

COMPREHENSIVE SERVICES

We offer competitive repair and calibration services, as well as easily accessible documentation and free downloadable resources.

SELL YOUR SURPLUS

We buy new, used, decommissioned, and surplus parts from every NI series. We work out the best solution to suit your individual needs.

 Sell For Cash  Get Credit  Receive a Trade-In Deal

OBSOLETE NI HARDWARE IN STOCK & READY TO SHIP

We stock **New**, **New Surplus**, **Refurbished**, and **Reconditioned** NI Hardware.



Bridging the gap between the manufacturer and your legacy test system.

 1-800-915-6216

 www.apexwaves.com

 sales@apexwaves.com

All trademarks, brands, and brand names are the property of their respective owners.

Request a Quote

 **CLICK HERE**

PXIe-4339

CALIBRATION PROCEDURE

NI PXI-4220

This document contains the information and instructions needed to calibrate the NI PXI-4220.

You should calibrate the NI PXI-4220 at a regular interval as defined by the measurement accuracy requirements of your application. NI recommends that you perform a complete calibration at least once every year. Based on your measurement accuracy needs, you can shorten this interval to 90 days or six months.

NI recommends verifying the operation of NI PXI-4220 prior to high accuracy applications. This document contains the NI PXI-4220 accuracy verification and adjustment procedure.

Conventions

The following conventions appear in this document:

»

The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.



This icon denotes a note, which alerts you to important information.

bold

Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names and hardware labels.

italic

Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. Italic text also denotes text that is a placeholder for a word or value that you must supply.

`monospace`

Monospace text denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories,

programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions.

monospace bold

Bold text in this font denotes the messages and responses that the computer automatically prints to the screen. This font also emphasizes lines of code that are different from the other examples.

monospace italic

Italic text in this font denotes text that is a placeholder for a word or value that you must supply.

Software

Calibration requires the latest version of NI-DAQmx, which includes high-level function calls to simplify the task of writing software to calibrate devices. NI-DAQmx supports many programming languages, including LabVIEW, LabWindows™/CVI™, Microsoft Visual C++, Microsoft Visual Basic, and Borland C++.

Documentation

The following documents are your primary references for writing your calibration utility:

- The *NI-DAQmx C Reference Help* includes information about the functions in NI-DAQmx.
- The *DAQ Getting Started Guide* provides instructions for installing and configuring NI-DAQ devices.
- The *SCXI Quick Start Guide* includes information for installing and configuring the SCXI-1600.
- The *NI-DAQmx Help* includes information about creating applications that use NI-DAQmx.

You can add these help files when you install NI-DAQmx. After adding these help files, you can access them by selecting **Start»Programs»National Instruments NI-DAQ»NI-DAQmx Help**. The documents provide instructions on installing and configuring DAQ devices. The documents also include detailed information on creating applications that use NI-DAQmx. These are your primary references for writing your calibration utility. For more information on the NI PXI-4220, refer to the *NI PXI-4220 User Manual*.

Test Equipment

Calibration calls for a high-precision voltage source with at least 50 ppm accuracy, a multiranging 5 1/2 digit digital multimeter (DMM) with 15 ppm accuracy. With the preceding conditions met, you can achieve proper calibration.

NI recommends the following instruments for calibrating the NI PXI-4220:

- Calibrator—Fluke 5700A.
- DMM—NI 4070 or Agilent 34401A.

If these instruments are not available, use the accuracy requirements listed above to select a substitute calibration standard.



Note A suitable 9-pin D-SUB adapter is recommended for connecting external signals to the analog ports. The input connections on both channels are discussed in this document and are shown in Figure 2.

Test Conditions

Follow these guidelines to optimize the connections and the environment during calibration. Following these guidelines helps ensure accurate calibration result:

- Keep connections to the PXI module short. Long cables and wires act as antennae, picking up extra noise and thermal offsets that can affect measurements.
- Use shielded copper wire for all cable connections to the NI PXI-4220. Use twisted-pair wire to reduce noise.
- Maintain the temperature between 18 and 28 °C.
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 15 minutes for the NI PXI-4220 to ensure that the measurement circuitry is at a stable operating temperature.

PXI-4220 Pinouts

Figure 1 shows the front label of the NI PXI-4220.

