CALIBRATION PROCEDURE

PXIe-4139

PXIe, ±60 V, ±3 A (DC)/±10 A (Pulsed) Precision System PXI Source Measure Unit

This document contains the verification and adjustment procedures for the PXIe-4139. Refer to *ni.com/calibration* for more information about calibration solutions.

Note In this document, the PXIe-4139 (40W) and PXIe-4139 (20W) are referred to inclusively as the PXIe-4139. The information in this document applies to all versions of the PXIe-4139 unless otherwise specified. To determine which version of the module you have, locate the device name in one of the following places:

- **In MAX**—The PXIe-4139 (40W) shows *NI PXIe-4139 (40W)*, and the PXIe-4139 (20W) shows as *NI PXIe-4139*.
- **Device front panel**—The PXIe-4139 (40W) shows *PXIe-4139 40W System SMU*, and the PXIe-4139 (20W) shows *NI PXIe-4139 Precision System SMU* on the front panel.

Please review and become familiar with the entire procedure before beginning the calibration process.

Contents

Required Software

Calibrating the PXIe-4139 requires you to install the following software on the calibration system:

- Supported driver software
  - For PXIe-4139 (20 W), install NI-DCPower 15.1 or later
  - For PXIe-4139 (40 W), install NI-DCPower 20.5 or later
- Supported application development environment (ADE)—LabVIEW or LabWindows™/CVI™
- Supported operating system—Windows

When you install NI-DCPower, you need to install support only for the application software that you intend to use. Access calibration support in the locations shown in the following table:

ADE	Calibration Support Location
LabVIEW	NI-DCPower Calibration palette
LabWindows/CVI	NI-DCPower function panel (`niDCPower.fp`)

You can download all required software from *ni.com/downloads*.

Related Documentation

For additional information, refer to the following documents as you perform the calibration procedure:

- *NI PXIe-4138/4139 Getting Started Guide*
- *NI DC Power Supplies and SMUs Help*
- *PXIe-4139 Specifications*
- *NI-DCPower Readme*
- *LabVIEW Help*

Visit *ni.com/manuals* for the latest versions of these documents.

Password

The default password for password-protected operations is `NI`.

Calibration Interval

Recommended calibration interval	1 year

Test Equipment

The following table lists the equipment NI recommends for the performance verification and adjustment procedures. If the recommended equipment is not available, select a substitute that meets the minimum required specifications listed in the table.

Table 1. Required Equipment for Calibration

Required Equipment	Recommended Model(s)	Parameter Measured	Minimum Specifications
Digital multimeter (DMM)	Keysight 3458 A	All parameters except remote sense accuracy	Voltage: < ±9 ppm accuracy and < 100 nV resolution. Current: < ±25 ppm accuracy and < 10 pA resolution.
1 MΩ current shunt	IET Labs SRL-1M/1Triax	1 µA and 10 µA current accuracy	< 8 ppm accuracy, < 0.2 ppm / °C tempco.
Triax adapter SA-413T	NI part number 784000-01	1 µA and 10 µA current accuracy	Triax adapter used for connecting a triax cable from the PXIe-4138/4139 to the 1 MΩ current shunt.
1 Ω current shunt	Ohm Labs CS-1	1 A current accuracy	< 50 ppm accuracy, < 5 ppm / °C tempco.
333 mΩ current shunt	Ohm Labs CS-3-1	3 A current accuracy	< 100 ppm accuracy, < 5 ppm / °C tempco.

Table 1. Required Equipment for Calibration (Continued)

Required Equipment	Recommended Model(s)	Parameter Measured	Minimum Specifications
3 kΩ resistor	Vishay PTF563K0000BYEB	Remote sense accuracy	0.1% 250 mW
Low thermal test leads	Fluke 5440	1 µA and 10 µA current accuracy	Shielded, twisted pair copper cables with copper or goldplated copper banana plugs

Test Conditions

Follow the setup and environmental information below to ensure the PXIe-4139 meets the published specifications.

- Keep cabling as short as possible. Long cables act as antennas, picking up extra noise that can affect measurements.
- Verify that all connections to the PXIe-4139, including front panel connections and screws, are secure.
- Ensure that the PXI chassis fan filters, if present, are clean, and that the empty slots contain filler panels.
- For chassis with slot cooling capacity = 38 W, ensure that the PXI chassis fan speed is set to HIGH. For more information about cooling, refer to the *Maintain Forced-Air Cooling Note to Users* document available at *ni.com/manuals*.
- Allow a warm-up time of at least 30 minutes after the chassis is powered on and NI-DCPower is loaded and recognizes the PXIe-4139. The warm-up time ensures that the PXIe-4139 and test instrumentation are at a stable operating temperature.
- Use shielded copper wire for all cable connections to the module. Use twisted-pair wire to eliminate noise and thermal offsets.
- To ensure the system has had adequate time to settle, wait one second after requesting a new current or voltage or after changing a load before taking a measurement.

