CALIBRATION PROCEDURE

PXIe-4081

PXIe, 7½-Digit, ±1,000 V, Onboard 1.8 MS/s Isolated Digitizer, PXI
Digital Multimeter

This document contains the verification and adjustment procedures for the PXIe-4081. Refer
to *ni.com/calibration* for more information about calibration solutions.

Contents

Required Software

Calibrating the PXIe-4081 requires you to install the following software on the calibration
system:

- Latest version of the NI-DMM driver

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*
- *NI PXIe-4081 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
Three sets of low thermal electromotive force (EMF) copper cables	Fluke 5440	Voltage and >1 mA Current (1 set), Resistance (2 sets), ≤1 mA Current (3 sets)	Shielded twisted pair copper cables with copper or gold-plated copper banana plugs
Banana shorting bar	Pomona 5145	DCV, 2-Wire Resistance	≤ 40 mΩ resistance

Equipment	Recommended Models	Where Used	Minimum Requirements
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
Ammeter	Keysight 3458A	≤1 mA DC Current	• ≤ 40 ppm uncertainty (100 µA and 1 mA ranges) • Optional: – ≤ 160 ppm uncertainty (10 µA range) – ≤ 300 ppm uncertainty (1 µA range)

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-4081 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-4081.
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-4081 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-4081 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-4081. 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-4081. 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-4081 before performing the verification procedures.

Verifying DC Voltage

Complete the following steps to verify DC voltage:

1. Plug in the shorting bar between the HI and LO terminals of the PXIe-4081.
2. Wait two minutes for thermal EMF to stabilize.
3. Reset the PXIe-4081.
4. Initialize the PXIe-4081 for DC voltage with a range of 100 mV and resolution of 7.5 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	-2.80 µV	2.80 µV	-2.50 µV	2.50 µV
1 V	>10 GΩ / 10 MΩ	-4.5 µV	4.5 µV	-2.8 µV	2.8 µV
10 V	>10 GΩ / 10 MΩ	-7 µV	7 µV	-7 µV	7 µV
100 V	10 MΩ	-0.25 mV	0.25 mV	-0.20 mV	0.20 mV
1000 V	10 MΩ	-0.5 mV	0.5 mV	-0.5 mV	0.5 mV

6. Remove the shorting bar from the PXIe-4081.
7. Set the calibrator to `Standby`.
8. Connect the PXIe-4081 to the calibrator using low thermal EMF cables according the following figure.

Figure 1. Voltage Connection Configuration
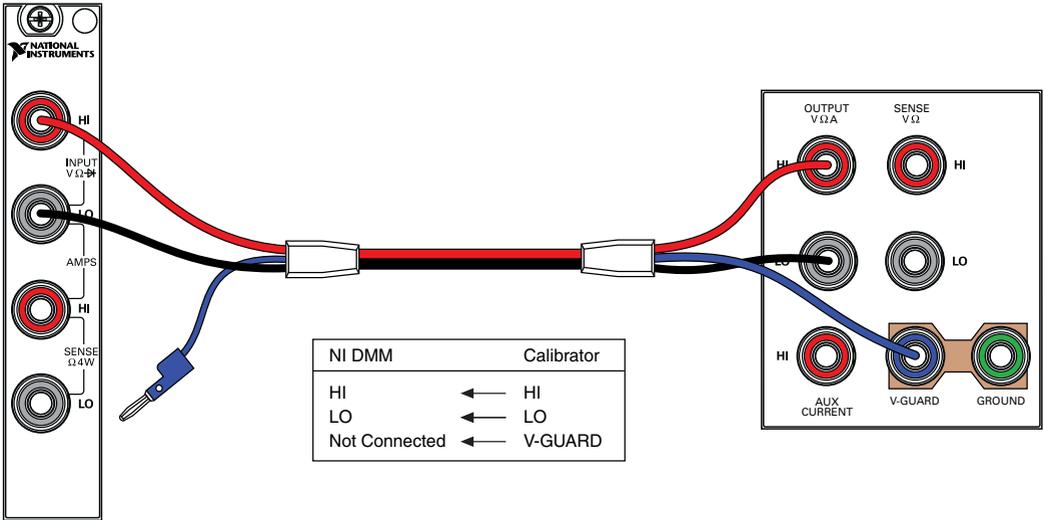
9. Wait two minutes for thermal EMF to stabilize.
10. Set the PXIe-4081 and Calibrator configuration as shown in the following table.
11. Acquire the specified measurements and record them for use as the offset nulls in the following steps.