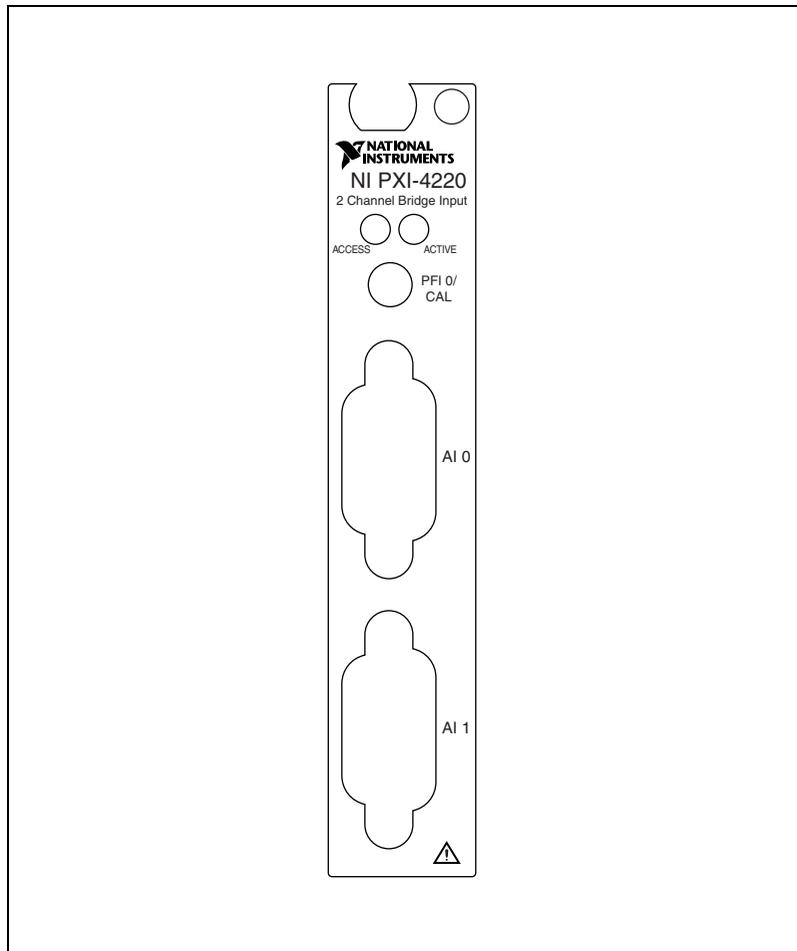


Figure 1. Front Label

Figure 2 shows the NI PXI-4220 front connectors.

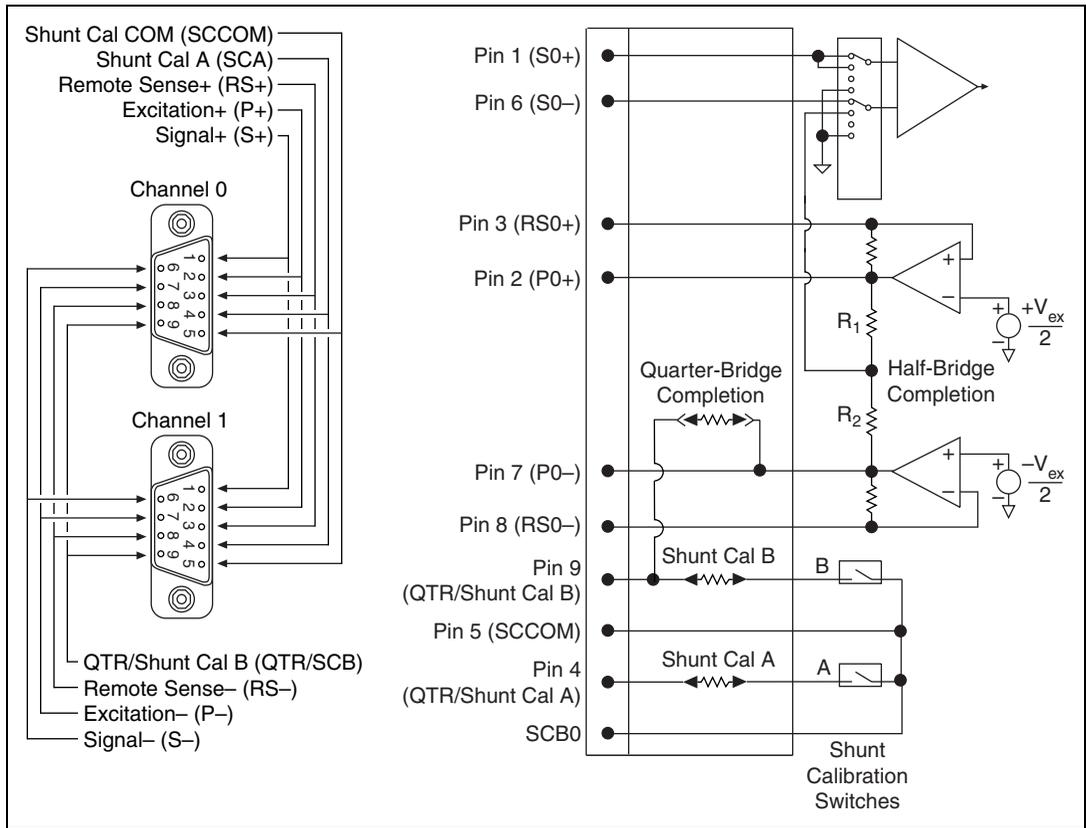


Figure 2. Front Connections

Calibration Process



Note The calibration procedure is for an NI PXI-4220 installed in PXI chassis using an external calibrator and DMM. The procedure is similar for other system configurations.

The steps used in the calibration process are as follows:

1. Setting up the NI PXI-4220 for testing.
2. Verifying the existing operation of the NI PXI-4220 to determine whether it is operating within its specifications.
3. Adjusting the offset and gain errors using a known external voltage source.
4. Verifying that the NI PXI-4220 is operating within its specifications after adjustments.

Setting up the NI PXI-4220 for Verification

Complete the following steps, while referring to Figures 3 and 4, to set up the NI PXI-4220 for testing.

1. Make sure all components involved in the calibration procedure are powered-off.
2. Connect an SMB cable to the PFI 0/CAL port.
3. Connect pins S+ and S– of the channel you want to verify to the calibrator output. See Figure 2 for pin layout. If the calibration signal is floating, connect S– to chassis ground.
4. Connect pins P+ and P– of the channel you want to verify to a DMM to verify the excitation voltage.
5. Power on the PXI Chassis and then the external computer if using one.
6. Make sure that all the appropriate driver and application software is installed.
7. Confirm that the hardware is properly configured with Measurement & Automation Explorer (MAX). For more information on configuring the system, refer to the documentation for the NI PXI-4220 module.

