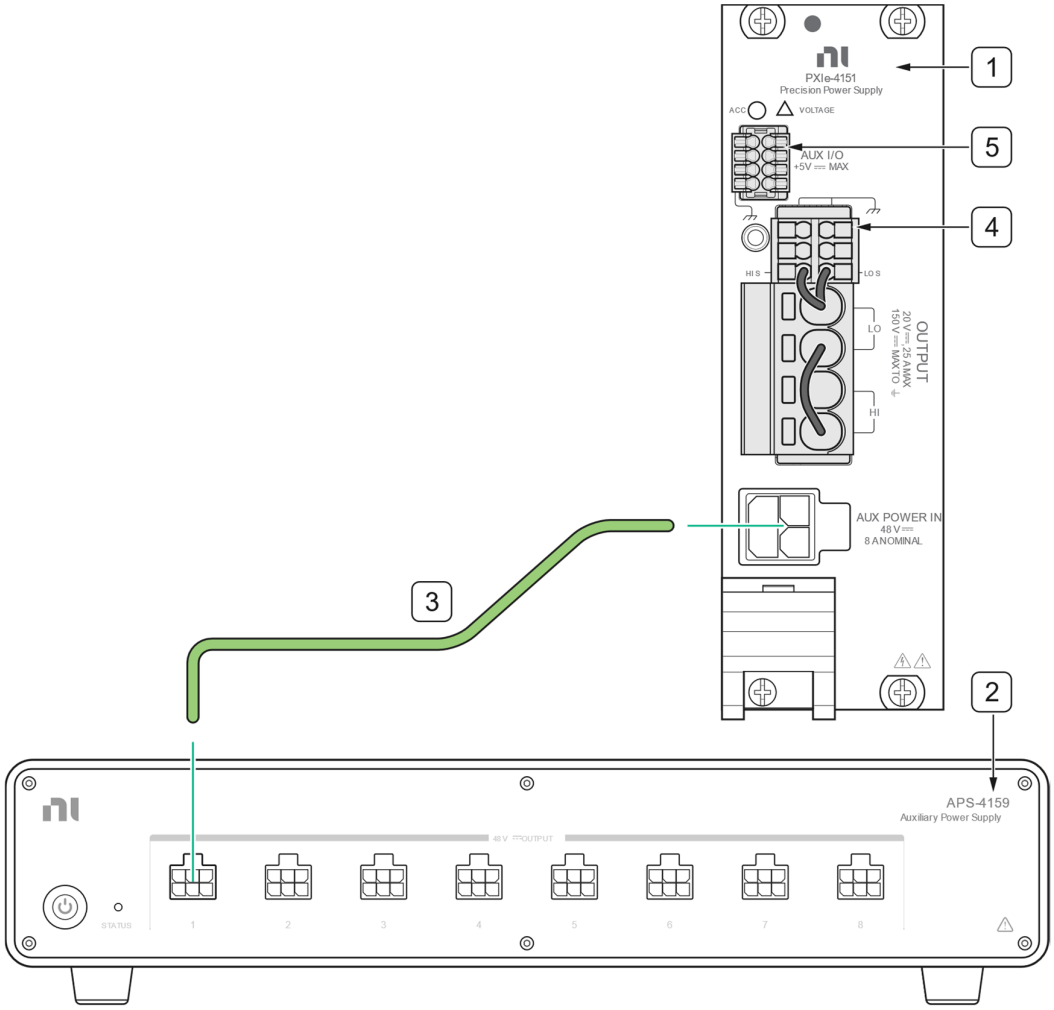
7.3.1. Test Limits

Table 6: Test Points/Limits for Voltage Load Regulation Verification Test

DUT Range	Source Range	Test Point	DUT Voltage Limit	DUT Model	DUT Sense Mode	As-Found Test Limit	
						Lower Limit	Upper Limit
6 V	10 A	2.5 A	3 V	PXIe-4150	Local	– 88 mV	88 mV
6 V	10 A	5 A	3 V	PXIe-4150	Local	– 176 mV	176 mV
6 V	10 A	10 A	3 V	PXIe-4150	Local	– 350 mV	350 mV
6 V	10 A	2.5 A	3 V	PXIe-4150	Remote	– 0.50 mV	0.50 mV
6 V	10 A	5 A	3 V	PXIe-4150	Remote	– 0.50 mV	0.50 mV
6 V	10 A	10 A	3 V	PXIe-4150	Remote	– 0.50 mV	0.50 mV
60 V	10 A	2.5 A	30 V	PXIe-4150	Remote	– 6.00 mV	6.00 mV
60 V	10 A	5 A	30 V	PXIe-4150	Remote	– 6.00 mV	6.00 mV
60 V	10 A	10 A	30 V	PXIe-4150	Remote	– 6.00 mV	6.00 mV
6 V	25 A	6.25 A	3 V	PXIe-4151	Local	– 69 mV	69 mV
6 V	25 A	12.5 A	3 V	PXIe-4151	Local	– 138 mV	138 mV
6 V	25 A	25 A	3 V	PXIe-4151	Local	– 275 mV	275 mV
6 V	25 A	6.25 A	3 V	PXIe-4151	Remote	– 0.50 mV	0.50 mV
6 V	25 A	12.5 A	3 V	PXIe-4151	Remote	– 0.50 mV	0.50 mV
6 V	25 A	25 A	3 V	PXIe-4151	Remote	– 0.50 mV	0.50 mV
20 V	25 A	6.25 A	10 V	PXIe-4151	Remote	– 2.00 mV	2.00 mV
20 V	25 A	12.5 A	10 V	PXIe-4151	Remote	– 2.00 mV	2.00 mV
20 V	25 A	25 A	10 V	PXIe-4151	Remote	– 2.00 mV	2.00 mV

7.3.2. Initial Test Connection

Figure 4. Initial Connection for Voltage Load Regulation Verification Test



1. DUT
2. Auxiliary Power Supply
3. Auxiliary Power Supply Cable
4. Cal Connector – Shorting (NI 101296A-01)
5. AUX I/O Connector for DUT

Note
Before operating the programmable power supply, short pin 4 to pin 5 on the AUX I/O connector. For more information, refer to *Installing the Input and AUX I/O Connector on the PXIe-4151.*

7.3.3. Verification Procedure

1. Reset the DUT.
2. Ensure that the warm-up time is observed for the DUT.