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-4081 to the specified configuration and commit.
    b) Set the calibrator to the listed 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	90 mV	0.08999681	0.09000319	0.08999841	0.09000159
		-90 mV	-0.09000319	-0.08999681	-0.09000159	-0.08999841
1 V	>10 GΩ / 10 MΩ	1 V	0.9999795	1.0000205	0.9999915	1.0000085
		-1 V	-1.0000205	-0.9999795	-1.0000085	-0.9999915
10 V	>10 GΩ / 10 MΩ	10 V	9.999875	10.000125	9.999966	10.000034
		-10 V	-10.000125	-9.999875	-10.000034	-9.999966
100 V	10 MΩ	100 V	99.99715	100.00285	99.99887	100.00113
		-100 V	-100.00285	-99.99715	-100.00113	-99.99887
1000 V	10 MΩ	1000 V	999.9647	1000.0353	999.9811	1000.0189
		-1000 V	-1000.0353	-999.9647	-1000.0189	-999.9811

You have completed verifying the DC voltage mode of the PXIe-4081. 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

1. Set the calibrator to Standby.
2. Connect the PXIe-4081 to the calibrator using low thermal EMF cables according to the configuration shown in *Figure 1.* on page 6.
3. Reset the PXIe-4081.
4. Initialize the PXIe-4081 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-4081 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 results to the limits.

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

d) Repeat for each listed coupling.
e) Set the `Standby`.

DMM Settings		Calibrator Settings		2-Year Limits (V)	
Range	Function	Amplitude	Frequency	Lower	Upper
50 mV	AC / DC	5 mV	1 kHz	0.0049883	0.0050117
	DC	50 mV	30 Hz	0.04994	0.05006
	AC / DC	50 mV	50 Hz	0.049966	0.050034
		50 mV	1 kHz	0.049966	0.050034
500 mV		50 mV	1 kHz	0.04995	0.05005
50 mV		50 mV	20 kHz	0.049966	0.050034
		50 mV	50 kHz	0.049958	0.050042
		50 mV	100 kHz	0.04984	0.05016
		50 mV	300 kHz	0.049575	0.050425
500 mV	DC	500 mV	30 Hz	0.499475	0.500525
	AC / DC	500 mV	50 Hz	0.499725	0.500275
		500 mV	1 kHz	0.499725	0.500275
5 V		500 mV	1 kHz	0.4995	0.5005
500 mV		500 mV	20 kHz	0.499725	0.500275
		500 mV	50 kHz	0.49965	0.50035
		500 mV	100 kHz	0.49895	0.50105
		500 mV	300 kHz	0.49575	0.50425
5 V	DC	5 V	30 Hz	4.99475	5.00525
	AC / DC	5 V	50 Hz	4.99725	5.00275
		5 V	1 kHz	4.99725	5.00275
50 V		5 V	1 kHz	4.969	5.031
5 V		5 V	20 kHz	4.99725	5.00275
		5 V	50 kHz	4.9965	5.0035
		5 V	100 kHz	4.9895	5.0105
		5 V	300 Hz	4.9575	5.0425

DMM Settings		Calibrator Settings		2-Year Limits (V)	
Range	Function	Amplitude	Frequency	Lower	Upper
50 V	DC	50 V	30 Hz	49.9475	50.0525
	AC / DC	50 V	50 Hz	49.915	50.085
		50 V	1 kHz	49.915	50.085
700 V		50 V	1 kHz	49.59	50.41
50 V		50 V	20 kHz	49.915	50.085
		50 V	50 kHz	49.675	50.325
		50 V	100 kHz	48.425	51.575
		50 V	300 kHz	48.425	51.575
700 V	DC	219 V	30 Hz	218.746	219.254
	AC / DC	700 V	50 Hz	698.81	701.19
		700 V	1 kHz	698.81	701.19
		219 V	20 kHz	218.387	219.613
		219 V	50 kHz	217.336	220.664
		219 V	100 kHz	211.38	226.62
		70 V	300 kHz	66.85	73.15

You have completed verifying the AC voltage mode of the PXIe-4081. 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-4081 to the calibrator using low thermal EMF cables, as shown in the following figure.

