SCXI™-1503

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		ni.com/manuals		

This document contains information for verifying and adjusting the SCXI-1503 module using NI-DAQmx 8.1 or later. For more information about calibration, visit `ni.com/calibration`.

Contents

Software Requirements

Calibrating the SCXI-1503 requires installing NI-DAQmx 8.1 or later on the calibration system. You can download NI-DAQmx from `ni.com/downloads`. NI-DAQmx 8.1 or later supports self-calibration and external calibration in the LabVIEW, LabWindows/CVI, C/C++, C#, and Visual Basic .NET application development environments (ADEs). When you install NI-DAQmx 8.1 or later, you only need to install support for the ADE that you intend to use.

NATIONAL INSTRUMENTS™

Documentation Requirements

For information about NI-DAQmx, and the SCXI-1503 module and SCXI-1306 terminal block, consult the following documents:

- *SCXI Quick Start Guide*—provides instructions for installing and configuring SCXI chassis and modules.

- *SCXI-1503 User Manual* (includes specifications)—includes detailed information and published specifications for the SCXI-1503.

- *SCXI-1306 Terminal Block Installation Guide*—includes detailed information and published specifications for the SCXI-1306.

- *NI-DAQmx Help*—includes information about creating applications that use NI-DAQmx.

- *NI-DAQmx C Reference Help*—includes information about the functions in the driver.

You can find the latest versions of the documentation at `ni.com/manuals`.

Calibration Interval

National Instruments recommends a calibration interval of one year for the SCXI-1503. You should adjust the recommended calibration interval based on the measurement accuracy demands of your application.

Test Equipment

National Instruments recommends using the equipment in Table 1 for adjusting and verifying the SCXI-1503.

Table 1. Recommended Equipment

Equipment	Recommended Model	Parameter Measured	Minimum Requirements
Calibrator	Fluke 5500A*	Analog Input	If this instrument is unavailable, use a calibrator that is accurate to 10 ppm (5 digits).
DMM	PXI-4071	Excitation Current Analog Input	If this instrument is unavailable, use a multiranging 7½ digit DMM.
SCXI Chassis	SCXI-1000	—	—
DAQ Device	NI PCI(e)/PXI(e) E, M or X Series Device	—	16-bit DAQ device that is supported by NI-DAQmx 8.1 or later.
Terminal Block Connection Accessory	SCXI-1306	—	—
Rear Connection Accessory	SCXI-1349	—	—
Terminal Accessory, 50-pin	CB-50	—	—
Ribbon Cable, 50-Pin	NB1	—	—
Cable between SCXI-1349 and E Series DAQ devices	SH68-68-EP	—	—
Cable between SCXI-1349 and M Series or X Series DAQ devices	SHC68-68-EPM	—	—
* If using the Fluke 5500A calibrator, you must have the Fluke Fl5xmcal driver installed on the test computer.			

Test Conditions

The following setup and environmental conditions are required to ensure the SCXI-1503 meets published specifications.

- Keep connections to the module as short as possible. Long cables and wires act as antennae, which can pick up extra noise that affects measurements.

- Verify that all connections to the calibration system are secure.

- Maintain an ambient temperature of 25 ±10 °C. The SCXI-1503 module temperature will be greater than the ambient temperature. If you plan to operate the SCXI-1503 at a specific temperature outside this range, calibrate the module at that temperature.

- Keep relative humidity below 80%.

- Allow a warm-up time of at least 30 minutes to ensure that the measurement circuitry is at a stable operating temperature.
- Use shielded copper wire for all cable connections to the SCXI-1306 terminal block. Use twisted-pair wire to eliminate noise and thermal offsets.
- Ensure that the SCXI chassis empty slots contain front and rear filler panels.
- Plug the SCXI chassis, computer, and the instrument standard into the same power strip to avoid ground loops.

Calibration Procedures

The calibration process includes the following steps:

1. *Initial Setup*—Install the module and configure it in Measurement & Automation Explorer (MAX).

2. *Self-Calibration*—Adjust the self-calibration constants of the module.

3. *Verification*—Verify the existing operation of the module. This step confirms whether the module is operating within the published specifications prior to adjustment.

4. *Adjustment*—Adjust the calibration constants of the module. The adjustment procedure automatically stores the calibration date on the EEPROM. Go to `ni.com/calibration` for information about returning a module to NI for a factory calibration.

5. *Reverification*—Repeat the verification procedure to ensure that the module is operating within the published specifications after adjustment.

These procedures are described in more detail in the following sections.

