

CALIBRATION PROCEDURE

PXIe-4080/4082

PXIe, 6½-Digit, ± 300 V, Onboard 1.8 MS/s Isolated Digitizer, L and C Measurement Support, PXI Digital Multimeter

This document contains the verification and adjustment procedures for the PXIe-4080/4082. Refer to ni.com/calibration for more information about calibration solutions.

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Required Software

Calibrating the PXIe-4080/4082 requires you to install the following software on the calibration system:

- NI-DMM version 15.2 or later

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 Digital Multimeters Help*
- *NI PXIe-4080/4081/4082 Getting Started Guide*
- *PXIe-4080 Specifications*
- *PXIe-4082 Specifications*

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 | 2 years |
|----------------------------------|---------|

Test Equipment

The following table lists the equipment required for calibrating your device. If you do not have the recommended instruments, use these specifications to select a substitute calibration standard.

| Equipment | Recommended Models | Where Used | Minimum Requirements |
|--|----------------------------|---|--|
| Multifunction calibrator | Fluke 5720A or Fluke 5730A | Voltage, Current, Resistance | Maintained at 90 day specifications |
| Two sets of low thermal electromotive force (EMF) copper cables | Fluke 5440 | Voltage, Current (1 set), Resistance (2 sets) | Shielded twisted pair copper cables with copper or gold-plated copper banana plugs |
| Banana shorting bar | Pomona 5145 | DCV, 2-Wire Resistance | $\leq 40 \text{ m}\Omega$ resistance |
| Double banana plug with binding posts | Pomona 5405 | 2-Wire Resistance | Gold-plated copper |
| Two insulated low thermal EMF spade lugs | Pomona 2305 | 2-Wire Resistance | Gold-plated copper |
| 25 Ω , 125 Ω , 5 k Ω , 100 k Ω resistors | | Capacitance and Inductance (adjustment only) | <ul style="list-style-type: none"> $\leq 1 \%$ tolerance $\leq 5 \text{ ppm/C}$ temperature coefficient $\leq 1 \text{ inch}$ from resistor to DMM terminals |
| 270 pF, 1 nF, 100 nF, 10 μF , 1000 μF capacitors | IET SCA series | Capacitance | $\leq 0.1\%$ uncertainty |
| Banana-to-banana coax cable | Pasternack PE3005 | Capacitance | $\leq 40 \text{ pF}$ |

Calibration Procedures

The calibration process includes the following steps:

- *Initial Setup* - Set up the test equipment.
- *Verification Procedures* - Verify the existing operation of the device. This step confirms whether the device is operating within its specified range prior to calibration.

- *Adjustment Procedures* - Perform an external adjustment of the device that adjusts the calibration constants with respect to standards of known values.
- *Reverification* - Repeat the verification procedure to ensure that the device is operating within its specifications after adjustment.

Initial Setup



Note Ensure that both the calibrator and the PXIe-4080/4082 are warmed up for at least 60 minutes before you begin this procedure.

To set up the test equipment, complete the following steps:

1. Remove all connections from the four inputs on the PXIe-4080/4082.
2. Verify that the calibrator has been calibrated within the time limits specified in the *Test Equipment* section, and that DC zeros calibration has been performed within the last 30 days. Consult the calibrator user documentation for instructions.

Test Conditions

The following setup and environmental conditions are required to ensure the PXIe-4080/4082 meets published specifications:

- Ensure that the PXI Express chassis fan speed is set to HIGH and that the fan filters are clean.
- Use PXI Express filler panels in all vacant slots to allow proper cooling.
- Plug the PXI Express chassis and the calibrator into the same power strip to avoid ground loops.
- Power on and warm up both the calibrator and the PXIe-4080/4082 for at least 60 minutes before beginning this calibration procedure.
- Maintain an ambient temperature of 23 ± 1 °C.
- Maintain an ambient relative humidity of less than 80%.
- Allow the calibrator to settle fully before taking any measurements. Consult the calibrator user documentation for instructions.
- Allow the thermal EMF enough time to stabilize when you change connections to the calibrator or the PXIe-4080/4082. The suggested time periods are stated where necessary throughout this document.
- Keep a shorting bar connected between the V-GUARD and GROUND binding posts of the calibrator at all times.
- Clean any oxidation from the banana plugs on the cables before plugging them into the binding posts of the calibrator or the connectors of the PXIe-4080/4082. Oxidation

tarnishes the copper plugs so that they appear dull rather than shiny and leads to greater thermal EMF.

- Prevent the cables from moving or vibrating by taping or strapping them to a nonvibrating surface. Movement or vibration causes triboelectric effects that can result in measurement errors.

As-Found and As-Left Limits

The *as-found limits* are the published 2-year 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 based on the published 24-hour specifications for the device, with consideration for measurement uncertainty. NI uses these limits to determine whether the device will meet the device specifications over its calibration interval.

Where a TUR of less than 4:1 was determined, a guardband technique was applied to the test limits to maintain the same Probability of False Accepts (PFA) as if it was 4:1. The method selected was the ANSI/NCSL Z540.3 method 6: Guard Bands Based on Test Uncertainty Ratio.

Verification

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

You can use the verification procedures described in this section for both pre-adjustment and post-adjustment verification. You can omit sections (for example, the *Verifying AC Current* section), however, any function not verified during post-adjustment will no longer be traceable and should not be used for measurements.



Note Self-calibrate the PXIe-4080/4082 before performing verification procedures.

Verifying DC Voltage

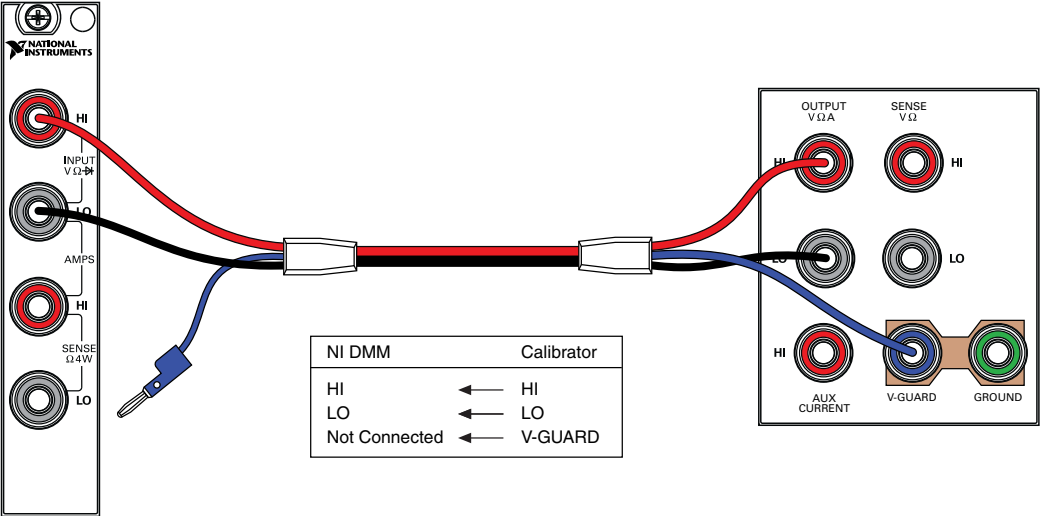
Complete the following steps to verify DC voltage:

1. Plug in the shorting bar across the HI and LO terminals on the PXIe-4080/4082.
2. Wait two minutes for thermal EMF to stabilize.
3. Reset the PXIe-4080/4082.
4. Initialize the PXIe-4080/4082 for DC Voltage with a range of 100 mV and resolution of 6.5 digits.
5. Verify the accuracy for each configuration in the following table:
 - a) Acquire the measurement at each specified range and input resistance.
 - b) Compare to the specified limits.

| DMM Settings | | As-Found Limits | | As-Left Limits | |
|--------------|------------------|-----------------|---------|----------------|---------|
| Range | Input Resistance | Lower | Upper | Lower | Upper |
| 100 mV | >10 GΩ/10 MΩ | -4.0 μV | 4.0 μV | -3.0 μV | 3.0 μV |
| 1 V | >10 GΩ/10 MΩ | -8 μV | 8 μV | -4 μV | 4 μV |
| 10 V | >10 GΩ/10 MΩ | -0.06 mV | 0.06 mV | -0.02 mV | 0.02 mV |
| 100 V | 10 MΩ | -0.6 mV | 0.6 mV | -0.2 mV | 0.2 mV |
| 300 V | 10 MΩ | -6 mV | 6 mV | -2 mV | 2 mV |

- Remove the shorting bar from the PXIe-4080/4082.
- Set the calibrator to Standby.
- Connect the PXIe-4080/4082 to the calibrator using low thermal EMF cables according to the following figure.

Figure 1. Voltage Connection Configuration



- Wait two minutes for the thermal EMF to stabilize.
- Set the PXIe-4080/4082 and Calibrator configuration as shown the following table.
- Acquire the specified measurements and record them for use as the offset nulls in the following steps.

| DMM Settings | | Calibrator Settings | |
|--------------|------------------|---------------------|---------------|
| Range | Input Resistance | Range | DCV Amplitude |
| 100 mV | > 10 GΩ | 2.2 V | 0 V |
| 100 mV | 10 MΩ | 2.2 V | 0 V |

12. Verify the accuracy for each configuration in the following table:
 - a) Set the PXIe-4080/4082 to the specified configuration and commit.
 - b) Set the calibrator to the specified configuration and allow it to settle.
 - c) Acquire the specified measurement.
 - d) Subtract the appropriate offset null you recorded previously and compare the result to the limits.
 - e) Repeat for each listed input resistance.
 - f) Set the calibrator to *Standby*.

| DMM Settings | | Calibrator Settings | As-Found Limits (V) | | As-Left Limits (V) | |
|--------------|------------------|----------------------------|---------------------|------------|--------------------|------------|
| Range | Input Resistance | DCV Amplitude ¹ | Lower | Upper | Lower | Upper |
| 100 mV | >10 GΩ/ 10 MΩ | 100 mV | 0.0999935 | 0.1000065 | 0.0999971 | 0.1000029 |
| | | -100 mV | -0.1000065 | -0.0999935 | -0.1000029 | -0.0999971 |
| 1 V | >10 GΩ/ 10 MΩ | 1 V | 0.999969 | 1.000031 | 0.999989 | 1.000011 |
| | | -1 V | -1.000031 | -0.999969 | -1.000011 | -0.999989 |
| 10 V | >10 GΩ/ 10 MΩ | 10 V | 9.99969 | 10.00031 | 9.99993 | 10.00007 |
| | | -10 V | -10.00031 | -9.99969 | -10.00007 | -9.99993 |
| 100 V | 10 MΩ | 100 V | 99.9959 | 100.0041 | 99.9989 | 100.0011 |
| | | -100 V | -100.0041 | -99.9959 | -100.0011 | -99.9989 |
| 300 V | 10 MΩ | 300 V | 299.984 | 300.017 | 299.995 | 300.005 |
| | | -300 V | -300.017 | -299.984 | -300.005 | -299.995 |

You have completed verifying the DC voltage mode of the PXIe-4080/4082. Select one of the following options:

- If you want to continue verifying other modes, go to the *Verifying AC Voltage* section.
- If you do not want to verify any additional modes, and you are performing a pre-adjustment verification, close the session.
- If you do not want to verify any additional modes, and you want to update the verification time stamp, complete the following steps:
 1. Open a new calibration session to the instrument (with correct calibration password).
 2. Close the calibration session with the **Action** set to *Save*.

Verifying AC Voltage

Complete the following steps to verify AC voltage:

1. Set the calibrator to *Standby* mode.

¹ For the ± 100 mV test points, lock the calibrator range to 2.2 V.

2. Connect the PXIe-4080/4082 to the calibrator using low leakage cables, as shown in [Figure 1](#), on page 6.
3. Reset the PXIe-4080/4082.
4. Initialize the PXIe-4080/4082 for AC Voltage with a range of 50 mV and resolution of 6.5 digits.
5. Verify the accuracy for each configuration in the following table:
 - a) Set the PXIe-4080/4082 to the listed configuration and commit.
 - b) Set the Calibrator to the listed configuration and allow it to settle.
 - c) Acquire the specified measurement and compare the result to the limits.
 - d) Repeat for each listed coupling.
 - e) Set the calibrator to Standby.