Figure 2. 4-Wire Resistance Connection Configuration
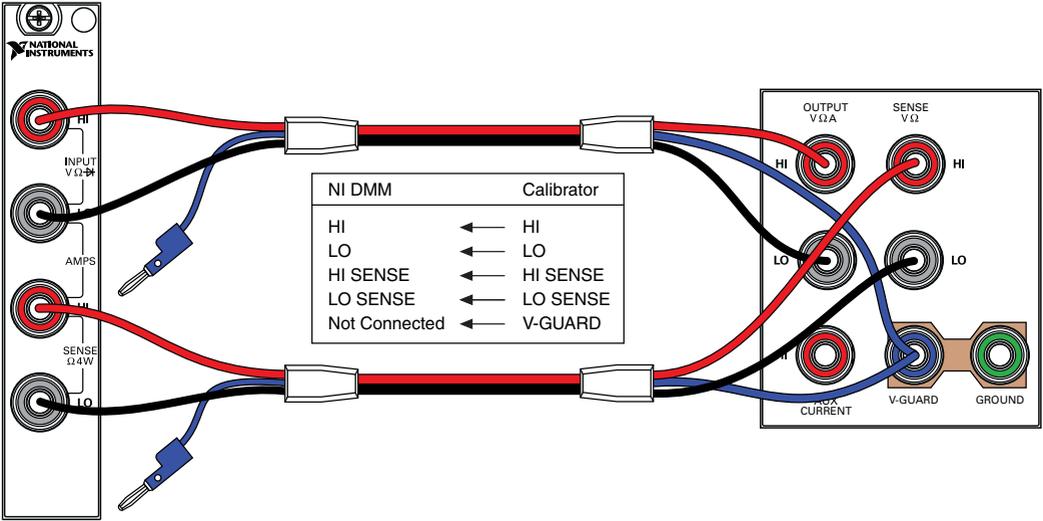
3. Wait two minutes for thermal EMF to stabilize.

4. Reset the PXIe-4081.

5. Configure the PXIe-4081 for 4-wire resistance measurements with a resolution of 7.5 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	External Sense	Comp	ppm of Reading	ppm of Range	ppm of Reading	ppm of Range
10 MΩ	Off	0 Ω	On	None	-	10	-	2
1 MΩ	Off	0 Ω	On	None	-	1	-	1
100 kΩ	Off	0 Ω	On	None	-	4.5	-	3
10 kΩ	On	0 Ω	On	None	-	1.5	-	0.7
1 kΩ	On	0 Ω	On	None	-	1.5	-	0.7

| DMM Settings | | Calibrator Settings | | | Tolerances | | | |
| | | | | | As-Found | | As-Left | |
Range	Offset Compensated Ohms (OCO)	Resistance	External Sense	Comp	ppm of Reading	ppm of Range	ppm of Reading	ppm of Range
100 Ω	On	0 Ω	On	None	-	12	-	6.8
10 MΩ	Off	10 MΩ	On	None	130	10	86	2
1 MΩ	Off	1 MΩ	On	None	60	1	16	1
100 kΩ	Off	100 kΩ	On	None	45	2.5	9	1
10 kΩ	On	10 kΩ	On	None	45	1.5	8	0.7
1 kΩ	On	1 kΩ	On	None	45	1.5	12	0.7
100 Ω	On	100 Ω	On	None	55.7	12	16	6.8

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

You have completed verifying the 4-wire resistance mode of the PXIe-4081. 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 the shorting bar between the HI and LO terminals of the PXIe-4081.
2. Wait two minutes for thermal EMF to stabilize.
3. Reset the PXIe-4081.
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 MΩ	Off	10	6
10 MΩ	Off	10	2
1 MΩ	Off	1.2	1.2
100 kΩ	Off	6.5	5
10 kΩ	On	21.5	20.5
1 kΩ	On	201.5	200.5
100 Ω	On	2012	2005

5. Remove the shorting bar from the PXIe-4081.
6. Set the calibrator to `Standby`.
7. Connect the PXIe-4081 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.