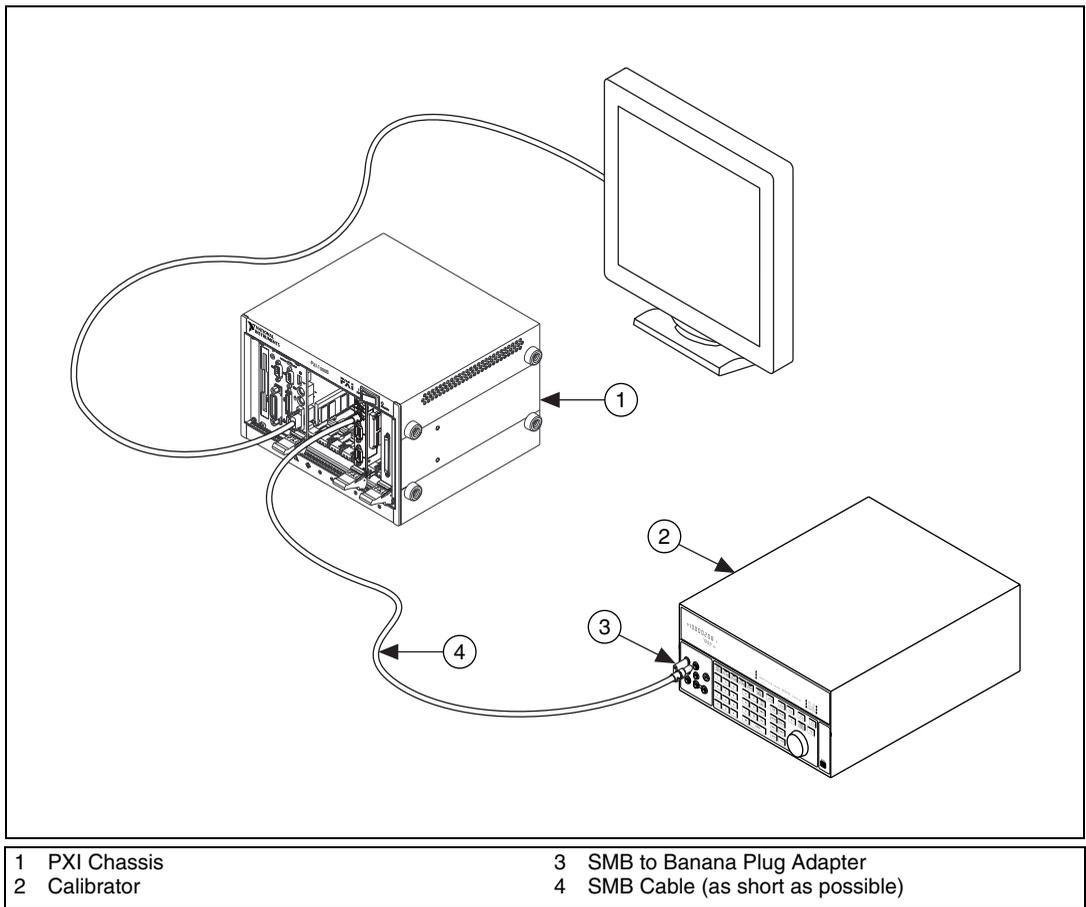


Figure 3. Typical NI PXI-4220 Setup for MIO Baseboard Calibration

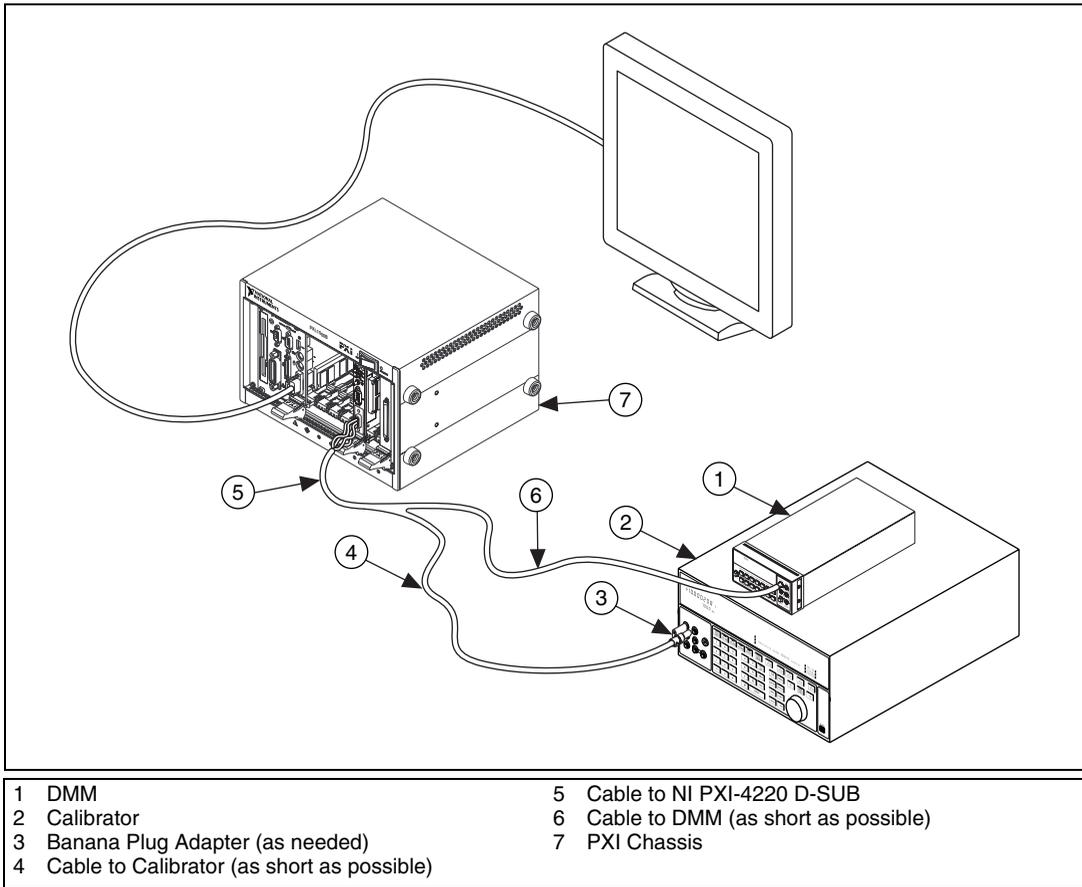


Figure 4. Typical NI PXI-4220 Setup for Signal Conditioning Component Verification and Calibration

8. In the functions used for demonstrating the following calibration process, use the device ID *dev1*. To verify that the device is properly named, complete the following steps:
 - a. Open MAX.
 - b. Expand **Devices and Interfaces»NI-DAQmx Devices** in the *Configuration* window.¹⁶
 - c. Verify that the NI PXI-4220 is named *dev1*. If it is not, right-click the device to rename it. Refer to the MAX documentation for instructions.