- When making measurements, configure the following aperture time-related settings:
  - Set the **niDCPower Aperture Time** property or `NIDCPOWER_ATTR_APERTURE_TIME` attribute to 2 power-line cycles (PLCs) on the module.
  - Set the **niDCPower Aperture Time Units** property or `NIDCPOWER_ATTR_APERTURE_TIME_UNITS` to power line cycles.
  - Set the **niDCPower Configure Power Line Frequency** property or the `NIDCPOWER_ATTR_POWER_LINE_FREQUENCY` attribute to either 50 or 60 depending on the frequency of the AC power line in your location.
- Ensure that properties or attributes for the module that are not specified in calibration procedures are set to their default values.
- When making measurements, configure any specified digital multimeters (DMMs) with the best available ranges and measurement settings for each specified test point.
- Keep relative humidity between 10% and 70%, noncondensing.
- For verification procedures, maintain an ambient temperature of 23 °C ±5 °C. Maintain an internal device temperature range of T_{cal} ±1 °C.[1]
- For adjustment procedures, maintain an ambient temperature of 23 °C ±1 °C. The PXIe-4139 internal temperature is greater than the ambient temperature.

As-Found and As-Left Limits

The *as-found limits* are the published specifications for the device. NI uses these limits to determine whether the device meets the device specifications when it is received for calibration.

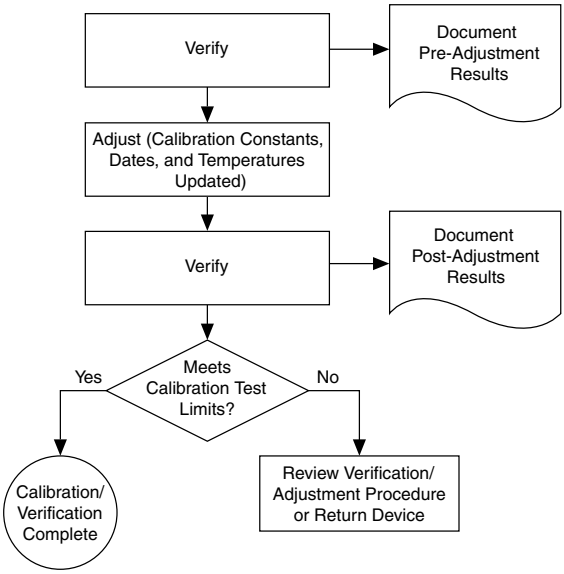
The *as-left limits* are equal to the published NI specifications for the device, less guard bands for measurement uncertainty, temperature drift, and drift over time. NI uses these limits to determine whether the device will meet the device specifications over its calibration interval.

Calibration Overview

Calibration includes the steps shown in the following figure.

[1] T_{cal} is the internal device temperature recorded by the PXIe-4139 at the completion of the last self-calibration. Call the niDCPower Get Self Cal Last Temp VI to query T_{cal} from the PXIe-4139.

Figure 1. Calibration Overview



1. Initial setup—Install the PXIe-4139 and configure it in Measurement & Automation Explorer (MAX).
2. Verification—Verify the existing operation of the PXIe-4139.

   This step confirms whether the PXIe-4139 is operating within the published specifications prior to adjustment.
3. Adjustment—Adjust the calibration constants of the PXIe-4139.
4. Reverification—Repeat the Verification procedure to ensure that the PXIe-4139 is operating within the published specifications after adjustment.

Verification

This section provides instructions for verifying the PXIe-4139 specifications.

You do not need to separately verify both measurement and output. The architecture of the PXIe-4139 ensures that if measurement is accurate, then output is as well, and vice versa.

Note The performance verification procedures assume that adequate traceable uncertainties are available for the calibration references.

Related Information

Reverification on page 24

After completing adjustment, wait a minimum of five minutes for the internal device temperature to stabilize. Repeat the *Verification* section to determine the as-left status of the device.

Self-Calibrating the PXIe-4139

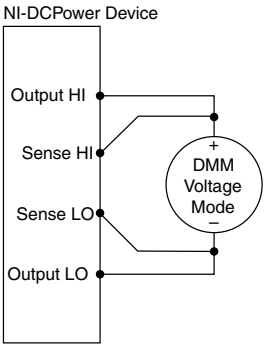
Complete the following steps to self-calibrate the PXIe-4139.

1. Disconnect or disable all connections to the PXIe-4139.
2. Allow the PXIe-4139 30 minutes to warm up with the PXI chassis fans set to HIGH.
3. Initialize an NI-DCPower session.
4. Call the self-calibration function.
5. Close the NI-DCPower session.

Connecting and Configuring Equipment for Voltage Verification

1. Make the necessary connections for this procedure, as shown in the following figure:

Figure 2. Voltage Verification or Adjustment Connection Diagram



2. Set the **niDCPower Output Function** property or `NIDCPOWER_OUTPUT_FUNCTION` attribute to DC Voltage for the PXIe-4139.

