SCXI™-1121

Introduction

This document contains information and step-by-step instructions for calibrating the National Instruments (NI) SCXI-1121 module.

What Is Calibration?

Calibration consists of verifying the measurement accuracy of a module and adjusting for any measurement error. *Verification* is measuring the performance of the module and comparing these measurements to the factory specifications. During calibration, you supply and read voltage levels using external standards, then you adjust the module calibration constants. This circuitry compensates for any inaccuracies in the module, and returns the accuracy of the module to the factory specifications.

Why Should You Calibrate?

The accuracy of electronic components drifts with time and temperature, which can affect measurement accuracy as a module ages. Calibration restores these components to their specified accuracy and ensures that the module still meets NI standards.

How Often Should You Calibrate?

The measurement requirements of your application determine how often the SCXI-1121 module needs to be calibrated to maintain accuracy. NI recommends that you perform a complete calibration at least once every year. You can shorten this interval to 90 days or six months based on the demands of your application.

Equipment and Other Test Requirements

This section describes the test equipment, software, documentation, and test conditions required for calibrating the SCXI-1121 module.

Test Equipment

Calibration requires a high-precision voltage source with at least 50 ppm accuracy, a multiranging 5 1/2 digit digital multimeter (DMM) with 15 ppm accuracy, and 120 and 800 Ω ±10% precision resistors.

Instruments

NI recommends the following instruments for calibrating the SCXI-1121 module:

- Calibrator—Fluke 5700A
- DMM—NI 4060 or HP 34401A

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

Connectors

If you do not have custom connection hardware, you need the following connectors:

- Terminal block, such as the SCXI-1320
- Shielded 68-pin connector cable
- 50-pin ribbon cable
- 50-pin breakout box
- SCXI-1349 adapter

These components give easy access to the individual pins on the SCXI-1121 front and rear connectors.

Software and Documentation

You do not need any special software or documentation to calibrate the SCXI-1121 module. This calibration document contains all the information you need to complete the verification and adjustment procedures. If you would like more information on the module, refer to the *SCXI-1121 User Manual*.

Test Conditions

Follow these guidelines to optimize the connections and environment during calibration:

- Keep connections to the SCXI-1121 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 device. Use twisted-pair wire to eliminate noise and thermal offsets.
- Maintain the temperature between 18–28 °C.
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 15 minutes for the SCXI-1121 module to ensure the measurement circuitry is at a stable operating temperature.

Calibration

The calibration procedure for the SCXI-1121 module consists of the following steps:

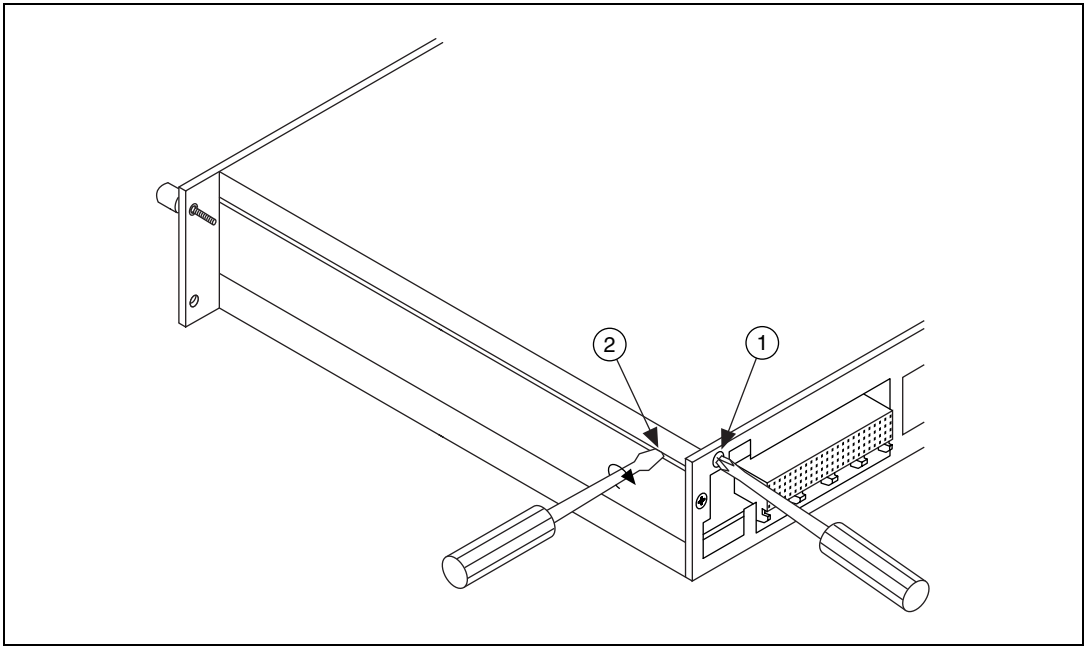
1. Setting up the module for testing.
2. Verifying the existing operation of the module to determine whether it is operating within its specifications.
3. Adjusting the module with respect to a known voltage source.
4. Verifying that the module is operating within its specifications after adjustments.