| DMM Settings | | Calibrator Settings | | As-Found Limits (V) | |
|--------------|----------|---------------------|-----------|---------------------|-----------|
| Range | Coupling | Amplitude | Frequency | Lower | Upper |
| 50 mV | AC / DC | 5 mV | 1 kHz | 0.0049775 | 0.0050225 |
| | DC | 50 mV | 30 Hz | 0.0499300 | 0.0500700 |
| | AC / DC | 50 mV | 50 Hz | 0.0499550 | 0.0500450 |
| | | 50 mV | 1 kHz | 0.0499550 | 0.0500450 |
| 500 mV | | 50 mV | 1 kHz | 0.049875 | 0.050125 |
| 50 mV | | 50 mV | 20 kHz | 0.0499550 | 0.0500450 |
| | | 50 mV | 50 kHz | 0.0499350 | 0.0500650 |
| | | 50 mV | 100 kHz | 0.0497100 | 0.0502900 |
| | | 50 mV | 300 kHz | 0.0484500 | 0.0515500 |
| 500 mV | DC | 500 mV | 30 Hz | 0.499450 | 0.500550 |
| | AC / DC | 500 mV | 50 Hz | 0.499650 | 0.500350 |
| | | 500 mV | 1 kHz | 0.499650 | 0.500350 |
| 5 V | | 500 mV | 1 kHz | 0.49875 | 0.50125 |
| 500 mV | | 500 mV | 20 kHz | 0.499650 | 0.500350 |
| | | 500 mV | 50 kHz | 0.499450 | 0.500550 |
| | | 500 mV | 100 kHz | 0.497400 | 0.502600 |
| | | 500 mV | 300 kHz | 0.484750 | 0.515250 |

| DMM Settings | | Calibrator Settings | | As-Found Limits (V) | |
|--------------|----------|---------------------|-----------|---------------------|---------|
| Range | Coupling | Amplitude | Frequency | Lower | Upper |
| 5 V | DC | 5 V | 30 Hz | 4.99450 | 5.00550 |
| | AC / DC | 5 V | 50 Hz | 4.99650 | 5.00350 |
| | | 5 V | 1 kHz | 4.99650 | 5.00350 |
| 50 V | | 5 V | 1 kHz | 4.9875 | 5.0125 |
| 5 V | | 20 kHz | 4.99650 | 5.00350 | |
| 5 V | | 50 kHz | 4.99450 | 5.00550 | |
| 5 V | | 100 kHz | 4.97400 | 5.02600 | |
| 5 V | | 300 kHz | 4.84750 | 5.15250 | |
| 50 V | DC | 50 V | 30 Hz | 49.9450 | 50.0550 |
| | AC /DC | 50 V | 50 Hz | 49.9650 | 50.0350 |
| | | 50 V | 1 kHz | 49.9650 | 50.0350 |
| 300 V | | 50 V | 1 kHz | 49.915 | 50.085 |
| 50 V | | 50 V | 20 kHz | 49.9650 | 50.0350 |
| | | 50 V | 50 kHz | 49.9450 | 50.0550 |
| | | 50 V | 100 kHz | 49.7400 | 50.2600 |
| | | 50 V | 300 kHz | 48.4750 | 51.5250 |
| 300 V | DC | 219 V | 30 Hz | 218.751 | 219.249 |
| | AC / DC | 300 V | 50 Hz | 299.790 | 300.210 |
| | | 219 V | 1 kHz | 218.831 | 219.170 |
| | | 219 V | 20 kHz | 218.831 | 219.170 |
| | | 219 V | 50 kHz | 218.743 | 219.257 |
| | | 219 V | 100 kHz | 217.845 | 220.155 |
| | | 70 V | 300 kHz | 67.750 | 72.250 |

You have completed verifying the AC voltage mode of the PXIe-4080/4082. Select one of the following options:

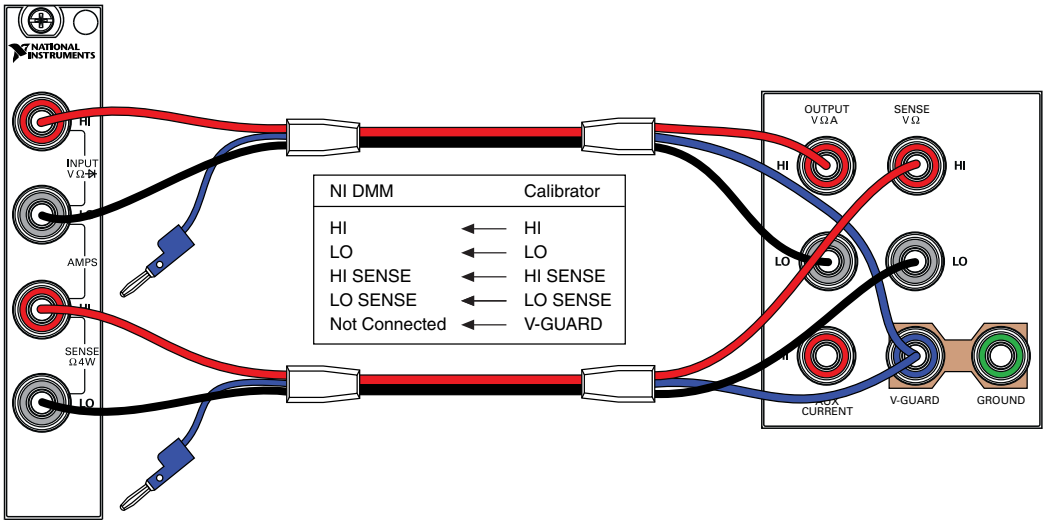
- If you want to continue verifying other modes, proceed to the *Verifying 4-Wire Resistance* section.
- If you do not want to verify any additional modes and you are performing a pre-adjustment verification, close the session.
- If you do not want to verify any additional modes, and you want to update the verification time stamp, complete the following steps:
 1. Open a new calibration session to the instrument (with correct calibration password).
 2. Close the calibration session with the **Action** set to *Save*.

Verifying 4-Wire Resistance

Complete the following steps to verify 4-wire resistance:

1. Set the calibrator to *Standby*
2. Connect the PXIe-4080/4082 to the calibrator using low thermal EMF cables, as shown in the following figure.

Figure 2. 4-Wire Resistance Connection Configuration



3. Wait two minutes for thermal EMF to stabilize.
4. Reset the PXIe-4080/4082.
5. Configure the PXIe-4080/4082 for 4-wire resistance measurements with a resolution of 6.5 digits.
6. Verify the accuracy for each configuration in the following table:
 - a) Acquire the measurement at each specified configuration.
 - b) Compare to the specified tolerances.