Initial Setup

Refer to the DAQ Getting Started Guides and the *SCXI Quick Start guide* for information about how to install the software and hardware, and how to configure the module in MAX. Figure 1 shows a typical SCXI setup for calibration using an NI PCI(e) DAQ device.

1	SCXI-1306 Terminal Block	7	DMM
2	SCXI-1503 Module	8	Calibrator
3	SCXI-1000 Chassis	9	Calibrator to SCXI-1306 Wiring
4	SCXI-1349 Adapter	10	CB-50 to DMM Wiring
5	SH68-68 EP Cable (for E Series DAQ Device)	11	CB-50 Terminal Accessory
	SHC68-68 EPM Cable (for M or X Series DAQ Device)	12	NB1 Ribbon Cable
6	Test Computer, with NI PCI(e) DAQ Device		
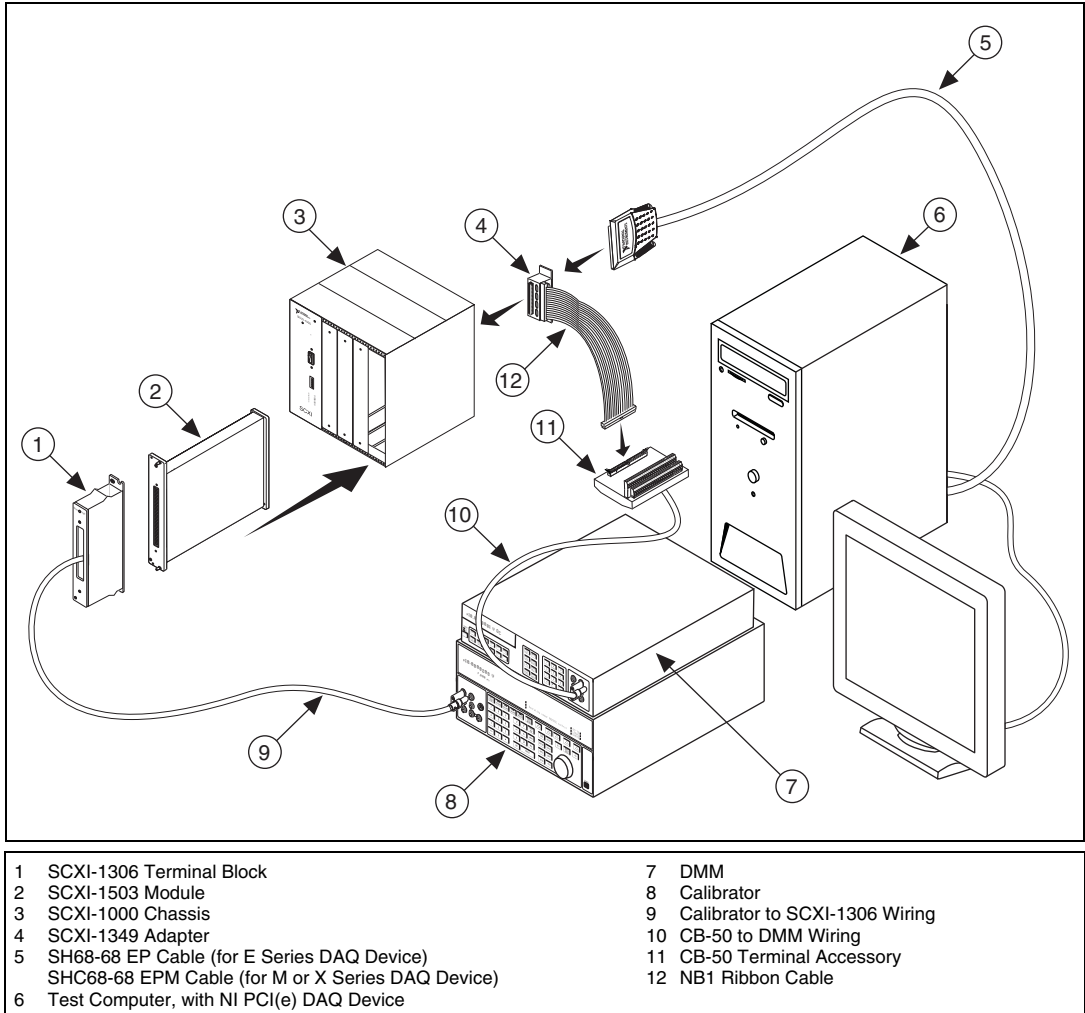
Figure 1. Typical Setup for Verification and Adjustment Using an NI PCI(e) DAQ Device

Figure 2 shows a typical SCXI setup for calibration using the NI PXI(e) DAQ device.