Setting Up the Module

Complete the following steps to set up the SCXI-1121 module for verification:

1. Remove the grounding screw from the module.
2. Remove the cover on the module to access the potentiometers.

Refer to Figure 1 for an illustration of steps 1 and 2.

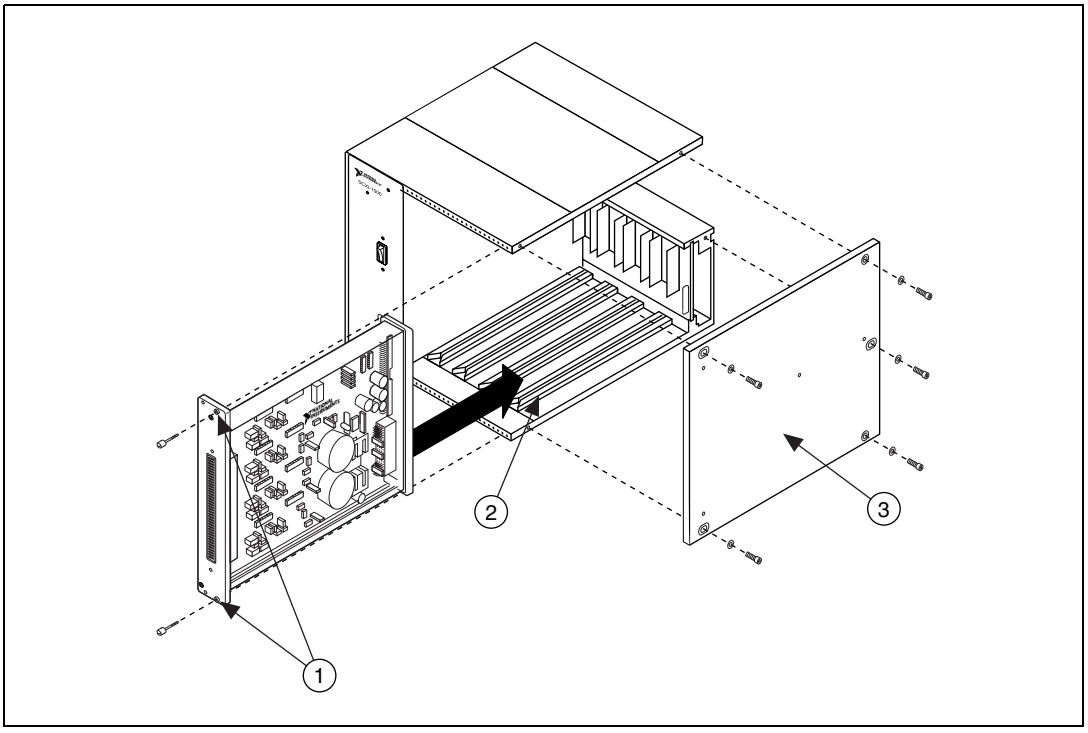


1 Grounding Screw	2 Module Cover

Figure 1. Grounding Screw and Cover Removal

3. Remove the side plate of the SCXI chassis.
4. Install the module into slot 4 of the SCXI chassis.

Refer to Figure 2 for an illustration of steps 3 and 4.