Note Tolerances are provided instead of absolute limits because your calibrator will have different discrete resistance values.

| DMM Settings | | Calibrator Settings | | | Tolerances | | | |
|----------------|-------------------------------|---------------------|-----------|------|----------------|--------------|----------------|--------------|
| | | | | | As-Found | | As-Left | |
| Range | Offset Compensated Ohms (OCO) | Resistance | Ext Sense | Comp | ppm of Reading | ppm of Range | ppm of Reading | ppm of Range |
| 10 M Ω | Off | 0 Ω | On | None | - | 10 | - | 2 |
| 1 M Ω | Off | 0 Ω | On | None | - | 10 | - | 2 |
| 100 k Ω | Off | 0 Ω | On | None | - | 8 | - | 4 |
| 10 k Ω | On | 0 Ω | On | None | - | 3 | - | 2.2 |
| 1 k Ω | On | 0 Ω | On | None | - | 3 | - | 2.2 |
| 100 Ω | On | 0 Ω | On | None | - | 13.4 | - | 11.2 |
| 10 M Ω | Off | 10 M Ω | On | None | 800 | 10 | 100 | 2 |
| 1 M Ω | Off | 1 M Ω | On | None | 95 | 10 | 32 | 2 |
| 100 k Ω | Off | 100 k Ω | On | None | 95 | 6 | 15 | 2 |
| 10 k Ω | On | 10 k Ω | On | None | 80 | 3 | 12 | 2.2 |
| 1 k Ω | On | 1 k Ω | On | None | 80 | 3 | 18 | 2.2 |
| 100 Ω | On | 100 Ω | On | None | 82 | 13.4 | 23 | 11.2 |



Note Apply an offset null to the 100 k Ω measurement by subtracting the corresponding 0 Ω measurement in the 100 k Ω range.

You have completed verifying the 4-wire resistance mode of the PXIe-4080/4082. Select one of the following options:

- If you want to continue verifying other modes, go to the *Verifying 2-Wire Resistance* section.
- If you do not want to verify any additional modes and you are performing a pre-adjustment verification, close the session.
- If you do not want to verify any additional modes, and you want to update the verification time stamp, complete the following steps:
 1. Open a new calibration session to the instrument (with correct calibration password).
 2. Close the calibration session with the **Action** set to *Save*.

Verifying 2-Wire Resistance

Complete the following steps to verify 2-wire resistance:

1. Plug in the shorting bar across the HI and LO terminals on the PXIe-4080/4082.

2. Wait two minutes for thermal EMF to stabilize.
3. Reset the PXIe-4080/4082.
4. Verify the accuracy for each configuration in the following table:
 - a) Acquire the measurement at each specified configuration.
 - b) Compare to the specified tolerances.

| DMM Settings | | Tolerances (ppm of range) | |
|----------------|-----|---------------------------|---------|
| Range | OCO | As-Found | As-Left |
| 100 M Ω | Off | 10 | 10 |
| 10 M Ω | Off | 10 | 2 |
| 1 M Ω | Off | 10 | 2 |
| 100 k Ω | Off | 10 | 6 |
| 10 k Ω | On | 23 | 22 |
| 1 k Ω | On | 203 | 202 |
| 100 Ω | On | 2015 | 2010 |

5. Remove the shorting bar from the PXIe-4080/4082.
6. Set the calibrator to *Standby*.
7. Connect the PXIe-4080/4082 to the calibrator using low thermal EMF cables, as shown in [Figure 1](#), on page 6.
8. Wait two minutes for thermal EMF to stabilize.
9. Verify the accuracy for each configuration in the following table:
 - a) Acquire the measurement at each specified configuration.
 - b) Compare to the specified tolerances.

| DMM Settings | | Calibrator Settings | | | Tolerances | | | |
|----------------|-----|---------------------|-----------|------|----------------|--------------|----------------|--------------|
| | | | | | As-Found | | As-Left | |
| Range | OCO | Resistance | Ext Sense | Comp | ppm of Reading | ppm of Range | ppm of Reading | ppm of Range |
| 1 M Ω | Off | 0 Ω | Off | None | - | - | - | - |
| 100 k Ω | Off | 0 Ω | Off | None | - | - | - | - |
| 100 M Ω | Off | 100 M Ω | Off | None | 3000 | 10 | 500 | 10 |
| 10 M Ω | Off | 10 M Ω | Off | None | 800 | 10 | 100 | 2 |

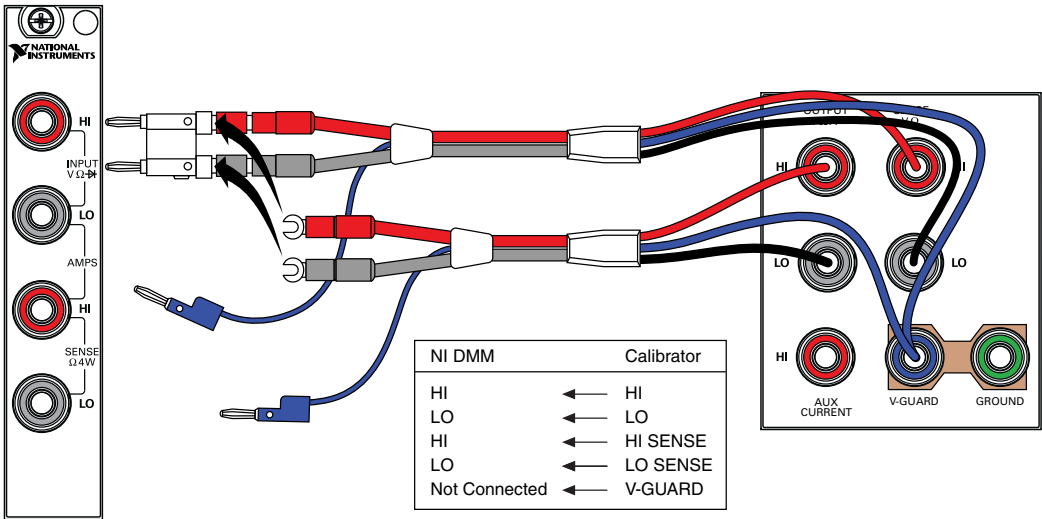
| DMM Settings | | Calibrator Settings | | | Tolerances | | | |
|----------------|-----|---------------------|-----------|------|----------------|--------------|----------------|--------------|
| | | | | | As-Found | | As-Left | |
| Range | OCO | Resistance | Ext Sense | Comp | ppm of Reading | ppm of Range | ppm of Reading | ppm of Range |
| 1 M Ω | Off | 1 M Ω | Off | None | 95 | 10 | 32 | 2 |
| 100 k Ω | Off | 100 k Ω | Off | None | 95 | 6 | 15 | 2 |



Note For the 1 M Ω and 100 k Ω measurements, subtract the corresponding 0 Ω measurement as an offset null.