1	SCXI-1306 Terminal Block	5	SHC68-68 EPM Cable	9	Calibrator to SCXI-1306 Wiring
2	SCXI-1503 Module	6	PXI Chassis	10	CB-50 to DMM Wiring
3	SCXI-1000 Chassis	7	DMM	11	CB-50 Terminal Accessory
4	SCXI-1349 Adapter	8	Calibrator	12	NB1 Ribbon Cable
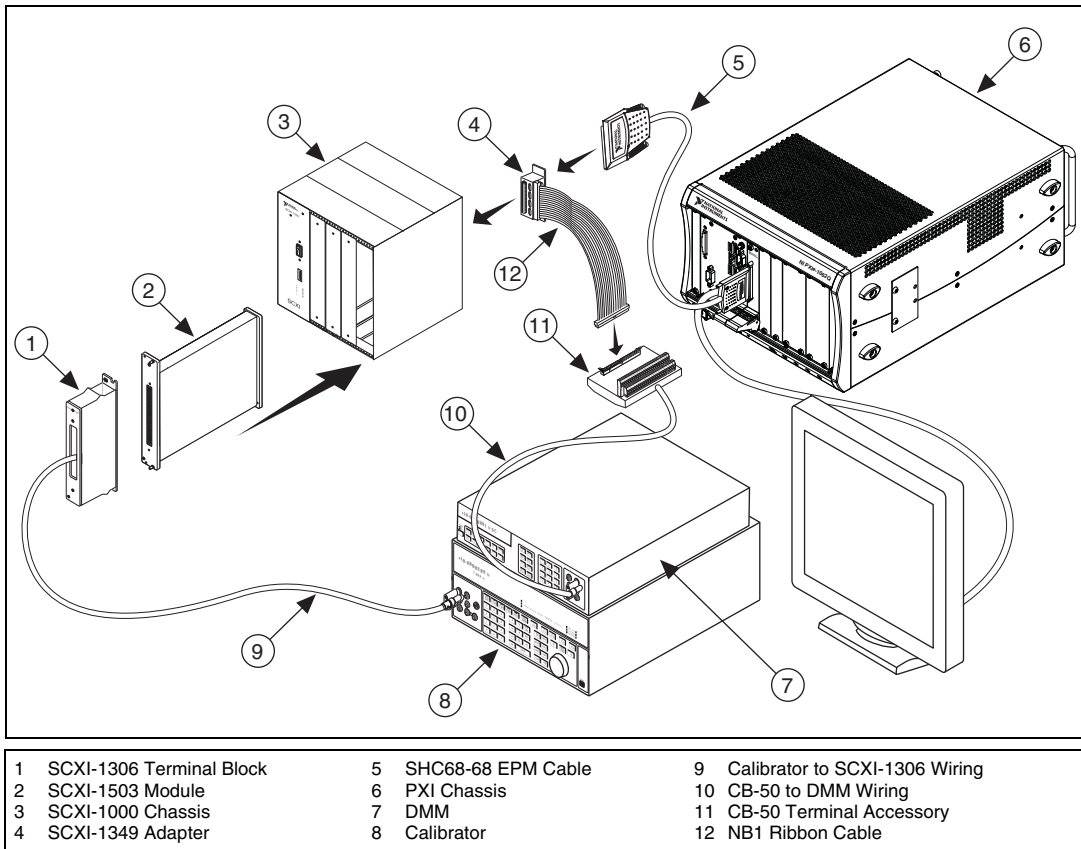
Figure 2. Typical Setup for Verification and Adjustment Using an NI PXI(e) DAQ Device

1. Power off the SCXI-1000 chassis.
2. Insert the SCXI-1503 into any available SCXI-1000 chassis slot.

Note If you are using an NI PCI(e) DAQ device, connect the SCXI-1349 to the NI PCI(e) DAQ device using an SHC68-68 cable.

Note If you are using an NI PXI(e) DAQ device rather than an NI PCI(e) DAQ device, refer to Figure 2 to make your connections.

