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PXIe-4162

CALIBRATION PROCEDURE

PXIe-4162/4163

12 or 24-Channel, ± 24 V Precision PXI Source Measure Unit

This document contains the verification and adjustment procedures for the PXIe-4162/4163. Refer to ni.com/calibration for more information about calibration solutions.

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Required Software

Calibrating the PXIe-4162/4163 requires you to install the following software on the calibration system:

- NI-DCPower 17.6 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 (<code>niDCPower.fp</code>)

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:

- *PXIe-4162 Getting Started Guide*
- *PXIe-4163 Getting Started Guide*
- *NI DC Power Supplies and SMUs Help*
- *PXIe-4162 Specifications*
- *PXIe-4163 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
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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 using the minimum requirements specifications listed in the table.

Table 1. Required Equipment for Calibration

Required Equipment	Recommended Model(s)	Parameter Measured	Minimum Requirements
Digital multimeter (DMM)	PXIe-4081	All parameters except load regulation verification and remote sense accuracy	Voltage accuracy: $\pm(50 \text{ ppm} + 500 \mu\text{V})$ Voltage resolution: 100 μV Current accuracy: <ul style="list-style-type: none"> • 100 μA to 10 mA range: $\pm(200 \text{ ppm} + 40 \text{ ppm of range})$ • 100 mA range: $\pm(200 \text{ ppm} + 20 \text{ ppm of range})$ Current resolution: 1 ppm of range
1 M Ω current shunt	IET Labs SRL-1M	10 μA current accuracy	Accuracy: $\pm 150 \text{ ppm}$ Tempco: 10 ppm/ $^{\circ}\text{C}$
3 k Ω resistor	Vishay PTF563K0000BYEB	Remote sense accuracy	$\pm 0.1\%$, 250 mW
Output shorting assembly	NI part number 147968A-01L	Residual voltage offset adjustment	—
Double banana plugs	NI part number 762533-01 or Pomona 4892	All parameters except load regulation verification and remote sense accuracy	—

Table 1. Required Equipment for Calibration (Continued)

Required Equipment	Recommended Model(s)	Parameter Measured	Minimum Requirements
Screw terminal breakout board ¹	NI part number 147971A-02L or NI part number 147971A-01L	Load regulation verification	—
62-pin D-Sub male to bare wire male cable	SHDB62M-BW-LL <ul style="list-style-type: none"> 1 m (NI part number 142948A-01) 2 m (NI part number 142948A-02) 	All parameters	28 AWG
Low-leakage, low-thermal cable (shielded twisted pair cable with banana plugs)	NI part number 779499-01	10 μ A current accuracy	22 AWG

Test Conditions

Follow the setup and environmental information below to ensure the PXIe-4162/4163 meets the published specifications. Test limits in this document are based on the January 2018 edition of the *PXIe-4162 Specifications* and *PXIe-4163 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-4162/4163, including front panel connections and screws, are secure.
- Ensure that the PXI chassis fan speed is set to HIGH, that the fan filters, if present, are clean, and that the empty slots contain filler panels. For more information about cooling,

¹ If you use the breakout board for the PXIe-4162 with a PXIe-4163 or the breakout board for the PXIe-4163 with a PXIe-4162, refer to the *Getting Started Guide* for your SMU for pinout information when connecting the breakout board.

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-4162/4163. The warm-up time ensures that the PXIe-4162/4163 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.
- Do not use the NI-DCPower Soft Front Panel (SFP) to request test points for any adjustment functions because you cannot set aperture time using the SFP.
- 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 $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. Maintain an internal device temperature range of $T_{\text{cal}} \pm 1\text{ }^{\circ}\text{C}$.²
- For adjustment procedures, maintain an ambient temperature of $23\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$. The PXIe-4162/4163 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.