3. Perform self-calibration on the DUT, if required. Follow instructions identified in this procedure regarding self-calibration.
4. Ensure DUT is not generating any signals, and the output is turned off prior to making any connections.
5. Set the DUT to **DC Current** function.
6. Connect all test equipment as shown in **Figure 4**.

> ⚠ **Caution**
> Before using any probes or accessories, ensure that they meet applicable safety requirements for the signal levels you may encounter.

Repeat 9 times, once for each current test point in Table 5.

7. Set the level range, limit range, and limit on the DUT according to **Table 5**.
8. Set the DUT sense attribute according to **Table 5**.
9. Set the sense configuration to **remote**.
10. Set the level of the DUT to the test point according to **Table 7**.

Table 7: Voltage Load Regulation Test Point Configuration

DUT Voltage Range	DUT Sense Mode	DUT Source Range	Test Point	DUT Model
6 V	Local	10 A	2.5 A	PXIe-4150
6 V	Local	10 A	5 A	PXIe-4150
6 V	Local	10 A	10 A	PXIe-4150

6 V	Remote	10 A	2.5 A	PXIe-4150
6 V	Remote	10 A	5 A	PXIe-4150
6 V	Remote	10 A	10 A	PXIe-4150
60 V	Remote	10 A	2.5 A	PXIe-4150
60 V	Remote	10 A	5 A	PXIe-4150
60 V	Remote	10 A	10 A	PXIe-4150
6 V	Local	25 A	6.25 A	PXIe-4151
6 V	Local	25 A	12.5 A	PXIe-4151
6 V	Local	25 A	25 A	PXIe-4151
6 V	Remote	25 A	6.25 A	PXIe-4151
6 V	Remote	25 A	12.5 A	PXIe-4151
6 V	Remote	25 A	25 A	PXIe-4151
20 V	Remote	25 A	6.25 A	PXIe-4151
20 V	Remote	25 A	12.5 A	PXIe-4151
20 V	Remote	25 A	25 A	PXIe-4151

11. Set the DUT to **2 PLC** for measurement.
12. Commit all settings to DUT.
13. Wait 2 seconds to ensure the system has adequate time to settle.
14. Take a voltage measurement from the DUT.
15. Verify the accuracy measurement against the test limits in **Table 6**.