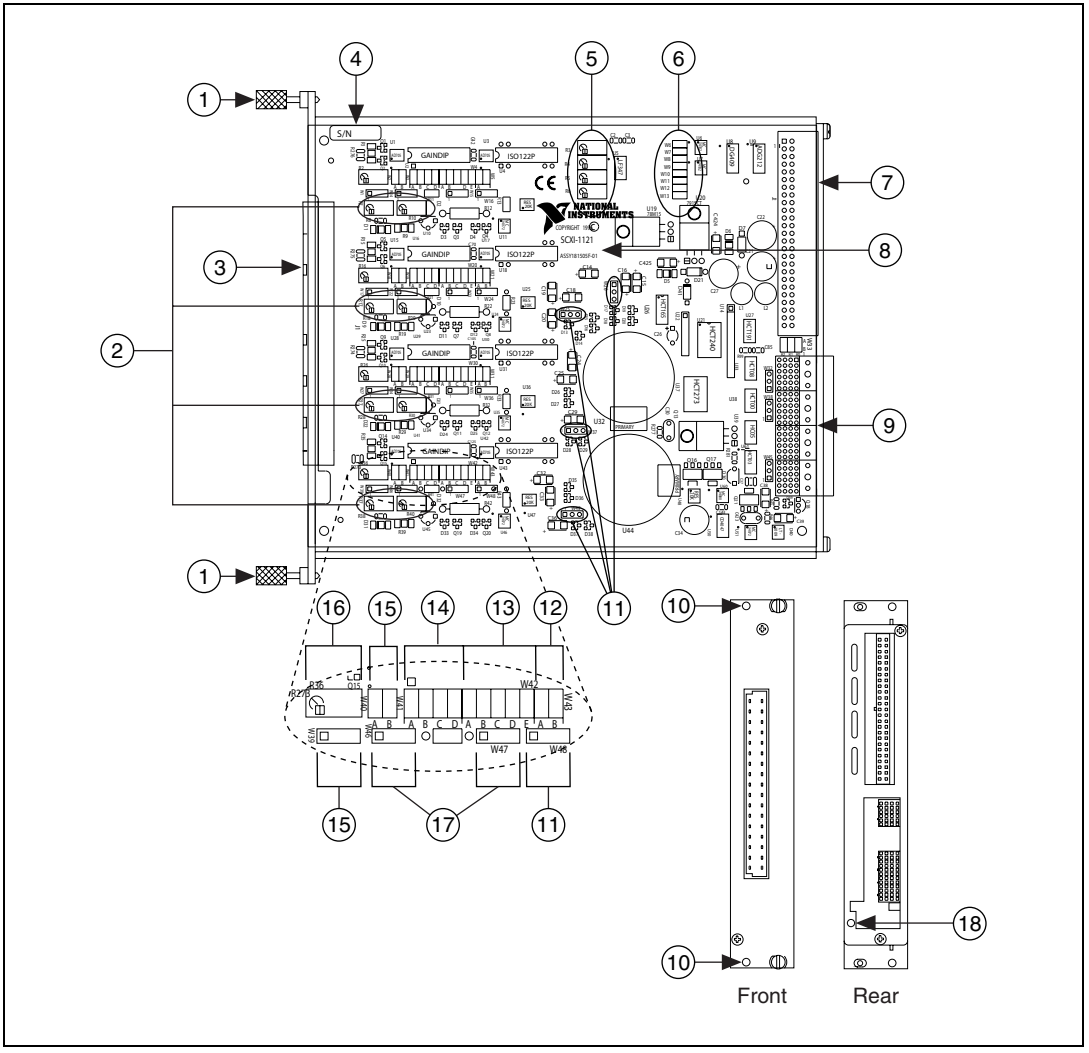
1 Thumbscrews	2 Slot 4	3 Side Plate

Figure 2. Side Plate Removal and Module Installation

The SCXI-1121 module does not need to be connected to a data acquisition (DAQ) device. Leave the configuration of the digital jumpers W41–W45 and W46 unchanged because they do not affect this procedure.

Configuring the Half-Bridge Completion Jumpers

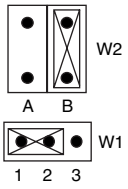
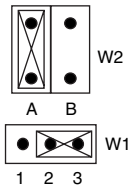
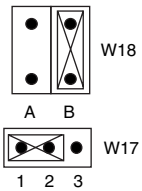
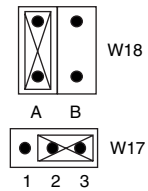
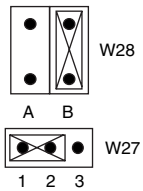
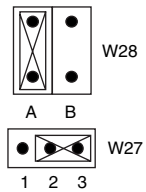
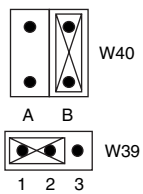
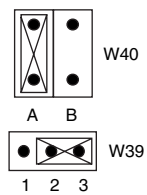
Verify that the half-bridge completion network is disabled prior to calibrating the module. Refer to Figure 3 for the location of the jumpers and Table 1 for the correct jumper settings to disable the network.