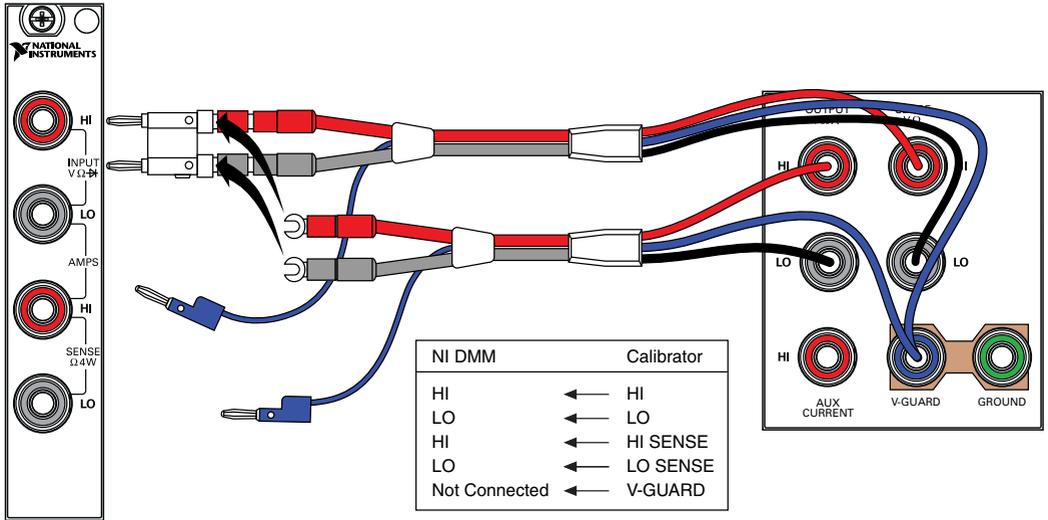| DMM Settings		Calibrator Settings			Tolerances			
					As-Found		As-Left	
Range[2]	OCO	Resistance	External Sense	Compensation	ppm of Reading	ppm of Range	ppm of Reading	ppm of Range
1 MΩ	Off	0 Ω	Off	None	-	-	-	-
100 kΩ	Off	0 Ω	Off	None	-	-	-	-
100 MΩ	Off	100 MΩ	Off	None	3000	10	500	6
10 MΩ	Off	10 MΩ	Off	None	130	10	86	2
1 MΩ	Off	1 MΩ	Off	None	60	1	16	1
100 kΩ	Off	100 kΩ	Off	None	45	2.5	7	1

📝 **Note** For the 1 MΩ and 100 kΩ measurements, subtract the corresponding 0 Ω measurement as an offset null.

10. Connect the PXIe-4081 to the calibrator using low thermal EMF cables according to the 2-wire compensated configuration shown in the following figure.

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[2] For the 1 MΩ and 100 kΩ measurements, subtract the corresponding 0 Ω measurement as an offset null.

Figure 3. 2-Wire Resistance Low Range Connection Configuration

NI DMM		Calibrator
HI	←	HI
LO	←	LO
HI	←	HI SENSE
LO	←	LO SENSE
Not Connected	←	V-GUARD

11. Wait two minutes for 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	External Sense	Compensation	ppm of Reading	ppm of Range	ppm of Reading	ppm of Range
10 kΩ	Off	10 kΩ	On	2-Wire	45	21.5	7	20.5
1 kΩ	Off	1 kΩ	On	2-Wire	45	201.5	7	200.5
100 Ω	Off	100 Ω	On	2-Wire	55	2012	9	2005