3. Ensure that all of the SCXI-1306 configuration switches are switched to the off position, as shown in Figure 3.

| 1 | Configuration Switches (shown in Off position) | 2 | Switch Legends | 3 | Ground Lug |
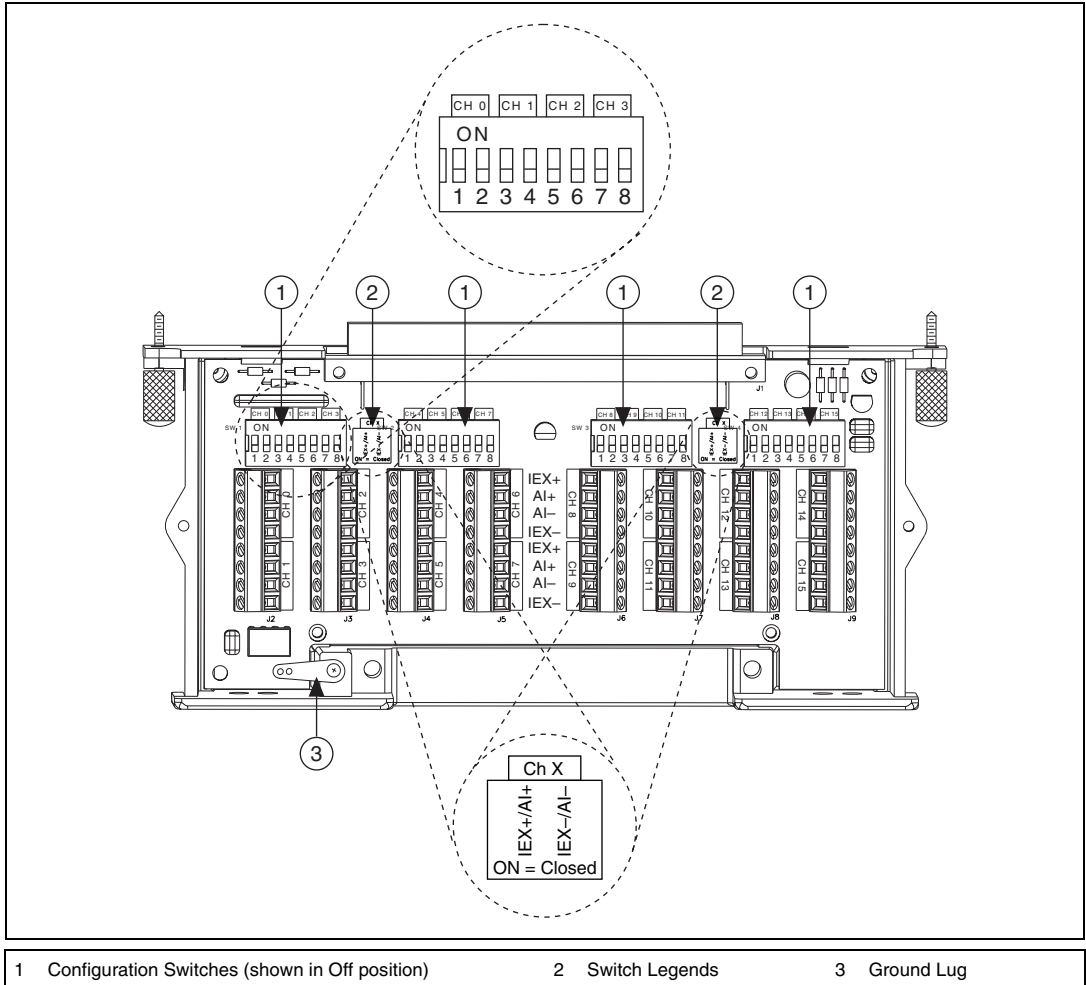
Figure 3. SCXI-1306 Switch Diagram

4. Install the SCXI-1306 on the SCXI-1503 DUT.
5. Power on the SCXI-1000 chassis.

Self-Calibration

The SCXI-1503 includes precise internal circuits and references used during self-calibration to adjust for any errors caused by short-term fluctuations in the environment.

Note Allow a 30 minute warm-up period before you begin self-calibration.

You can initiate self-calibration from MAX.

MAX

To initiate self-calibration from MAX, complete the following steps:

1. Launch MAX.
2. Select **My System»Devices and Interfaces»NI-DAQmx Devices**.

Note NI-DAQmx Devices is not displayed when using NI-DAQmx 9.0 or later.

3. Select the DAQ device you are using to digitize the SCXI-1503.
4. Initiate self-calibration in one of the following ways:
   - Click **Self-Calibrate** in the upper right corner of the window. If the Self-Calibrate button is not displayed, click the **»** button.
   - Right-click the module and select **Self-Calibrate** from the context menu.
5. Select the chassis containing the module you want to calibrate.
6. Select the module that you want to calibrate.
7. Initialize a self-calibration of the module you want to calibrate.

