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PXIe-4480

CALIBRATION PROCEDURE

PXIe-4480/4481

6-Channel, 24-bit, 1.25 MS/s DSA Analog Input

This document contains the verification and adjustment procedures for the PXIe-4480 and PXIe-4481 Dynamic Signal Acquisition (DSA) analog input modules. The procedures for the PXIe-4481 are a subset of those for the PXIe-4480, specifically with regards to the absence of the charge measurement function, which is available on the PXIe-4480, but not the PXIe-4481. However, for clarity, the adjustment procedures for each module are listed separately. For more information about calibration solutions, visit `ni.com/calibration`.

Contents

Software

Calibrating the PXIe-4480/4481 requires the installation of NI-DAQmx on the calibration system. NI-DAQmx 16.1 added driver support for the PXIe-4480/4481. For the list of devices supported by a specific release, refer to the *NI-DAQmx Readme*, available on the version-specific download page or installation media.

You can download NI-DAQmx from `ni.com/downloads`. NI-DAQmx supports LabVIEW, LabWindows™/CVI™, C/C++, C#, and Visual Basic .NET. When you install NI-DAQmx, you only need to install support for the application software that you intend to use.

NATIONAL INSTRUMENTS™

Documentation

Consult the following documents for information about the PXIe-4480/4481, NI-DAQmx, and your application software. All documents are available on ni.com and help files install with the software.

PXIe-4480/4481 Getting Started Guide

NI-DAQmx driver software installation and hardware setup

PXIe-4480/4481 Specifications

PXIe-4480/4481 specifications and calibration interval

DAQ Getting Started Guide for PXI/PXI Express

Information about hardware and software installation, device configuration, and programming

NI-DAQmx Readme

Operating system and application software support in NI-DAQmx

NI-DAQmx Help

Information about creating applications that use the NI-DAQmx driver

LabVIEW Help

LabVIEW programming concepts and reference information about NI-DAQmx VIs and functions

NI-DAQmx C Reference Help

Reference information for NI-DAQmx C functions and NI-DAQmx C properties

NI-DAQmx .NET Help Support for Visual Studio

Reference information for NI-DAQmx .NET methods and NI-DAQmx .NET properties, key concepts, and a C enum to .NET enum mapping table

Test Equipment

Table 1 lists the equipment recommended for the performance verification and adjustment procedures for the PXIe-4480. Table 2 lists the same for the PXIe-4481. If the recommended equipment is not available, select a substitute using the minimum requirements listed in the table.

Table 1. Recommended Equipment (PXIe-4480)

Equipment	Recommended Model(s)	Where Used	Minimum Requirements
Calibrator	Fluke 5700A	AI Gain	Frequency Range: 40 Hz to 200 kHz Voltage Range: up to 6.3 V_{rms} ACV Accuracy: 40 Hz: 0.017% 1 kHz: 0.016% 20 kHz: 0.017% 50 kHz: 0.037% 100 kHz: 0.086% 200 kHz: 0.32%
Function Generator	Keysight (Agilent) 33250A series	Timebase Frequency	Frequency Range: up to 90 kHz Frequency Accuracy: 2 ppm Voltage Range: up to 9 V_{pk}
Digital Multimeter	PXI-4070	IEPE Current	Current Accuracy: 0.9%
InfiniBand 12X-6BNC Cable	National Instruments SHB12X-6BNC	All	N/A
BNC Shorting Cap (quantity 6)	Pomona Electronics 5085 or Pomona Electronics 3840-50	AI Offset	Resistance: ≤50 Ω

Table 1. Recommended Equipment (PXIe-4480) (Continued)

Equipment	Recommended Model(s)	Where Used	Minimum Requirements
BNC (F) to Banana Plug Adapter	Pomona Electronics 1269	AI Gain	N/A
BNC (M) Cable* (quantity 1 minimum, 11 maximum)	Pomona Electronics 5697	AI Gain	Characteristic Impedance: 50 Ω
BNC F-F-F T-Connector* (quantity 0 minimum, 5 maximum)	Pomona Electronics 3284	AI Gain	Characteristic Impedance: 50 Ω
Calibration Capacitor†	Meggitt Endevco 2947C	Charge Gain	1000 pF 1% C0G, calibrated to 0.1%
10-32 (M) to BNC (M) Interface Cable†	PCB Piezotronics 002C03	Charge Gain	N/A

* AI Gain verification and adjustment can be conducted one channel at a time, all six channels simultaneously, as well as any number in between. The minimum quantity corresponds to one channel at a time. The maximum quantity corresponds to all six channels simultaneously.

† Charge verification/adjustment is optional.

Table 2. Recommended Equipment (PXIe-4481)

Equipment	Recommended Model(s)	Where Used	Minimum Requirements
Calibrator	Fluke 5700A	AI Gain	Frequency Range: 40 Hz to 200 kHz Voltage Range: up to 6.3 V_{rms} ACV Accuracy: 40 Hz: 0.017% 1 kHz: 0.016% 20 kHz: 0.017% 50 kHz: 0.037% 100 kHz: 0.086% 200 kHz: 0.32%
Function Generator	Keysight (Agilent) 33250A series	Timebase Frequency	Frequency Range: up to 90 kHz Frequency Accuracy: 2 ppm Voltage Range: up to 9 V_{pk}
InfiniBand 12X-6BNC Cable	National Instruments SHB12X-6BNC	All	N/A
BNC Shorting Cap (quantity 6)	Pomona Electronics 5085 or Pomona Electronics 3840-50	AI Offset	Resistance: ≤50 Ω
BNC (F) to Banana Plug Adapter	Pomona Electronics 1269	AI Gain	N/A

Table 2. Recommended Equipment (PXIe-4481) (Continued)

Equipment	Recommended Model(s)	Where Used	Minimum Requirements
BNC (M) Cable* (quantity 1 minimum, 11 maximum)	Pomona Electronics 5697	AI Gain	Characteristic Impedance: 50 Ω
BNC F-F-F T-Connector* (quantity 0 minimum, 5 maximum)	Pomona Electronics 3284	AI Gain	Characteristic Impedance: 50 Ω

* AI Gain verification and adjustment can be conducted one channel at a time, all six channels simultaneously, as well as any number in between. The minimum quantity corresponds to one channel at a time. The maximum quantity corresponds to all six channels simultaneously.

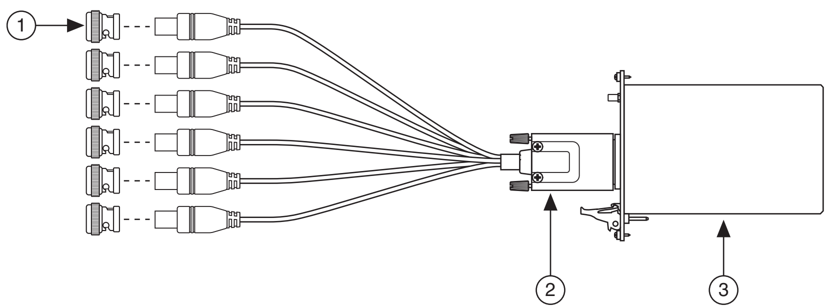
Connecting the PXIe-4480/4481

This section describes the options in connecting the PXIe-4480/4481 to the calibration equipment.

Voltage Offset Accuracy Verification/Adjustment

Figure 1 illustrates the connections for voltage offset accuracy verification/adjustment.

