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**PXIe-4610**

# CALIBRATION PROCEDURE

# NI PXIe-4610

## Power Amplifier

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[ni.com/manuals](http://ni.com/manuals)

This document contains the verification procedures for the National Instruments PXIe-4610. For more information about calibration solutions, visit [ni.com/calibration](http://ni.com/calibration).

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## Software

NI-DAQmx 9.8 added support for the NI PXIe-4610. Ensure the version of NI-DAQmx on the calibration system supports the NI PXIe-4610. You can download NI-DAQmx from [ni.com/downloads](http://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.

# Documentation

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Consult the following documents for information about the NI PXIe-4610, NI-DAQmx, and your application software. All documents are available on [ni.com](http://ni.com) and help files install with the software.



## *NI PXIe-4610 Getting Started Guide*

NI-DAQmx installation and hardware setup.



## *NI PXIe-4610 Specifications*

NI PXIe-4610 specifications and calibration interval.



## *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 procedures. If the recommended equipment is not available, select a substitute using the requirements listed in Table 1.

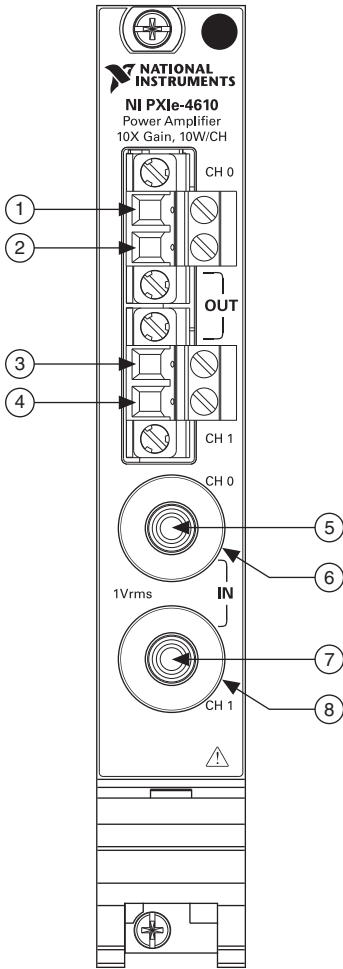
**Table 1.** Recommended Equipment

Equipment	Recommended Models	Where Used	Requirements
DMM	NI PXI-4070	Gain and Residual Offset Verification	If this instrument is unavailable, use a digitizer capable of measuring $\pm 10 V_{pk}$ sine waves at 1 kHz with an amplitude uncertainty of 0.1 dB or less, a linearity error of 100 ppm or less and an offset measurement uncertainty of 100 $\mu V$ or less.
Function Generator	NI PXI-4461	Gain and Residual Offset Verification	If this instrument is unavailable, use a function generator capable of sourcing $\pm 1.0 V_{pk}$ sine waves at 1 kHz with an amplitude uncertainty of 0.1 dB or less and a frequency uncertainty of 1% or less.
PXI Express Chassis	NI PXIe-1062Q	—	—

# Connecting the NI PXIe-4610

The NI PXIe-4610 provides connections for 2 channels. Refer to Figure 1 for the connection pinout.

Figure 1. NI PXIe-4610 Pinout



1	OUT CH0+	3	OUT CH1+	5	IN CH0+	7	IN CH1+
2	OUT CH0-	4	OUT CH1 -	6	IN CH0-	8	IN CH1-

# Test Conditions

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The following setup and environmental conditions are required to ensure the NI PXIe-4610 meets published specifications.

- Keep connections to the NI PXIe-4610 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 NI PXIe-4610 are secure.
- Use 50  $\Omega$  BNC coaxial cables for all connections to the NI PXIe-4610 inputs.
- Maintain an ambient temperature of  $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ . The NI PXIe-4610 temperature will be greater than the ambient temperature.
- Keep relative humidity below 90%.
- Allow a warm-up time of at least 15 minutes to ensure that the NI PXIe-4610 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.
- Ensure that the PXI/PXI Express chassis fan speed is set to High, that the fan filters are clean, and that the empty slots contain filler panels. For more information, refer to the *Maintain Forced-Air Cooling Note to Users* document available at [ni.com/manuals](http://ni.com/manuals).