1	Thumbscrews	10	Terminal Block Mounting Hole
2	Voltage and Current Adjust	11	Excitation Level Jumpers
3	Front Connector	12	First-Stage Filter Jumpers
4	Serial Number	13	Second-Stage Gain Jumpers
5	Output Null Adjust Potentiometers	14	First-Stage Gain Jumpers
6	Second-Stage Filter Jumpers	15	Half-Bridge Completion Jumpers
7	Rear Signal Connector	16	Input Null Adjust Potentiometers
8	Product Name, Assembly Number, Revision Letter	17	Excitation Mode Jumpers
9	SCXIbus Connector	18	Grounding Screw

Figure 3. SCXI-1121 Parts Locator Diagram

Table 1. Completion Network Jumpers

Channel	Jumpers	Enable Completion	Disable Network (Factory Setting)
0	W1 and W2		
1	W17 and W18		
2	W27 and W28		
3	W39 and W40		

Configuring the Gain Jumpers

Each input channel has two user-configurable gain stages. The first-stage gain provides gains of 1, 10, 50, and 100. The second-stage gain provides gains of 1, 2, 5, 10, and 20. The device ships with the first-stage gain set to 100 (position A) and the second-stage gain set to 10 (position D).

To change the gain setting of a specified channel on the module, refer to Table 2 for the jumper reference designator of the channel gain stage you want to change, and Figure 3 for the location of this jumper. Move the jumper to the position indicated in Table 3.

Table 2. Gain Jumper Reference Designators

Input Channel Number	First-Stage Gain Jumper	Second-Stage Gain Jumper
0	W3	W4
1	W19	W20
2	W29	W30
3	W41	W42

Table 3. Gain Jumper Positions

Gain	Setting	Jumper Position
First-Stage	1	D
	10	C
	50	B
	100	A (factory setting)
Second-Stage	1	A
	2	B
	5	C
	10	D (factory setting)
	20	E

The order of the settings for the first- and second-stage gain does not matter as long as the first-stage gain multiplied by the second-stage gain equals the desired final gain value.

Configuring the Filter Jumpers

Each input channel also has two user-configurable filter stages.
The SCXI-1121 module ships in the 4 Hz position. Refer to Table 4 to find the correct jumper setting for the desired cutoff frequency. Figure 3 shows the locations of the jumper blocks on the SCXI-1121 module. Verify that both filter stages are set to the same filter setting to ensure that you achieve the desired bandwidth.

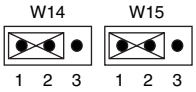
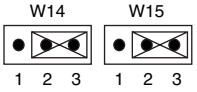
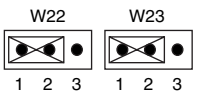
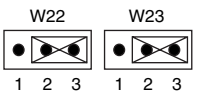
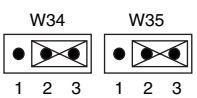
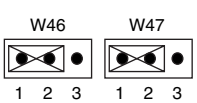
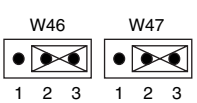
Table 4. Filter Jumper Settings

Input Channel Number	First Filter Jumper		Second Filter Jumper	
	4 Hz (Factory Setting)	4 kHz	4 Hz (Factory Setting)	4 kHz
0	W5-A	W5-B	W6	W7
1	W21-A	W21-B	W8	W9
2	W31-A	W31-B	W10	W11
3	W43-A	W43-B	W12	W13

Configuring the Excitation Jumpers

You can configure each excitation channel of the SCXI-1121 module to either a voltage or current excitation mode. Each channel has two jumpers for this purpose. Set both jumpers in the same mode for correct operation of the excitation channel. Refer to Table 5 to determine how to set up the module in the mode you want. The SCXI-1121 module ships to you in the voltage mode.

Table 5. Voltage and Current Mode Excitation Jumper Settings

Excitation Channel	Jumpers	Voltage Mode (Factory Setting)	Current Mode
0	W14 and W15		
1	W22 and W23		
2	W34 and W35		
3	W46 and W47		

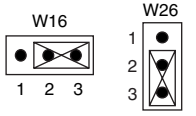
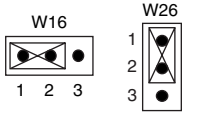
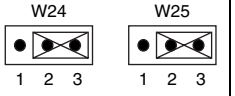
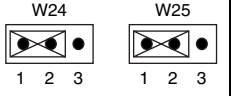
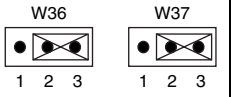
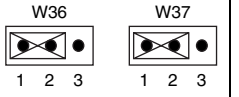
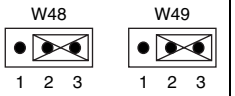
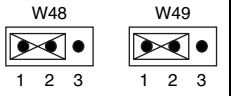
Configuring the Excitation Level

Each excitation channel of the SCXI-1121 module has two different current or voltage levels. You can set a given channel to one of the following level modes:

- In the current mode—0.150 or 0.450 mA
- In the voltage mode—3.333 or 10 V

After selecting the excitation mode of operation desired—voltage or current—as described in the previous section, refer to Table 6 to set the SCXI-1121 module for the level of operation. The SCXI-1121 module ships with the voltage mode set to 3.333 V.