Verifying Gain and Offset Errors

The verification procedure determines how well the NI PXI-4220 module is meeting its specifications. You can use this information to select the appropriate calibration interval for your application.

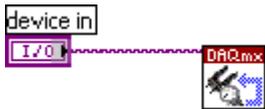
The NI PXI-4220 stores gain calibration constants for each gain setting per analog input channel in addition to an offset constant for each channel. A complete verification of the inputs involves measuring the accuracy at all possible gain settings on both channels of the NI PXI-4220.

You can find all VIs in LabVIEW using the search tool in the palette.

Complete the following steps to verify gain and offset errors of the NI PXI-4220 analog inputs.

1. Read the *Test Conditions* section.
2. Refer to the specifications in Table 19 for test-point limits.
3. Ensure that no external signals are connected to the NI PXI-4220.
4. Run the *Self-Calibrate (DAQmx Self Calibrate VI)* function before doing the first verification. This function measures the onboard reference voltage of the NI PXI-4220 and adjusts the PXI-4220 baseboard calibration constants to account for any errors caused by short-term fluctuations in the operating environment.

Table 1. Self Calibration of the NI PXI-4220

NI-DAQ Function Call	LabVIEW Block Diagram
Call <code>DAQmxSelfCal</code> with the following parameters: Device_Name: dev1	 <p>The diagram shows a 'device in' block with a terminal labeled 'I/O' connected to the 'DAQmx Self Calibrate' block. The 'DAQmx Self Calibrate' block is represented by a red icon with a blue and white pattern.</p>

5. Connect your calibrator to the appropriate analog input, starting with channel 0 at pins S+ and S– inputs. See Figure 2 for pin connections. If the source is not ground referenced, reference it by connecting the S– to the PXI chassis.
6. Set the calibrator voltage to the desired test point indicated in Table 19.

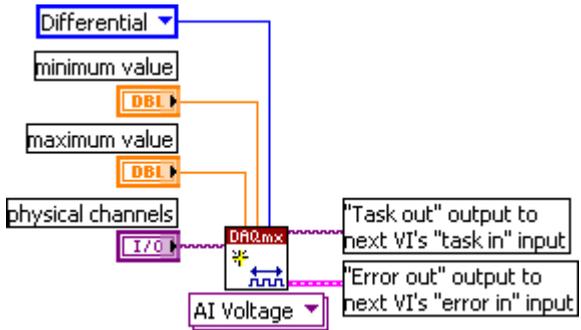
7. Create a task using DAQmxCreateTask.

Table 2. DAQmx Create Task

NI-DAQ Function Call	LabVIEW Block Diagram
Call DAQmxCreateTask with the following parameters: taskName: "AIVerificationTask" taskHandle: &taskHandle	LabVIEW does not require this step.

8. Add a channel to the task using DAQmxCreateAIVoltageChan (DAQmx Create Virtual Channel VI) and configure the channel.

Table 3. Add a Channel to the Task

NI-DAQ Function Call	LabVIEW Block Diagram
Call DAQmxCreateAIVoltageChan with the following parameters: taskHandle: taskHandle physicalChannel: "dev1/ai0" nameToAssignToChannel: "myVoltageChannel" terminalConfig: DAQmx_Val_Cfg_Default minVal: -10.0 maxVal: 10.0 units: DAQmx_Val_Volts customScaleName: " "	 <p>The LabVIEW block diagram shows the configuration of the DAQmx Create Virtual Channel VI. The 'terminalConfig' dropdown is set to 'Differential'. The 'minimum value' and 'maximum value' controls are set to -10.0 and 10.0, respectively, with 'DBL' (Double) data type indicators. The 'physical channels' control is set to 'AI Voltage'. The 'Task out' output is connected to the 'task in' input of the next VI, and the 'Error out' output is connected to the 'error in' input of the next VI.</p>

9. Configure the DAQmx Channel Properties by setting the Gain control.

Table 4. Gain Control and Lowpass Filtering

NI-DAQ Function Call	LabVIEW Block Diagram
<p>Call DAQmxSetAIGain with the following parameters:</p> <p>taskHandle: taskHandle</p> <p>Channel: " "</p> <p>Data: (float64 gain value for particular test-point)</p>	



Note You must acquire three test points per gain setting, as listed in Table 19, to properly verify the NI PXI-4220 at any particular gain setting.

10. Configure timing for the voltage acquisition using DAQmxCfgSampClkTiming (**DAQmx Timing VI**). Set the samples per channel to 1000 at a sample rate of 1000.

Table 5. Configure Timing for the Voltage Acquisition

NI-DAQ Function Call	LabVIEW Block Diagram
<p>Call DAQmxCfgSampClkTiming with the following parameters:</p> <p>taskHandle: taskHandle</p> <p>source: " "</p> <p>rate: 1000.0</p> <p>activeEdge: DAQmx_Val_Rising</p> <p>sampleMode: DAQmx_Val_FiniteSamps</p> <p>sampsPerChan: 1000</p>	

- Start the acquisition using DAQmxStartTask (DAQmx Start Task VI).

Table 6. Start the Acquisition

NI-DAQ Function Call	LabVIEW Block Diagram
Call DAQmxStartTask with the following parameter: taskHandle: taskHandle	

- Acquire 1000 points of voltage data using DAQmxReadAnalogF64 (DAQmx Read VI).