## Initial Setup

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Refer to the *NI PXIe-4610 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 with MAX, it is assigned a device identifier. Each function call uses this identifier to determine which DAQ device to verify or, verify and adjust.

## Verification

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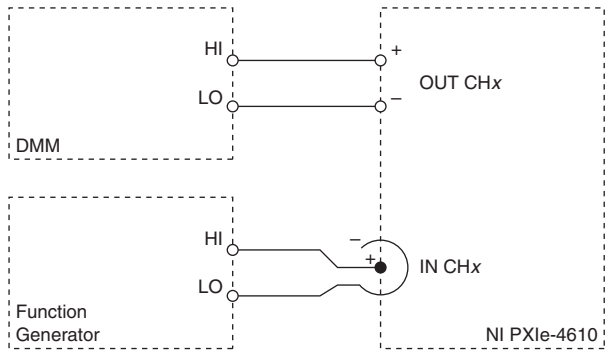
The following performance verification procedures describe the sequence of operations and provide test points required to verify the NI PXIe-4610. The verification procedures assume that adequate traceable uncertainties are available for the calibration references.

# Gain and Residual Offset Verification

Complete the following procedure to verify the gain accuracy and residual offset of the NI PXIe-4610:

1. Connect the NI PXIe-4610 channel to be verified as shown in Figure 2.

**Figure 2.** Gain and Residual Offset Verification Connections



2. Configure the function generator as shown in Table 2.

**Table 2.** Function Generator Configuration for Gain and Residual Offset Verification

Signal Type	Amplitude	Frequency
Sine Wave	0.9 V <sub>pk</sub>	1 kHz

3. Enable the function generator.
4. Enable the NI PXIe-4610 outputs. Additional information about enabling the outputs is available in the *NI PXIe-4610 Getting Started Guide*.
5. Allow at least 10 s for the input AC Coupling filter to fully settle.

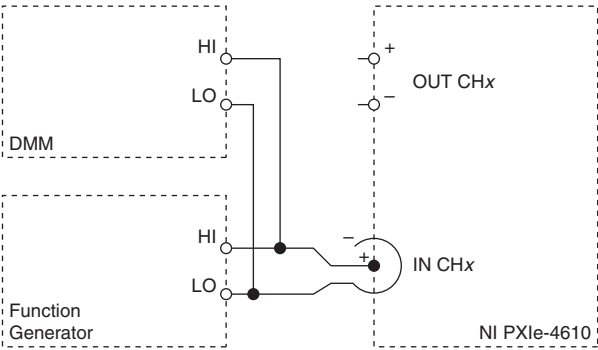
6. Configure the DMM in digitizer mode as shown in Table 3.

**Table 3.** DMM Configuration for Gain and Residual Offset Verification

Configuration	Value
Measurement	Voltage
Range	10 V
Waveform Coupling	DC
Acquisition Mode	Waveform
Acquisition Rate	1.8 MS/s
Samples to Acquire	180,000

7. Acquire samples using the DMM.
8. Calculate the amplitude of the acquired signal and record as *Amplitude<sub>OUT</sub>*. NI recommends using the Extract Single Tone Information VI to calculate the amplitude.
9. Calculate the residual offset of the acquired signal and record as *ResidualOffset*. NI recommends using the Extract Single Tone VI to export the residual signal. The residual offset is the average of the residual signal.
10. Connect the DMM as shown in Figure 3.