7.4. Current Load Regulation Verification

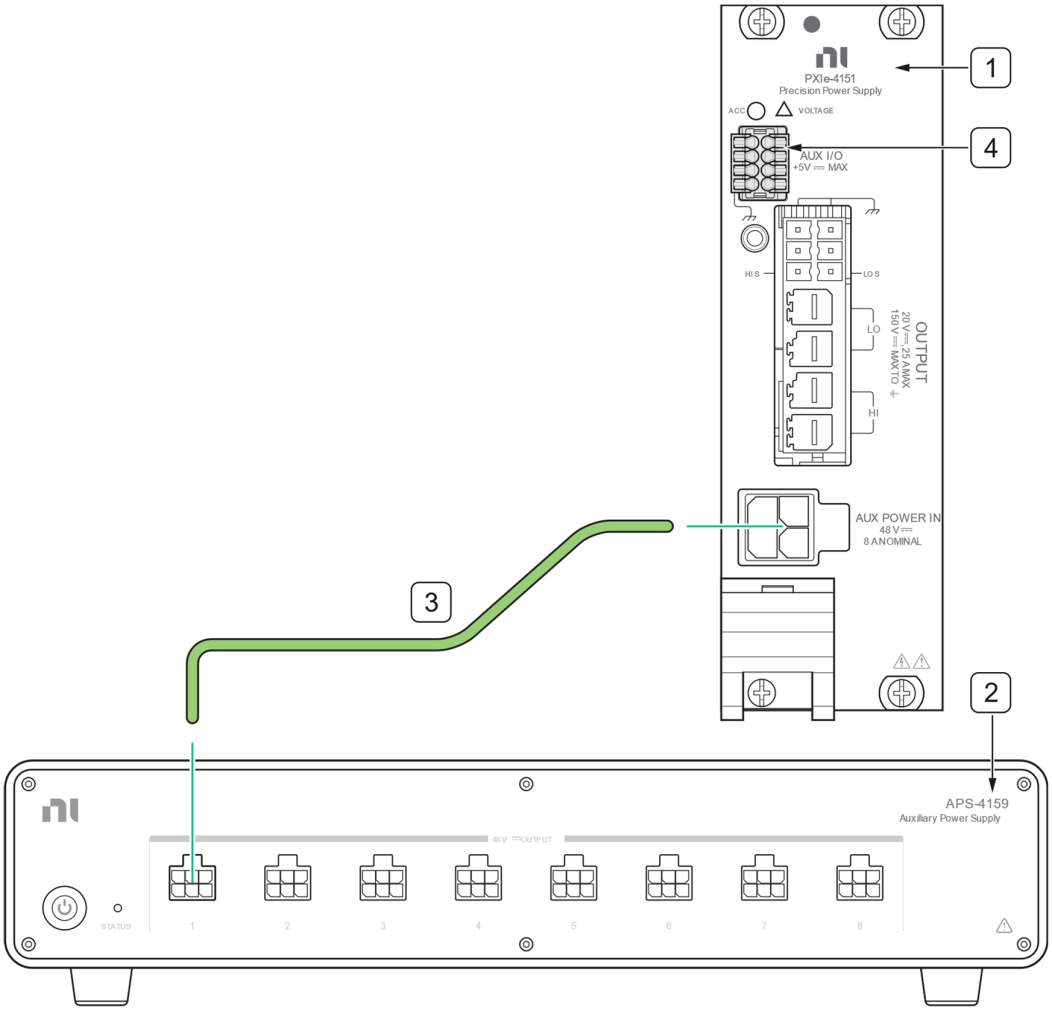
7.4.1. Test Limits

Table 8: Test Points/Limits for Current Load Regulation Verification Test

DUT Range	Source Range	Test Point	DUT Model	As-Found Test Limit	
				Lower Limit	Upper Limit
100 mA	60 V	15 V	PXIe-4150	– 0.03 mA	0.03 mA
100 mA	60 V	30 V	PXIe-4150	– 0.03 mA	0.03 mA
100 mA	60 V	60 V	PXIe-4150	– 0.03 mA	0.03 mA
1 A	60 V	15 V	PXIe-4150	– 0.30 mA	0.30 mA
1 A	60 V	30 V	PXIe-4150	– 0.30 mA	0.30 mA
1 A	60 V	60 V	PXIe-4150	– 0.30 mA	0.30 mA
10 A	60 V	15 V	PXIe-4150	– 0.70 mA	0.70 mA
10 A	60 V	30 V	PXIe-4150	– 0.70 mA	0.70 mA
10 A	60 V	60 V	PXIe-4150	– 0.70 mA	0.70 mA
100 mA	20 V	5 V	PXIe-4151	– 0.03 mA	0.03 mA
100 mA	20 V	10 V	PXIe-4151	– 0.03 mA	0.03 mA
100 mA	20 V	20 V	PXIe-4151	– 0.03 mA	0.03 mA
1 A	20 V	5 V	PXIe-4151	– 0.30 mA	0.30 mA
1 A	20 V	10 V	PXIe-4151	– 0.30 mA	0.30 mA
1 A	20 V	20 V	PXIe-4151	– 0.30 mA	0.30 mA
25 A	20 V	5 V	PXIe-4151	– 2.00 mA	2.00 mA
25 A	20 V	10 V	PXIe-4151	– 2.00 mA	2.00 mA
25 A	20 V	20 V	PXIe-4151	– 2.00 mA	2.00 mA

7.4.2. Initial Test Connection

Figure 5. Initial Connection for Current Load Regulation Verification Test



1. DUT
2. Auxiliary Power Supply
3. Auxiliary Power Supply Cable
4. AUX I/O Connector for DUT

Note
Before operating the programmable power supply, short pin 4 to pin 5 on the AUX I/O connector. For more information, refer to *Installing the Input and AUX I/O Connector on the PXIe-4151.*

7.4.3. Verification Procedure

1. Reset the DUT.
2. Ensure that the warm-up time is observed for the DUT.

3. Perform self-calibration on the DUT, if required. Follow instructions identified in this procedure regarding self-calibration.
4. Ensure DUT is not generating any signals, and the output is turned off prior to making any connections.
5. Set the DUT to **DC Voltage** function.
6. Connect all test equipment as shown in **Figure 5**.

> ⚠ **Caution**