10. Connect the PXIe-4080/4082 to the calibrator using low thermal EMF cables, as shown in the following figure.

Figure 3. 2-Wire Resistance Low Range Connection Configuration



11. Wait two minutes for the thermal EMF to stabilize.
12. Verify the accuracy for each configuration in the following table:
 - a) Acquire the measurement at each specified configuration.
 - b) Compare to the specified tolerances.

| DMM Settings | | Calibrator Settings | | | Tolerances | | | |
|---------------|-----|---------------------|-----------|--------|----------------|--------------|----------------|--------------|
| | | | | | As-Found | | As-Left | |
| Range | OCO | Resistance | Ext Sense | Comp | ppm of Reading | ppm of Range | ppm of Reading | ppm of Range |
| 10 k Ω | Off | 10 k Ω | On | 2-Wire | 80 | 23 | 12 | 22 |
| 1 k Ω | Off | 1 k Ω | On | 2-Wire | 80 | 203 | 12 | 202 |
| 100 Ω | Off | 100 Ω | On | 2-Wire | 80 | 2015 | 15 | 2010 |

You have completed verifying the 2-wire resistance mode of the PXIe-4080/4082. Select one of the following options:

- If you want to continue verifying other modes, go to the *Verifying DC Current* section.
- If you are performing a pre-adjustment verification, close the session.
- If you do not want to verify any additional modes, and you want to update the verification time stamp, complete the following steps:
 1. Open a new calibration session to the instrument (with correct calibration password).
 2. Close the calibration session with the **Action** set to **Save**.

Verifying DC Current

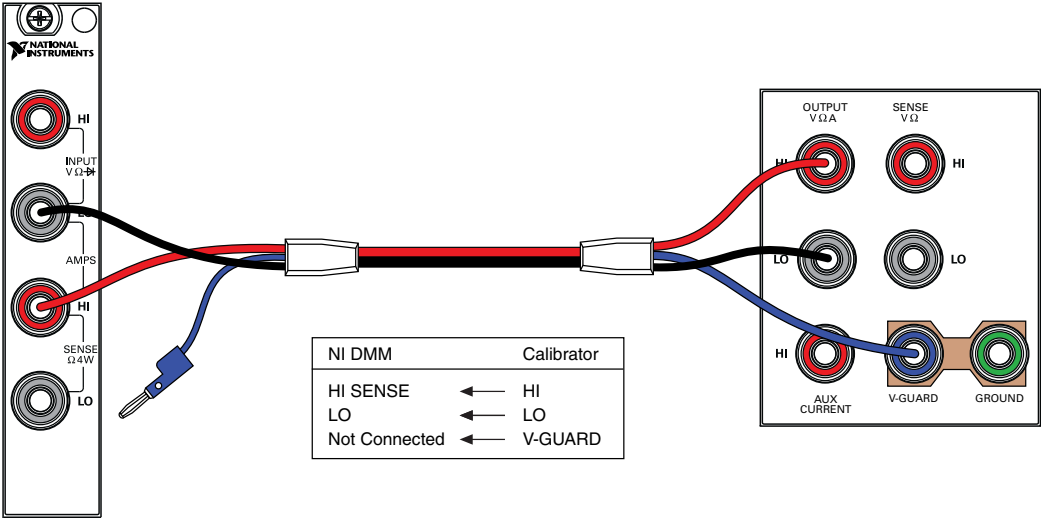
Complete the following steps to verify DC current:

1. Unplug all cables from the PXIe-4080/4082.
2. Reset the PXIe-4080/4082.
3. Initialize the PXIe-4080/4082 for DC current with a range of 20 mA and resolution of 6.5 digits.
4. Verify the accuracy for each configuration in the following table:
 - a) Acquire the measurement at each specified range.
 - b) Compare to the specified limits.

| DMM Range | As-Found Limits | | As-Left Limits | |
|-----------|-----------------|--------------|----------------|--------------|
| | Lower | Upper | Lower | Upper |
| 20 mA | -4.00 μ A | 4.00 μ A | -0.30 μ A | 0.30 μ A |
| 200 mA | -4.0 μ A | 4.0 μ A | -3.0 μ A | 3.0 μ A |
| 1 A | -50 μ A | 50 μ A | -15 μ A | 15 μ A |

5. Set the calibrator to **Standby**.
6. Connect the PXIe-4080/4082 to the calibrator using low leakage cables according to the configuration in the following figure.

Figure 4. DC Current Connection Configuration



7. Verify the accuracy for each configuration in the following table:
- Set the PXIe-4080/4082 to the listed configuration and commit.
 - Set the calibrator to the listed configuration and allow it to settle.
 - Acquire the specified measurement and compare to the limits.
 - Set the calibrator to Standby after you have completed all test points in the DMM Range.

| DMM Range | Calibrator Output | As-Found Limits (A) | | As-Left Limits (A) | |
|-----------|-------------------|---------------------|-------------|--------------------|-------------|
| | | Lower | Upper | Lower | Upper |
| 20 mA | 18 mA | 0.01798790 | 0.01801210 | 0.01799902 | 0.01800098 |
| 20 mA | -18 mA | -0.01801210 | -0.01798790 | -0.01800098 | -0.01799902 |
| 200 mA | 180 mA | 0.1798970 | 0.1801030 | 0.1799894 | 0.1800106 |
| 200 mA | -180 mA | -0.1801030 | -0.1798970 | -0.1800106 | -0.1799894 |
| 1 A | 900 mA | 0.899320 | 0.900680 | 0.899942 | 0.900058 |
| 1 A | -900 mA | -0.900680 | -0.899320 | -0.900058 | -0.899942 |

You have completed verifying the DC current of the PXIe-4080/4082. Select one of the following options:

- If you want to continue verifying other modes, go to the *Verifying AC Current* section.
- If you do not want to verify any additional modes and you are performing a pre-adjustment verification, close the session.
- If you do not want to verify any additional modes, and you want to update the verification time stamp, complete the following steps:
 1. Open a new calibration session to the instrument (with correct calibration password).
 2. Close the calibration session with the **Action** set to *Save*.