You have completed verifying the 2-wire resistance mode of the PXIe-4081. 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-4081.
2. Reset the PXIe-4081.
3. Initialize the PXIe-4081 for DC current with a range of 1 µA and a 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 Settings	As-Found Limits		As-Left Limits	
	Lower	Upper	Lower	Upper
1 µA	-0.120 nA	0.120 nA	-0.060 nA	0.060 nA
10 µA	-0.45 nA	0.45 nA	-0.06 nA	0.06 nA
100 µA	-2.0 nA	2.0 nA	-1.0 nA	1.0 nA
1 mA	-0.020 µA	0.020 µA	-0.010 µA	0.010 µA
10 mA	-0.20 µA	0.20 µA	-0.10 µA	0.10 µA
100 mA	-2.0 µA	2.0 µA	-1.0 µA	1.0 µA
1 A	-0.020 mA	0.020 mA	-0.010 mA	0.010 mA
3 A	-0.06 mA	0.06 mA	-0.02 mA	0.02 mA

5. Set the calibrator to `Standby`.
6. Connect the PXIe-4081 to the calibrator with the ammeter in series as shown in the following figure.

Figure 4. DC Current Low Range Connection Configuration

NI DMM	Ammeter	Calibrator
HI SENSE ←		HI
LO →	I	
	LO →	LO
	Guard* ←	V-GUARD

*Set Guard Switch to Open

7. Verify the accuracy for each configuration in the following table:

   a) Set the PXIe-4081 and the ammeter to the listed configuration and commit. Configure the ammeter for a single acquisition.

   b) Set the Calibrator to the listed configuration and allow it to settle.

   c) Acquire the specified measurement and compare the difference between the PXIe-4081 and the ammeter to the limits.

   d) Set the calibrator to Standby if you have completed all testpoints in a DMM range.

DMM/Ammeter Settings	Calibrator Output	Tolerances			
		As-Found		As-Left	
		ppm of reading	ppm of range	ppm of reading	ppm of range
1 µA	0.9 µA	1050	120	144	60
1 µA	-0.9 µA				
10 µA	9 µA	600	45	108	6
10 µA	-9 µA				
100 µA	90 µA	175	20	27	10
100 µA	-90 µA				
1 mA	0.9 mA	170	20	27	10
1 mA	-0.9 mA				

8. Connect the PXIe-4081 to the calibrator using low leakage cables according to the configuration shown in the following figure.

Figure 5. DC Current Connection Configuration
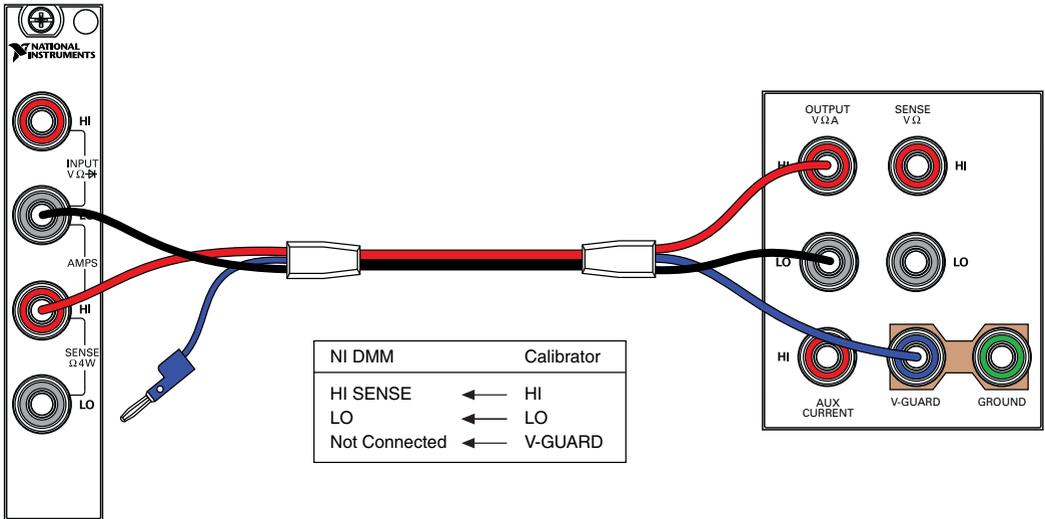
9. Verify the accuracy for each configuration in the following table:
    a) Set the PXIe-4081 to the listed configuration and commit.
    b) Set the calibrator to the listed configuration and allow it to settle.
    c) Acquire the specified measurement and compare to the limits.
    d) Set the calibrator to Standby if you have completed all testpoints in the DMM Range.