Figure 1. Voltage Offset Accuracy Connections



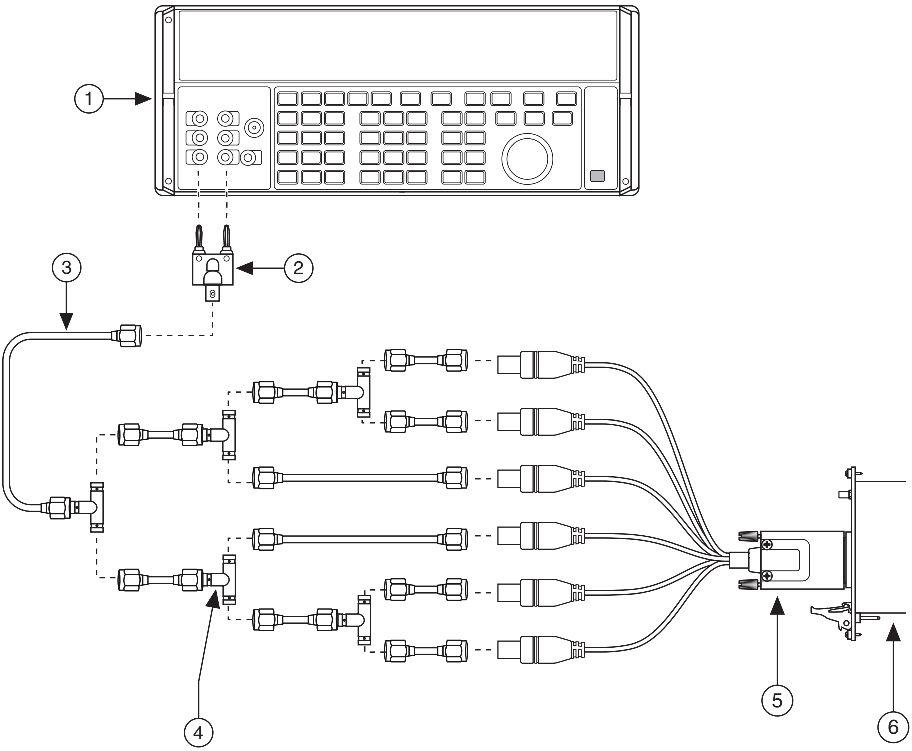
1 BNC Shorting Cap
2 InfiniBand 12X-6BNC Cable
3 PXIe-4480/4481

Note Secure the cable to the module front panel using the cable connector jackscrews.

Voltage Gain Accuracy Verification/Adjustment

Voltage gain verification and adjustment can be conducted one channel at a time, all six channels simultaneously, as well as any number in between. Figure 2 illustrates the connections for parallel channel operation, while Figure 3 illustrates the connections for sequential channel operation.

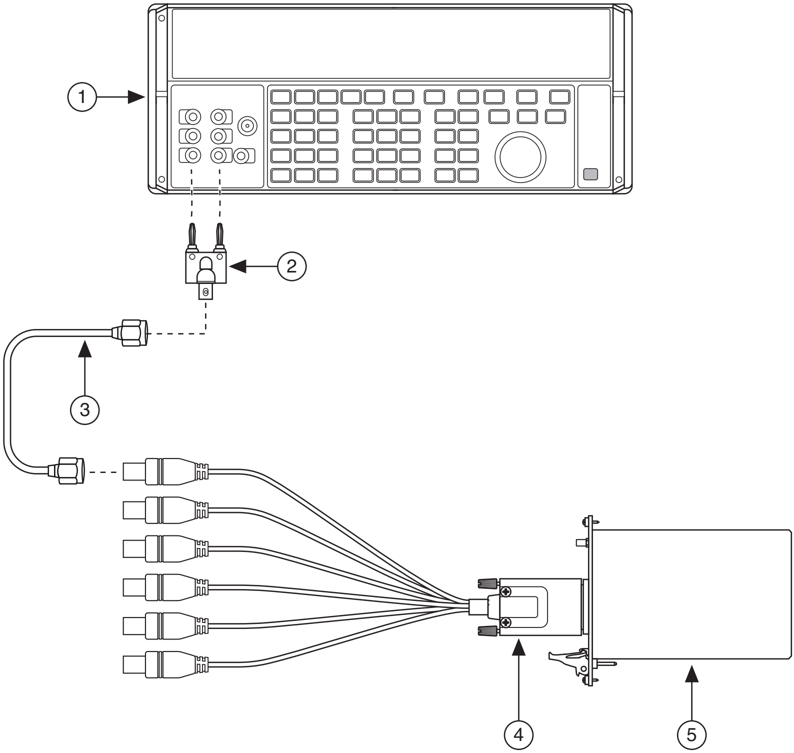
Figure 2. Voltage Gain Accuracy/Flatness Connections (Six Channels)



1	Calibrator	4	BNC T-Connector
2	Banana Plug Adapter	5	InfiniBand 12X-6BNC Cable
3	BNC Cable	6	PXIe-4480/4481

Note Secure the cable to the module front panel using the cable connector jackscrews.

Figure 3. Voltage Gain Accuracy/Flatness Connections (One Channel)



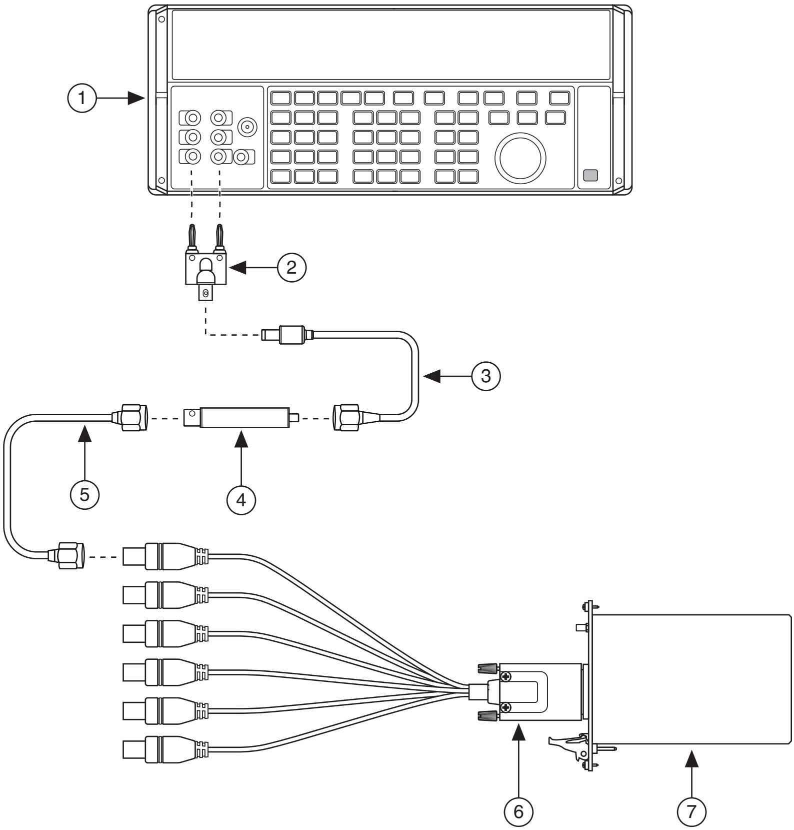
1	Calibrator	4	InfiniBand 12X-6BNC Cable
2	Banana Plug Adapter	5	PXIe-4480/4481
3	BNC Cable		

Note Secure the cable to the module front panel using the cable connector jackscrews.

Charge Gain Accuracy Verification/Adjustment (PXIe-4480 only)

Charge gain verification and adjustment is conducted one channel at a time. Figure 4 illustrates the connections for charge gain accuracy verification/adjustment.