Verification

This section provides instructions for verifying the following SCXI-1503 specifications:

- Analog input.
- Excitation current.

Note Limits in Table 2 are based on the March 2007 edition of the *SCXI-1503 User Manual*, which includes the specifications. Refer to ni.com/manuals to determine if there is a more recent edition of the specifications. If a more recent edition of the specifications is available, recalculate the limits based upon the latest specifications.

Verifying the Analog Input

Complete the following steps to verify the analog input of the SCXI-1503:

1. Connect the calibrator ± output to all of the SCXI-1306 AI± input channels.

Note Ensure that all switches on the SCXI-1306 are in the off position as shown in Figure 3.

2. Insert the NB1 ribbon cable into the breakout connector on the SCXI-1349.
3. Insert the SCXI-1349 into the SCXI-1503 rear connector.
4. Insert the other end of the NB1 ribbon cable into the CB-50 ribbon cable connector.

5. Connect the DMM V+ to pin 3 and DMM V- to pin 4 of the CB-50 terminal accessory. Refer to Figure 4 for pin locations.

1	To DMM V+	3	NB1 Ribbon Cable Connector	5	CB-50 Side View
2	To DMM V-	4	CB-50 Top View		
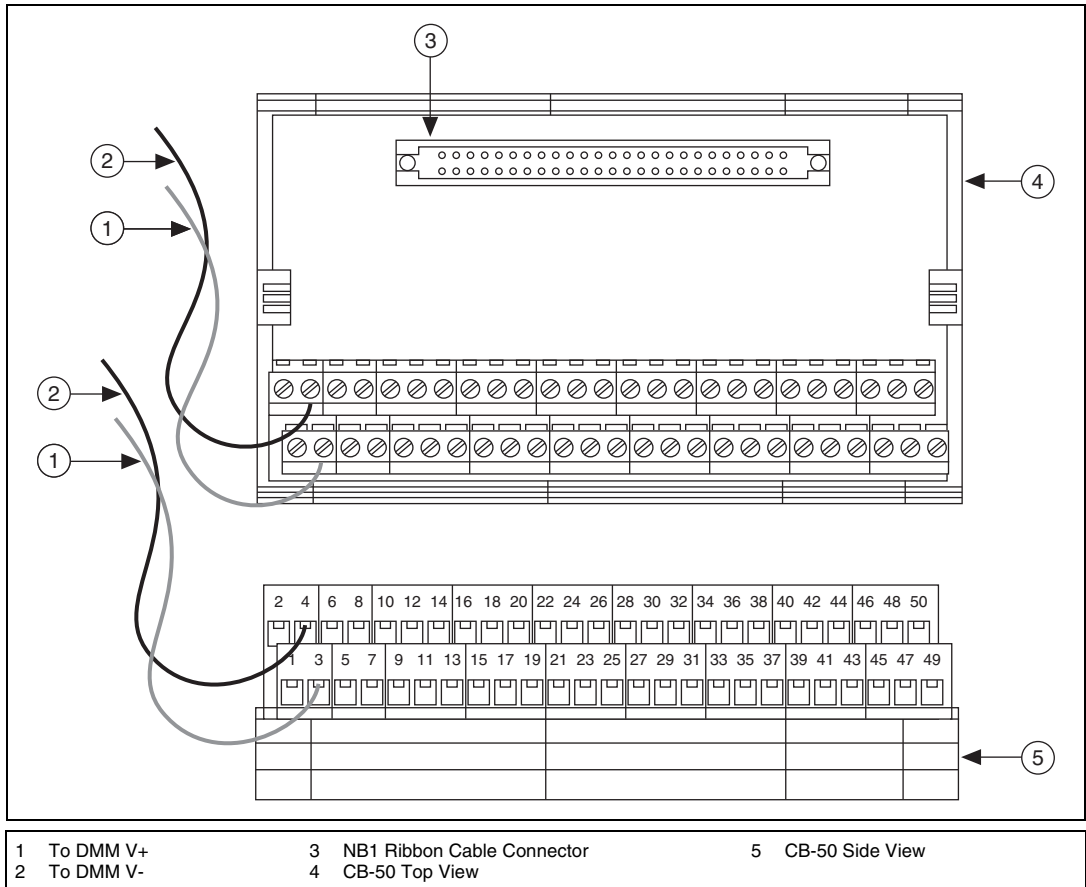
Figure 4. CB-50 Terminal Accessory Wiring Diagram for Connection to DMM

6. Configure an AI voltage channel with an input range of ±10 V for channel ai0 on the NI PCI(e)/PXI(e) DAQ device.

7. Use DAQmx properties to read the AI dev scaling coefficients of the DAQ device. E Series have two scaling coefficients while M Series and X Series have four scaling coefficients. Record the first two scaling coefficients and save the values as a_0 and a_1.