DMM Settings	Calibrator Output	Tolerances (ppm)			
		As-Found		As-Left	
		ppm of reading	ppm of range	ppm of reading	ppm of range
10 mA	9 mA	170	20	39	10
10 mA	-9 mA	170	20	39	10
100 mA	90 mA	180	20	43	10
100 mA	-90 mA	180	20	43	10
1 A	450 mA	350	20	70	10
1 A	-450 mA	350	20	70	10
3 A	450 mA	350	20	70	5
3 A	-450 mA	350	20	70	5
1 A	1 A	425	20	138	10
1 A	-1 A	425	20	138	10
3 A	2.2 A	713	20	445	5
3 A	-2.2 A	713	20	445	5

You have completed verifying the DC current of the PXIe-4081. 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-4081 to the calibrator using low leakage cables according to the configuration shown in *Figure 5.* on page 16.
3. Reset the PXIe-4081.
4. Initialize the PXIe-4081 for AC current with a range of 100 µA and resolution of 6.5 digits.

5. Verify the accuracy for each configuration in the following table:
   a) Set the PXIe-4081 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 testpoints in a DMM Range.

DMM Settings	Calibrator Settings		2-Year Limits	
	Amplitude	Frequency	Lower	Upper
100 μA	9 μA	1 kHz	8.9757 μA	9.0243 μA
100 μA	90 μA	1 kHz	89.9215 μA	90.0785 μA
1 mA	90 μA	1 kHz	89.769 μA	90.231 μA
1 mA	900 μA	1 kHz	899.495 μA	900.505 μA
10 mA	900 μA	1 kHz	0.89768 mA	0.90232 mA
10 mA	9 mA	1 kHz	8.99495 mA	9.00505 mA
100 mA	9 mA	1 kHz	8.9764 mA	9.0236 mA
100 mA	90 mA	55 Hz	89.9440 mA	90.0560 mA
100 mA	90 mA	5 kHz	89.9170 mA	90.0830 mA
100 mA	90 mA	1 kHz	89.9440 mA	90.0560 mA
1 A	90 mA	1 kHz	89.737 mA	90.263 mA
1 A	900 mA	1 kHz	899.201 mA	900.799 mA
3 A	300 mA	1 kHz	0.29916 A	0.30084 A
3 A	2.2 A	1 kHz	2.19764 A	2.20236 A

You have completed verifying AC current for the PXIe-4081. 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-4081. 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-4081 .
2. Reset the calibrator.
3. Initialize an external calibration session to the PXIe-4081.
4. Self-calibrate the PXIe-4081.
5. Connect the PXIe-4081 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-4081, leaving the other end of the cable connected to the calibrator binding posts.
9. Plug in the banana shorting bar across the HI and LO terminals on the PXIe-4081.
10. Wait two minutes for 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-4081.

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-4081. 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 Voltages (AC- and DC-coupled) section.

Complete the following steps to adjust the resistance of the device:
1. Connect the PXIe-4081 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 PXIe-4081 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	External Sense	Compensation	
4-wire resistance	10 kΩ	N/A	(value from calibrator)	10 kΩ	On	None	1 s
			(value from calibrator)	0 Ω			1 s
	100 kΩ	N/A	(value from calibrator)	100 kΩ			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-4081 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	External Sense	Compensation	
4-wire resistance	10 MΩ	N/A	(value from calibrator)	0 Ω	On	None	0 s
			(value from calibrator)	10 MΩ			10 s
2-wire resistance	10 MΩ	N/A	(value from calibrator)	0 Ω	Off	None	0 s
				10 MΩ			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-4081.

8. Adjust the resistance calibration with each configuration in the following table:
   a) Commit the PXIe-4081 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**	**External Sense**	**Compensation**	
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 kΩ
		10 kΩ
		100 kΩ
		1 MΩ
		10 MΩ

11. Call the niDMM Cal Adjust Misc VI or the `niDMM_CalAdjustMisc` function with **Type** set to `NIDMM_EXTCAL_MISCCAL_VREF_RESISTANCE`.