Verifying Voltage Measurement and Output

Compare a set of voltages measured by a DMM to the voltage test points requested by the PXIe-4139.

Refer to the following table as you complete the following steps.

Verify ranges in the order listed in the table.

Table 2. Voltage Output and Measurement Verification

Level Range	Limit Range and Limit	Test Point	As-Found Measurement Test Limit		As-Left Measurement Test Limit	
			Lower	Upper	Lower	Upper
600 mV	1 mA	-600 mV	-600.126 mV	-599.874 mV	-600.064 mV	-599.936 mV
		0 mV	-0.03 mV	0.03 mV	-0.025 mV	0.025 mV
		600 mV	599.874 mV	600.126 mV	599.936 mV	600.064 mV
6 V		-6 V	-6.00105 V	-5.99895 V	-6.000355 V	5.999645 V
		0 V	-0.00009 V	0.00009 V	-0.000085 V	0.000085 V
		6 V	5.99895 V	6.00105 V	5.999645 V	6.000355 V
60 V		-60 V	-60.0105 V	-59.9895 V	-60.00472 V	-59.99528 V
		0 V	-0.0009 V	0.0009 V	-0.00082 V	0.00082 V
		60 V	59.9895 V	60.0105 V	59.99528 V	60.00472 V

Note The lower and upper voltage measurement test limits are calculated using the following formula:

Voltage Measurement Test Limits = *Test Point* ± (|*Test Point*| * *% of Voltage* + *Offset*)

1. Set the first specified level range, limit range, and limit on the PXIe-4139.
2. Set the **niDCPower Sense** property or `NIDCPOWER_ATTR_SENSE` attribute to Local.
3. Measure the internal device temperature and perform self-calibration if necessary.
   a) After measuring the internal device temperature, wait for the internal device temperature to stabilize. Temperature is considered stable when it has not changed by more than ±1 °C in the previous 5 minutes.
   b) After the internal temperature has stabilized, if the temperature still exceeds T_{cal} ± 1 °C, call the self-calibration VI or function.
4. Set the level on the PXIe-4139 to the first specified test point.
5. Compare a DMM voltage measurement to the voltage measurement test limits.
   a) Take a voltage measurement using the DMM.
   b) Verify the DMM measurement falls within the test limits in the *Voltage Output and Measurement Verification* table.
6. Repeat step 4 through step 5 for each test point.
7. Repeat step 1 through step 6 for each level range.

Verifying Remote Sense Voltage Offset

Compare a set of voltages measured by a DMM to the voltage test points requested by the PXIe-4139.

Refer to the following table as you complete the following steps.

Verify ranges in the order listed in the table. Use the same connections as the previous test.

Table 3. Remote Sense Voltage Offset Verification

Level Range	Limit Range and Limit	Test Point	As-Found Measurement Test Limit	As-Left Measurement Test Limit
600 mV	1 mA	0 V	±30 µV	±25 µV
6 V			±90 µV	±85 µV
60 V			±900 µV	±820 µV

1. Set the first specified level range, limit range, and limit on the PXIe-4139.
2. Set the **niDCPower Sense** property or `NIDCPOWER_ATTR_SENSE` attribute to Remote.
3. Set the level on the PXIe-4139 to the first specified test point.
4. Compare a DMM voltage measurement to the voltage measurement test limits.
   a) Take a voltage measurement using the DMM.
   b) Verify the DMM measurement falls within the test limits.
5. Repeat step 1 through step 4 for each level range.

Verifying Voltage Remote Sense

Use the PXIe-4139 in constant current mode with a test circuit to simulate the voltage drop between the device and a load.

Complete this procedure only after successfully completing all previous verification procedures. Verify level ranges in the specified order.

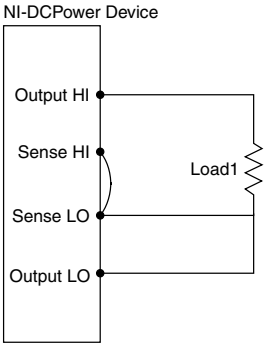
Refer to the following table as you complete the following steps:

Table 4. Remote Sense Voltage Output Verification

Level Range	Limit Range and Limit	Test Point	Load1	Load2	Voltage Remote Sense Test Limit	
					Load1	Load2
1 mA	600 mV	0 mA	3 kΩ	3 kΩ	≤38.4 µV	≤6 µV
		1 mA				

1. Make the necessary connections for this procedure, as shown in the following figure:

Figure 3. Voltage Remote Sense Diagram, Part 1[2]