Note The DAQ device scaling coefficients, a_0 and a_1, are the same for each channel on the SCXI module since the DAQ device multiplexes all SCXI channels to channel ai0 on the DAQ device.

8. Clear the task.

9. Configure the calibrator to output a DC voltage. Table 2 shows the test point values.

Table 2. Test Point and Limit

SCXI-1503 Gain	Test Point Level (V)	Lower Limit (V)	Upper Limit (V)
1	9	8.991680513	9.008319487
	6	5.993900513	6.006099487
	3	2.996120513	3.003879487
	0	-0.001659487	0.001659487
	-3	-3.003879487	-2.996120513
	-6	-6.006099487	-5.993900513
	-9	-9.008319487	-8.991680513
100	0.09	0.089898305	0.090101695
	0.06	0.059920505	0.060079495
	0.03	0.029942705	0.030057295
	0	-0.0000350949	0.0000350949
	-0.03	-0.030057295	-0.029942705
	-0.06	-0.060079495	-0.059920505
	-0.09	-0.090101695	-0.089898305

10. Create an AI voltage channel with an input range of ±10 V for one channel on the SCXI-1503.

11. Configure the SCXI-1503 input channel for a finite acquisition with a sample rate of 1000 Hz and 1000 samples per channel.

12. Use DAQmx properties to set a gain of 1.

13. Use DAQmx properties to read the DAQ device scaling coefficients. E Series have two scaling coefficients while M Series and X Series have four scaling coefficients. Record the first two scaling coefficients and save the values as b_0 and b_1.

14. Start the task to set the channel MUX to the specified channel.

15. Use the saved device scaling coefficients from the DAQ device, a_0 and a_1 from step 7, and the combined DAQ device and SCXI-1503 module, b_0 and b_1 from step 13, to compute the device scaling coefficients for just the SCXI-1503, c_0 and c_1.

$$c_0 = b_0 - \frac{b_1}{a_1} \times a_0$$

$$c_1 = \frac{b_1}{a_1}$$

16. Configure the DMM to measure voltage at the CB-50 outputs and take a measurement.

17. Apply the calculated scaling coefficients, c_0 and c_1 to the DMM measurement using the following formula:

$$Scaled\ DMM\ Reading\ =\ (DMM\ Reading \times c_1) + c_0$$

18. Compare the average scaled DMM reading with the test limit shown in Table 2.

19. Stop and then clear the DAQmx task.

20. Repeat steps 9 through 19 for each test point.

21. Repeat steps 9 through 20 with an input range of ±100 mV and a gain of 100.

Note The combined DAQ/SCXI-1503 scaling coefficients, b_0 and b_1, will not change for each test point, but each channel and gain will have different scaling coefficients. Recalculate c_0 and c_1 each time a channel and/or gain changes.

22. Repeat steps 9 through 21 for the remaining channels.

Verifying the Excitation Current

Complete the following steps to verify the excitation current of the SCXI-1503:

1. Connect IEXx+ and IEXx- to the DMM current input where x is a channel value from 0 to 15.

Note Ensure that all switches on the SCXI-1306 are in the off position as shown in Figure 3.

2. Configure the DMM to do a current measurement with a range of 100 µA and an accuracy of 15 nA or better at 100 µA.

Note The PXI-4071 can measure up to 105 µA in the 100 µA range.

3. Create an AI voltage channel and configure it to use internal excitation by setting the AI.Excit.Src to internal and then read the excitation current value from the AI.Excit.Val property node. Save this value to DUT IEX.

4. Configure the DMM to get current measurement results. Save this value to DMM Reading.

5. Calculate the excitation error using the following formula:

$$IEx\ Accuracy\ =\ \left(\frac{DUT\ IEx}{DMM\ Reading} - 1 \right) \times 100$$

6. Compare the calculated excitation error with the limit IEx Accuracy = ±0.05%.

7. Clear the DAQmx task.

8. Repeat steps 1 through 7 to verify all other channels.

Adjustment

Following the adjustment procedure automatically updates the calibration date and temperature in the EEPROM of the SCXI-1503.