> Before using any probes or accessories, ensure that they meet applicable safety requirements for the signal levels you may encounter.

Repeat 9 times, once for each voltage test point.

7. Set the level range, limit range, and limit on the DUT.
8. Set the level of the DUT to the test point according to **Table 9**.

Table 9: Current Load Regulation Test Point Configuration

DUT Current Range	DUT Source Range	Test Point	DUT Model
100 mA	60 V	15 V	PXIe-4150
100 mA	60 V	30 V	PXIe-4150
100 mA	60 V	60 V	PXIe-4150
1 A	60 V	15 V	PXIe-4150
1 A	60 V	30 V	PXIe-4150
1 A	60 V	60 V	PXIe-4150
10 A	60 V	15 V	PXIe-4150
10 A	60 V	30 V	PXIe-4150
10 A	60 V	60 V	PXIe-4150

100 mA	20 V	5 V	PXIe-4151
100 mA	20 V	10 V	PXIe-4151
100 mA	20 V	20 V	PXIe-4151
1 A	20 V	5 V	PXIe-4151
1 A	20 V	10 V	PXIe-4151
1 A	20 V	20 V	PXIe-4151
25 A	20 V	5 V	PXIe-4151
25 A	20 V	10 V	PXIe-4151
25 A	20 V	20 V	PXIe-4151

9. Set the DUT to **2 PLC** for measurement.
10. Commit all settings to DUT.
11. Wait 2 seconds to ensure the system has adequate time to settle.
12. Take a current measurement from the DUT.
13. Verify the accuracy measurement against the test limit in **Table 8**.

8. Perform Adjustment

Recommend performing 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. Self-Cal shall be executed after the entire adjustment procedure to ensure that all ranges have been adjusted correctly.

Note
Performing self-calibration routine during external adjustment behaves differently than during normal operation. Do not exclude any

self-calibration routines as none of them are redundant and are necessary to complete the adjustment procedure.

8.1. Initialize for Adjust

Initiate an external calibration session. It is required to keep this session open throughout the entire adjust sequence. After each adjust procedure, commit the new constants to hardware. Then close the session after all adjustment procedures have been completed.