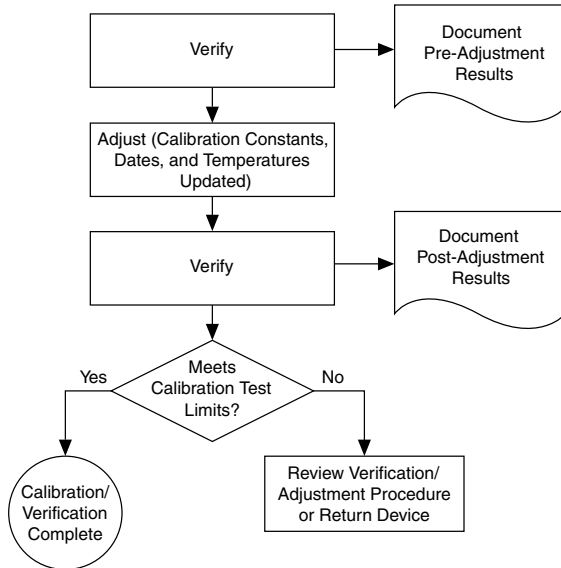
The *as-left limits* are equal to the published NI specifications for the device, less guard bands for measurement uncertainty, temperature drift, and drift over time. NI uses these limits to determine whether the device will meet the device specifications over its calibration interval.

² T_{cal} is the internal device temperature recorded by the PXIe-4162/4163 at the completion of the last self-calibration. Call the niDCPower Get Self Cal Last Temp VI to query T_{cal} from the PXIe-4162/4163.

Calibration Overview

Calibration includes the steps shown in the following figure.

Figure 1. Calibration Overview



1. Initial setup—Install the PXIe-4162/4163 and configure it in Measurement & Automation Explorer (MAX).
2. Verification—Verify the existing operation of the PXIe-4162/4163.
This step confirms whether the PXIe-4162/4163 is operating within the published specifications prior to adjustment.
3. Adjustment—Adjust the calibration constants of the PXIe-4162/4163.
4. Reverification—Repeat the Verification procedure to ensure that the PXIe-4162/4163 is operating within the published specifications after adjustment.

Verification

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

You must repeat verification procedures for each channel on the PXIe-4162/4163.

You do not need to separately verify both measurement and output. The architecture of the PXIe-4162/4163 ensures that if measurement is accurate, then output is as well, and vice versa.

Self-Calibrating the PXIe-4162/4163

Complete the following steps to self-calibrate the PXIe-4162/4163.

1. Disconnect or disable all connections to the PXIe-4162/4163.
2. Allow the PXIe-4162/4163 30 minutes to warm up with the PXI chassis fans set to HIGH.
3. Initialize an NI-DCPower session containing all device channels.
4. Call the self-calibration function.
5. Close the NI-DCPower session.

Verifying Voltage Measurement and Output

Compare a set of voltages measured by a DMM to the voltage test points requested by the PXIe-4162/4163.

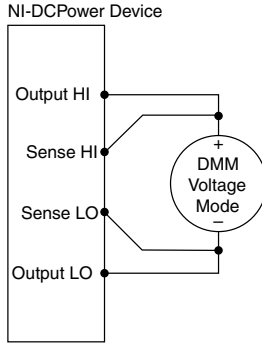
Refer to the following table as you complete the following steps.

Table 2. PXIe-4162/4163 Voltage Measurement and Output Verification

Level Range	Limit Range and Limit	Test Point	As-Found Measurement Test Limit \pm (% of Voltage + Offset)	As-Left Measurement Test Limit \pm (% of Voltage + Offset)
24 V	1 mA	-24V	0.05% + 5 mV	0.02% + 2.4 mV
		0 mV		
		24 V		

1. 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 $T_{cal} \pm 1$ °C, call the self-calibration VI or function.
2. Make the necessary connections for this procedure, as shown in the following figure:

Figure 2. Voltage Verification Connection Diagram



3. Set the **niDCPower Output Function** property or `NIDCPOWER_OUTPUT_FUNCTION` attribute to DC Voltage for the PXIe-4162/4163.
4. Set the first specified level range, limit range, and limit on the PXIe-4162/4163.
5. Set the **niDCPower Sense** property or `NIDCPOWER_ATTR_SENSE` attribute to Local.
6. Configure the PXIe-4162/4163 to output the first specified test point.
7. Compare a DMM voltage measurement to the voltage measurement test limits.
 - a) Take a voltage measurement using the DMM.
 - b) Calculate the lower and upper voltage measurement test limits using the following formula:

$$\text{Voltage Measurement Test Limits} = \text{Test Point} \pm (|\text{Test Point}| * \% \text{ of Voltage} + \text{Offset})$$
 - c) Verify the DMM measurement falls within the test limits.
8. If more than one test point per level range is specified, repeat the previous steps for each test point, from setting the level to the test point on the PXIe-4162/4163 up to this step.
9. Set the **niDCPower Sense** property or `NIDCPOWER_ATTR_SENSE` attribute to Remote.
10. Repeat [step 6](#) through [step 8](#) to complete the verification procedure using remote sense.
11. Repeat the previous steps for each channel.

Verifying Voltage Remote Sense

Use the PXIe-4162/4163 in constant current mode with a test circuit to simulate the voltage drop between the device and a load.

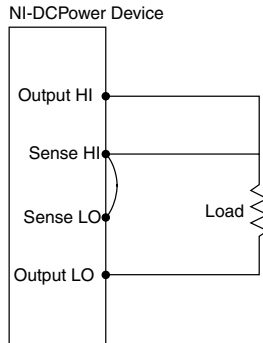
Refer to the following table as you complete the following steps.

Table 3. Remote Sense Voltage Output Verification

Level Range	Limit Range and Limit	Test Point	Load	As-Found Measurement Test Limit	As-Left Measurement Test Limit
1 mA	24 V	1 mA	3 kΩ	±5 mV	±2.4 mV

1. 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 $T_{cal} \pm 1$ °C, call the self-calibration VI or function.
2. Make the necessary connections for this procedure, as shown in the following figure:

Figure 3. Voltage Remote Sense Verification Connection Diagram³



3. Set the **niDCPower Output Function** property or `NIDCPOWER_OUTPUT_FUNCTION` attribute to DC Current for the PXIe-4162/4163.
4. Set the **niDCPower Sense** property or `NIDCPOWER_ATTR_SENSE` attribute to Remote.
5. Set the first specified level, limit range, and limit on the PXIe-4162/4163.
6. Set the level on the PXIe-4162/4163 to the specified test point and enable the output.
7. Take a voltage measurement using the PXIe-4162/4163.
8. Record the voltage from the previous step.
9. Verify that the recorded value falls within the test limits.
10. Repeat the previous steps for each channel.

Verifying 10 μ A Current Measurement and Output

Compare a set of measured currents reported by the PXIe-4162/4163 to the currents measured by a voltmeter and current shunt.

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

Complete this procedure only after successfully completing all previous verification tests.

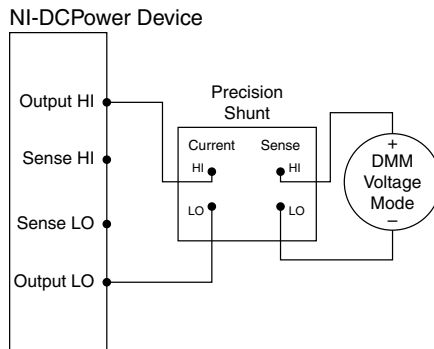
³ Follow industry best practices for minimizing thermal electromotive force (EMF) when making the necessary connections for this procedure.