Note National Instruments recommends a complete adjustment of your module to renew the calibration interval. However, if you do not want to perform an adjustment, you can update the calibration date and onboard calibration temperature without making any adjustments by calling only the DAQmx Initialize External Calibration and DAQmx Close External Calibration VIs.

Adjustment corrects the following SCXI-1503 specifications:

• Analog input.
• Excitation current.

Adjusting the Analog Input

Complete the following steps to adjust the analog input of the SCXI-1503:

1. Connect the calibrator output to all of the input channels on the SCXI-1306.

📝 **Note** Ensure that all switches on the SCXI-1306 are in the off position as shown in Figure 3.

2. Insert the NB1 ribbon cable into the breakout connector on the SCXI-1349.

3. Insert the SCXI-1349 into the SCXI-1503 rear connector.

4. Insert the other end of the NB1 ribbon cable into the CB-50 ribbon cable connector.

5. Connect the DMM V+ to pin 3 and DMM V- to pin 4 of the CB-50 terminal accessorys. Refer to Figure 5 for pin locations.

| 1 | To DMM V+ | 3 | NB1 Ribbon Cable Connector | 5 | CB-50 Side View |
| 2 | To DMM V- | 4 | CB-50 Top View | | |
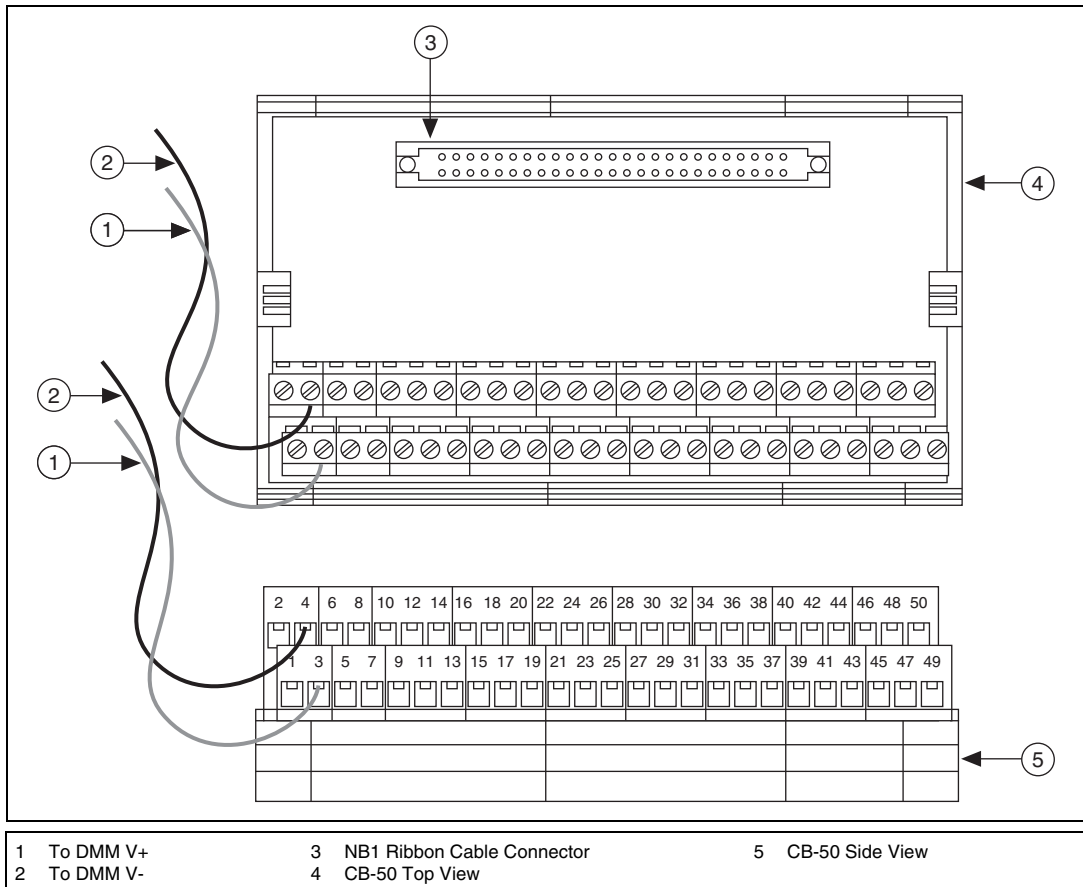
Figure 5. CB-50 Terminal Accessory Wiring Diagram for Connection to DMM

📝 **Note** When MAX configures a module, it is assigned a module name. Each function call uses this module name to determine the correct module to adjust. This document uses `Dev1` when referring to the module name. When you calibrate your module, use the module name assigned to it by MAX.