Table 6. Excitation Level Jumper Settings

Excitation Channel	Jumpers	3.333 V or 0.150 mA (Factory Setting)	10 V or 0.450 mA
0	W16 and W26		
1	W24 and W25		
2	W36 and W37		
3	W48 and W49		

Verifying the Operation of the Module

The verification procedure determines how well the SCXI-1121 module is meeting its specifications. You can use this information to select the appropriate calibration interval for your application. Refer to the *Setting Up the Module* section for information on how to configure the channel gain, channel filter, and excitation level.

Verifying Analog Input Offsets

Complete the following steps to verify the analog input offsets:

1. Read the *Test Conditions* section in this document.
2. Refer to Table 12 in the *Specifications* section for all acceptable settings for the module. NI recommends verifying all ranges and gains, but you can save time by checking only those ranges used in your application.
3. Set the channel gain on all channels to the gain you want to test, starting with the smallest gain available for the module. Table 12 shows available gains.
4. Set the channel filter for all channels on the module to 10 kHz.
5. Connect the calibrator to the analog input channel you are testing, starting with channel 0. If you do not have an SCXI terminal block such as the SCXI-1320, refer to Table 7 to determine the pins on the 96-pin front connector that correspond to the positive and negative inputs of the specified channel. For example, the positive input for channel 0 is pin A32, which is labeled *CH0+*. The negative input for channel 0 is pin C32, which is labeled *CH0–*.

Table 7. SCXI-1121 Front Connector Pin Assignments

Pin Number	Column A	Column B	Column C
32	CH0+	NC	CH0–
31	NC	NC	NC
30	EX0+	NC	EX0–
29	NC	NC	NC
28	EGND0	NC	NC
27	NC	NC	NC
26	CH1+	NC	CH1–
25	NC	NC	NC
24	EX1+	NC	EX1–

Table 7. SCXI-1121 Front Connector Pin Assignments (Continued)

Pin Number	Column A	Column B	Column C
23	NC	NC	NC
22	EGND1	NC	NC
21	NC	NC	NC
20	CH2+	NC	CH2–
19	NC	NC	NC
18	EX2+	NC	EX2–
17	NC	NC	NC
16	EGND2	NC	NC
15	NC	NC	NC
14	CH3+	NC	CH3–
13	NC	NC	NC
12	EX3+	NC	EX3–
11	NC	NC	NC
10	EGND3	NC	NC
9	NC	NC	NC
8	NC	NC	RSVD
7	NC	NC	NC
6	SCAL	NC	RSVD
5	NC	NC	NC
4	+5V	NC	MTEMP
3	NC	NC	NC
2	CGND	NC	DTEMP
1	NC	NC	NC

NC—No connect

6. Set the DMM to voltage mode, and connect it to the output of the same channel to which the calibrator was connected in step 5. Refer to Figure 4 to determine the pins on the 50-pin rear connector that correspond to the positive and negative outputs for the specified channel. For example, the positive output for channel 0 is pin 3, which is labeled *MCH0*+. The negative output for channel 0 is pin 4, which is labeled *MCH0*–.