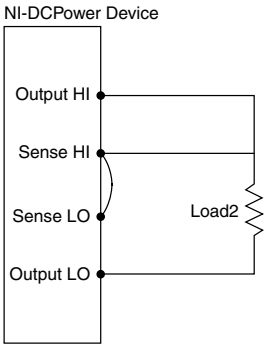


2. Set the **niDCPower Output Function** property or `NIDCPOWER_OUTPUT_FUNCTION` attribute to DC Current for the PXIe-4139.
3. Set the **niDCPower Sense** property or `NIDCPOWER_ATTR_SENSE` attribute to Remote.
4. Set the first specified level range, limit range, and limit on the PXIe-4139.
5. Measure the internal device temperature and perform self-calibration if necessary.
   a) After measuring the internal device temperature, wait for the internal device temperature to stabilize. Temperature is considered stable when it has not changed by more than ±1 °C in the previous 5 minutes.
   b) After the internal temperature has stabilized, if the temperature still exceeds T_{cal} ± 1 °C, call the self-calibration VI or function.
6. Set the level on the PXIe-4139 to the first specified test point and enable the output.
7. Take a voltage measurement using the PXIe-4139.
8. Record the voltage from the previous step as *V1*.
9. Repeat step 6 through step 8 for the other test point specified in the level range. This time, record the value as *V2*.
10. Calculate the remote sense error using the following formula, and then record the value.

    Remote Sense Error = |*V*2 - *V*1|
11. Verify that the recorded value falls within the test limits.
12. Repeat the previous steps. This time, make the necessary connections as shown in the following figure:

[2] Follow industry best practices for minimizing thermal electromotive force (EMF) when making the necessary connections for this procedure.

Figure 4. Voltage Remote Sense Diagram, Part 2[3]



Verifying Current Offset

Remove all connections from the PXIe-4139 and confirm the current measured by the PXIe-4139 at 0 V falls within the test limits.

Refer to the following table as you complete the following steps. Complete this procedure only after successfully completing all previous verification procedures. Verify ranges in the order listed in the table.

Table 5. Current Offset Verification

Level Range	Limit Range and Limit	Test Point	As-Found Offset Test Limit		As-Left Offset Test Limit	
			Lower Limit	Upper Limit	Lower Limit	Upper Limit
600 mV	1 µA	0 mV	-40 pA	40 pA	-25 pA	25 pA
	10 µA		-300 pA	300 pA	-200 pA	200 pA
	100 µA		-2 nA	2 nA	-1.5 nA	1.5 nA
	1 mA		-20 nA	20 nA	-15 nA	15 nA
	10 mA		-200 nA	200 nA	-150 nA	150 nA
	100 mA		-2 µA	2 µA	-1.5 µA	1.5 µA
	1 A		-20 µA	20 µA	-15 µA	15 µA
	3 A		-600 µA	600 µA	-500 µA	500 µA

[3] Follow industry best practices for minimizing thermal electromotive force (EMF) when making the necessary connections for this procedure.

1. Disconnect all equipment from the output of the PXIe-4139.
2. Measure the internal device temperature and perform self-calibration if necessary.
   a) After measuring the internal device temperature, wait for the internal device temperature to stabilize. Temperature is considered stable when it has not changed by more than ±1 °C in the previous 5 minutes.
   b) After the internal temperature has stabilized, if the temperature still exceeds T_{cal} ± 1 °C, call the self-calibration VI or function.
3. Take a current measurement using the PXIe-4139.
4. Record the value from the previous step.
5. Verify that the recorded value falls within the test limits.
6. Repeat step 2 through step 5 for each level range.

Verifying Load Regulation

Note Although load regulation is listed as a typical specification for the PXIe-4139, verification is required. If the PXIe-4139 fails the load regulation verification procedure, discontinue use of the device and contact an authorized NI service representative to request a Return Material Authorization (RMA).

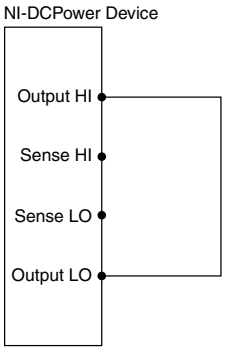
Refer to the following table as you complete the following steps:

Table 6. Load Regulation Verification

Level Range	Limit Range and Limit	Test Point	As-found/As-left Limit
10 mA	600 mV	10 mA	1 mV

1. Set the **niDCPower Output Function** property or `NIDCPOWER_OUTPUT_FUNCTION` attribute to DC Current for the PXIe-4139.
2. Set the **niDCPower Sense** property or `NIDCPOWER_ATTR_SENSE` attribute to Local.
3. Make the necessary connections for this procedure, as shown in the following figure:

Figure 5. Load Regulation Connection Diagram



Note Connection wires should be 18 or 20 AWG and as short as possible to ensure low resistance.

4. Set the first specified level range, limit range, and limit on the PXIe-4139.
5. Measure the internal device temperature and perform self-calibration if necessary.
   a) After measuring the internal device temperature, wait for the internal device temperature to stabilize. Temperature is considered stable when it has not changed by more than ±1 °C in the previous 5 minutes.
   b) After the internal temperature has stabilized, if the temperature still exceeds T_{cal} ± 1 °C, call the self-calibration VI or function.
6. Set the level on the PXIe-4139 to the first specified test point.
7. Take a voltage measurement using the PXIe-4139.
8. Record the value from the previous step.
9. Verify that the recorded value falls within the test limits in the *Load Regulation Verification* table.