Verifying AC Current

Complete the following steps to verify AC current:

1. Set the calibrator to *Standby*.
2. Connect the PXIe-4080/4082 to the calibrator using low leakage cables as shown in *Figure 4*, on page 15.
3. Reset the PXIe-4080/4082.
4. Initialize the PXIe-4080/4082 for AC Current with a range of 10mA and a resolution of 6.5 digits.
5. Verify the accuracy for each configuration in the following table:
 - a) Set the PXIe-4080/4082 to the listed configuration and commit.
 - b) Set the Calibrator to the listed configuration and allow it to settle.
 - c) Acquire the specified measurement and compare to the limits.
 - d) Set the calibrator to *Standby* if you have completed all test points in a DMM Range.

| Calibrator Settings | | DMM Range | Limits (A) | |
|---------------------|-----------|-----------|------------|------------|
| Amplitude | Frequency | | Lower | Upper |
| 1 mA | 1 kHz | 10 mA | 0.00099760 | 0.00100240 |
| 10 mA | 1 kHz | 10 mA | 0.00999400 | 0.01000600 |
| 10 mA | 1 kHz | 100 mA | 0.0099760 | 0.0100240 |
| 100 mA | 55 Hz | 100 mA | 0.0999400 | 0.1000600 |
| 100 mA | 5 kHz | 1 A | 0.099700 | 0.100300 |
| 1 A | 1 kHz | 1 A | 0.998800 | 1.001200 |

You have completed verifying AC current for the PXIe-4080/4082. Select one of the following options:

- If you want to continue verifying the PXIe-4082, go to the *Verifying Capacitance and Inductance* section.
- If you do not want to verify any additional modes and are performing a pre-adjustment verification, close the session.
- If you do not want to verify any additional modes, and you want to update the verification time stamp, complete the following steps:
 1. Open a new calibration session to the instrument (with correct calibration password).
 2. Close the calibration session with the **Action** set to *Save*.

Verifying Capacitance and Inductance

Complete the following steps to verify capacitance and inductance for the PXIe-4082:



Note The PXIe-4082 inductance accuracy is theoretically verified if the capacitance accuracy meets its specification. If you have access to precision inductors, you can verify the inductance measurements by comparing your results with the published accuracy specifications.

You can use different verification capacitors to verify each capacitance range. You can verify two ranges with the same verification capacitor as long as its value is $\geq 10\%$ of the higher capacitance range. For example, you can use a 1 nF verification capacitor to test both the 10 nF and 1 nF ranges.

The following verification procedure assumes the use of verification capacitors with the following values: 270 pF, 1 nF, 100 nF, 10 μ F, and 1000 μ F.

The configuration of the cables and fixtures should be consistent throughout each measurement. If you are using cables to connect the verification capacitors to the inputs of the PXIe-4082, minimize noise by ensuring that the cables remain fixed and do not move during the measurement.

Keep direct contact with the verification capacitors to a minimum so that they are constantly kept at the ambient temperature. After connecting a capacitor to the PXIe-4082, NI recommends waiting 30 seconds for the capacitor temperature to stabilize.



Note You should know the total capacitance up to the banana connectors that plug into the PXIe-4082 before performing the verification procedure.

1. Disconnect any fixtures or cables from the device.
2. Reset the PXIe-4082.
3. Verify the accuracy for each configuration in the following table:
 - a) Connect the indicated standard to the device and wait the recommended settling time.
 - b) Configure the device as indicated in DMM Range and take a measurement.
 - c) Compare the acquired value to the specified tolerances.
 - d) Repeat the previous steps for each standard listed in the table.

| Standard | Recommended Settling Time | DMM Range | Tolerance | |
|-------------------|---------------------------|----------------|--------------|------------|
| | | | % of Reading | % of Range |
| OPEN (0 pF) | 0 s | 300 pF | - | 0.6 |
| SHORT (0 μ H) | 0 s | 10 μ H | - | 1 |
| 270 pF | 30 s | 300 pF | 0.5 | 0.6 |
| 1 nF | 30 s | 1 nF | 0.4 | 0.2 |
| 1 nF | 30 s | 10 nF | 0.3 | 0.1 |
| 100 nF | 30 s | 100 nF | 0.3 | 0.1 |
| 100 nF | 30 s | 1 μ F | 0.3 | 0.1 |
| 10 μ F | 30 s | 10 μ F | 0.3 | 0.1 |
| 10 μ F | 30 s | 100 μ F | 0.3 | 0.1 |
| 1,000 μ F | 30 s | 1,000 μ F | 0.4 | 0.1 |
| 1,000 μ F | 30 s | 10,000 μ F | 0.3 | 0.1 |

You have completed verifying the capacitance and inductance of the PXIe-4082. Select one of the following options:

- If you are performing a pre-adjustment verification, close the session.
- To update the verification time stamp, complete the following steps:
 1. Open a new calibration session to the instrument (with correct calibration password).
 2. Close the calibration session with the **Action** set to *Save*.

Adjustment

This section explains how to adjust the PXIe-4080/4082. You can choose to perform these adjustment procedures with or without performing the verification procedure first.



Note Repeat the verification procedures after you perform these adjustment procedures. NI recommends that you perform a post-adjustment verification to ensure that the device you have calibrated is operating within specifications after adjustments.



Caution Do not skip any of the steps within a section of the adjustment procedures.

Adjusting DC Voltage

Complete the following steps to adjust DC Voltage:

1. Disconnect all inputs from the PXIe-4080/4082.
2. Reset the calibrator.

3. Initialize an external calibration session to the PXIe-4080/4082.
4. Self-calibrate the PXIe-4080/4082.
5. Connect the PXIe-4080/4082 to the calibrator using low thermal EMF cables according to the configuration shown in [Figure 1](#), on page 6.
6. Wait two minutes for thermal EMF to stabilize.
7. Adjust the voltage gain with each configuration in the following table:
 - a) Output the specified voltage from the calibrator.
 - b) Call the niDMM Cal Adjust Gain VI or the `niDMM_CalAdjustGain` function with the specified DMM settings.

| Calibrator Settings | DMM Settings | | | |
|---------------------|--------------|-------|------------------|----------------|
| | Function | Range | Input Resistance | Expected Value |
| 10 V | DC Volts | 10 V | >10 GΩ | 10 V |
| -10 V | | | | -10 V |

8. Disconnect the cables from the PXIe-4080/4082, leaving the other end of the cable connected to the calibrator binding posts.
9. Plug in the shorting bar across the HI and LO terminals on the PXIe-4080/4082.
10. Wait two minutes for the thermal EMF to stabilize.
11. Call the niDMM Cal Adjust Misc VI or the `niDMM_CalAdjustMisc` function with **Type** set to `NIDMM_EXTCAL_MISCCAL_VREF_DC_VOLTAGE`.
12. Self-calibrate the PXIe-4080/4082.
13. Call the niDMM Cal Adjust Offset VI or the `niDMM_CalAdjustOffset` function with the following parameters:
 - Function: DC Volts
 - Range: 100 mV
 - Input Resistance: >10 GΩ

You have completed adjusting the DC voltage mode of the PXIe-4080/4082. Proceed to one of the following sections:

- *Adjusting Resistance*
- *Adjusting AC Voltage*
- *Adjusting Current*

If you are not performing additional adjustments, proceed to the *Completing the Adjustment Procedures* section to commit the calibration constants.

Adjusting Resistance



Note You must adjust DC voltage before you adjust resistance.