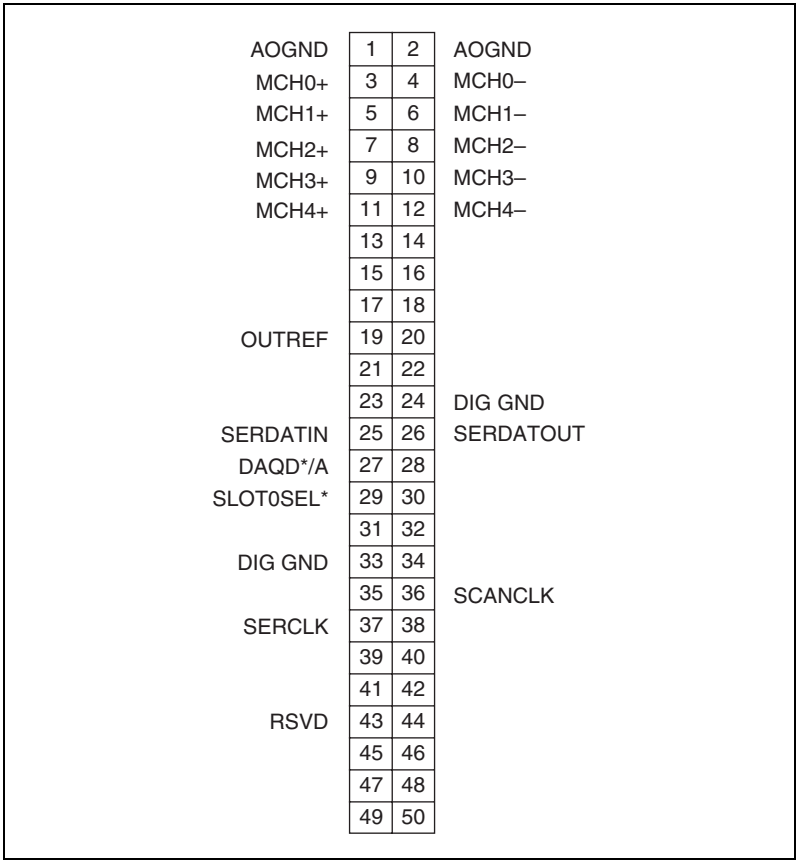


Figure 4. SCXI-1121 Rear Connector Pin Assignments

7. Set the calibrator voltage to the value specified by the Test Point entry listed in Table 12.
8. Read the resulting output voltage on the DMM. If the output voltage result falls between the Upper Limit and the Lower Limit values, the module passed the test.
9. Repeat steps 5 through 8 for the remaining test points.
10. Repeat steps 5 through 9 for the remaining analog input channels.

11. Repeat steps 3 through 10 for the remaining gain and filter values specified in Table 12.

You have completed verifying the analog input offsets. If any of your measurements fall outside the specifications listed in Table 12, adjust the module as described in the *Adjusting Analog Input Offsets* section.

Verifying Voltage Excitation Limits

Complete the following steps to verify the voltage excitation limits:

1. Connect a 120 Ω resistor to the output of the excitation channel you are testing, starting with excitation channel 0.

   If you have a terminal block such as the SCXI-1320, the excitation channel connections are marked on the terminal block. If you do not have a terminal block, refer to Table 7 for connection information.
2. Configure the excitation channel to the 3.333 V level.
3. Connect the DMM leads to the excitation output as closely as possible to the resistor body.
4. Compare the DMM reading to the limits for excitation shown in Table 8. If the reading falls between the Upper Limit and the Lower Limit values, the module passed the test.

Table 8. SCXI-1121 Voltage Excitation Limits

Test Point (V)	Upper Limit (V)	Lower Limit (V)
3.333	3.337000	3.329000
10	10.020000	9.980000

5. Configure the excitation channel to the 10 V level, replace the 120 Ω resistor with the 800 Ω resistor, and repeat steps 3 and 4.
6. Repeat steps 2 through 5 for all remaining channels.

You have completed verifying the voltage excitation limits. If any of your measurements fall outside the specifications listed in Table 8, adjust the module as described in the *Adjusting Voltage Excitation* section.

Verifying Current Excitation Limits

Complete the following steps to verify current excitation limits:

1. Remove the resistor from the excitation channel if you have not already done so.
2. Configure the channel to the 0.150 mA excitation level.
3. Set the DMM to current mode, and connect it to the excitation channel output, starting with excitation channel 0.

If you do not have a terminal block, refer to Figure 3 for connection information.

4. Compare the DMM reading to the limits for excitation shown in Table 9. If the reading falls between the Upper Limit and Lower Limit values, the module passed the test.

Table 9. SCXI-1121 Current Excitation Limits

Test Point (mA)	Upper Limit (mA)	Lower Limit (mA)
0.150	0.150060	0.149940
0.450	0.450900	0.449100

5. Configure the channel for 0.450 mA excitation level and repeat steps 2 and 4.
6. Repeat steps 2 through 5 for all remaining channels.

You have completed verifying the current excitation limits. If any of your measurements fall outside the specifications listed in Table 9, adjust the module as described in the *Adjusting Current Excitation* section.

Adjusting the Module

This section contains adjustment procedures for the analog input offsets, the voltage excitation limits, and the current excitation limits. Refer to the *Setting Up the Module* section for information on how to configure the channel gain, channel filter, and excitation level.