Verifying 1 µA and 10 µA Current Measurement and Output

Compare a set of measured currents reported by the PXIe-4139 to the currents measured by a DMM.

Refer to the following table as you complete the following steps.

Complete this procedure only after successfully completing all previous verification procedures. Verify level ranges in the order listed in the table.

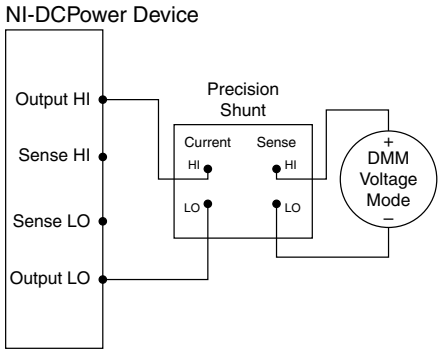
Table 7. 1 µA and 10 µA Current Output and Measurement Verification

Level Range	Limit Range and Limit	Shunt	Test Point	As-Found Measurement Test Limit (% of Current + Offset)	As-Left Measurement Test Limit (% of Current + Offset)
6 V	1 µA	1 MΩ	-0.9 V	0.022% + 40 pA	0.013% + 25 pA
			0.9 V		
60 V	10 µA		-9 V	0.022% + 300 pA	0.013% + 200 pA
			9 V		

Note The lower and upper voltage measurement test limits are calculated using the following formula:
Current Measurement Test Limits = DMM Measured Current ± (|*DMM Measured Current*| * *% of Current* + *Offset*)

1. Make the necessary connections for this procedure, as shown in the following figure:

Figure 6. Current Connection Diagram, Part 1



Note Ensure to keep cabling as short as possible. Use twisted-pair wire to eliminate noise and thermal offsets. When connecting to the IET Labs SRL-1M/1Triax, use adapter SA-413T Triaxial adapter for PXIe-4139.

2. Set the **niDCPower Output Function** property or `NIDCPOWER_OUTPUT_FUNCTION` attribute to DC Voltage for the PXIe-4139.
3. Set the first specified level range, limit range, and limit on the PXIe-4139.
4. Measure the internal device temperature and perform self-calibration if necessary.
   a) After measuring the internal device temperature, wait for the internal device temperature to stabilize. Temperature is considered stable when it has not changed by more than ±1 °C in the previous 5 minutes.

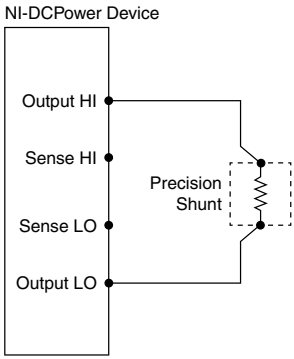
b) After the internal temperature has stabilized, if the temperature still exceeds T_{cal} ± 1 °C, call the self-calibration VI or function.

5. Set the level on the PXIe-4139 to the first specified test point.

   Complete the following four steps within 5 minutes or less of completing step 4 in order to ensure the internal device temperature remains stable.

6. Calculate the current through the shunt by completing the following steps.
   a) Take a voltage measurement across the shunt using the DMM.
   b) Divide the voltage measurement by the calibrated value of the shunt.
   c) Record the calculated value as *DMM Measured Current*.
7. Disconnect the DMM. Leave the PXIe-4139 output on.
8. Leave the DUT connected to the shunt as shown in the following figure:

Figure 7. Current Connection Diagram, Part 2



9. Take a current measurement using the PXIe-4139.
10. Record the value from the previous step.
11. Verify that the recorded PXIe-4139 value falls within the test limits.
12. Repeat step 5 through step 12 for each test point.
13. Repeat step 3 through step 13 for each level range.
14. Configure the PXIe-4139 output to disable.

Verifying 100 µA to 100 mA Current Measurement and Output

Compare a set of currents measured by a DMM to the current test points requested by the PXIe-4139.

Complete this procedure only after successfully completing all previous verification procedures. Verify level ranges in the order listed in the table.

Refer to the following table as you complete the following steps:

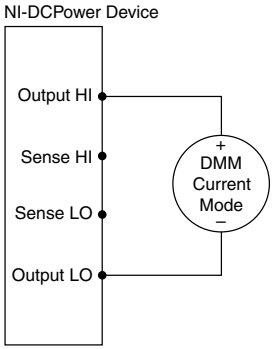
Table 8. 100 µA to 100 mA Current Output and Measurement Verification