**Figure 3.** DMM Connections



11. Repeat steps 7 and 8, and record the amplitude of the acquired waveform as *Amplitude<sub>IN</sub>*.
12. Perform the following calculation using the recorded *Amplitude<sub>OUT</sub>* from step 8 and *Amplitude<sub>IN</sub>* values for step 11.

$$UnadjustedGain = \frac{Amplitude_{OUT}}{Amplitude_{IN}}$$



13. Convert the unadjusted gain to decibels.

$$UnadjustedGain\ (dB) = 20 \cdot \log (UnadjustedGain)$$

14. Disable the NI PXIe-4610 outputs.

15. Disable the function generator.

16. Read the gain constant of the channel being verified with the AO.PowerAmp.Gain DAQmx property and convert the gain to decibels.

$$CalibrationGain\ (dB) = 20 \cdot \log (GainEEPROM)$$

17. Perform the following calculation using the *UnadjustedGain (dB)* calculated in step 13 and the *CalibrationGain (dB)* calculated in step 16, and record the result as *AdjustedGain (dB)*.

$$AdjustedGain\ (dB) = 20\ dB + (UnadjustedGain\ (dB) - CalibrationGain\ (dB))$$

18. Repeat steps 1 through 17 for each channel.

19. Compare the recorded *UnadjustedGain (dB)* and *AdjustedGain (dB)* of each channel to the limits in Table 4.

**Table 4.** NI PXIe-4610 2-Year Verification Test Limits for Gain

Input Signal Source	Lower Limit (dB)	Upper Limit (dB)
Unadjusted	19.969	20.031
Adjusted*	19.989	20.011
*Input signal source gain adjusted using the gain calibration constant stored in the EEPROM.		



**Note** The test limits listed are derived using the values in Table 7.

20. Compare the recorded residual offset for each channel to the limits in Table 5.

**Table 5.** NI PXIe-4610 2-Year Verification Test Limits for Residual Offset

Lower Limit (mV)	Upper Limit (mV)
-1	+1



**Note** The test limits listed are derived using the values in Table 8.

If the NI PXIe-4610 is outside the limits found in Tables 4 and 5, refer to [World Wide Support and Services](#) for assistance in returning the device to NI.

# EEPROM Update

After completing a verification procedure, complete the following steps:

1. Open a calibration session for the NI PXIe-4610. The default password is `NI`.
2. Store the calibration temperature.
  - a. Record the ambient temperature.
  - b. Call the DAQmx Set Temperature DSA Calibration function to store the calibration temperature measured in step a.
3. Store the calibration constants.
  - a. Perform steps 1 through 9 of the [Gain and Residual Offset Verification](#) section to calculate the *ResidualOffset* of each channel for which you want to update the offset calibration constant.
  - b. Continue with steps 10 through 12 of the [Gain and Residual Offset Verification](#) section to calculate the *UnadjustedGain* of each channel for which you want to update the gain calibration constant.
  - c. Call the DAQmx Adjust DSA Power Amplifier Calibration function for the NI PXIe-4610 and configure it as shown in Table 6.

**Table 6.** DAQmx Adjust DSA Power Amplifier Calibration Configuration

Physical Channel	Gain	Offset
Dev1/chx	The value obtained from step a.	The value obtained from step b.

- d. Repeat steps a through c for each channel for which you want to store a calibration constant.
4. Close the calibration session.

## Accuracy Under Calibration Conditions

The following calibration specifications are valid for the following conditions:

- Ambient temperature is  $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ .
- PXI Express chassis fan speed is set to HIGH and has clean fan filters.
- Empty slots have filler panels installed.



**Note** The test limits listed in Table 4 and 5 are derived using the values in Table 6 and 7, respectively.

**Table 7.** NI PXIe-4610 Gain Accuracy Under Calibration Conditions

Input Signal Source	Gain Accuracy ( $\pm$ dB)
Unadjusted	0.031
Adjusted*	0.011
*Input signal source gain adjusted using the gain calibration constant stored in the EEPROM.	

**Table 8.** NI PXIe-4610 Residual Offset Under Calibration Conditions

Residual Offset
$\pm 1$ mV



**Note** For operational specifications, refer to the most recent *NI PXIe-4610 Specifications* document at [ni.com/manuals](http://ni.com/manuals).

## World Wide Support and Services

The National Instruments website is your complete resource for technical support. At [ni.com/support](http://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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