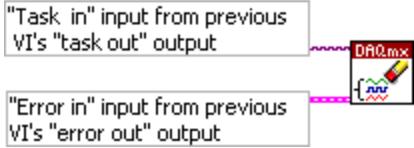
Table 7. DAQmx Read Analog

NI-DAQ Function Call	LabVIEW Block Diagram
Call DAQmxReadAnalogF64 with the following parameters: taskHandle: taskHandle numSampsPerChan: -1 timeout: 10.0 fillMode: DAQmx_Val_GroupByChannel readArray: data arraySizeInSamples: 1000 sampsPerChanRead: &read reserved: NULL	

- Average the voltage values that you acquired.
- Compare the resulting average to the upper and lower limits listed in Table 19. If the result is between these values, the module passes the test.

- Clear the acquisition using DAQmxClearTask (DAQmx Clear Task VI).

Table 8. Clear the Acquisition

NI-DAQ Function Call	LabVIEW Block Diagram
Call DAQmxClearTask with the following parameter: taskHandle: taskHandle	

- Repeat steps 6 through 15 for all test points in Table 19.
- Repeat steps 5 through 16 for the remaining channel.
- Disconnect the calibrator from the NI PXI-4220.

You have finished verifying the analog input accuracy of the module.

Verifying Voltage Excitation

This section describes how to verify the voltage excitation of the NI PXI-4220. If the measured values of the excitation fall outside the limits given in Table 20, the module is not operating within specifications. Return it to NI for repair. For more information about how to contact NI for repair, refer to the *Technical Support Information* document.

Complete the following steps to verify the voltage excitation of the two NI PXI-4220 channels.

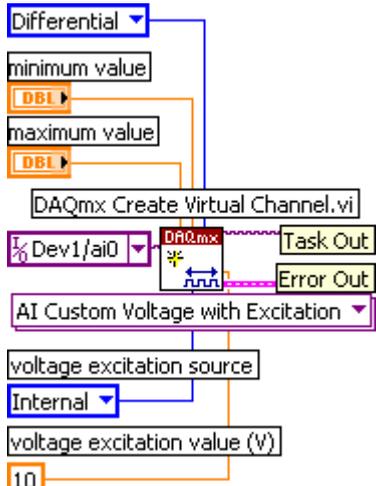
- Read the *Test Conditions* section.
- Review *Setting up the NI PXI-4220 for Verification* for hardware configuration.
- Connect the DMM to the appropriate excitation output terminals P+ and P– of the channel you want to verify. Refer to *Setting up the NI PXI-4220 for Verification* to determine pin locations.
- Create a task using DAQmxCreateTask.

Table 9. DAQmx Create Task

NIDAQ Function Call	LabVIEW Block Diagram
Call DAQmxCreateTask with the following parameters: taskName: "AIVerificationTask" taskHandle: &taskHandle	LabVIEW does not require this step.

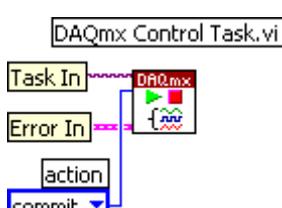
5. Add a channel to the task using `DAQmxCreateAIVoltageChanWithExcit` (**DAQmx Create Virtual Channel VI**) and configure the channel. In LabVIEW you must change the polymorphic VI **Analog Input»More»Custom Voltage with Excitation**. Set the excitation voltage using the parameters in Table 10.

Table 10. Create Voltage Channel

NI-DAQ Function Call	LabVIEW Block Diagram
<p>Call <code>DAQmxCreateAIVoltageChanWithExcit</code> with the following parameters:</p> <p>taskHandle: <code>taskHandle</code></p> <p>physicalChannel: <code>"dev1/ai0"</code></p> <p>nameToAssignToChannel: <code>"myVoltageChannel"</code></p> <p>terminalConfig: <code>DAQmx_Val_Cfg_Default</code></p> <p>minVal: <code>-10.0</code></p> <p>maxVal: <code>10.0</code></p> <p>units: <code>DAQmx_Val_Volts</code></p> <p>bridgeConfiguration: <code>DAQmx_Val_NoBridge</code></p> <p>voltageExcitationSources: <code>DAQmx_Val_Internal</code></p> <p>voltageExcitationValue: (voltage excitation values are listed in Table 20, float 64 value)</p> <p>useExcitationforScaling?: <code>0</code></p> <p>customScaleName: <code>" "</code></p>	 <p>The LabVIEW block diagram shows the configuration of a virtual channel. It starts with a 'DAQmx Create Virtual Channel.vi' block. The 'physical channel' is set to 'Dev1/ai0'. The 'terminal configuration' is set to 'Differential'. The 'minimum value' is set to -10.0 and the 'maximum value' is set to 10.0, both using 'DBL' (double) data types. The 'voltage excitation source' is set to 'Internal' and the 'voltage excitation value (V)' is set to 10. The block has 'Task Out' and 'Error Out' terminals. Below this, an 'AI Custom Voltage with Excitation' block is shown, which is a polymorphic VI that has been configured to use the 'Internal' excitation source and a value of 10.0 V.</p>

6. Stop and commit the task using `DAQmxTaskControl` (**DAQmx Control Task**).

Table 11. Task Control

NI-DAQ Function Call	LabVIEW Block Diagram
<p>Call <code>DAQmxTaskControl</code> with the following parameters:</p> <p>taskHandle: <code>&taskHandle</code></p> <p>action: <code>DAQmx_Val_Task_Commit</code></p>	 <p>The LabVIEW block diagram shows the 'DAQmx Control Task.vi' block. It has 'Task In' and 'Error In' terminals. The 'action' is set to 'commit'.</p>

- Repeat steps 4 through 6 for all excitation values in Table 20. Verify that the measured value from the DMM is within the limits specified. If so, the NI PXI-4220 excitation voltage is sufficiently accurate.