Figure 4. Charge Gain Accuracy Connections



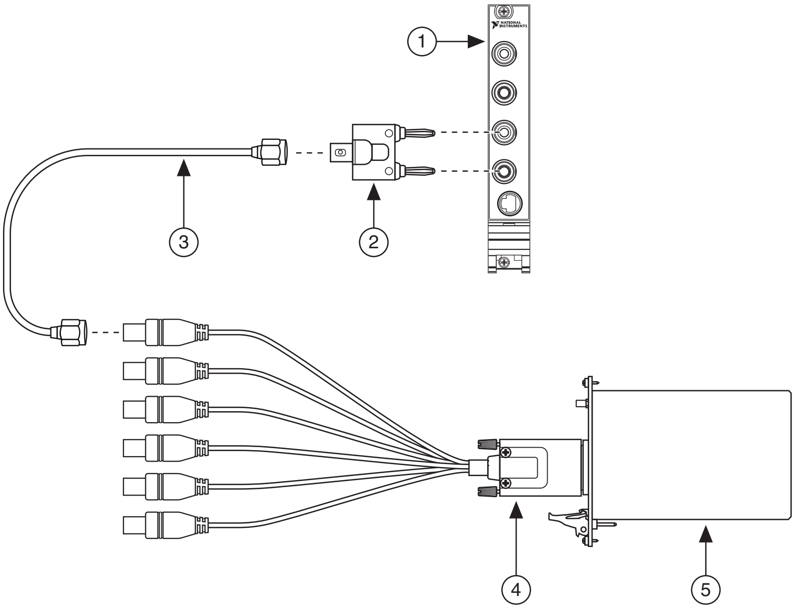
1	Calibrator	5	BNC Cable
2	Banana Plug Adapter	6	InfiniBand 12X-6BNC Cable
3	10-32 to BNC Interface Cable	7	PXIe-4480
4	Calibration Capacitor		

Note Secure the cable to the module front panel using the cable connector jackscrews.

IEPE Current Accuracy Verification (PXIe-4480 only)

Figure 5 illustrates the connections for IEPE current accuracy verification.

Figure 5. IEPE Current Accuracy Connections



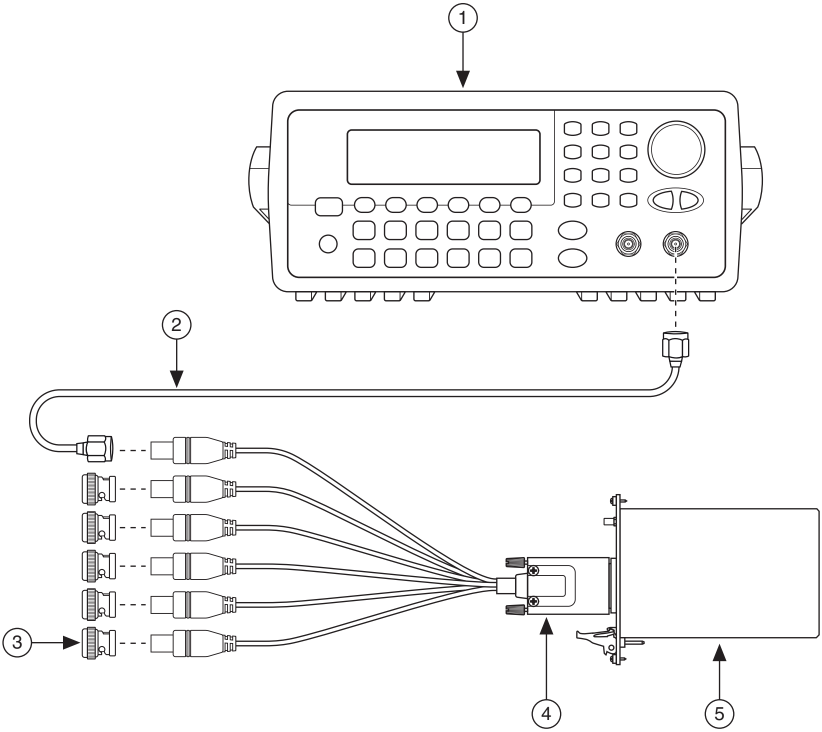
1	Digital Multimeter	4	InfiniBand 12X-6BNC Cable
2	Banana Plug Adapter	5	PXIe-4480
3	BNC Cable		

Note Secure the cable to the module front panel using the cable connector jackscrews.

Timebase Accuracy Verification/Adjustment

Figure 6 illustrates the connections for timebase accuracy verification/adjustment.

Figure 6. Timebase Accuracy Connections



1	Function Generator	4	InfiniBand 12X-6BNC Cable
2	BNC Cable	5	PXIe-4480/4481
3	BNC Shorting Cap		

Note Secure the cable to the module front panel using the cable connector jackscrews.

Test Conditions

The following setup and environmental conditions are required to ensure the PXIe-4480/4481 meets published specifications.

- Keep connections to the PXIe-4480/4481 as short as possible. Long cables and wires act as antennas, picking up extra noise that can affect measurements.
- Verify that all connections to the device are secure.
- Maintain an ambient temperature of 23 °C ±5 °C. The device temperature will be greater than the ambient temperature.
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 15 minutes to ensure that the PXIe-4480/4481 measurement circuitry is at a stable operating temperature.
- Allow adequate warm-up time for all of the instruments and equipment according to the manufacturer instructions.

Initial Setup

Refer to the *DAQ Getting Started Guide* and the *PXIe-4480/4481 Getting Started Guide* for information about how to install the software and hardware and how to configure the device in Measurement & Automation Explorer (MAX).

Note When a device is configured in MAX, it is assigned a device name. Each function call uses this device name to determine which device to calibrate. This document uses `Dev_name` to refer to the device name. In the following procedures, use the device name as it appears in MAX.

Verification

The following performance verification procedures describe the sequence of operation and provide test points required to verify the PXIe-4480/4481. The verification procedures assume that adequate traceable uncertainties are available for the calibration references.

Voltage Input Performance Verification

This section verifies the voltage input performance of the PXIe-4480/4481. Some, but not all, performance characteristics are affected by adjustment and are subject to reverification after adjustment. Characteristics affected by adjustment have As Left test limits in addition to As Found test limits. Characteristics unaffected by adjustment solely have test limits with no additional qualification.

Voltage Offset Accuracy Verification

Complete the following steps to verify the voltage offset accuracy:

1. Using the equipment described in Table 1 (PXIe-4480) or Table 2 (PXIe-4481), connect the module as shown in Figure 1.
2. Create and configure an AI voltage task on the device as shown in Table 3.

Table 3. Voltage Offset Accuracy Verification Configuration

Configuration	Value
Physical channels	`Dev_name`/ai0:5
Range	10 (V)
Coupling	DC
Terminal configuration	Pseudodifferential
Acquisition mode	Finite number of samples
Sample rate	102,400
Samples per channel	102,400

3. Start the task.
4. Acquire readings with the PXIe-4480/4481.
5. On a per channel basis, average all of the acquired samples.
6. Stop and clear the task.
7. Compare the averaged values to the appropriate limits in Table 4. The average is the offset of the 10 V range.

Table 4. Voltage Offset Accuracy Limits

Range (V)	As Found Test Limit		As Left Test Limit	
	Lower Limit (mV)	Upper Limit (mV)	Lower Limit (mV)	Upper Limit (mV)
10	-5.0	5.0	-0.2	0.2
5	-2.2	2.2	-0.1	0.1
1	-0.8	0.8	-0.05	0.05
0.5	-0.65	0.65	-0.05	0.05

8. Repeat steps 2 through 7 for each range of the device. When performing step 2, set the **range** parameter to 5, 1, and 0.5 as required.