Figure 6 Initiate External Calibration Session vi

Execute a self-calibration after initiating the external calibration session to ensure that default tables are used during session. Without executing this self-calibration, the DUT will not create accurate correction factors.

Figure 7 Cal Self Calibrate vi

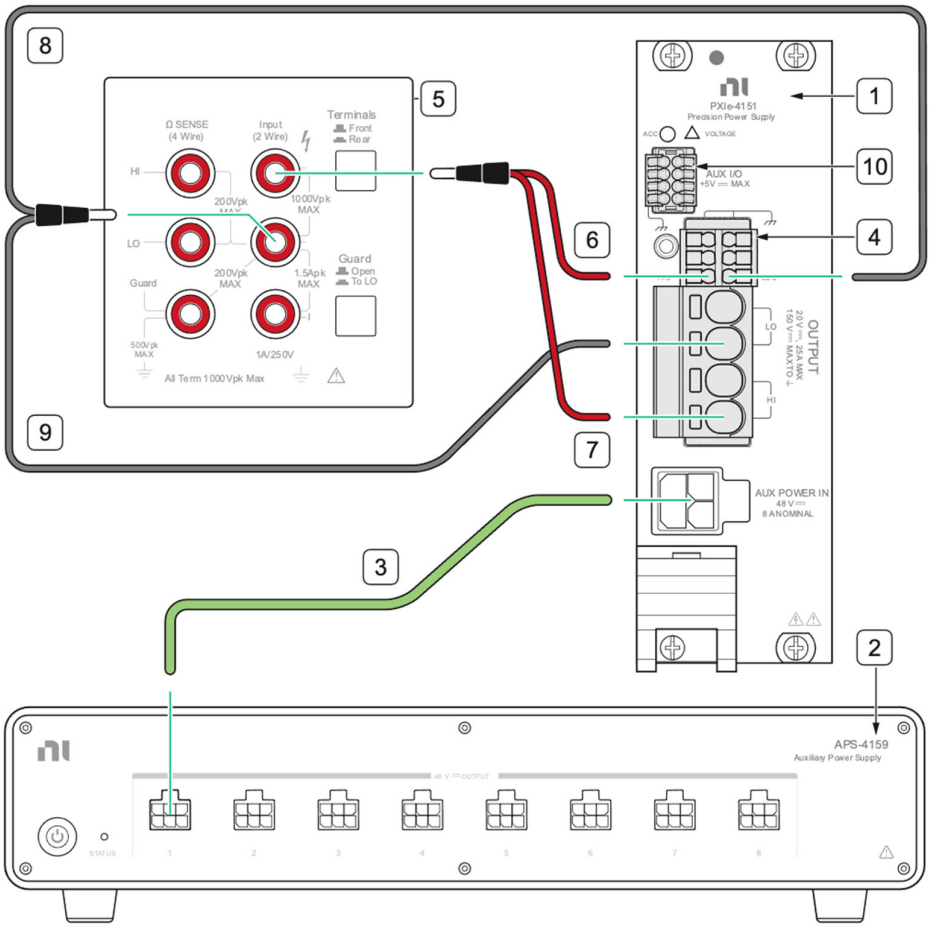
8.2. Voltage Accuracy Adjustment Procedure

8.2.1. Initial Test Connection

Note
Always refer to the specifications document for your device before connecting signals. Failure to observe the specified maximum signal ratings can cause a fire hazard or damage to the device connected to the DUT.

Note
Before using any probes or accessories, ensure that they meet applicable safety requirements for the signal levels you may encounter.

Figure 8. Connections for Voltage Accuracy Adjustment Procedure



1. DUT
2. Auxiliary Power Supply
3. Auxiliary Power Supply Cable
4. Cal cable – "Banana" (NI 101295A-01)
5. DMM
6. HI Sense signal cable
7. HI signal cable from DUT (Positive polarity defined as voltage measured on NI > LO)
8. LO Sense signal cable
9. LO single wire from DUT (Positive polarity defined as voltage measured on NI > LO)
10. AUX I/O Connector for DUT

Note
Before operating the programmable power supply, short pin 4 to pin 5 on the AUX I/O connector. For more information, refer to *Installing the Input and AUX I/O Connector on the PXIe-4151.*

8.2.2. Adjustment Procedure

1. Ensure DUT is not generating any signals, and the output is turned off prior to making any connections.
2. Set the DUT function to **DC Voltage**.
3. Connect all test equipment as shown in **Figure 8**.

