SCXI™-1121

Introduction

This document contains information and step-by-step instructions for verifying and calibrating the National Instruments SCXI-1121 signal conditioning module.

What Is Calibration?

Calibration is a procedure of reading offset and gain errors from a device and updating special analog calibration circuitry that corrects these errors. During the factory calibration process, the calibration constants are stored in the non-volatile memory of the device. These values are loaded from memory and used as needed by the device. SCXI-1121 modules have two potentiometers per channel for amplifier offset nulling. One potentiometer nulls the input offset, the other nulls the output offset. During calibration, you adjust these onboard calibration potentiometers with respect to external standards.

Why Should You Calibrate?

Offset and gain errors drift with time and temperature, which could invalidate the factory-set calibration of a device. Calibration restores the device to its specified accuracy.

How Often Should You Calibrate?

The measurement accuracy requirements of your application determine how often you should calibrate your SCXI-1121 module. National Instruments recommends you perform a complete calibration at least once every year. You can shorten this interval to six months or 90 days, based on the demands of your application.

Equipment and Other Test Requirements

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

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 a National Instruments E Series DAQ device.

National Instruments recommends the following instruments for calibration of an SCXI-1121:

- Calibrator—Fluke 5700A
- DMM—NI 4060 or HP 34401A
- 800 Ω precision resistor
- 120 Ω precision resistor
- National Instruments E Series DAQ device

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

Note If you do not have custom connection hardware, you need a connector block such as the National Instruments SCXI-1320, a shielded 68-pin connector cable, a 50-pin ribbon cable, a 50-pin breakout box, and an SCXI adapter. These components give easy access to the individual pins on the SCXI-1121 front and rear connectors.

Software and Documentation

No special software or documentation is necessary to verify the operation of the SCXI-1121. This calibration document contains all the information you need to complete the verification and adjustment procedures. However, if you would like more information on the product, refer to the *SCXI-1121 User Manual*.

Test Conditions

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

- Keep connections to the SCXI 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 and 28 °C.
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 15 minutes for the SCXI module.

Calibration

The calibration process consists of the following steps:

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

Setting Up Your Module

Install the module into slot 1of a properly functioning SCXI chassis. Remove the side plate of the SCXI chassis and the cover on the module to access the potentiometers. The SCXI-1121 does not need to be connected to a data acquisition device during this procedure. Refer to Table 1 for the jumpers for gain selection associated with each channel, and Table 3 to see how to position each jumper to select the desired gain for each channel.

Each input channel has two user-configurable gain stages. The first gain stage provides gains of 1, 10, 50, and 100, and the second stage provides gains of 1, 2, 5, 10, and 20. The device is shipped 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, move the appropriate jumper on your module to the position indicated in Table 2. Refer to Table 1 for jumper reference designators on the module.

Table 1. Gain Jumper Allocation

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

Table 2. 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 does not matter as long as the first stage gain multiplied by the second stage gain equals the desired final gain value.

Table 3. Filter Jumper Allocation

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

Table 4. Voltage and Current Mode Excitation Jumper Setup

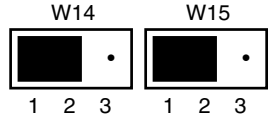
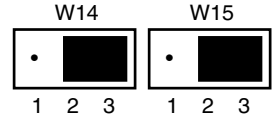
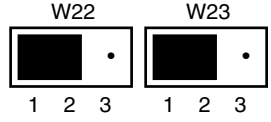
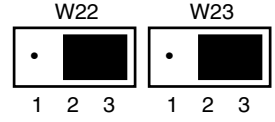
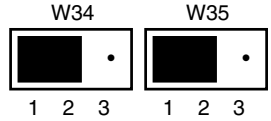
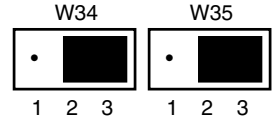
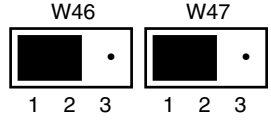
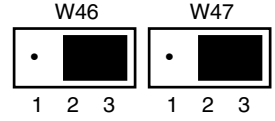
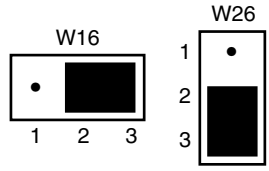
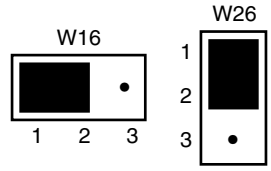
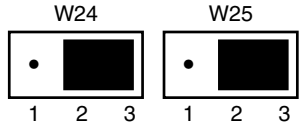
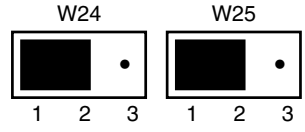
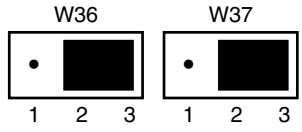
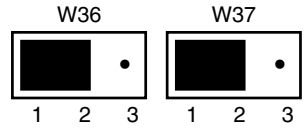
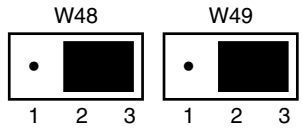
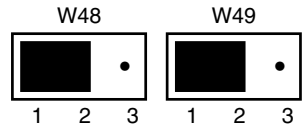
Excitation Channel	Jumpers	Voltage Mode (Factory Setting)	Current Mode
0	W14 and W15		
1	W22 and W23		
2	W34 and W35		
3	W46 and W47		