12. Disconnect all inputs from the PXIe-4081 and plug in the shorting bar between the HI and LO terminals.

13. Wait two minutes for thermal EMF to stabilize.

14. 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 kΩ
		10 kΩ
		100 kΩ
		1 MΩ
		10 MΩ
		100 MΩ

You have completed adjusting the resistance of the PXIe-4081. Proceed to one of the following sections:

- *Adjusting AC Voltage*
- *Adjusting Current*

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

Adjusting AC Voltages

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 Modes section.

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

1. Reset the calibrator.
2. Connect the PXIe-4081 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 PXIe-4081 to the 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
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

DMM Settings		Calibrator Settings	
Function	Range	Amplitude	Frequency
AC Volts	50 V	50 V	1 kHz
			5 kHz
			20 kHz
			50 kHz
			100 kHz
			200 kHz
			300 kHz
		10 V	500 kHz
AC Volts	700 V	100 V	1 kHz
			5 kHz
			20 kHz
			50 kHz
			100 kHz
			200 kHz
		50 V	300 kHz
		10 V	500 kHz

5. Reset the calibrator.
6. Call the niDMM_Cal Adjust Misc VI or the `niDMM_CalAdjustMisc` function with **Type** set to `NIDMM_EXTCAL_MISCCAL_VOLTAGE_AC_FILTER`.
7. Self-calibrate the PXIe-4081.

You have completed adjusting the AC voltage modes of the PXIe-4081. Proceed to one of the following sections:

* *Adjusting Current*

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 DC 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 *Completing the Adjustment Procedures* section.

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

1. Reset the calibrator.
2. Disconnect all inputs of the PXIe-4081.
3. Call the niDMM Cal Adjust Misc VI or `niDMM_CalAdjustMisc` function with **Type** set to `NIDMM_EXTCAL_MISCCAL_VREF_DC_CURRENT`.
4. Repeat the previous step, setting **Type** to `NIDMM_EXTCAL_MISCCAL_VREF_AC_CURRENT`.
5. Call the niDMM Cal Adjust Offset VI or `niDMM_CalAdjustOffset` function for each configuration in the following table:

DMM Settings		
Function	**Input Resistance**	**Range**
DC current	N/A	1 µA
DC current	N/A	10 µA

6. Connect the PXIe-4081 to the calibrator with the ammeter in series as shown in *Figure 4.* on page 15.
7. Adjust the current gain with each configuration in the following table:
   a) Commit the PXIe-4081 and ammeter 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. Configure the ammeter for a single acquisition.
   d) Set the calibrator to `Standby`.

DMM and Ammeter Settings			Calibrator Output	Expected Value
Function	**Range**	**Input Resistance**		
DC current	1 µA	N/A	1 µA	Ammeter measurement
			-1 µA	
	10 µA	N/A	10 µA	Ammeter measurement
			-10 µA	
	100 µA	N/A	100 µA	Ammeter measurement
			-100 µA	
	1 mA	N/A	1 mA	Ammeter measurement
			-1 mA	

8. Connect the PXIe-4081 to the calibrator as shown in *Figure 5.* on page 16.

9. Adjust the current gain with each configuration in the following table:
    a) Commit the PXIe-4081 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	10 mA	N/A	10 mA	10 mA
			-10 mA	-10 mA
	100 mA	N/A	100 mA	100 mA
			-100 mA	-100 mA
	1 A	N/A	0.5 A	0.5 A
			-0.5 A	-0.5 A
	3 A	N/A	0.5 A	0.5 A
			-0.5 A	-0.5 A

10. Self-calibrate the PXIe-4081.

You have completed adjusting the current modes of the PXIe-4081. Proceed to the *Completing the Adjustment Procedures* section.

Completing the Adjustment Procedures

To complete the adjustment procedure for the PXIe-4081 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-4081.

> **Note** If any test fails reverification after performing an adjustment, verify that you have met the test conditions before returning your PXIe-4081 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.

Visit *ni.com/services* for NI Factory Installation Services, repairs, extended warranty, and other services.

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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