You have finished verifying excitation voltage levels on the NI PXI-4220.

Adjusting Calibration Constants

The following sections explain how to adjust the calibration constants on the NI PXI-4220. You must first calibrate then baseboard and then perform both a gain and offset calibration. Do the offset calibration once per analog channel and the gain calibration for each gain setting for each analog channel. You should complete the [Verifying Gain and Offset Errors](#) section prior to completing this section to determine the pre calibration values and whether you need to make adjustments.

Baseboard Calibration

Perform the baseboard calibration prior to gain and offset calibration. The baseboard houses the Analog to Digital Converter (ADC). If it is not properly calibrated, an external voltage supply will not be converted accurately for the calculations of the calibration constants.

You can find all VIs in LabVIEW using the search tool in the palette.

Complete the following steps to calibrate the baseboard of the NI PXI-4220.

- Review [Setting up the NI PXI-4220 for Verification and Test Conditions](#) sections.
- Connect the calibrator to the PFI 0/CAL port using an SMB cable.
- Start an external calibration session using DAQmxInitExtCal (**Initialize External Calibration VI**). The default password is NI.

Table 12. Start External Calibration Session (Baseboard)

NI-DAQ Function Call	LabVIEW Block Diagram
<p>Call DAQmxInitExtCal with the following parameters:</p> <p>deviceName: "Dev1 "</p> <p>password: "NI "</p> <p>calHandle: &calHandle</p>	 <p>The diagram shows a LabVIEW block diagram for the DAQmxInitExtCal VI. A dropdown menu labeled 'Dev1' is connected to the 'Device' input of the DAQmxInitExtCal block. A 'Password' control is connected to the 'Password' input of the DAQmxInitExtCal block. The DAQmxInitExtCal block has two outputs: 'Callhandle Out' and 'Error Out'.</p>

- Adjust the calibrator to a voltage between 6.0 and 9.99 V. The value you source must be consistent with the value you choose in your software. Use the `DAQmxSCBaseboardCalAdjust` (**DAQmx Adjust SC Baseboard Calibration VI**).



Note If the reference voltage does not match the declared reference voltage in your software, **error -200546** occurs and the baseboard remains uncalibrated.

Table 13. SC Baseboard Calibration Adjustment

NI-DAQ Function Call	LabVIEW Block Diagram
<p>Call <code>DAQmxSCBaseboardCalAdjust</code> with the following parameters:</p> <p>calHandle: <code>calHandle</code></p> <p>referenceVoltage: (must be consistent with the external reference voltage applied) <code>float64</code></p>	

- Close the external calibration session and commit the calibration data using `DAQmxCloseExtCal` (**DAQmx Close External Calibration VI**).

Table 14. Close External Calibration Session

NI-DAQ Function Call	LabVIEW Block Diagram
<p>Call <code>DAQmxCloseExtCal</code> with the following parameters:</p> <p>calHandle: <code>calHandle</code></p> <p>action: <code>DAQmx_Val_Action_Commit</code></p>	

- Verify that no errors occurred.

You have finished calibrating the baseboard of the NI PXI-4220.

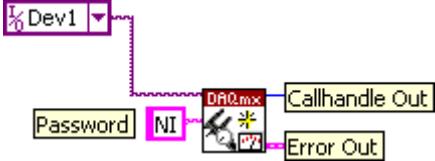
Gain and Offset Calibration Constants

Perform gain calibrations for each gain per analog channel. NI advises calibrations references of 95, 0, and -95% of the full voltage input swing. For example, the input swing for a gain of 1 is 10 to -10 V. Therefore, the reference points are 9.5, 0, and -9.5 V.

Complete the following steps to calibrate the gain constants of the NI PXI-4220.

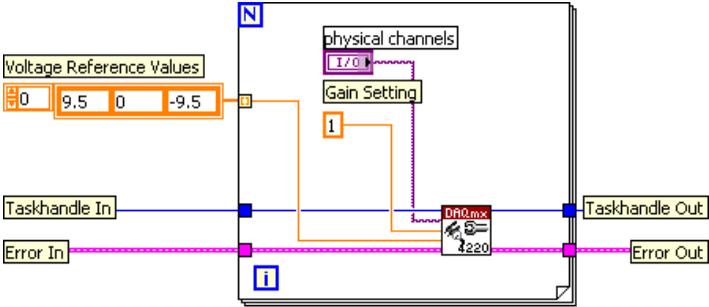
1. Complete the *Baseboard Calibration* section.
2. Review the *Setting up the NI PXI-4220 for Verification and Test Conditions* sections for instructions on connecting to the analog input channel of interest.
3. Start an external calibration session using DAQmxInitExtCal (**Initialize External Calibration VI**).

Table 15. Start External Calibration Session (Gain)

NI-DAQ Function Call	LabVIEW Block Diagram
<p>Call DAQmxInitExtCal with the following parameters:</p> <p>deviceName: "Dev1"</p> <p>password: "NI"</p> <p>calHandle: &calHandle</p>	

4. Set the calibrator to the desired voltage for the current gain setting. Refer to Table 19 for appropriate voltage set points.
5. Run DAQmxAdjust4220Cal (**DAQmx Adjust 4220 Calibration VI**), with the appropriate voltage set point and gain setting.

Table 16. Calibration of the Gain Constant at One Gain Setting

NI-DAQ Function Call	LabVIEW Block Diagram
<p>Call DAQmxAdjust4220Cal with the following parameters:</p> <p>calHandle: calHandle</p> <p>channelNames: "dev1/ai0"</p> <p>gain: (reference Table 19 for valid gain settings) <i>float64</i>.</p> <p>inputVal: (input 95%, 0%, and -95% of the full range for each gain) <i>float64</i>.</p>	



Note You must give the calibrator appropriate time to settle after updating the voltage before executing the `DAQmxAdjust4220Cal` function. This is not implemented in the above concept program. To properly calibrate each gain setting, include a wait in software after you update the external voltage to account for any settling time requirements for the calibrator.