Table 4. 10 μ A Current Measurement and Output Verification

Level Range	Limit Range and Limit	Shunt	Test Point	As-Found Measurement Test Limit \pm (% of Current + Offset)	As-Left Measurement Test Limit \pm (% of Current + Offset)
10 μ A	24 V	1 M Ω	-10 μ A	0.10% + 5 nA	0.075% + 2 nA
			0 A		
			10 μ A		

1. 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 $^{\circ}$ C in the previous 5 minutes.
 - b) After the internal temperature has stabilized, if the temperature still exceeds $T_{cal} \pm 1$ $^{\circ}$ C, call the self-calibration VI or function.
2. Make the necessary connections for this procedure, as shown in the following figure:

Figure 4. 10 μ A Current Verification Connection Diagram



3. Set the **niDCPower Output Function** property or `NIDCPOWER_OUTPUT_FUNCTION` attribute to DC Current for the PXIe-4162/4163.
4. Set the first specified level range, limit range, and limit on the PXIe-4162/4163.
5. Set the level on the PXIe-4162/4163 to the first specified test point.
6. Calculate the current through the shunt by completing the following steps.
 - a) Configure the DMM for voltage measurements and >10 G Ω input impedance.
 - b) Take a voltage measurement across the shunt using the DMM.
 - c) Divide the voltage measurement by the calibrated value of the shunt.
 - d) Record the calculated value as *DMM Measured Current*.
7. Calculate the lower and upper current measurement test limits using the following formula:

$$\text{Current Measurement Test Limits} = \text{Test Point} \pm (|\text{Test Point}| * \% \text{ of Current} + \text{Offset})$$

8. Verify that the calculated *DMM Measured Current* value falls within the test limits.
9. If more than one test point per level range is specified, repeat the previous steps for each test point, from setting the level to the test point on the PXIe-4162/4163 up to this step.
10. Repeat the previous steps for each channel.

Verifying 100 μ A to 60 mA Current Measurement and Output

Compare a set of currents measured by a DMM to the current test points requested by the PXIe-4162/4163.

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 5. 100 μ A to 60 mA Current Measurement and Output Verification

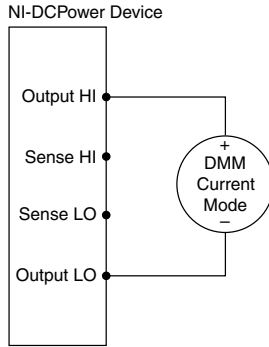
Level Range	Limit Range and Limit	Test Point	As-Found Measurement Test Limit \pm (% of Current + Offset)	As-Left Measurement Test Limit \pm (% of Current + Offset)
100 μ A	24 V	-100 μ A	0.10% + 50 nA	0.075% + 20 nA
		0 A		
		100 μ A		
1 mA	24 V	-1 mA	0.10% + 500 nA	0.075% + 200 nA
		0 A		
		1 mA		
10 mA	24 V	-10 mA	0.10% + 5 μ A	0.075% + 2 μ A
		0 A		
		10 mA		
30 mA (PXIe-4163 only)	24 V	-30 mA	0.10% + 25 μ A	0.075% + 10 μ A
		0 A		
		30 mA		

Table 5. 100 μ A to 60 mA Current Measurement and Output Verification (Continued)

Level Range	Limit Range and Limit	Test Point	As-Found Measurement Test Limit \pm (% of Current + Offset)	As-Left Measurement Test Limit \pm (% of Current + Offset)
60 mA (PXIe-4162 only)	24 V	-60 mA	0.10% + 50 μ A	0.075% + 20 μ A
		0 A		
		60 mA		

1. 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 $^{\circ}$ C in the previous 5 minutes.
 - b) After the internal temperature has stabilized, if the temperature still exceeds $T_{cal} \pm 1$ $^{\circ}$ C, call the self-calibration VI or function.
2. Make the necessary connections for this procedure, as shown in the following figure:

Figure 5. 100 μ A to 60 mA Current Verification Connection Diagram



3. Set the **niDCPower Output Function** property or `NIDCPOWER_OUTPUT_FUNCTION` attribute to DC Current for the PXIe-4162/4163.
4. Set the first specified level range, limit range, and limit on the PXIe-4162/4163.
5. Set the level on the PXIe-4162/4163 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) Calculate the lower and upper current measurement test limits using the following formula:

$$\text{Current Measurement Test Limits} = \text{Test Point} \pm (|\text{Test Point}| * \% \text{ of Current} + \text{Offset})$$

- c) Verify the DMM measurement falls within the test limits.
7. If more than one test point per level range is specified, repeat the previous steps for each test point, from setting the level to the test point on the PXIe-4162/4163 up to this step.
8. If more than one level range is specified, repeat the previous steps using the values specified in each level range.
9. Repeat the previous steps for each channel.