Voltage Gain Accuracy Verification

Complete the following steps to verify the voltage gain accuracy:

1. Using the equipment described in Table 1 (PXIe-4480) or Table 2 (PXIe-4481), connect the module to the calibrator as shown in Figure 2 (six channels) or Figure 3 (analog input channel 0).
2. Configure the calibrator to generate an output with the amplitude and frequency listed in the 10 V row of Table 5.

Table 5. Voltage Gain Accuracy Limits

Range (V)	Calibrator Output		As Found Test Limit		As Left Test Limit	
	Amplitude (V_{rms})	Frequency (Hz)	Lower Limit (V_{rms})	Upper Limit (V_{rms})	Lower Limit (V_{rms})	Upper Limit (V_{rms})
10	6.3	1,000	6.2638	6.3364	6.29748	6.30252
5	3.15	1,000	3.1319	3.1682	3.14874	3.15126
1	0.63	1,000	0.62638	0.63364	0.62975	0.63025
0.5	0.315	1,000	0.31319	0.31682	0.31487	0.31513

3. Create and configure an AI voltage task on the device as shown in Table 6.

Table 6. Voltage Gain Accuracy Verification Configuration

Configuration	Value
Physical channel	*`Dev_name`*/ai0 or *`Dev_name`*/ai0:5
Range	10 (V)
Coupling	AC
Terminal configuration	Pseudodifferential
Acquisition mode	Finite number of samples
Sample rate	102,400
Samples per channel	102,400

4. If the coupling changes from DC to AC (for example, on the first gain verification point tested), commit the configuration using the DAQmx Control Task VI and wait 5 seconds for the input to settle. Subsequent gain verification points, which do not change the coupling, do not require a delay.
5. Start the task.
6. Acquire readings with the PXIe-4480/4481.

7. Calculate the RMS amplitude of the acquired fundamental harmonic. Compare this amplitude to the appropriate voltage limits in Table 5. The calculated amplitude is used to verify the gain accuracy of the measured analog input channels at the 10 V range setting.

   As an example, you can use the Extract Single Tone Information VI to help calculate RMS. Note that the output of this VI is peak amplitude, and you must divide the result by $\sqrt{2}$ to convert to RMS.
8. Stop and clear the task.
9. Repeat steps 2 through 8 for each range setting of the device. When performing step 2, configure the calibrator output to the amplitude and frequency indicated for the range to be verified. When performing step 3, set the **range** parameter to 5, 1, and 0.5 as required.
10. If necessary, repeat steps 1 through 9 for all input channels of the device. In step 1, connect the output of the calibrator to the channel being verified. In step 3, replace `ai0` in the **physical channel** parameter with the channel being verified.

Voltage Gain Flatness Verification

Note This performance characteristic is not affected by adjustment. Consequently, reverification after adjustment is not necessary.

Note DC-coupled gain flatness is inherently better than AC-coupled gain flatness, specifically at low frequencies. Consequently, the verification of AC-coupled gain flatness covers both configurations.

Complete the following steps to verify the voltage gain flatness:

1. Using the equipment described in Table 1 (PXIe-4480) or Table 2 (PXIe-4481), connect the module to the calibrator as shown in Figure 2 (six channels) or Figure 3 (analog input channel 0).
2. Configure the calibrator to generate an output with the amplitude and frequency listed in the 10 V row of Table 7.

Table 7. Voltage Gain Flatness Inputs

Range (V)	Calibrator Output	
	Amplitude (V_{rms})	Frequency (Hz)
10	6.3	1,000
5	3.15	1,000
1	0.63	1,000
0.5	0.315	1,000

3. Create and configure an AI voltage task on the device as shown in Table 8.

Table 8. Voltage Gain Flatness Verification Configuration

Configuration	Value
Physical channel	`Dev_name`/ai0 or `Dev_name`/ai0:5
Range	10 (V)
Coupling	AC
Terminal configuration	Pseudodifferential
Acquisition mode	Finite number of samples
Sample rate	1,250,000
Samples per channel	625,000

4. Start the task.
5. Acquire readings with the PXIe-4480/4481.
6. Calculate the RMS amplitude of the acquired fundamental harmonic. The measured amplitude represents V_{1kHz} of the measured analog input channels referenced in Table 9 at the 10 V range setting.

   As an example, you can use the Extract Single Tone Information VI to help calculate RMS. Note that the output of this VI is peak amplitude, and you must divide the result by √2 to convert to RMS.
7. Stop and clear the task.
8. Repeat steps 2 through 7 for each row in Table 9. When performing step 2, instead of 1 kHz, configure the calibrator output to the frequency listed in Table 9. The calibrator output amplitude remains constant. Compare this amplitude to the appropriate limits in Table 9.

Note The value of V_{1kHz} is the measured amplitude of the 1 kHz tone, not the nominal amplitude listed in Table 7.

9. Repeat steps 2 through 8 for each range setting of the device. When performing step 2, configure the calibrator output to the amplitude and frequency indicated for the range to be verified. When performing step 3, set the **range** parameter to 5, 1, and 0.5 as required.

10. If necessary, repeat steps 1 through 9 for all input channels of the device. In step 1, connect the output of the calibrator to the channel being verified. In step 3, replace `ai0` in the **physical channel** parameter with the channel being verified.

Table 9. Voltage Gain Flatness Limits

Calibrator Output Frequency (Hz)	Test Limit (10 V, 5 V ranges)		Test Limit (1 V range)		Test Limit (0.5 V range)	
	Lower Limit (V_{rms})	Upper Limit (V_{rms})	Lower Limit (V_{rms})	Upper Limit (V_{rms})	Lower Limit (V_{rms})	Upper Limit (V_{rms})
40	0.9992 * V_{1kHz}	1.0008 * V_{1kHz}	0.9992 * V_{1kHz}	1.0008 * V_{1kHz}	0.9991 * V_{1kHz}	1.0009 * V_{1kHz}
20,000	0.9992 * V_{1kHz}	1.0008 * V_{1kHz}	0.9992 * V_{1kHz}	1.0008 * V_{1kHz}	0.9991 * V_{1kHz}	1.0009 * V_{1kHz}
50,000	0.9985 * V_{1kHz}	1.0015 * V_{1kHz}	0.9982 * V_{1kHz}	1.0018 * V_{1kHz}	0.9971 * V_{1kHz}	1.0029 * V_{1kHz}
100,000	0.9965 * V_{1kHz}	1.0035 * V_{1kHz}	0.9935 * V_{1kHz}	1.0066 * V_{1kHz}	0.9892 * V_{1kHz}	1.0109 * V_{1kHz}
200,000	0.9874 * V_{1kHz}	1.0127 * V_{1kHz}	0.9750 * V_{1kHz}	1.0257 * V_{1kHz}	0.9594 * V_{1kHz}	1.0423 * V_{1kHz}

Charge Input Performance Verification (PXIe-4480 only)

This section verifies the charge input performance of the PXIe-4480.

Charge Gain Accuracy Verification

Complete the following steps to verify the charge gain accuracy.

1. Using the equipment described in Table 1, connect analog input channel 0 of the module to the calibrator as shown in Figure 4. Record the exact value of the calibrator capacitor, which is printed on its label or provided on its calibration certificate. In this procedure, this value is termed C_{CAL}.
2. Configure the calibrator to generate an output with the amplitude and frequency listed in the 20,000 pC row of Table 10.