Adjusting Analog Input Offsets

Complete the following steps to adjust the offset null value:

1. Set the channel gain on the channel you are adjusting to a gain of 1. Set the filter value to 4 Hz.
2. Connect the calibrator to the analog input channel you want to adjust. Refer to Table 7 to determine the pins on the 96-pin front connector that correspond to the positive and negative inputs of the specified channel. For example, the positive input for channel 0 is pin A32, which is labeled *CH0+*. The negative input for channel 0 is pin C32, which is labeled *CH0–*.
3. Set the DMM to voltage mode, and connect it to the output of the same channel to which the calibrator was connected in step 2. Refer to Figure 4 to determine the pins on the 50-pin rear connector that corresponds to the positive and negative outputs for the specified channel. For example, the positive output for channel 0 is pin 3, which is labeled *MCH0+*. The negative output for channel 0 is pin 4, which is labeled *MCH0–*.

4. Set the calibrator to output 0.0 V.
5. Adjust the output null potentiometer of the channel until the DMM reading is 0.0 ±3.0 mV. Refer to Figure 3 for the potentiometer location and Table 10 for the potentiometer reference designator.

Table 10. Calibration Potentiometers Reference Designators

Input Channel Number	Input Null	Output Null
0	R02	R03
1	R16	R04
2	R26	R05
3	R36	R06

6. Set the channel gain to a gain of 1000.0 on the channel you are adjusting. Refer to Tables 2, 3, and 4 for more information.
7. Adjust the input null potentiometer of channel 0 until the DMM reading is 0.0 ±6.0 mV. Refer to Figure 3 for the potentiometer location and Table 10 for the potentiometer reference designator.
8. Repeat steps 1 through 7 for the remaining analog inputs.

You have completed adjusting the analog input offsets.

Adjusting Voltage Excitation

When you adjust the excitation channels, you should always start with the voltage excitation and then proceed to the current excitation. Use the voltage excitation reference as the voltage reference for the current excitation.

Complete the following steps to adjust the voltage excitation:

1. Connect the 120 Ω resistor across the output of the excitation channel you are adjusting.
2. Configure the excitation channel to 3.333 V excitation level.
3. Connect the DMM leads to the excitation outputs as closely as possible to the resistor body.
4. Adjust the excitation voltage potentiometer until the voltage reading falls between 3.337 and 3.329 V. Refer to Figure 3 for the potentiometer location and Table 11 for the potentiometer reference designator.

Table 11. Excitation Calibration Potentiometer Reference Designators

Input Channel Number	Excitation Channel	
	Voltage Mode	Current Mode
0	R10	R7
1	R20	R17
2	R30	R27
3	R40	R37

5. Configure the excitation channel for the 10 V excitation level.
6. Remove the 120 Ω resistor and connect the 800 Ω resistor across the output of the excitation channel.
7. Adjust the excitation voltage potentiometer until the voltage reading falls between 10.02 and 9.98 V.
8. Repeat steps 1 through 7 for all remaining channels.

You have completed adjusting the voltage excitation channels.

Adjusting Current Excitation

Complete the following steps to adjust the current excitation:

1. Remove the resistor from the excitation channel if you have not already done so.
2. Configure the channel for 0.150 mA current excitation level.
3. Set the DMM to current mode and connect it to the excitation channel output you want to adjust. Adjust the excitation current potentiometer until the current reading falls between 0.150060–0.149940 mA. Refer to Figure 3 for the potentiometer location and Table 11 for the potentiometer reference designator.
4. Configure the channel for 0.450 mA current excitation level.
5. Adjust the excitation current potentiometer until the current reading falls between 0.450900–0.449100 mA. Refer to Figure 3 for the potentiometer location and Table 11 for the potentiometer reference designator.
6. Repeat steps 1 through 5 for all remaining channels.

You have completed adjusting the current excitation channels.

Verifying Adjusted Values

After completing the adjustments, it is important to verify the analog input operation, the voltage excitation, and the current excitation again by repeating the steps listed in the *Verifying the Operation of the Module* section. Verifying the adjusted values ensures that the SCXI-1121 module is operating within its specifications after adjustments.

Note If the SCXI-1121 module fails after calibration, return it to NI for repair or replacement.

Specifications

Table 12 contains test specifications for the SCXI-1121 module. If the device was calibrated within the last year, the output from the module should fall between the Upper Limit and Lower Limit values.