Note
Before using any probes or accessories, ensure that they meet applicable safety requirements for the signal levels you may encounter.

Repeat 4 times, once for each test point.

4. Set the level range, limit range, and limit on the DUT.
5. Set current limit to **100 mA**.
6. Set current range to **100 mA**.
   a. Set current set point to **0 A**.
7. Configure the DMM
   a. Set the DMM NPLC to **100**.
   b. Set digits of resolution to **8.5**.
   c. Set function to **DC Voltage**.

Note
Recommended to start with smallest signal level and iterate through test points according to increasing signal level.

8. Set the DMM to the voltage range according to **Table 10**.

9. Set the level of the DUT to the test point according to **Table 10**.

Note
Recommended to start with smallest signal level and iterate through test points according to increasing signal level.

Table 10: Voltage Test Point Configuration

DUT Range	DUT Limit Range	Test Point	DMM Range	DUT Model
6 V	1 A	100 mV	1 V	PXIe-4150/4151
6 V	1 A	6 V	10 V	PXIe-4150/4151
60 V	1 A	100 mV	1 V	PXIe-4150
60 V	1 A	60 V	100 V	PXIe-4150
20 V	1 A	100 mV	1 V	PXIe-4151
20 V	1 A	20 V	100 V	PXIe-4151

10. Wait 2 seconds to ensure the system has adequate time to settle.

11. An additional 4 minute wait is required when the DMM has changed either function of range.

Note
The additional 4 minute wait is to reduce thermal EMF and a requirement of using the DMM identified in this procedure.

12. Take a voltage measurement using the DMM.

13. Provide the DMM measurement to the DUT by calling the **niDCPower Cal Adjust Voltage Level vi** or **niDCPower_CalAdjustVoltageLevel** function.
    a. Input the DMM measurements as the **measured outputs**.