Note While the calibrator output is voltage, its application through the series calibration capacitor creates an effective charge input ($Q_{CAL} = V_{CAL} * C_{CAL}$). For example, 6.3 V_{rms} applied through 1000 pF creates a charge input of 6300 pC_{rms}.

Table 10. Charge Gain Accuracy Limits

Range (pC)	Calibrator Output		As Found Test Limit		As Left Test Limit	
	Amplitude (V_{rms})	Frequency (Hz)	Lower Limit (pC_{rms})	Upper Limit (pC_{rms})	Lower Limit (pC_{rms})	Upper Limit (pC_{rms})
20,000	6.3	1,000	6.3 V * C_{CAL} * 0.9886	6.3 V * C_{CAL} * 1.0116	6.3 V * C_{CAL} * 0.995	6.3 V * C_{CAL} * 1.005
10,000	6.3	1,000	6.3 V * C_{CAL} * 0.9886	6.3 V * C_{CAL} * 1.0116	6.3 V * C_{CAL} * 0.995	6.3 V * C_{CAL} * 1.005
2,000	1.26	1,000	1.26 V * C_{CAL} * 0.9886	1.26 V * C_{CAL} * 1.0116	1.26 V * C_{CAL} * 0.995	1.26 V * C_{CAL} * 1.005
1,000	0.63	1,000	0.63 V * C_{CAL} * 0.9886	0.63 V * C_{CAL} * 1.0116	0.63 V * C_{CAL} * 0.995	0.63 V * C_{CAL} * 1.005

3. Create and configure an AI charge task on the device as shown in Table 11.

Table 11. Charge Gain Accuracy Verification Configuration

Configuration	Value
Physical channel	*Dev_name*/ai0
Measurement type	Charge
Range	20,000 (pC)
Acquisition mode	Finite number of samples
Sample rate	102,400
Samples per channel	102,400

4. Start the task.
5. Acquire readings with the PXIe-4480.
6. Calculate the RMS amplitude of the acquired fundamental harmonic. Compare this amplitude to the appropriate charge limits in Table 10. The calculated amplitude is used to verify the gain accuracy of the measured analog input channel at the 20,000 pC range setting.

As an example, you can use the Extract Single Tone Information VI to help calculate RMS. Note that the output of this VI is peak amplitude, and you must divide the result by √2 to convert to RMS.

7. Stop and clear the task.
8. Repeat steps 2 through 7 for each range setting of the device. When performing step 2, configure the calibrator output to the amplitude and frequency indicated for the range to be verified. When performing step 3, set the **range** parameter to 10,000; 2,000; and 1,000 as required.
9. Repeat steps 1 through 8 for all input channels of the device. In step 1, connect the output of the calibrator to the channel being verified. In step 3, replace `ai0` in the **physical channel** parameter with the channel being verified.

IEPE Current Accuracy Verification (PXIe-4480 only)

Note This performance characteristic is not affected by adjustment. Consequently, reverification after adjustment is not necessary.

Note During the IEPE verification, the Active LED on the device front panel will illuminate RED, indicating a fault condition. This is an expected condition, and the validity of the verification is unaffected. This is a result of the DMM's low resistance tripping the IEPE's short detection monitor.

Complete the following steps to verify the IEPE current accuracy:

1. Set the digital multimeter to DC Current mode and a range suitable to measure currents between 4 mA and 20 mA.
2. Using the equipment described in Table 1, connect the Current input of the digital multimeter to the analog input channel 0 of the device.
3. Create and configure an AI voltage task on the device as shown in Table 12.

Table 12. IEPE Current Accuracy Verification Configuration

Configuration	Value
Physical channel	*Dev_name*/ai0
Range	10 (V)
Coupling	AC
Terminal configuration	Pseudodifferential
Excitation (IEPE)	0.004 (A)
Acquisition mode	Finite number of samples
Sample rate	102,400
Samples per channel	10,240

4. Start the task.

5. Acquire readings with the PXIe-4480. The readings are not used; the task is simply run to set the device configuration.
6. Measure the output current on the digital multimeter.
7. Stop and clear the task.
8. Compare this value to the appropriate limit in Table 13.

Table 13. IEPE Current Accuracy Limits

IEPE Current Setting (mA)	Test Limit	
	Lower Limit (mA)	**Upper Limit (mA)**
4	4.0	4.3
10	9.7	10.3
20	19.4	20.6

9. Repeat steps 3 through 8 for each IEPE current setting of the device. When performing step 3, set the **excitation** parameter to 0.010 and 0.020 as required.
10. After the last IEPE current verification step for an input channel, turn off the current by performing steps 3 through 7 with the **excitation** parameter in step 3 set to 0. This is done to turn off the excitation prior to changing the channel configuration.
11. Repeat steps 2 through 10 for all input channels of the device. In step 2, connect the Current input of the digital multimeter to the channel being verified. In step 3, replace `ai0` in the **physical channel** parameter with the channel being verified.

Timebase Frequency Accuracy Verification

Note All analog inputs on a single device use the same timebase circuitry. Therefore, the measurements made on one channel are valid for all channels.

Complete the following steps to verify the timebase frequency accuracy:

1. Using the equipment described in Table 1 (PXIe-4480) or Table 2 (PXIe-4481), connect the output of the function generator to analog input channel 0 of the device. Connect a BNC shorting cap to the other device input channels.
2. Configure the function generator to output a sine wave of 6.3 V_{rms} (8.9 V_{pk}) signal, no offset, at a frequency of 10.000 kHz.
3. Create and configure an AI voltage task on the device as shown in Table 14.

Table 14. Timebase Frequency Accuracy Verification Configuration

Configuration	Value
Physical channel	*`Dev_name`*/ai0
Range	10 (V)

Table 14. Timebase Frequency Accuracy Verification Configuration (Continued)

Configuration	Value
Coupling	AC
Terminal configuration	Pseudodifferential
Acquisition mode	Finite number of samples
Sample rate	40,000
Samples per channel	2,560,000

4. Start the task.
5. Acquire readings with the PXIe-4480/4481.
6. Measure the frequency of the acquired signal around 10 kHz. Compare the measured frequency to the limits in Table 15.

Table 15. Timebase Frequency Accuracy Limits

Function Generator Output		As Found Test Limit		As Left Test Limit	
Amplitude (V_{rms})	Frequency (kHz)	Lower Limit (kHz)	Upper Limit (kHz)	Lower Limit (kHz)	Upper Limit (kHz)
6.3	10.000	9.99950	10.00050	9.99992	10.00008

7. Stop and clear the task.

Adjustment (PXIe-4480)

If the PXIe-4480 successfully passed each of the verification procedures within the As Left test limits *without adjustment*, then an adjustment is recommended, but not required, to warrant the published specifications for the next calibration interval. If the device was not within the As Left test limits, you can perform the adjustment procedure to improve the device accuracy and reset the calibration interval.

In order to update the calibration date without performing adjustment, see the instructions in the *Updating the Calibration Date without Performing Adjustment* section.

The external calibration interval is listed in the *PXIe-4480/4481 Specifications*. An adjustment is required at least once within this interval. Performing the adjustment procedure automatically updates the calibration constants, date, and temperature in the device EEPROM.

The following performance adjustment procedures describe the sequence of operation required to adjust the PXIe-4480.

It is possible to adjust the PXIe-4480 in either of two methods. The Minimum Time method adjusts the voltage gain of all channels in parallel, utilizing the cable connections shown in Figure 2. Alternatively, the Minimum Cabling method adjusts the voltage gain of each channel sequentially, utilizing the cable connections shown in Figure 3. Performance is not affected by the choice. The trade-off is simply between adjustment time and cabling complexity.