Table 5. Excitation Level Jumper Selection

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 Your 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 Table 8, Table 9, and Table 10 for the test specifications of the SCXI-1121.

Verifying Analog Inputs

Complete the following steps to verify analog input offsets:

1. Read the *Test Conditions* section earlier in this document.
2. Refer to Table 8 for the specification limits that you will test. This table shows all acceptable settings for the module. Although National Instruments recommends you verify all ranges and gains, you may want to save time by checking only the ranges you use 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. Available gains are shown in Table 8. Refer to the *Setting Up Your Module* section earlier in this document for information on how to set the channel gain.
4. Set the channel filter to the value specified in the appropriate table.
5. Connect the calibrator to the analog input channel you will test, starting with channel 0. If you do not have an SCXI connector block such as the SCXI-1320, refer to Figure 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–.
6. Connect your DMM to the output of the same channel to which the calibrator was connected in step 5. Refer to Figure 2 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 input for channel 0 is pin 4, which is labeled MCH0–.
7. Set the calibrator voltage to the value specified by the *Test Point* entry listed in the appropriate table.
8. Read the resulting output voltage on the DMM. If the output voltage result falls between the *Upper Limit* and the *Lower Limit*, the module has passed the test.
9. Repeat steps 5 through 8 for the remaining analog input channels.
10. Repeat steps 3 through 9 for the remaining gain and filter values specified in the appropriate table.

You have completed verifying the analog input offsets of your SCXI-1121.

Verifying Voltage Excitation Limits

Complete the following steps to verify voltage excitation limits on your SCXI-1121:

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 Figure 1 for connection information.
2. Configure the excitation channel to the 3.333 V level. Refer to Table 4 and Table 5 for the correct settings to achieve the 3.333 V level.
3. Connect the DMM leads to the excitation output as close as possible to the resistor body.
4. Read the measurement and compare it to the values in Table 9. If the reading falls between the *Upper Limit* and the *Lower Limit*, the module is operating within its specifications.
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 analog input offsets of your SCXI-1121. If any of your measurements fall outside the specifications listed in Table 9, go to the *Adjusting Voltage Excitation* section later in this document.

Verifying Current Excitation Limits

Complete the following steps to verify current excitation limits on your SCXI-1121:

1. Remove the resistor from the excitation channel.
2. Configure the channel for 150 µA excitation level. Refer to Tables 4 and 5 for the correct settings to achieve the 150 µA level.
3. Connect the ammeter leads to the excitation channel output, 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 Figure 1 for connection information.
4. Read the measurement and compare it to the values in Table 10. If the reading falls between the upper and lower limits, the module is operating within its specifications.
5. Configure the channel for 450 µA excitation level and repeat steps 3 and 4.
6. Repeat steps 2 through 5 for all remaining channels.

You have completed verifying the current excitation limits of your SCXI-1121. If any of your measurements fall outside the specifications listed in Table 10, go to the *Adjusting Current Excitation* section later in this document.

Adjusting Your Module

This section contains adjustment procedures for the analog inputs, the voltage excitation limits, and the current excitation limits.