6. Configure the calibrator to send out a DC voltage. Table 3 shows the test point.

Table 3. DC Source

SCXI-1503 Gain	Test Voltage
1	9.1 V
	6.1 V
	3.1 V
	0 V
	-3.1 V
	-6.1 V
	-9.1 V
100	0.091 V
	0.061 V
	0.031 V
	0 V
	-0.031 V
	-0.061 V
	-0.091 V

7. Use the DAQmx Initialize External Calibration VI to create a calibration task.

LabVIEW Block Diagram	NI-DAQmx Function Call
device in — calhandle out password error in — error out	Call `DAQmxInitExtCal` with the following parameters: **deviceName**: `Dev1` **password**: `NI` or `SCXI` (default) **calHandle**: `&calHandle`

8. Use the DAQmx Setup SCXI Calibration VI to configure the input channel.

LabVIEW Block Diagram	NI-DAQmx Function Call
calhandle in — calhandle out physical channel gain — error out error in	Call `DAQmxSetup1503Cal` with the following parameters: **calHandle**: `calHandle` **channelName**: `Dev1/ai`*x*, where *x* refers to the channel number **gain**: `1`

9. Configure the DMM to measure voltage at the CB-50 outputs and take a measurement.

10. Use the DAQmx Adjust SCXI Calibration VI to calculate and store the constants.

LabVIEW Block Diagram	NI-DAQmx Function Call
calhandle in / reference voltage / measured output / error in → DAQmx SCXI → calhandle out / error out	Call `DAQmxAdjust1503Cal` with the following parameters: **calHandle**: `calHandle` **refVoltage**: test point sent out by the calibrator. **measOutput**: DMM measurement result in step 9.

11. Use the DAQmx Close External Calibration VI to commit the constant overwritten.
12. Repeat steps 6 through 11 for all SCXI-1503 channels.
13. Repeat steps 6 through 12 to test all test points for gain = 1.

LabVIEW Block Diagram	NI-DAQmx Function Call
calhandle in / action / error in → DAQmx → error out	Call `DAQmxCloseExtCal` with the following parameters: **calHandle**: `calHandle` **action**: `DAQmx_Val_Action_ commit`

14. Repeat steps 7 through 13 using a gain of 100 on the SCXI-1503.
15. Self-calibrate the SCXI-1503.

Adjusting the Excitation Current

Complete the following steps to adjust the excitation current of the SCXI-1503:

1. Connect IEXx+ and IEXx- to DMM current input with x being the number of the channel from 0 to 15.

📝 **Note** Ensure that all switches on the SCXI-1306 are in the off position as shown in Figure 3.

2. Configure the DMM to do a current measurement with a range of 100 µA and an accuracy of 15 nA or better at 100 µA.

📝 **Note** The PXI-4071 can measure up to 105 µA in the 100 µA range.

3. Take a current measurement using the DMM. Save this value to DMM Reading.
4. Use the DAQmx Initialize External Calibration VI to create a calibration task.

LabVIEW Block Diagram	NI-DAQmx Function Call
device in / password / error in → DAQmx → calhandle out / error out	Call `DAQmxInitExtCal` with the following parameters: **deviceName**: `Dev1` **password**: `NI` or `SCXI` **calHandle**: `&calHandle`

5. Use the DAQmx Adjust SCXI Calibration VI and select 1503 Current to store the excitation current constant.

LabVIEW Block Diagram	NI-DAQmx Function Call
	Call `DAQmxAdjust1503CurrentCal` with the following parameters: **calHandle**: `calHandle` **channelName**: Channel under test **measOutput**: Result from DMM in step 3.

6. Use the DAQmx Close External Calibration VI to commit the constant overwritten.

LabVIEW Block Diagram	NI-DAQmx Function Call
	Call `DAQmxCloseExtCal` with the following parameters: **calHandle**: `calHandle` **action**: `DAQmx_Val_Action_commit`

7. Repeat steps 1 through 6 for all of the other channels.
8. Once you have completed adjusting the SCXI-1503, reverify the module.

Where to Go for Support

The National Instruments Web site 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.

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world to help address your support needs. For telephone support in the United States, create your service request at `ni.com/support` and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, visit the Worldwide Offices section of `ni.com/niglobal` to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

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