6. Repeat steps 4 and 5 for the three voltage set points at the current gain setting from Table 19.
7. Close the external calibration session using `DAQmxCloseExtCal` (**DAQmx Close External Calibration VI**) to apply the adjustment from the current gain setting.

Table 17. Close External Calibration Session

NI-DAQ Function Call	LabVIEW Block Diagram
<p>Call <code>DAQmxCloseExtCal</code> with the following parameters:</p> <p>calHandle: <code>calHandle</code></p> <p>action: <code>DAQmx_Val_Action_Commit</code></p>	

8. Repeat steps 3 through 7 for all gain settings on both channels in Table 19.

You have finished adjusting the gain constants on the NI PXI-4220.

Verifying Adjusted Values

After completing the adjustments to the NI PXI-4220, it is important that you verify the analog input operation by repeating the steps listed in the [Verifying Gain and Offset Errors](#) section. Re-verifying after making the adjustments ensures that the NI PXI-4220 is operating within its specifications.

Specifications

This section lists the specifications for the NI PXI-4220. These specifications are typical at 25 °C unless otherwise noted. All specifications are with the default filter setting of 10 kHz unless otherwise noted. See *NI PXI-4220 User Manual* for further specification information.

Analog Input

Number of input channels 2

Voltage gain settings Range from 1 to 1000

Accuracy Information

Table 18. NI PXI-4220 Accuracy Information

Nominal Range	Gain	Absolute Accuracy 15 to 35 °C						Absolute Accuracy at Full Scale
		% of reading max, 1 Year	Maximum Offset (μV)	Noise + Quantization (μV)		Temperature Drift		
				Single Pt.	100 pt. Average	Gain Drift (μ/°C)	Offset Drift (μ/°C)	
±10.0 V	1	0.1	3000	5000	500	0.0300	25.00	±13.5 mV
±5.0 V	2	0.1	1500	2500	250	0.0300	25.00	±6.8 mV
±1.8 V	4.2	0.1	500	1000	100	0.0300	25.00	±2.4 mV
±1.0 V	10	0.1	300	500	50	0.0300	25.00	±1.4 mV
±500.0 mV	20	0.1	150	250	25	0.0300	5.00	±675 μV
±180.0 mV	42	0.1	75	100	10	0.0300	5.00	±265 μV
±100.0 mV	100	0.1	50	50	5.0	0.0300	5.00	±155 μV
±50.0 mV	200	0.1	50	25	2.5	0.0300	5.00	±103 μV
±18.0 mV	420	0.1	50	10	1.0	0.0300	5.00	±69 μV
±10.0 mV	1000	0.1	50	10	1.0	0.0300	5.00	±61 μV

Absolute accuracy is (Voltage Reading) × (% of Reading) + (Offset Error) + (System Noise).
 To include the effects of Temperature Drift outside the range of 15 to 35 °C, add the term $\Delta T \times [(\text{Gain Drift}) \times (\text{Voltage Reading}) + (\text{Offset Drift})]$, where ΔT is the absolute temperature difference between the module, and 15 or 35 °C.

Gain and Offset

Table 19 contains the specifications for use when verifying and calibrating the gain and offset of the NI PXI-4220. If the module was calibrated within the last year, the test point value should fall between the *Lower Limit (V)* and *Upper Limit (V)* values.

Table 19. NI PXI-4220 Gain and Offset Calibration Table

Gain	Test Point (V)	Lower Limit (V)	Upper Limit (V)
1	9.5	9.487000	9.513000
1	0	-0.003500	0.003500
1	-9.5	-9.513000	-9.487000
1.15	8.3	8.288200	8.311800
1.15	0	-0.003500	0.003500
1.15	-8.3	-8.311800	-8.288200
1.3	7.3	7.289200	7.310800
1.3	0	-0.003500	0.003500
1.3	-7.3	-7.310800	-7.289200
1.5	6.3	6.290200	6.309800
1.5	0	-0.003500	0.003500
1.5	-6.3	-6.309800	-6.290200
1.8	5.3	5.291200	5.308800
1.8	0	-0.003500	0.003500
1.8	-5.3	-5.308800	-5.291200
2	4.8	4.793450	4.806550
2	0	-0.001750	0.001750
2	-4.8	-4.806550	-4.793450
2.2	4.3	4.293950	4.306050
2.2	0	-0.001750	0.001750
2.2	-4.3	-4.306050	-4.293950
2.4	4	3.994250	4.005750
2.4	0	-0.001750	0.001750

Table 19. NI PXI-4220 Gain and Offset Calibration Table (Continued)

Gain	Test Point (V)	Lower Limit (V)	Upper Limit (V)
2.4	-4	-4.005750	-3.994250
2.7	3.5	3.494750	3.505250
2.7	0	-0.001750	0.001750
2.7	-3.5	-3.505250	-3.494750
3.1	3.1	3.095150	3.104850
3.1	0	-0.001750	0.001750
3.1	-3.1	-3.104850	-3.095150
3.6	2.6	2.595650	2.604350
3.6	0	-0.001750	0.001750
3.6	-2.6	-2.604350	-2.595650
4.2	2.3	2.297100	2.302900
4.2	0	-0.000600	0.000600
4.2	-2.3	-2.302900	-2.297100
5.6	1.7	1.697700	1.702300
5.6	0	-0.000600	0.000600
5.6	-1.7	-1.702300	-1.697700
6.5	1.5	1.497900	1.502100
6.5	0	-0.000600	0.000600
6.5	-1.5	-1.502100	-1.497900
7.5	1.3	1.298100	1.301900
7.5	0	-0.000600	0.000600
7.5	-1.3	-1.301900	-1.298100
8.7	1.1	1.098300	1.101700
8.7	0	-0.000600	0.000600
8.7	-1.1	-1.101700	-1.098300
10	0.95	0.948700	0.951300
10	0	-0.000350	0.000350