14. Input the DUT measurements as the **requested outputs**.
    a. Input the specified level range as the **range**.

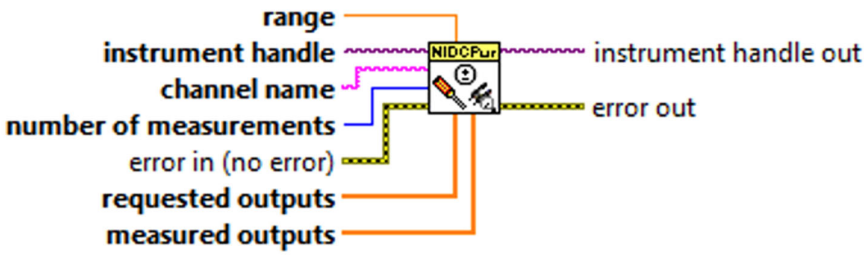


Figure 9. Cal Adjust Voltage Level vi

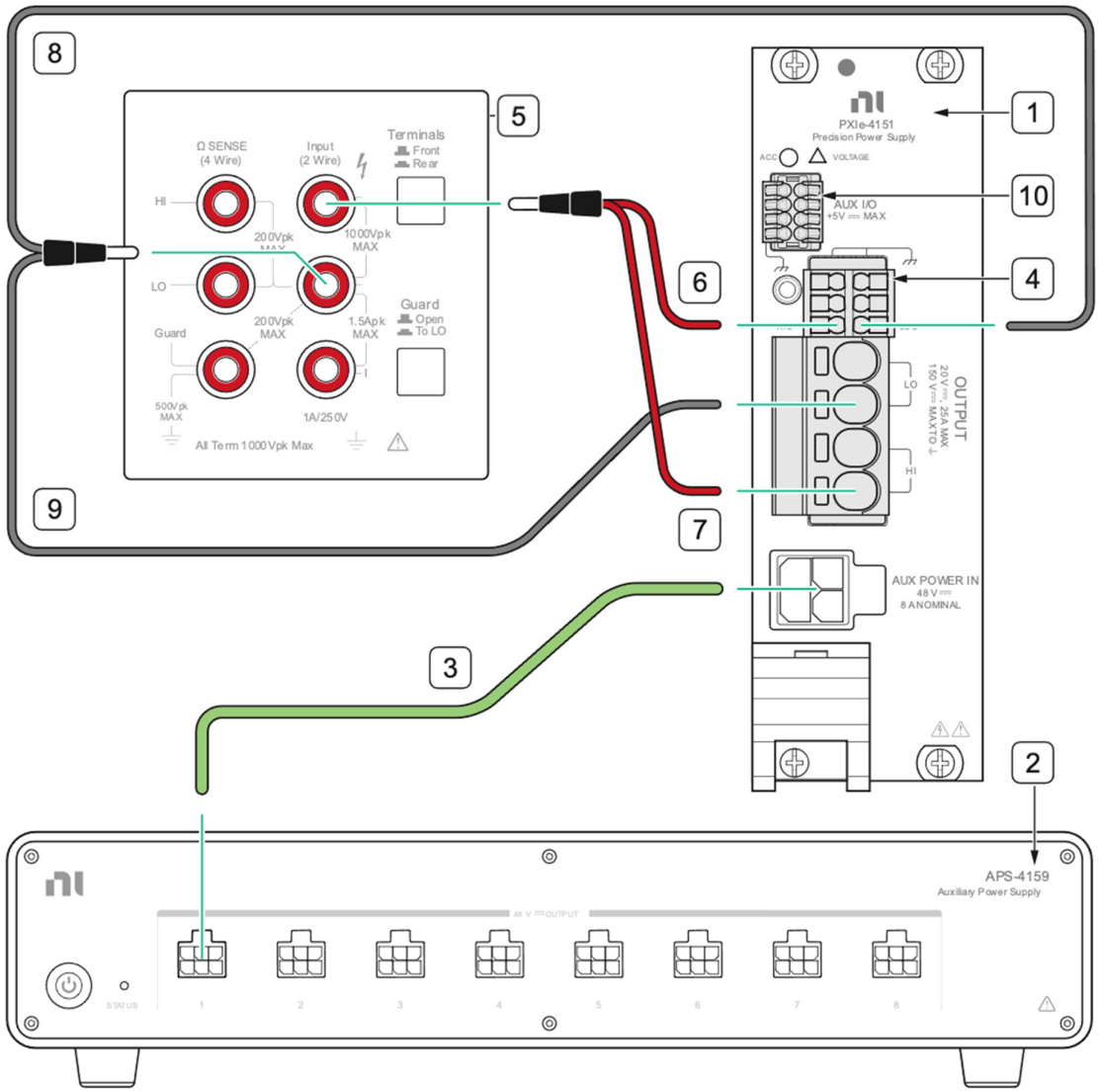
15. Execute calibration self-calibration on DUT. This process will update the voltage correction factors, which will impact the current adjustment.

Figure 10. Cal Self Calibrate vi

8.3. Adjusting Current Accuracy Procedure

8.3.1. Initial Test Connection

Figure 11. Connection for Adjusting Current Accuracy Procedure



1. DUT
2. Auxiliary Power Supply
3. Auxiliary Power Supply Cable
4. Cal cable – "Banana" (NI 101295A-01)
5. DMM
6. HI Sense signal cable
7. HI signal cable from DUT (Positive polarity defined as voltage measured on NI > LO)
8. LO Sense signal cable
9. LO single wire from DUT (Positive polarity defined as voltage measured on NI > LO)
10. AUX I/O Connector for DUT

Note
Before operating the programmable power supply, short pin 4 to pin 5 on the AUX I/O connector. For more information, refer to *Installing the Input and AUX I/O Connector on the PXIe-4151.*

8.3.2. Adjustment Procedure

1. Ensure DUT is not generating any signals, and the output is turned off prior to making any connections.
2. Set the DUT to **DC Current** function.
3. Connect all test equipment as shown in **Figure 11**.

Caution
Before using any probes or accessories, ensure that they meet applicable safety requirements for the signal levels you may encounter.

Repeat 4 times, once for each test point.

4. Set the level range, limit range, and limit on the DUT.
   a. Set voltage limit to **6 V**.
   b. Set voltage range to **6 V**.
5. Configure the DMM
   a. Set the DMM NPLC to **100**.
   b. Set digits of resolution to **8.5**.
   c. Set function to **DC Current**.