Functional Tests

Verifying Load Regulation (Functional Test)



Note Although load regulation is listed as a typical specification for the PXIe-4162/4163, verification is required. If the PXIe-4162/4163 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).

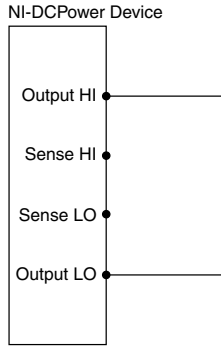
Refer to the following table as you complete the following steps.

Table 6. Load Regulation Verification

Level Range	Limit Range and Limit	Test Point	As-Found/As-Left Limit
10 mA	24 V	0 mA	±1.5 mV
		10 mA	

1. 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 $T_{cal} \pm 1$ °C, call the self-calibration VI or function.
2. Set the **niDCPower Output Function** property or `NIDCPOWER_OUTPUT_FUNCTION` attribute to DC Current for the PXIe-4162/4163.
3. Set the **niDCPower Sense** property or `NIDCPOWER_ATTR_SENSE` attribute to Local.
4. Make the necessary connections for this procedure, as shown in the following figure:

Figure 6. Load Regulation Verification Connection Diagram



Note Connection wires should be 18 or 20 AWG and as short as possible to ensure low resistance. Refer to the pinout information in the *Getting Started Guide* for your SMU and on the screw terminal breakout board to make the necessary connections.

5. Set the specified level range, limit range, and limit on the PXIe-4162/4163.
6. Configure the PXIe-4162/4163 to output the first specified test point.
7. Take a voltage measurement using the PXIe-4162/4163.
8. Record the voltage from the previous step as $V1$.
9. Repeat the previous three steps for the other test point specified in the level range. This time, record the value as $V2$.
10. Calculate the load regulation error using the following formula, and then record the value.
$$\text{Load Regulation Error} = V2 - V1$$
11. Verify that the recorded value falls within the test limits.
12. Repeat the previous steps for each channel.

Adjustment

This section describes the steps needed to adjust the PXIe-4162/4163 to meet published specifications.

Adjusted Specifications

Adjustment corrects the following specifications for the PXIe-4162/4163:

- Voltage measurement/output accuracy
- Current measurement/output 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-4162/4163 ensures that if measurement is accurate, then output is as well, and vice versa.

Initiating the Adjustment Session

Initiate an external calibration session (a specific type of NI-DCPower session) by calling the niDCPower Initialize External Calibration VI or niDCPower_InitExtCal function.

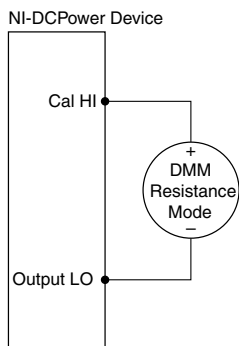
Follow the actions below during adjustment:

- Keep the calibration session open until you complete all adjustment procedures.
- Complete all adjustment procedures in the specified order.
- Do not self-calibrate the device except as specified in a procedure.

Connecting Equipment for Resistor Reference and Voltage Adjustment

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

Figure 7. Voltage Adjustment Connection Diagram



Adjusting Resistor Reference

Compare resistance measurements and a ground measurement from a DMM.

1. Use the niDCPower Connect Internal Reference VI or niDCPower_ConnectInternalReference function to set **internal reference** to ground.
2. Configure the DMM to take 2-wire resistance measurements in the 100 k Ω range.
3. Take a 2-wire resistance measurement using the DMM to determine the ground reference measurement.