Level Range	Limit Range and Limit	Test Point	As-Found Measurement Test Limit		As-Left Measurement Test Limit	
			Lower	Upper	Lower	Upper
100 µA	6 V	-100 µA	-100.024 uA	-99.976 uA	-100.0145 uA	-99.9855 uA
		100 µA	99.976 uA	100.024 uA	99.9855 uA	100.0145 uA
1 mA		-1 mA	-1.00024 mA	-0.99976 mA	-1.000145 mA	-0.999855 mA
		1 mA	0.99976 mA	1.00024 mA	0.999855 mA	1.000145 mA
10 mA		-10 mA	-10.0024 mA	-9.9976 mA	-10.00145 mA	-9.99855 mA
		10 mA	9.9976 mA	10.0024 mA	9.99855 mA	10.00145 mA
100 mA		-100 mA	-100.024 mA	-99.976 mA	-100.0145 mA	-99.9855 mA
		100 mA	99.976 mA	100.024 mA	99.9855 mA	100.0145 mA

Note The lower and upper voltage measurement test limits are calculated using the following formula:
Current Measurement Test Limits = Test Point ± (|*Test Point*| * *% of Current* + *Offset*)

1. Make the necessary connections for this procedure, as shown in the following figure:

Figure 8. Current Verification Connection Diagram



2. Set the **niDCPower Output Function** property or `NIDCPOWER_OUTPUT_FUNCTION` attribute to DC Current for the PXIe-4139.
3. Set the first specified level range, limit range, and limit on the PXIe-4139.

4. Measure the internal device temperature and perform self-calibration if necessary.
   a) After measuring the internal device temperature, wait for the internal device temperature to stabilize. Temperature is considered stable when it has not changed by more than ±1 °C in the previous 5 minutes.
   b) After the internal temperature has stabilized, if the temperature still exceeds T_{cal} ± 1 °C, call the self-calibration VI or function.
5. Set the level on the PXIe-4139 to the first specified test point.
6. Compare a DMM current measurement to the current measurement test limits.
   a) Take a current measurement using the DMM.
   b) Verify the DMM measurement falls within the test limits in the *100 µA to 100 mA Current Output and Measurement Verification* table.
7. Repeat step 5 through step 6 for each test point.
8. Repeat step 3 through step 7 for each level range.
9. Configure the PXIe-4139 output to disable.

Verifying 1 A and 3 A Current Measurement and Output

Compare a set of currents measured by a DMM to the current test points requested by the PXIe-4139.

Refer to the following table as you complete the following steps.

Complete this procedure only after successfully completing all previous verification procedures. Verify level ranges in the order listed in the table.

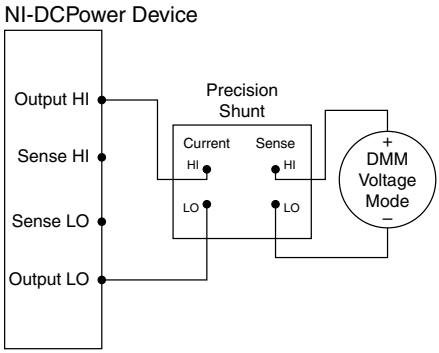
Table 9. 1 A and 3 A Current Output and Measurement Verification

Level Range	Limit Range and Limit	Test Point	As-Found Measurement Test Limit		As-Left Measurement Test Limit	
			Lower	Upper	Lower	Upper
1 A	6 V	-1 A	-1.00029 A	-0.99971 A	-1.000145 A	-0.999855 A
		1 A	0.99971 A	1.00029 A	0.999855 A	1.000145 A
3 A		-3 A	-3.00309 A	-2.99691 A	-3.00185 A	-2.99815 A
		3 A	2.99691 A	3.00309 A	2.99815 A	3.00185 A

Note The lower and upper voltage measurement test limits are calculated using the following formula:
Current Measurement Test Limits = *Test Point* ± (|*Test Point*| * *% of Current* + *Offset*)

1. Make the necessary connections for this procedure, as shown in the following figure:

Figure 9. Current Verification Connection Diagram



Note Ensure cabling is as short as possible. Use twisted-pair wire to eliminate noise and thermal offsets.

2. Set the **niDCPower Output Function** property or `NIDCPOWER_OUTPUT_FUNCTION` attribute to DC Current for the PXIe-4139.
3. Set the first specified level range, limit range, and limit on the PXIe-4139.
4. Measure the internal device temperature and perform self-calibration if necessary.
   a) After measuring the internal device temperature, wait for the internal device temperature to stabilize. Temperature is considered stable when it has not changed by more than ±1 °C in the previous 5 minutes.
   b) After the internal temperature has stabilized, if the temperature still exceeds T_{cal} ± 1 °C, call the self-calibration VI or function.
5. Set the level on the PXIe-4139 to the first specified test point.
6. Calculate the current through the shunt by completing the following steps.
   a) Take a voltage measurement across the shunt using the DMM.
   b) Divide the voltage measurement by the calibrated value of the shunt.
   c) Record the calculated value as *DMM Measured Current*.
7. Verify that the recorded *DMM Measured Current* value falls within the test limits.
8. Repeat step 5 through step 8 for each test point.
9. Repeat step 3 through step 9 for each level range.