Note
Recommended to start with smallest signal level and iterate through test points according to increasing signal level.

6. Set the DMM to the voltage range according to **Table 11**.

7. Set the level of the DUT to the test point according to **Table 11.**

Note
Recommended to start with smallest signal level and iterate through test points according to increasing signal level.

Table 11: Current Test Point Configuration

DUT Range	DUT Limit Range	Test Point	DMM Range	DUT Model
100 mA	6 V	1 mV	100 mA	PXIe-4150/4151
100 mA	6 V	100 mA	100 mA	PXIe-4150/4151
1 A	6 V	10 mA	100 mA	PXIe-4150/4151
1 A	6 V	1 A	1 A	PXIe-4150/4151

8. Wait 2 seconds to ensure the system has adequate time to settle.
9. An additional 4 minute wait is required when the DMM has changed either function of range.

Note
The additional 4 minute wait is to reduce thermal EMF and a requirement of using the DMM identified in this procedure.

10. Take a current measurement using the DMM.
11. Provide the DMM measurement to the DUT by calling the **niDCPower Cal Adjust Current Limit vi** or **niDCPower_CalAdjustCurrentLimit** function.
    a. Input the DMM measurements as the **measured outputs**.
12. Input the DUT measurements as the **requested outputs**.
    a. Input the specified level range as the **range**.

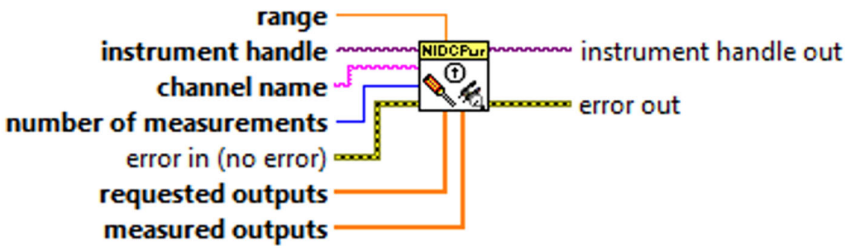


Figure 12. Cal Adjust Current Limit vi

13. Execute calibration self-calibration on DUT. This process will update the current correction factors, which will impact the commit portion of the adjustment.

Figure 13. Cal Self Calibrate vi

8.4. Closing Adjustment Session

Close the session and commit the new constants to hardware by calling the **niDCPower Close External Calibration vi** or **niDCPower_CloseExtCal** function and specifying Commit as the **calibration close action**.

8.5. Running Self Cal

1. Ensure that all connections to the DUT are removed and disconnected.

2. Complete the following steps to conduct self-calibration using Measurement & Automation Explorer (MAX).

3. Launch Measurement Automation Explorer (MAX).

4. Select **My System»Devices and Interfaces»*[DUT model name]***.

5. Start self-calibration using one of the following methods:
   a. Click **Self-Calibrate** in the upper right corner of MAX.
   b. Right-click the name of the DUT in the MAX configuration tree and select **Self-Calibrate** from the drop-down menu.

9. 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 may be tighter than the As-Found limits.

10. Update the Onboard Calibration Information

If the DUT passes all verification procedures successfully, meets the As Left limits, and the adjustment procedure is not going to be executed, then the calibration date can be updated by completing the following steps.

Note
NI recommends following the adjustment procedure in order to update the calibration constants and renew the device calibration interval.

1. Open a session to the DUT with either the **niDCPower Initialize External vi** or **niDCPower_InitExtCal** function.
2. Specify commit in the calibration close action when closing the session with either the **niDCPower Close External Calibration vi** or **niDCPower_CloseExtCal** function.

Use either Measurement Automation Explorer (MAX) or NI System Configuration API to set a calibration due date for the DUT or to clear the calibration due date. NI suggests a minimum calibration due date of the date of external calibration plus the recommended external calibration interval.

3. In MAX, navigate to the External Calibration section of the Settings tab to update the Calibration Due Date entry.
4. Alternatively, use the Update Calibration vi in the NI System Configuration API to set the calibration due date.

11. Revision History

Revision	Section	Changes
379060A-01 May 2025	All	This is the initial release version of the PXIe-4150 and PXIe-4151 Calibration Procedure.

12. 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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379060A-01 May 2025