4. Use the niDCPower Connect Internal Reference VI or `niDCPower_ConnectInternalReference` function to set **internal reference** to 100 k Ω .
5. Take a 2-wire resistance measurement using the DMM to determine the resistance reference measurement.
6. Use the niDCPower Connect Internal Reference VI or `niDCPower_ConnectInternalReference` function to set **internal reference** to none.
7. Configure the DMM to take 2-wire resistance measurements in the 10 M Ω range.
8. Take a 2-wire resistance measurement using the DMM to determine the resistance measurement in the 10 M Ω range.
9. Calculate the new value for resistor reference using the following formula:

$$R = \left(\frac{1}{\left(\frac{1}{R_{REF}} - \frac{1}{R_{10M\Omega}} \right)} \right) - R_{GND}$$

where R_{GND} is the resistance measured in [step 3](#), R_{REF} is the resistance measured in [step 5](#), and $R_{10M\Omega}$ is the resistance measured in [step 8](#).

10. To program the new internal reference value to the PXIe-4162/4163, call the niDCPower Adjust Internal Reference VI or `niDCPower_AdjustInternalReference` function with the **internal reference** set to 100 k Ω and **adjusted internal reference value** set to the new value for the resistor reference.

Adjusting Voltage Measurement and Output

Compare a voltage measurement and a ground measurement from a DMM.

1. Use the niDCPower Connect Internal Reference VI or `niDCPower_ConnectInternalReference` function to set **internal reference** to ground.
2. Configure the DMM to take voltage measurements in the smallest range.
3. Take a voltage measurement using the DMM to determine the ground reference measurement.
4. Use the niDCPower Connect Internal Reference VI or `niDCPower_ConnectInternalReference` function to set **internal reference** to 5 V.
5. Configure the DMM to take voltage measurements in the 10 V range.
6. Take a voltage measurement using the DMM to determine the voltage reference measurement.
7. Use the niDCPower Connect Internal Reference VI or `niDCPower_ConnectInternalReference` function to set **internal reference** to none.

- Calculate the new value for voltage reference using the following formula:

$$V = V_{\text{REF}} * \left(1 + \frac{20 \text{ k}\Omega}{R_{10\text{M}\Omega}} \right) - V_{\text{GND}}$$

where V_{GND} is the voltage measured in [step 3](#), V_{REF} is the voltage measured in [step 6](#), and $R_{10\text{M}\Omega}$ is the resistance measured in [step 8](#) in the [Adjusting Resistor Reference](#) section.

- To program the new internal reference value to the PXIe-4162/4163, call the niDCPower Adjust Internal Reference VI or niDCPower_AdjustInternalReference function with the **internal reference** set to 5 V and **adjusted internal reference value** set to the new value for the voltage reference.

Self-Calibrating the PXIe-4162/4163

Complete the following steps to self-calibrate the PXIe-4162/4163.

- Disconnect or disable all connections to the PXIe-4162/4163.
- Call the self-calibration function with all channels.

Adjusting 10 μA Current Measurement and Output

Compare a set of currents measured by an external DMM and current shunt to the current test points requested by the PXIe-4162/4163.

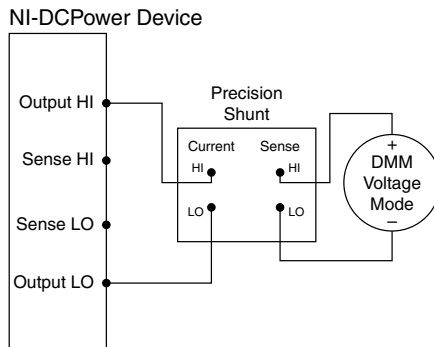
Refer to the following table as you complete the following steps.