Note In normal measurement applications, the input configuration of the PXIe-4480 is controlled using the **range** parameter. However, during adjustment, the input configuration is controlled using the **gain** parameter. This is a result of employing an existing adjustment VI that is common across all DSA devices.

Minimum Time Method

Complete the following performance adjustment procedures to adjust the PXIe-4480 using the "minimum time" method. To view a programming block diagram that provides an overview of this adjustment procedure, go to `ni.com/info` and enter the Info Code `PXIe448x`.

Initialization

1. Call `DAQmxInitExtCal` (DAQmx Initialize External Calibration VI) to initialize the calibration, using the following parameters:

   deviceName: *`Dev_name`*

   password: `NI`

   calHandle: `&myCalHandle`

Timebase Adjustment

2. Using the equipment described in Table 1, connect the output of the function generator to device input channel 0, as shown in Figure 6. Connect a BNC shorting cap to the other device input channels.
3. Configure the function generator to output a sine wave of 6.3 V_{rms} (8.9 V_{pk}) signal, no offset, at a frequency of 90.000 kHz.
4. Call `DAQmxAdjustDSATimebaseCal` (DAQmx Adjust DSA Timebase Calibration VI) with the following parameters:

   calHandle: `myCalHandle`

   referenceFrequency: `90000.0`

Voltage Offset Adjustment

5. Using the equipment described in Table 1, connect a BNC shorting cap to each device input channel, as shown in Figure 1.
6. Call `DAQmxAdjustDSAAICalWithGainAndCoupling` (DAQmx Adjust DSA AI Calibration With Gain and Coupling VI from the DAQmx Adjust DSA AI Calibration Polymorphic VI), using the following parameters:

   calHandle: `myCalHandle`

   coupling: `DAQmx_Val_DC`

   gain: `0`

   referenceVoltage: `0.0`

Note Set the **gain** parameter to the value of the device gain setting being calibrated, where 0, for example, represents 0 dB.

7. Repeat step 6 for each of the remaining gain ranges, sequentially substituting the **gain** parameter with 6, 20, and 26.

Note All ranges must be adjusted for offset for the calibration to be valid.

Voltage Gain Adjustment

8. Using the equipment described in Table 1, connect the output of the calibrator to all of the device input channels in parallel, as shown in Figure 2.
9. Configure the calibrator to output a 6.3 V_{rms} signal at 1 kHz.
10. Call `DAQmxAdjustDSAAICalWithGainAndCoupling` (DAQmx Adjust DSA AI Calibration With Gain and Coupling VI from the DAQmx Adjust DSA AI Calibration Polymorphic VI), using the following parameters:

    calHandle: `myCalHandle`

    coupling: `DAQmx_Val_AC`

    gain: `0`

    referenceVoltage: `6.3`

Note Set the **gain** parameter to the value of the device gain setting being calibrated, where 0, for example, represents 0 dB.

11. Configure the calibrator to output a 3.15 V_{rms} signal at 1 kHz.
12. Repeat step 10 for the 6 dB gain range, substituting the **gain** parameter with 6 and the **referenceVoltage** parameter with 3.15.
13. Configure the calibrator to output a 630 mV_{rms} signal at 1 kHz.
14. Repeat step 10 for the 20 dB gain range, substituting the **gain** parameter with 20 and the **referenceVoltage** parameter with 0.63.
15. Configure the calibrator to output a 315 mV_{rms} signal at 1 kHz.
16. Repeat step 10 for the 26 dB gain range, substituting the **gain** parameter with 26 and the **referenceVoltage** parameter with 0.315.

Note All ranges must be adjusted for gain for the calibration to be valid.

Charge Gain Adjustment

Note Charge gain adjustment is optional. However, if charge adjustment is conducted on one channel, it must be conducted on all channels to be valid.

17. Using the equipment described in Table 1, connect the output of the calibrator through the calibration capacitor to device input channel 0, as shown in Figure 4.

18. Configure the calibrator to output a 6.3 V_{rms} signal at 1 kHz.
19. Call `DAQmxSetup4480Calibration` using the following parameters:

    calHandle: `myCalHandle`

    physical channels: `0`

    cal mode: `DAQmx_Val_Charge`

> **Note** Set the **physical channels** parameter to the channel of the device being calibrated, where 0, for example, represents channel 0.

20. Call `DAQmxAdjustDSAAICalWithGainAndCoupling` (DAQmx Adjust DSA AI Calibration With Gain and Coupling VI from the DAQmx Adjust DSA AI Calibration Polymorphic VI), using the following parameters:

    calHandle: `myCalHandle`

    coupling: `DAQmx_Val_AC`

    gain: `6`

    referenceVoltage: *Calculated input charge value*

    The *calculated input charge value* is the product of the value of the calibration capacitor and the calibrator output value (that is, Q = C * V). The capacitor value may be obtained from its calibration certificate or from the sticker applied to its housing body. For example, for a capacitor value of 1001 pF and a calibrator voltage of 6.3 V, the calculated input charge value in Coulombs is 6306.3e-12.
21. Repeat steps 17 through 20 for each input channel, changing the cable connections accordingly and substituting the **physical channels** parameter with the channel being calibrated.

Committal

22. Call `DAQmxCloseExtCal` (DAQmx Close External Calibration VI) with the following parameters to finish the calibration adjustment:

    calHandle: `myCalHandle`

    action: `DAQmx_Val_Action_Commit` or `DAQmx_Val_Action_Cancel`

    Use the action `cancel` if there has been any error during the calibration or if you do not want to save the new calibration constants in the device EEPROM.

    Use the action `commit` if you want to save the new calibration constants in the device EEPROM.

The device is now calibrated with respect to the external sources.

Minimum Cabling Method

Complete the following performance adjustment procedures to adjust the PXIe-4480 using the "minimum cabling" method. To view a programming block diagram that provides an overview of this adjustment procedure, go to `ni.com/info` and enter the Info Code `PXIe448x`.

Initialization

1. Call `DAQmxInitExtCal` (DAQmx Initialize External Calibration VI) to initialize the calibration, using the following parameters:

   deviceName: *`Dev_name`*

   password: `NI`

   calHandle: `&myCalHandle`

Timebase Adjustment

2. Using the equipment described in Table 1, connect the output of the function generator to device input channel 0, as shown in Figure 6. Connect a BNC shorting cap to the other device input channels.
3. Configure the function generator to output a sine wave of 6.3 V_{rms} (8.9 V_{pk}) signal, no offset, at a frequency of 90.000 kHz.
4. Call `DAQmxAdjustDSATimebaseCal` (DAQmx Adjust DSA Timebase Calibration VI) with the following parameters:

   calHandle: `myCalHandle`

   referenceFrequency: `90000.0`

Voltage Offset Adjustment

5. Using the equipment described in Table 1, connect a BNC shorting cap to each device input channel, as shown in Figure 1.
6. Call `DAQmxAdjustDSAAICalWithGainAndCoupling` (DAQmx Adjust DSA AI Calibration With Gain and Coupling VI from the DAQmx Adjust DSA AI Calibration Polymorphic VI), using the following parameters:

   calHandle: `myCalHandle`

   coupling: `DAQmx_Val_DC`

   gain: `0`

   referenceVoltage: `0.0`

   Note Set the **gain** parameter to the value of the device gain setting being calibrated, where 0, for example, represents 0 dB.

7. Repeat step 6 for each of the remaining gain ranges, sequentially substituting the **gain** parameter with 6, 20, and 26.