Adjustment

This section describes the steps needed to adjust the PXIe-4139 to meet published specifications.

Adjusted Specifications

Adjustment corrects the following specifications for the device:

- Voltage programming accuracy
- Current programming accuracy
- Voltage measurement accuracy
- Current measurement accuracy

Following the adjustment procedure automatically updates the calibration date and temperature on the device.

Note You do not need to separately adjust both measurement and output. The architecture of the PXIe-4139 ensures that if measurement is accurate, then output is as well, and vice versa.

Initiating the Adjustment Session

1. After completing verification, wait a minimum of five minutes for the internal device temperature to stabilize.
2. Initiate an external calibration session (a specific type of NI-DCPower session) by calling the niDCPower Initialize External Calibration VI or `niDCPower_InitExtCal` function.
3. Call the self-calibration function.

Follow the actions below during adjustment:

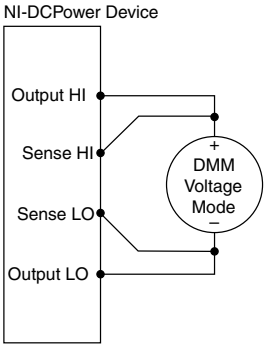
- Keep the calibration session open until you complete all adjustment procedures.
- Complete all adjustment procedures within 15 minutes or less after initiating the external calibration session.
- Complete all adjustment procedures in the specified order.
- Do not self-calibrate the device except as specified in a procedure.

Voltage and Current Output

Connecting and Configuring Equipment for Voltage Adjustment

1. Make the necessary connections for this procedure, as shown in the following figure:

Figure 10. Voltage Verification or Adjustment Connection Diagram



2. Set the **niDCPower Sense** property or `NIDCPOWER_ATTR_SENSE` attribute to Local.
3. Set the **niDCPower Output Function** property or `NIDCPOWER_OUTPUT_FUNCTION` attribute to DC Voltage for the PXIe-4139.

Adjusting Voltage Output and Measurement

Compare a set of measured voltages reported by the PXIe-4139 to the voltages measured by a DMM.

Refer to the following table as you complete the following steps:

Table 10. Voltage Output and Measurement Adjustment

Level Range	Limit Range and Limit	Test Point
6 V	100 mA	5 V
		-5 V

1. Set the first specified level range, limit range, and limit on the PXIe-4139.
2. Set the level on the PXIe-4139 to the first specified test point.
3. Take a voltage measurement using the DMM.
4. Store the value from the previous step to use as an input for the niDCPower Cal Adjust VI or function called in the following steps.
5. Repeat step 2 through step 4 for each test point.
6. Update the output calibration constants by configuring and calling the niDCPower Cal Adjust Voltage Level VI or `niDCPower_CalAdjustVoltageLevel` function.
   a) Input the DMM measurements as the **measured outputs**.
   b) Input the test points as the **requested outputs**.
   c) Input the specified level range as the **range**.

Adjusting 1 µA to 100 mA Current Output and Measurement

Complete this procedure only after successfully completing all previous adjustment procedures. Adjust ranges in the specified order.

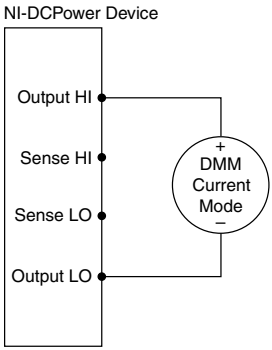
Refer to the following table as you complete the following steps:

Table 11. 1 µA to 100 mA Current Output and Measurement Adjustment[4]

Level Range	Limit Range and Limit	Test Point
100 µA	6 V	100 µA
		-100 µA
1 mA[5]	6 V	100 µA
		-100 µA

1. Make the necessary connections for this procedure, as shown in the following figure:

Figure 11. Current Output and Measurement Adjustment Connection Diagram



2. Set the **niDCPower Output Function** property or `NIDCPOWER_OUTPUT_FUNCTION` attribute to DC Current for the PXIe-4139.
3. Set the first specified level range, limit range, and limit on the PXIe-4139.
4. Set the level on the PXIe-4139 to the first specified test point.
5. Take a current measurement using the DMM.
6. Store the value from the previous step to use as an input for the niDCPower Cal Adjust VI or function called in the following steps.
7. Repeat step 4 through step 6 for each test point.
8. Update the output calibration constants by configuring and calling the niDCPower Cal Adjust Current Limit VI or `niDCPower_CalAdjustCurrentLimit` function.
   a) Input the calculated shunt current measurements as the **measured outputs**.
   b) Input the test points as the **requested outputs**.
   c) Input the specified level range as the **range**.

[4] Adjusting the 100 µA and 1 mA level ranges automatically adjusts the following ranges: 1 µA, 10 µA, 10 mA, and 100 mA.

[5] The PXIe-4139 requires that you adjust ±100 µA test points in the 1 mA level range.