Note If you do not use the resistance modes for any measurements or the accuracy of these modes is irrelevant, you can skip this section and go directly to the *Adjusting AC Voltage* section.

Complete the following steps to adjust the resistance of the device:

1. Connect the PXIe-4080/4082 to the calibrator using low thermal EMF cables as shown in [Figure 2](#), on page 10.
2. Wait two minutes for thermal EMF to stabilize.
3. Adjust the resistance calibration with each configuration in the following table:
 - a) Commit the DMM to the specified range.
 - b) Configure the calibrator as specified.
 - c) Wait the specified settling time.
 - d) Call niDMM Cal Adjust Gain VI or the niDMM_CalAdjustGain function with the specified parameters.

| DMM Settings | | | | Calibrator Settings | | | Minimum Settling Time |
|-------------------|----------------|------------------|-------------------------|---------------------|------------|------|-----------------------|
| Function | Range | Input Resistance | Expected Value | Resistance | Ext. Sense | Comp | |
| 4-wire resistance | 10 k Ω | N/A | (value from calibrator) | 10 k Ω | On | None | 1 s |
| | | | (value from calibrator) | 0 Ω | | | 1 s |
| | 100 k Ω | N/A | (value from calibrator) | 100 k Ω | | | 10 s |
| | | | (value from calibrator) | 0 Ω | | | 1 s |

4. Call the niDMM Cal Adjust Misc VI or the niDMM_CalAdjustMisc function with **Type** set to NIDMM_EXTCAL_MISCCAL_RREF.
5. Adjust the resistance calibration with each configuration in the following table:
 - a) Commit the PXIe-4080/4082 to the specified range.
 - b) Configure the calibrator as specified.
 - c) Wait the specified settling time.
 - d) Call niDMM Cal Adjust Gain VI or the niDMM_CalAdjustGain function with the specified parameters.

| DMM Settings | | | | Calibrator Settings | | | Minimum Settling Time |
|-------------------|---------------|------------------|-------------------------|---------------------|------------|------|-----------------------|
| Function | Range | Input Resistance | Expected Value | Resistance | Ext. Sense | Comp | |
| 4-wire resistance | 10 M Ω | N/A | (value from calibrator) | 0 Ω | On | None | 0 s |
| | | | (value from calibrator) | 10 M Ω | | | 10 s |
| 2-wire resistance | 10 M Ω | N/A | (value from calibrator) | 0 Ω | Off | None | 0 s |
| | | | (value from calibrator) | 10 M Ω | | | 10 s |

6. Call the niDMM Cal Adjust Misc VI or the niDMM_CalAdjustMisc function with **Type** set to NIDMM_EXTCAL_MISCCAL_RREF.
7. Self-calibrate the PXIe-4080/4082.
8. Adjust the resistance calibration with each configuration in the following table:
 - a) Commit the PXIe-4080/4082 to the specified range.
 - b) Configure the calibrator as specified.
 - c) Wait the specified settling time.
 - d) Call niDMM Cal Adjust Gain VI or the niDMM_CalAdjustGain function with the specified parameters.

| DMM Settings | | | | Calibrator Settings | | | |
|-------------------|--------|------------------|-------------------------|---------------------|------------|------|-----------------------|
| Function | Range | Input Resistance | Expected Value | Resistance | Ext. Sense | Comp | Minimum Settling Time |
| 2-wire resistance | 100 MΩ | N/A | (value from calibrator) | 0 Ω | Off | None | 0 s |
| | | | (value from calibrator) | 100 MΩ | | | 10 s |
| | | | +Inf | Standby | | | 10 s |

9. Output 0 Ω on the calibrator with External Sense turned on and Compensation set to None.
10. Call the niDMM Cal Adjust Offset VI or the niDMM_CalAdjustOffset function for each range in the following table.

| DMM Settings | | |
|-------------------|------------------|----------------|
| Function | Input Resistance | Range |
| 4-wire resistance | N/A | 100 Ω |
| | | 1 k Ω |
| | | 10 k Ω |
| | | 100 k Ω |
| | | 1 M Ω |
| | | 10 M Ω |

- Call the niDMM Cal Adjust Misc VI or the niDMM_CalAdjustMisc function with **Type** set to NIDMM_EXTCAL_MISCCAL_VREF_RESISTANCE.
- Disconnect all inputs from the PXIe-4080/4082 and plug in the shorting bar between the HI and LO terminals.
- Wait two minutes for the thermal EMF to stabilize.
- Call the niDMM Cal Adjust Offset VI or the niDMM_CalAdjustOffset function for each range in the following table.

| DMM Settings | | |
|-------------------|------------------|----------------|
| Function | Input Resistance | Range |
| 2-wire resistance | N/A | 100 Ω |
| | | 1 k Ω |
| | | 10 k Ω |
| | | 100 k Ω |
| | | 1 M Ω |
| | | 10 M Ω |
| | | 100 M Ω |

You have completed adjusting the resistance of the PXIe-4080/4082. Proceed to one of the following sections:

- Adjusting AC Voltage*
- Adjusting Current*
- Adjusting Capacitance and Inductance*

If you are not performing additional adjustments, proceed to the *Completing the Adjustment Procedures* section to commit your calibration constants.

Adjusting AC Voltage



Note You must adjust DC voltage before you adjust AC voltage.



Note If you do not use the AC voltage modes for any measurements, or the accuracy of these modes is irrelevant, you can skip this section in the calibration procedure and go directly to the *Adjusting Current* section.

Complete the following steps to adjust the AC voltage of the device:

1. Reset the calibrator.
2. Connect the PXIe-4080/4082 to the calibrator as shown in [Figure 1](#), on page 6.
3. Call the niDMM Cal Adjust Misc VI or the niDMM_CalAdjustMisc function with **Type** set to NIDMM_EXTCAL_MISCCAL_VREF_AC_VOLTAGE.
4. Adjust the AC Voltage gain with each configuration in the following table:
 - a) Commit the device to specified range.
 - b) Configure the calibrator as specified and allow it to settle.
 - c) Call the niDMM Cal Adjust AC Filter VI or the niDMM_CalAdjustACFilter function with the specified parameters.