   Note All ranges must be adjusted for offset for the calibration to be valid.

Voltage Gain Adjustment

8. Using the equipment described in Table 1, connect the output of the calibrator to device input channel 0, as shown in Figure 3.
9. Configure the calibrator to output a 6.3 V_{rms} signal at 1 kHz.
10. Call `DAQmxSetup4480Calibration` using the following parameters:

    calHandle: `myCalHandle`

    physical channels: `0`

    cal mode: `DAQmx_Val_Voltage`

> **Note** Set the **physical channels** parameter to the channel of the device being calibrated, where 0, for example, represents channel 0.

11. Call `DAQmxAdjustDSAAICalWithGainAndCoupling` (DAQmx Adjust DSA AI Calibration With Gain and Coupling VI from the DAQmx Adjust DSA AI Calibration Polymorphic VI), using the following parameters:

    calHandle: `myCalHandle`

    coupling: `DAQmx_Val_AC`

    gain: `0`

    referenceVoltage: `6.3`

> **Note** Set the **gain** parameter to the value of the device gain setting being calibrated, where 0, for example, represents 0 dB.

12. Configure the calibrator to output a 3.15 V_{rms} signal at 1 kHz.
13. Repeat step 11 for the 6 dB gain range, substituting the **gain** parameter with 6 and the **referenceVoltage** parameter with 3.15.
14. Configure the calibrator to output a 630 mV_{rms} signal at 1 kHz.
15. Repeat step 11 for the 20 dB gain range, substituting the **gain** parameter with 20 and the **referenceVoltage** parameter with 0.63.
16. Configure the calibrator to output a 315 mV_{rms} signal at 1 kHz.
17. Repeat step 11 for the 26 dB gain range, substituting the **gain** parameter with 26 and the **referenceVoltage** parameter with 0.315.

> **Note** All ranges must be adjusted for gain for the calibration to be valid.

18. Repeat steps 8 through 17 for each input channel, changing the cable connections accordingly and substituting the **physical channels** parameter with the channel being calibrated.

> **Note** All channels must be adjusted for gain for the calibration to be valid.

Charge Gain Adjustment

Note Charge gain adjustment is optional. However, if charge adjustment is conducted on one channel, it must be conducted on all channels to be valid.

19. Using the equipment described in Table 1, connect the output of the calibrator through the calibration capacitor to device input channel 0, as shown in Figure 4.
20. Configure the calibrator to output a 6.3 V_{rms} signal at 1 kHz.
21. Call `DAQmxSetup4480Calibration` using the following parameters:

    calHandle: `myCalHandle`

    physical channels: `0`

    cal mode: `DAQmx_Val_Charge`

Note Set the **physical channels** parameter to the channel of the device being calibrated, where 0, for example, represents channel 0.

22. Call `DAQmxAdjustDSAAICalWithGainAndCoupling` (DAQmx Adjust DSA AI Calibration With Gain and Coupling VI from the DAQmx Adjust DSA AI Calibration Polymorphic VI), using the following parameters:

    calHandle: `myCalHandle`

    coupling: `DAQmx_Val_AC`

    gain: `6`

    referenceVoltage: *Calculated input charge value*

    The *calculated input charge value* is the product of the value of the calibration capacitor and the calibrator output value (that is, Q = C * V). The capacitor value may be obtained from its calibration certificate or from the sticker applied to its housing body. For example, for a capacitor value of 1001 pF and a calibrator voltage of 6.3 V, the calculated input charge value in Coulombs is 6306.3e-12.
23. Repeat steps 19 through 22 for each input channel, changing the cable connections accordingly and substituting the **physical channels** parameter with the channel being calibrated.

Committal

24. Call `DAQmxCloseExtCal` (DAQmx Close External Calibration VI) with the following parameters to finish the calibration adjustment:

    calHandle: `myCalHandle`

    action: `DAQmx_Val_Action_Commit` or `DAQmx_Val_Action_Cancel`

    Use the action `cancel` if there has been any error during the calibration or if you do not want to save the new calibration constants in the device EEPROM.

    Use the action `commit` if you want to save the new calibration constants in the device EEPROM.

The device is now calibrated with respect to the external sources.

Adjustment (PXIe-4481)

If the PXIe-4481 successfully passed each of the verification procedures within the As Left test limits *without adjustment*, then an adjustment is recommended, but not required, to warrant the published specifications for the next calibration interval. If the device was not within the As Left test limits, you can perform the adjustment procedure to improve the device accuracy and reset the calibration interval.

In order to update the calibration date without performing adjustment, see the instructions in the *Updating the Calibration Date without Performing Adjustment* section.

The external calibration interval is listed in the *PXIe-4480/4481 Specifications*. An adjustment is required at least once within this interval. Performing the adjustment procedure automatically updates the calibration constants, date, and temperature in the device EEPROM.

The following performance adjustment procedures describe the sequence of operation required to adjust the PXIe-4481.

It is possible to adjust the PXIe-4481 in either of two methods. The Minimum Time method adjusts the voltage gain of all channels in parallel, utilizing the cable connections shown in Figure 2. Alternatively, the Minimum Cabling method adjusts the voltage gain of each channel sequentially, utilizing the cable connections shown in Figure 3. Performance is not affected by the choice. The trade-off is simply between adjustment time and cabling complexity.

Note In normal measurement applications, the input configuration of the PXIe-4481 is controlled using the **range** parameter. However, during adjustment, the input configuration is controlled using the **gain** parameter. This is a result of employing an existing adjustment VI that is common across all DSA devices.

Minimum Time Method

Complete the following performance adjustment procedures to adjust the PXIe-4481 using the "minimum time" method. To view a programming block diagram that provides an overview of this adjustment procedure, go to `ni.com/info` and enter the Info Code `PXIe448x`.

Initialization

1. Call `DAQmxInitExtCal` (DAQmx Initialize External Calibration VI) to initialize the calibration, using the following parameters:

   deviceName: *`Dev_name`*

   password: `NI`

   calHandle: `&myCalHandle`

Timebase Adjustment

2. Using the equipment described in Table 2, connect the output of the function generator to device input channel 0, as shown in Figure 6. Connect a BNC shorting cap to the other device input channels.
3. Configure the function generator to output a sine wave of 6.3 V_{rms} (8.9 V_{pk}) signal, no offset, at a frequency of 90.000 kHz.
4. Call `DAQmxAdjustDSATimebaseCal` (DAQmx Adjust DSA Timebase Calibration VI) with the following parameters:

   calHandle: `myCalHandle`

   referenceFrequency: `90000.0`

Voltage Offset Adjustment

5. Using the equipment described in Table 2, connect a BNC shorting cap to each device input channel, as shown in Figure 1.
6. Call `DAQmxAdjustDSAAICalWithGainAndCoupling` (DAQmx Adjust DSA AI Calibration With Gain and Coupling VI from the DAQmx Adjust DSA AI Calibration Polymorphic VI), using the following parameters:

   calHandle: `myCalHandle`

   coupling: `DAQmx_Val_DC`

   gain: `0`

   referenceVoltage: `0.0`

Note Set the **gain** parameter to the value of the device gain setting being calibrated, where 0, for example, represents 0 dB.

7. Repeat step 6 for each of the remaining gain ranges, sequentially substituting the **gain** parameter with 6, 20, and 26.

Note All ranges must be adjusted for offset for the calibration to be valid.