9. Repeat step 3 through step 8 for each level range.

Adjusting 1 A and 3 A Current Output and Measurement

Compare a set of measured currents reported by the PXIe-4139 to the currents measured by a DMM.

Complete this procedure only after successfully completing all previous adjustment procedures. Adjust ranges in the specified order.

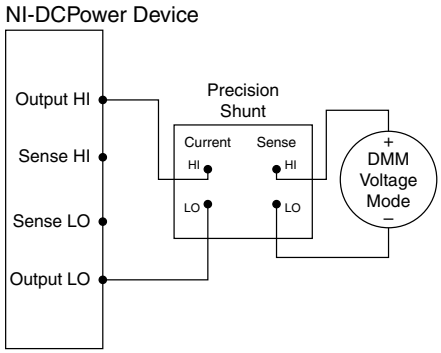
Refer to the following table as you complete the following steps:

Table 12. 1 A and 3 A Current Output and Measurement Adjustment

Level Range	Limit Range and Limit	Shunt	Test Point
1 A	6 V	1 Ω	1 A
			-1 A
3 A	6 V	333 mΩ	3 A
			-3 A

1. Make the necessary connections for this procedure, as shown in the following figure:

Figure 12. Current Verification Connection Diagram



2. Set the **niDCPower Output Function** property or `NIDCPOWER_OUTPUT_FUNCTION` attribute to DC Current for the PXIe-4139.
3. Set the first specified level range, limit range, and limit on the PXIe-4139.
4. Set the level on the PXIe-4139 to the first specified test point.
5. Calculate the current through the shunt by completing the following steps.
   a) Take a voltage measurement across the shunt using the DMM.
   b) Divide the voltage measurement by the calibrated value of the shunt.
6. Store the value from the previous step to use as an input for the niDCPower Cal Adjust VI or function called in the following steps.

7. Repeat step 4 through step 6 for each test point.
8. Update the output calibration constants by configuring and calling the niDCPower Cal Adjust Current Limit VI or `niDCPower_CalAdjustCurrentLimit` function.
   a) Input the calculated shunt current measurements as the **measured outputs**.
   b) Input the test points as the **requested outputs**.
   c) Input the specified level range as the **range**.
9. Repeat steps 3 through step 8 for each level range.
10. Configure the PXIe-4139 output to disable.

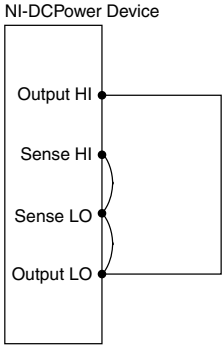
Residual Offset Voltage

Connecting and Configuring Equipment to Adjust Residual Offset Voltage

1. Before completing adjustment of residual offset voltage, wait a minimum of 5 minutes for the internal device temperature to stabilize.
2. Make the necessary connections for this procedure, as shown in the following figure:

Figure 13. Residual Voltage Offset Diagram

[6]



3. Set the **niDCPower Output Function** property or `NIDCPOWER_OUTPUT_FUNCTION` attribute to DC Voltage for the PXIe-4139.

Adjusting Residual Voltage Offset

Eliminate residual offset voltage at 0 V by configuring and calling the niDCPower Cal Adjust Residual Voltage Offset VI or `niDCPower_CalAdjustResidualVoltageOffset` function.

[6] Follow industry best practices for minimizing thermal electromotive force (EMF) when making the necessary connections for this procedure.

Closing the 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**.

Alternative to Performing Adjustment Procedures

If your device passes all as-left limits in the verification procedures successfully and you want to skip updating the calibration constants, you can update solely the calibration date by completing the following steps.

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

1. Call either the niDCPower Initialize External Calibration VI or the `niDCPower_InitExtCal` function.
2. Call either the niDCPower Close External Calibration VI or the `niDCPower_CloseExtCal` function, specifying Commit in **calibration close action**.

Reverification

After completing adjustment, wait a minimum of five minutes for the internal device temperature to stabilize. Repeat the *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 PXIe-4139 to NI. Refer to the *NI Services* section for information about support resources or service requests.

Related Information

Verification on page 6

Setting the Calibration Due Date

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

1. In MAX, navigate to the External Calibration section of the Settings tab to update the Calibration Due Date entry.
2. Alternatively, use the Update Calibration VI in the NI System Configuration API to set the calibration due date for either a specific date or an interval in months.

Revision History

Revision	Section	Changes
374215C-01 April 2021	Various	Verbiage to include the PXIe-4139 (40W) variant into the calibration procedure.
	Test Equipment	Added Triax adapter and low thermal test leads.
	Test Conditions	Updated content regarding the chassis fan.
	Verification	Formula to calculate test limits are removed from instructions across Verification procedures and are instead included with their test limit tables. Test limits in tables updated to reflect this change.

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.

NI corporate headquarters is located at 11500 N Mopac Expwy, Austin, TX, 78759-3504, USA.

374215C-01 March 29, 2021