| DMM Settings | | Calibrator Settings | |
|--------------|-------|---------------------|-----------|
| Function | Range | Amplitude | Frequency |
| AC Volts | 50 mV | 50 mV | 1 kHz |
| | | | 5 kHz |
| | | | 20 kHz |
| | | | 50 kHz |
| | | | 100 kHz |
| | | | 200 kHz |
| | | | 300 kHz |
| | | | 500 kHz |

| DMM Settings | | Calibrator Settings | |
|--------------|--------|---------------------|-----------|
| Function | Range | Amplitude | Frequency |
| AC Volts | 500 mV | 500 mV | 1 kHz |
| | | | 5 kHz |
| | | | 20 kHz |
| | | | 50 kHz |
| | | | 100 kHz |
| | | | 200 kHz |
| | | | 300 kHz |
| | | | 500 kHz |
| AC Volts | 5 V | 5 V | 1 kHz |
| | | | 5 kHz |
| | | | 20 kHz |
| | | | 50 kHz |
| | | | 100 kHz |
| | | | 200 kHz |
| | | | 300 kHz |
| | | | 500 kHz |
| AC Volts | 50 V | 50 V | 1 kHz |
| | | | 5 kHz |
| | | | 20 kHz |
| | | | 50 kHz |
| | | | 100 kHz |
| | | | 200 kHz |
| | | | 300 kHz |
| | | 10 V | 500 kHz |

| DMM Settings | | Calibrator Settings | |
|--------------|-------|---------------------|-----------|
| Function | Range | Amplitude | Frequency |
| AC Volts | 300 V | 100 V | 1 kHz |
| | | | 5 kHz |
| | | | 20 kHz |
| | | | 50 kHz |
| | | | 100 kHz |
| | | | 200 kHz |
| | 50 V | 50 V | 300 kHz |
| | | | 500 kHz |

- Reset the calibrator.
- Call the niDMM_Cal Adjust Misc VI or the niDMM_CalAdjustMisc function with **Type** set to NIDMM_EXTCAL_MISCCAL_VOLTAGE_AC_FILTER.
- Self-calibrate the PXIe-4080/4082.

You have completed adjusting the AC voltage modes of the PXIe-4080/4082. Proceed to one of the following sections:

- Adjusting Current*
- Adjusting Capacitance and Inductance*

If you are not performing additional adjustments, proceed to the *Completing the Adjustment Procedures* section to commit the calibration constants.

Adjusting Current



Note You must adjust DC voltage before you adjust current.



Note If you do not use the current modes (DC and AC), or the accuracy is insignificant for your application you can skip this section and go directly to the *Adjusting Capacitance and Inductance* section.

Complete the following steps to adjust the current modes of the device:

- Reset the calibrator.
- Disconnect all inputs of the PXIe-4080/4082 .
- Call the niDMM Cal Adjust Misc VI or niDMM_CalAdjustMisc function with **Type** set to NIDMM_EXTCAL_MISCCAL_VREF_DC_CURRENT.
- Repeat the previous step, setting **Type** to NIDMM_EXTCAL_MISCCAL_VREF_AC_CURRENT.
- Connect the PXIe-4080/4082 to the calibrator as shown in [Figure 4](#), on page 15.

6. Adjust the current gain with each configuration in the following table:

- a) Commit the device to the specified range.
- b) Configure the calibrator to the specified DC output current and allow it to settle.
- c) Call the niDMM Cal Adjust Gain VI or niDMM_CalAdjustGain function with the specified parameters.
- d) Set the calibrator to Standby.

| DMM Settings | | | Calibrator Output | Expected Value |
|--------------|--------|------------------|-------------------|----------------|
| Function | Range | Input Resistance | | |
| DC Current | 20 mA | N/A | 20 mA | 20 mA |
| | | | -20 mA | -20 mA |
| | 200 mA | N/A | 200 mA | 200 mA |
| | | | -200 mA | -200 mA |
| | 1 A | N/A | 1 A | 1 A |
| | | | -1 A | -1 A |

7. Self-calibrate the PXIe-4080/4082.

You have completed adjusting the current modes of the PXIe-4080/4082. To continue adjusting other modes, proceed to the *Adjusting Capacitance and Inductance* section.

If you are finished adjusting modes, proceed to the *Completing the Adjustment Procedures* section to commit the calibration constants.

Adjusting Capacitance and Inductance



Note If you do not use the capacitance or inductance modes for any measurements, or the accuracy of these modes is irrelevant, you can skip this section.



Caution It is necessary to adjust DC voltage and resistance before running these adjustment steps. During this procedure, be sure to keep hands and any other moving objects away from the fixture after calling every function.

Complete the following steps to adjust the capacitance and inductance of the PXIe-4082.

- 1. Disconnect all inputs of the PXIe-4082.
- 2. Call the niDMM Cal Adjust LC VI or the niDMM_CalAdjustLC function with **Type** set to NIDMM_EXTCAL_LC_OPEN.
- 3. Plug in the shorting bar across the HI and LO terminals on the PXIe-4082.
- 4. Call the niDMM Cal Adjust LC VI or the niDMM_CalAdjustLC function with **Type** set to NIDMM_EXTCAL_LC_SHORT.
- 5. Remove the shorting bar from the PXIe-4082.

6. Adjust the capacitance and inductance calibration with each standard in the following table:
- a) Plug the specified resistor between the HI and LO terminals of the PXIe-4082. The leads between the resistor and the PXIe-4082 should be ≤ 1 inch.
 - b) Wait 30 seconds for thermal EMF to stabilize.
 - c) Call the niDMM Cal Adjust LC VI or the `niDMM_CalAdjustLC` function with the specified Type parameter.

| Value of Resistor | niDMM Cal Adjust LC Parameter - Type |
|-------------------|--------------------------------------|
| 25 Ω | NIDMM_EXTCAL_LC_25OHM |
| 125 Ω | NIDMM_EXTCAL_LC_125OHM |
| 5 k Ω | NIDMM_EXTCAL_LC_5KOHM |
| 100 k Ω | NIDMM_EXTCAL_LC_100KOHM |

You have completed adjusting the capacitance and inductance modes of the PXIe-4082. Proceed to the *Completing the Adjustment Procedures* section to commit the calibration constants.

Completing the Adjustment Procedures

To complete the adjustment procedure for the PXIe-4080/4082 and close the session, call the niDMM Close Ext Cal VI or the `niDMM_CloseExtCal` function with the following parameter:

- Action = NIDMM_EXTCAL_ACTION_SAVE if you want to save the new calibration coefficients to the device. Otherwise,
- Action = NIDMM_EXTCAL_ACTION_ABORT if you want to restore the original calibration coefficients to the device.

Reverification

Repeat the *Verification* section to determine the as-left status of the PXIe-4080/4082.



Note If any test fails reverification after performing an adjustment, verify that you have met the test conditions before returning your PXIe-4080/4082 to NI. Refer to the *Worldwide Support and Services* section for information about support resources or service requests.

Worldwide Support and Services

The NI website is your complete resource for technical support. At ni.com/support, you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

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375281B-01 March 21, 2017