Adjusting Analog Inputs

Complete the following steps to adjust the offset null value of your SCXI-1121:

1. Set the channel gain on the channel you are adjusting to a gain of 1. Set the filter value to 4 Hz. Refer to Table 1, Table 2, and Table 3 for the correct configuration.
2. Connect the calibrator to the analog input channel you want to adjust. Refer to Figure 1 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. Connect your DMM to the output of the same channel to which the calibrator was connected in step 2. Refer to Figure 2 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 input 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 reading on the DMM is 0.0 ±3 mV. The potentiometer locations and functions are listed in Table 6.
6. Set the channel gain to a gain of 1000.0 on the channel you are adjusting. Refer to Table 1, Table 2, and Table 3 for more information.
7. Adjust the input null potentiometer of the channel 0 until the reading on the DMM is 0.0 ±6 mV. Refer to Table 6 for potentiometer locations and functions.
8. Repeat steps 1 through 7 for the remaining analog inputs.

You have finished adjusting the analog input offsets of your SCXI-1121.

Table 6. Calibration Potentiometers Reference Designators

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

Adjusting Voltage Excitation

When adjusting the excitation channels, you should always start with the voltage excitation and then proceed to the current excitation.You will use the voltage excitation reference as the voltage reference for the current excitation. This procedure will show you how to adjust your module excitation channel to the factory-calibration setting.

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. Refer to Tables 4 and 5 for the correct settings to achieve the 3.333 V 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 3.334–3.332 V.
5. Configure the excitation channel to 10 V excitation level. Refer to Tables 4 and 5 for more information.
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 10.040 V and 9.960 V.
8. Repeat steps 1 through 7 for all remaining channels.

You have now completed adjusting the voltage excitation channels of your SCXI-1121 module.

Table 7. 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

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 150 mA current excitation level. Refer to Tables 4 and 5 for more information on configuration.
3. Connect the ammeter leads to the excitation channel output you want to adjust. Adjust the excitation current potentiometer until the current reading falls between 0.150060–0.14994 A. Refer to Table 7 for potentiometer numbers.
4. Configure the channel for 450 mA current excitation level. Refer to Tables 4 and 5 for more information on configuration.
5. Adjust the excitation current potentiometer until the current reading falls between 0.451800–0.448200 A. Refer to Table 7 for potentiometer numbers.
6. Repeat steps 1 through 5 for all remaining channels.

You have now completed adjusting the current excitation of your SCXI-1121.

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 section *Verifying the Operation of Your Module*. Verifying the adjusted values ensures that your SCXI-1121 module is now operating within its specifications.

Front and Rear Panel Diagrams

Figure 1 shows the pin assignments for the SCXI-1121 module front panel connector. Figure 2 shows the pin assignments for the SCXI-1121 rear panel connector