Table 12. SCXI-1121 Specifications

Gain	Test Point (V)	4Hz filter setting		10kHz filter setting	
		Upper Limit (V)	Lower Limit (V)	Upper Limit (V)	Lower Limit (V)
0.01[1]	225.0000	2.269765	2.230236	2.346618	2.303382
0.01[1]	0.0000	0.005144	–0.05144	0.006510	–0.006510
0.01[1]	–225.0000	–2.230236	–2.269765	–2.303382	–2.346618
0.02[1]	225.0000	4.534387	4.465613	3.750713	3.689287
0.02[1]	0.0000	0.005146	–0.005146	0.006540	–0.006540
0.02[1]	–225.0000	–4.465613	–4.534387	–3.689287	–3.750713
0.05[1]	90.0000	4.534387	4.465614	4.686836	4.613164
0.05[1]	0.0000	0.005146	–0.005146	0.006620	–0.006620
0.05[1]	–90.0000	–4.465614	–4.534387	–4.613164	–4.686836
0.01[1]	45.0000	4.534387	4.465613	4.686936	4.613064
0.01[1]	0.0000	0.005146	–0.005146	0.006720	–0.006720
0.01[1]	–45.0000	–4.465613	–4.534387	–4.613064	–4.686936
0.02[1]	22.5000	4.534387	4.465613	4.687516	4.612484
0.02[1]	0.0000	0.005146	–0.005146	–0.007300	–0.007300
0.02[1]	–22.5000	–4.465613	–4.534387	–4.612484	–4.687516
0.05[1]	9.0000	4.534388	4.465613	4.686911	4.613089
0.05[1]	0.0000	0.005147	–0.005147	0.006695	–0.006695
0.05[1]	–9.0000	–4.465613	–4.534388	–4.613089	–4.686911
1	4.5000	4.534295	4.465705	4.535671	4.464329
1	0.0000	0.005144	–0.005144	0.006520	–0.006520
1	–4.5000	–4.465705	–4.534295	–4.464329	–4.535671
2	2.2500	4.534292	4.465708	4.535693	4.464307

Table 12. SCXI-1121 Specifications (Continued)

Gain	Test Point (V)	4Hz filter setting		10kHz filter setting	
		Upper Limit (V)	Lower Limit (V)	Upper Limit (V)	Lower Limit (V)
2	0.0000	0.005141	–0.005141	0.006542	–0.006542
2	–2.2500	–4.465708	–4.534292	–4.464307	–4.535693
5	0.9000	4.534293	4.465707	4.535706	4.464294
5	0.0000	0.005142	–0.005142	0.006555	–0.006555
5	–0.9000	–4.465707	–4.534293	–4.464294	–4.535706
10	0.4500	4.534387	4.465613	4.535771	4.464229
10	0.0000	0.005236	–0.005236	0.006620	–0.006620
10	–0.4500	–4.465613	–4.534387	–4.464229	–4.535771
20	0.2250	4.534456	4.465544	4.535979	4.464021
20	0.0000	0.005305	–0.005305	0.006828	–0.006828
20	–0.2250	–4.465544	–4.534456	–4.464021	–4.535979
50	0.0900	4.534694	4.465306	4.536146	4.463854
50	0.0000	0.005543	–0.005543	0.006995	–0.006995
50	–0.0900	–4.465306	–4.534694	–4.463854	–4.536146
100	0.0450	4.535095	4.464905	4.536551	4.463449
100	0.0000	0.005944	–0.005944	0.007400	–0.007400
100	–0.0450	–4.464905	–4.535095	–4.463449	–4.536551
200	0.0225	4.535892	4.464108	4.537797	4.462203
200	0.0000	0.006741	–0.006741	0.008646	–0.008646
200	0.0225	–4.464108	–4.535892	–4.462203	–4.537797
250	0.0180	4.536294	4.463706	4.538614	4.461387
250	0.0000	0.007143	–0.007143	0.009463	–0.009463
250	–0.0180	–4.463706	–4.536294	–4.461387	–4.538614
500	0.0090	4.538303	4.461698	4.540951	4.459049
500	0.0000	0.009152	–0.009152	0.011800	–0.011800
500	–0.0090	–4.461698	–4.538303	–4.459049	–4.540951

Table 12. SCXI-1121 Specifications (Continued)

Gain	Test Point (V)	4Hz filter setting		10kHz filter setting	
		Upper Limit (V)	Lower Limit (V)	Upper Limit (V)	Lower Limit (V)
1000	0.0045	4.542321	4.457679	4.546501	4.453499
1000	0.0000	0.013170	–0.013170	0.017350	–0.017350
1000	–0.0045	–4.457679	–4.542321	–4.453499	–4.546501
2000	0.00225	4.551389	4.448611	4.558631	4.441369
2000	0.00000	0.022238	–0.022238	0.029480	–0.029480
2000	–0.00225	–4.448611	–4.551389	–4.441369	–4.558631

[1] Value available only when used with the SCXI-1327 high-voltage terminal block