Voltage Gain Adjustment

8. Using the equipment described in Table 2, connect the output of the calibrator to all of the device input channels in parallel, as shown in Figure 2.
9. Configure the calibrator to output a 6.3 V_{rms} signal at 1 kHz.
10. Call `DAQmxAdjustDSAAICalWithGainAndCoupling` (DAQmx Adjust DSA AI Calibration With Gain and Coupling VI from the DAQmx Adjust DSA AI Calibration Polymorphic VI), using the following parameters:

    calHandle: `myCalHandle`

    coupling: `DAQmx_Val_AC`

    gain: `0`

    referenceVoltage: `6.3`

Note Set the **gain** parameter to the value of the device gain setting being calibrated, where 0, for example, represents 0 dB.

11. Configure the calibrator to output a 3.15 V_{rms} signal at 1 kHz.
12. Repeat step 10 for the 6 dB gain range, substituting the **gain** parameter with 6 and the **referenceVoltage** parameter with 3.15.
13. Configure the calibrator to output a 630 mV_{rms} signal at 1 kHz.
14. Repeat step 10 for the 20 dB gain range, substituting the **gain** parameter with 20 and the **referenceVoltage** parameter with 0.63.
15. Configure the calibrator to output a 315 mV_{rms} signal at 1 kHz.
16. Repeat step 10 for the 26 dB gain range, substituting the **gain** parameter with 26 and the **referenceVoltage** parameter with 0.315.

Note All ranges must be adjusted for gain for the calibration to be valid.

Committal

17. Call `DAQmxCloseExtCal` (DAQmx Close External Calibration VI) with the following parameters to finish the calibration adjustment:

    calHandle: `myCalHandle`

    action: `DAQmx_Val_Action_Commit` or `DAQmx_Val_Action_Cancel`

    Use the action `cancel` if there has been any error during the calibration or if you do not want to save the new calibration constants in the device EEPROM.

    Use the action `commit` if you want to save the new calibration constants in the device EEPROM.

The device is now calibrated with respect to the external sources.

Minimum Cabling Method

Complete the following performance adjustment procedures to adjust the PXIe-4481 using the "minimum cabling" method. To view a programming block diagram that provides an overview of this adjustment procedure, go to `ni.com/info` and enter the Info Code `PXIe448x`.

Initialization

1. Call `DAQmxInitExtCal` (DAQmx Initialize External Calibration VI) to initialize the calibration, using the following parameters:

    deviceName: *`Dev_name`*

    password: `NI`

    calHandle: `&myCalHandle`

Timebase Adjustment

2. Using the equipment described in Table 2, connect the output of the function generator to device input channel 0, as shown in Figure 6. Connect a BNC shorting cap to the other device input channels.
3. Configure the function generator to output a sine wave of 6.3 V_{rms} (8.9 V_{pk}) signal, no offset, at a frequency of 90.000 kHz.
4. Call `DAQmxAdjustDSATimebaseCal` (DAQmx Adjust DSA Timebase Calibration VI) with the following parameters:

   calHandle: `myCalHandle`

   referenceFrequency: `90000.0`

Voltage Offset Adjustment

5. Using the equipment described in Table 2, connect a BNC shorting cap to each device input channel, as shown in Figure 1.
6. Call `DAQmxAdjustDSAAICalWithGainAndCoupling` (DAQmx Adjust DSA AI Calibration With Gain and Coupling VI from the DAQmx Adjust DSA AI Calibration Polymorphic VI), using the following parameters:

   calHandle: `myCalHandle`

   coupling: `DAQmx_Val_DC`

   gain: `0`

   referenceVoltage: `0.0`

Note Set the **gain** parameter to the value of the device gain setting being calibrated, where 0, for example, represents 0 dB.

7. Repeat step 6 for each of the remaining gain ranges, sequentially substituting the **gain** parameter with 6, 20, and 26.

Note All ranges must be adjusted for offset for the calibration to be valid.

Voltage Gain Adjustment

8. Using the equipment described in Table 2, connect the output of the calibrator to device input channel 0, as shown in Figure 3.
9. Configure the calibrator to output a 6.3 V_{rms} signal at 1 kHz.
10. Call `DAQmxSetup4480Calibration` using the following parameters:

    calHandle: `myCalHandle`

    physical channels: `0`

    cal mode: `DAQmx_Val_Voltage`

Note Set the **physical channels** parameter to the channel of the device being calibrated, where 0, for example, represents channel 0.

11. Call `DAQmxAdjustDSAAICalWithGainAndCoupling` (DAQmx Adjust DSA AI Calibration With Gain and Coupling VI from the DAQmx Adjust DSA AI Calibration Polymorphic VI), using the following parameters:

    calHandle: `myCalHandle`

    coupling: `DAQmx_Val_AC`

    gain: `0`

    referenceVoltage: `6.3`

> **Note** Set the **gain** parameter to the value of the device gain setting being calibrated, where 0, for example, represents 0 dB.

12. Configure the calibrator to output a 3.15 V_{rms} signal at 1 kHz.
13. Repeat step 11 for the 6 dB gain range, substituting the **gain** parameter with 6 and the **referenceVoltage** parameter with 3.15.
14. Configure the calibrator to output a 630 mV_{rms} signal at 1 kHz.
15. Repeat step 11 for the 20 dB gain range, substituting the **gain** parameter with 20 and the **referenceVoltage** parameter with 0.63.
16. Configure the calibrator to output a 315 mV_{rms} signal at 1 kHz.
17. Repeat step 11 for the 26 dB gain range, substituting the **gain** parameter with 26 and the **referenceVoltage** parameter with 0.315.

> **Note** All ranges must be adjusted for gain for the calibration to be valid.

18. Repeat steps 8 through 17 for each input channel, changing the cable connections accordingly and substituting the **physical channels** parameter with the channel being calibrated.

> **Note** All channels must be adjusted for gain for the calibration to be valid.

Committal

19. Call `DAQmxCloseExtCal` (DAQmx Close External Calibration VI) with the following parameters to finish the calibration adjustment:

    calHandle: `myCalHandle`

    action: `DAQmx_Val_Action_Commit` or `DAQmx_Val_Action_Cancel`

    Use the action `cancel` if there has been any error during the calibration or if you do not want to save the new calibration constants in the device EEPROM.

    Use the action `commit` if you want to save the new calibration constants in the device EEPROM.

The device is now calibrated with respect to the external sources.

Reverification

After completing the adjustment procedure, repeat the *Verification* section to determine the As Left status of the device. Some, but not all, performance characteristics are affected by adjustment and would be subject to reverification after adjustment. Characteristics affected by adjustment have As Left test limits in addition to As Found test limits. Characteristics unaffected by adjustment solely have test limits with no additional qualification.

Note If any test fails reverification after performing an adjustment, verify that you have met the *Test Conditions* before returning your device to NI. Refer to *Where to Go for Support* for assistance in returning the device to NI.

Updating the Calibration Date without Performing Adjustment

You can update the calibration date without performing the adjustment procedure. This might be appropriate if the PXIe-4480/4481 successfully passed each of the verification procedures within the As Left test limits *without adjustment*. Complete the following steps to update the calibration date:

1. Open a calibration session using the DAQmx Initialize External Calibration VI with the following parameters:
   - **deviceName**: `Dev_name`
   - **password**: `NI`
   - **calHandle**: `&myCalHandle`
2. Close the session with the DAQmx Close External Calibration VI with the following parameters:
   - **calHandle**: `myCalHandle`
   - **action**: `DAQmx_Val_Action_Commit`

Specifications

Refer to the *PXIe-4480/4481 Specifications* for calibration intervals and detailed specification information.

Where to Go for Support

The National Instruments 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.

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