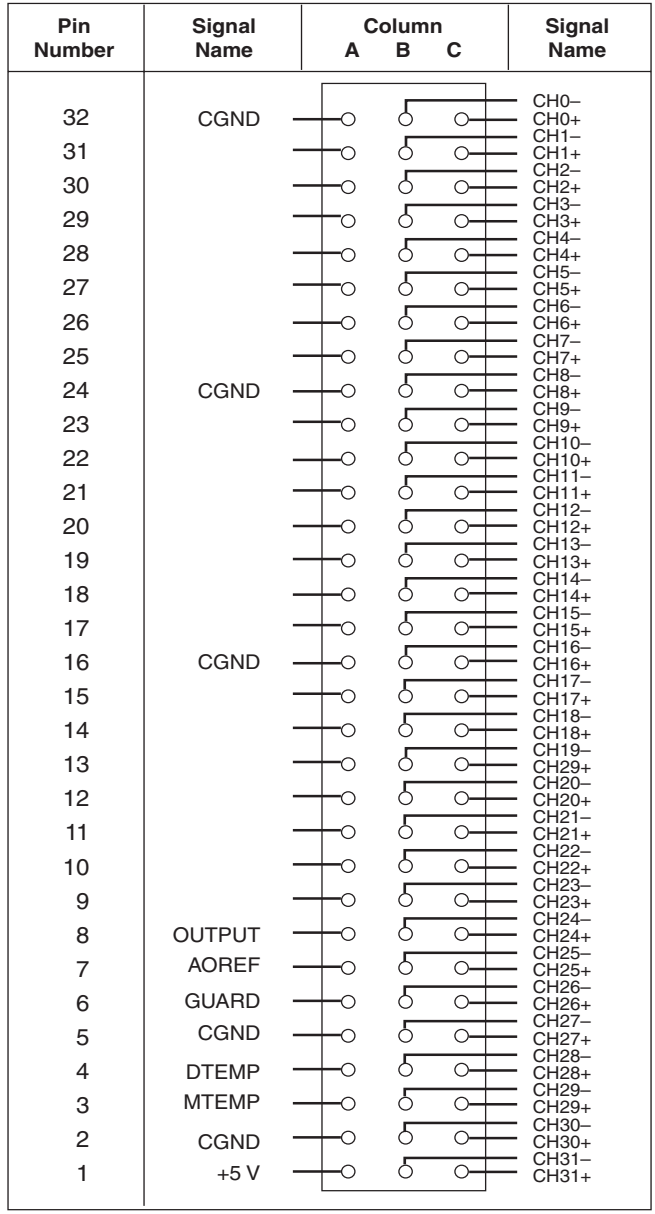


Figure 1. SCXI-1121 Front Connector Pin Assignments

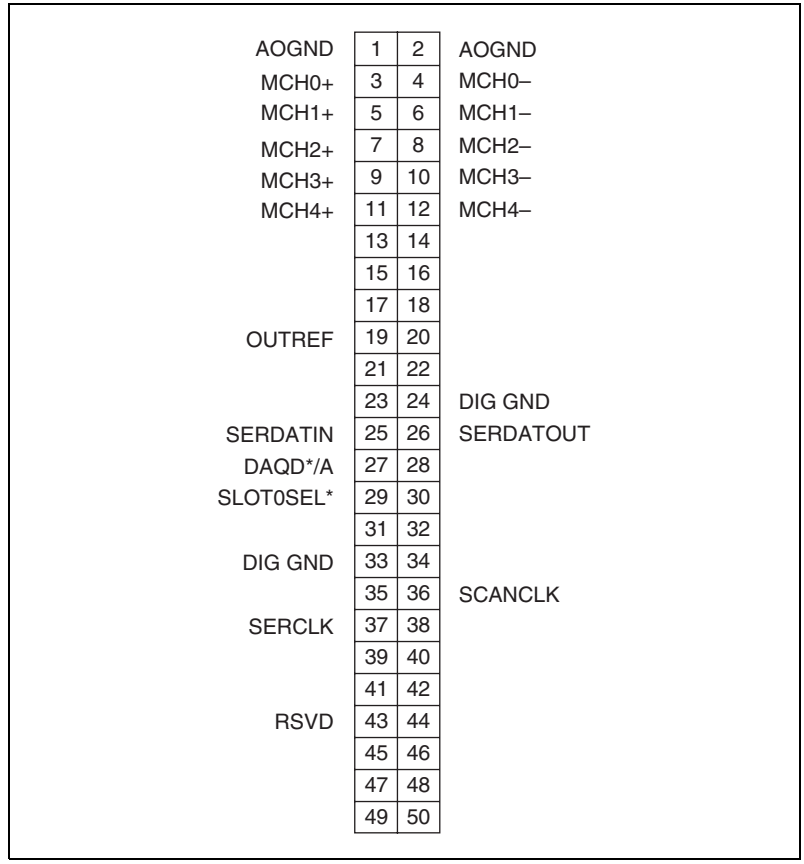


Figure 2. SCXI-1121 Rear Connector Pin Assignments

Specifications

The following tables contain test specifications for the SCXI-1121 signal conditioning module. If the device has been calibrated within the last year, the *Test Point* value should fall between the *Upper Limit* and *Lower Limit* values.