Table 7. 10 μA Current Measurement and Output Adjustment

Level Range	Limit Range and Limit	Test Point
10 μA	24 V	-9 μA
		9 μA

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

Figure 8. 10 μA Current Adjustment Connection Diagram



2. Set the first specified level range, limit range, and limit on the PXIe-4162/4163.
3. Configure the DMM to measure current in the specified level range.
4. Set the level on the PXIe-4162/4163 to the first specified test point.
5. Allow one second to settle.
6. Take a current measurement using the DMM.
7. 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.
8. If more than one test point per level range is specified, repeat the previous steps for each test point, from setting the level to the test point on the PXIe-4162/4163 up to this step.
9. Update the output calibration constants by configuring and calling the niDCPower Cal Adjust Current Limit VI or niDCPower_CalAdjustCurrentLimit 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**.
10. Repeat the previous steps for each channel.

Adjusting 100 μ A to 60 mA Current Measurement and Output

Compare a set of currents measured by an external DMM to the current test points requested by the PXIe-4162/4163.

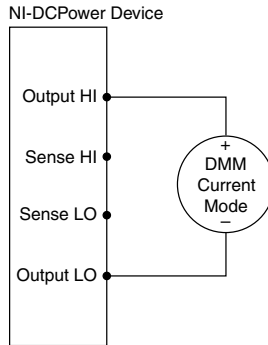
Refer to the following table as you complete the following steps.

Table 8. 100 μ A to 60 mA Current Measurement and Output Adjustment

Level Range	Limit Range and Limit	Test Point
100 μ A	24 V	-90 μ A
		90 μ A
1 mA	24 V	-0.9 mA
		0.9 mA
10 mA	24 V	-9 mA
		9 mA
30 mA (PXIe-4163 only)	24 V	-27 mA
		27 mA
60 mA (PXIe-4162 only)	24 V	-54 mA
		54 mA

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

Figure 9. 100 μ A to 60 mA Current Adjustment Connection Diagram



2. Set the first specified level range, limit range, and limit on the PXIe-4162/4163.
3. Configure the DMM to measure current in the specified level range.
4. Set the level on the PXIe-4162/4163 to the first specified test point.
5. Allow one second to settle.
6. Take a current measurement using the DMM.
7. 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.
8. If more than one test point per level range is specified, repeat the previous steps for each test point, from setting the level to the test point on the PXIe-4162/4163 up to this step.
9. Update the output calibration constants by configuring and calling the niDCPower Cal Adjust Current Limit VI or niDCPower_CalAdjustCurrentLimit 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**.
10. If more than one level range is specified, repeat the previous steps using the values specified in each level range.
11. Repeat the previous steps for each channel.

Self-Calibrating the PXIe-4162/4163

Complete the following steps to self-calibrate the PXIe-4162/4163.

1. Disconnect or disable all connections to the PXIe-4162/4163.
2. Call the self-calibration function with all channels.

Adjusting Residual Voltage Offset

1. Disconnect all equipment from the output of the PXIe-4162/4163 and insert the output shorting assembly onto the front panel connector.
2. Set the switch on the output shorting assembly to the setting for your SMU: **PXIe-4162** or **PXIe-4163**.

3. With the Output HI, Sense HI, Output LO, and Sense LO terminals shorted, eliminate residual voltage offset at 0 V by configuring and calling the niDCPower Cal Adjust Residual Voltage Offset VI or `niDCPower_CalAdjustResidualVoltageOffset` function.
4. Repeat the previous step for each channel on the PXIe-4162/4163.

Adjusting Residual Current Offset

1. Disconnect all equipment from the output of the PXIe-4162/4163.
2. With terminals open, eliminate current offset at 0 A by configuring and calling the niDCPower Cal Adjust Residual Current Offset VI or `niDCPower_CalAdjustResidualCurrentOffset` function.
3. Repeat the previous step for each channel on the PXIe-4162/4163.

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-found 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-4162/4163 to NI. Refer to the [Worldwide Support and Services](#) section for information about support resources or service requests.

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.

Worldwide Support and Services

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Visit ni.com/services for information about the services NI offers.

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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