Table 19. NI PXI-4220 Gain and Offset Calibration Table (Continued)

Gain	Test Point (V)	Lower Limit (V)	Upper Limit (V)
10	-0.95	-0.951300	-0.948700
11.5	0.83	0.828820	0.831180
11.5	0	-0.000350	0.000350
11.5	-0.83	-0.831180	-0.828820
13	0.73	0.728920	0.731080
13	0	-0.000350	0.000350
13	-0.73	-0.731080	-0.728920
15	0.63	0.629020	0.630980
15	0	-0.000350	0.000350
15	-0.63	-0.630980	-0.629020
18	0.53	0.529120	0.530880
18	0	-0.000350	0.000350
18	-0.53	-0.530880	-0.529120
20	0.48	0.479345	0.480655
20	0	-0.000175	0.000175
20	-0.48	-0.480655	-0.479345
22	0.43	0.429395	0.430605
22	0	-0.000175	0.000175
22	-0.43	-0.430605	-0.429395
24	0.4	0.399425	0.400575
24	0	-0.000175	0.000175
24	-0.4	-0.400575	-0.399425
27	0.35	0.349475	0.350525
27	0	-0.000175	0.000175
27	-0.35	-0.350525	-0.349475
31	0.31	0.309515	0.310485
31	0	-0.000175	0.000175

Table 19. NI PXI-4220 Gain and Offset Calibration Table (Continued)

Gain	Test Point (V)	Lower Limit (V)	Upper Limit (V)
31	-0.31	-0.310485	-0.309515
36	0.26	0.259565	0.260435
36	0	-0.000175	0.000175
36	-0.26	-0.260435	-0.259565
42	0.23	0.229685	0.230315
42	0	-0.000085	0.000085
42	-0.23	-0.230315	-0.229685
56	0.17	0.169745	0.170255
56	0	-0.000085	0.000085
56	-0.17	-0.170255	-0.169745
65	0.15	0.149765	0.150235
65	0	-0.000085	0.000085
65	-0.15	-0.150235	-0.149765
75	0.13	0.129785	0.130215
75	0	-0.000085	0.000085
75	-0.13	-0.130215	-0.129785
87	0.11	0.109805	0.110195
87	0	-0.000085	0.000085
87	-0.11	-0.110195	-0.109805
100	0.095	0.094850	0.095150
100	0	-0.000055	0.000055
100	-0.095	-0.095150	-0.094850
110	0.086	0.085859	0.086141
110	0	-0.000055	0.000055
110	-0.086	-0.086141	-0.085859
130	0.073	0.072872	0.073128
130	0	-0.000055	0.000055

Table 19. NI PXI-4220 Gain and Offset Calibration Table (Continued)

Gain	Test Point (V)	Lower Limit (V)	Upper Limit (V)
130	-0.073	-0.073128	-0.072872
150	0.063	0.062882	0.063118
150	0	-0.000055	0.000055
150	-0.063	-0.063118	-0.062882
180	0.053	0.052892	0.053108
180	0	-0.000055	0.000055
180	-0.053	-0.053108	-0.052892
200	0.048	0.047900	0.048101
200	0	-0.000053	0.000053
200	-0.048	-0.048101	-0.047900
220	0.043	0.042905	0.043096
220	0	-0.000053	0.000053
220	-0.043	-0.043096	-0.042905
240	0.04	0.039908	0.040093
240	0	-0.000053	0.000053
240	-0.04	-0.040093	-0.039908
270	0.035	0.034913	0.035088
270	0	-0.000053	0.000053
270	-0.035	-0.035088	-0.034913
310	0.031	0.030917	0.031084
310	0	-0.000053	0.000053
310	-0.031	-0.031084	-0.030917
360	0.026	0.025922	0.026079
360	0	-0.000053	0.000053
360	-0.026	-0.026079	-0.025922
420	0.023	0.022926	0.023074
420	0	-0.000051	0.000051

Table 19. NI PXI-4220 Gain and Offset Calibration Table (Continued)

Gain	Test Point (V)	Lower Limit (V)	Upper Limit (V)
420	-0.023	-0.023074	-0.022926
560	0.017	0.016932	0.017068
560	0	-0.000051	0.000051
560	-0.017	-0.017068	-0.016932
650	0.015	0.014934	0.015066
650	0	-0.000051	0.000051
650	-0.015	-0.015066	-0.014934
750	0.013	0.012936	0.013064
750	0	-0.000051	0.000051
750	-0.013	-0.013064	-0.012936
870	0.011	0.010938	0.011062
870	0	-0.000051	0.000051
870	-0.011	-0.011062	-0.010938
1000	0.0095	0.009440	0.009561
1000	0	-0.000051	0.000051
1000	-0.0095	-0.009561	-0.009440

Table 20. Excitation Limits

Excitation (V)	Lower Limit (V)	Upper Limit (V)
0	-0.020000	0.020000
2.5	2.472500	2.527500
5	4.965000	5.035000
7.5	7.457500	7.542500
10	9.950000	10.050000

National Instruments, NI, ni.com, and LabVIEW are trademarks of National Instruments Corporation. Refer to the *Terms of Use* section on ni.com/legal for more information about National Instruments trademarks. Other product and company names mentioned herein are trademarks or trade names of their respective companies. For patents covering National Instruments products, refer to the appropriate location: **Help>Patents** in your software, the `patents.txt` file on your CD, or ni.com/patents.