Table 8. SCXI-1121 Specifications

Gain	Test Point (V)	4 Hz		10 kHz	
		Upper Limit (V)	Lower Limit (V)	Upper Limit (V)	Lower Limit (V)
0.01	225.000000	2.269873	2.230127	2.269904	2.230097
	0.000000	0.005252	–0.005252	0.005283	–0.005283
	–225.000000	–2.230127	–2.269873	–2.230097	–2.269904
0.02	225.000000	4.534493	4.465507	4.534524	4.465476
	0.000000	0.005252	–0.005252	0.005283	–0.005283
	–225.000000	–4.465507	–4.534493	–4.465476	–4.534524
0.05	90.000000	4.534494	4.465507	4.534524	4.465476
	0.000000	0.005253	–0.005253	0.005283	–0.005283
	–90.000000	–4.465507	–4.534494	–4.465476	–4.534524
0.1	45.000000	4.534493	4.465507	4.534524	4.465476
	0.000000	0.005252	–0.005252	0.005283	–0.005283
	–45.000000	–4.465507	–4.534493	–4.465476	–4.534524
0.2	22.500000	4.534493	4.465507	4.534524	4.465476
	0.000000	0.005252	–0.005252	0.005283	–0.005283
	–22.500000	–4.465507	–4.534493	–4.465476	–4.534524
0.5	9.000000	4.534594	4.465407	4.534624	4.465376
	0.000000	0.005353	–0.005353	0.005383	–0.005383
	–9.000000	–4.465407	–4.534594	–4.465376	–4.534624
1	4.500000	4.534603	4.465397	4.534634	4.465366
	0.000000	0.005452	–0.005452	0.005483	–0.005483
	–4.500000	–4.465397	–4.534603	–4.465366	–4.534634

Table 8. SCXI-1121 Specifications

Gain	Test Point (V)	4 Hz		10 kHz	
		Upper Limit (V)	Lower Limit (V)	Upper Limit (V)	Lower Limit (V)
2	2.250000	4.534803	4.465197	4.534834	4.465166
	0.000000	0.005652	–0.005652	0.005683	–0.005683
	–2.250000	–4.465197	–4.534803	–4.465166	–4.534834
5	0.900000	4.535454	4.464547	4.535484	4.464516
	0.000000	0.006303	–0.006303	0.006333	–0.006333
	–0.900000	–4.464547	–4.535454	–4.464516	–4.535484
10	0.450000	4.536463	4.463537	4.536494	4.463506
	0.000000	0.007312	–0.007312	0.007343	–0.007343
	–0.450000	–4.463537	–4.536463	–4.463506	–4.536494
20	0.225000	4.538523	4.461477	4.538554	4.461446
	0.000000	0.009372	–0.009372	0.009403	–0.009403
	–0.225000	–4.461477	–4.538523	–4.461446	–4.538554
50	0.090000	4.544704	4.455297	4.544734	4.455266
	0.000000	0.015553	–0.015553	0.015583	–0.015583
	–0.090000	–4.455297	–4.544704	–4.455266	–4.544734
100	0.045000	4.555003	4.444997	4.555034	4.444966
	0.000000	0.025852	–0.025852	0.025883	–0.025883
	–0.045000	–4.444997	–4.555003	–4.444966	4.555034
200	0.022500	4.575603	4.424397	4.575661	4.424339
	0.000000	0.046452	–0.046452	0.046510	–0.046510
	–0.022500	–4.424397	–4.575603	–4.424339	–4.575661
500	0.009000	4.637204	4.362797	4.637275	4.362726
	0.000000	0.108053	–0.108053	0.108124	–0.108124
	–0.009000	–4.362797	–4.637204	–4.362726	–4.637275
1000	0.004500	4.740203	4.259797	4.740463	4.259537
	0.000000	0.211052	–0.211052	0.211312	–0.211312
	–0.004500	–4.2597970	–4.740203	–4.259537	–4.740463

Table 8. SCXI-1121 Specifications

Gain	Test Point (V)	4 Hz		10 kHz	
		Upper Limit (V)	Lower Limit (V)	Upper Limit (V)	Lower Limit (V)
2000	0.002250	4.947203	4.052797	4.947743	4.052257
	0.000000	0.418052	–0.418052	0.418592	–0.418592
	–0.002250	–4.052797	–4.947203	–4.052257	–4.947743

Figure 3. SCXI-1121 Voltage Excitation Limits

Test Point (V)	Upper Limit (V)	Lower Limit (V)
3.333	3.334333	3.331667
10	10.040000	9.960000

Table 9. SCXI-1121 Current Excitation Limits

Test Point (mA)	Upper Limit (mA)	Lower Limit (mA)
0.15	0.150060	0.149940
0.45	0.451800	0.448200