SCXI™-1120/1120D

Introduction

This document contains information and step-by-step instructions for verifying and calibrating National Instruments SCXI-1120 and SCXI-1120D signal conditioning modules.

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-1120/1120D 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 the calibration interval of your SXCI-1120/1120D. 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-1120/1120D.

Test Equipment

Calibration requires a high-precision voltage source with at least 50 ppm accuracy and a multiranging 5 1/2 digit digital multimeter (DMM) with 15 ppm accuracy.

National Instruments recommends the following instruments for calibrating SCXI-1120/1120D modules:

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

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 will 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-1120/1120D front and rear connectors.

Software and Documentation

No special software or documentation is necessary to verify the operation of the SCXI-1120/1120D. 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-1120/1120D 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 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 Your Module

Install the SCXI-1120/1120D into slot 1 of 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-1120/1120D does not need to be connected to a data acquisition device during this procedure.

Each input channel has two user-configurable gain stages. The first gain stage provides gains of 1, 10, 50, and 100. The second stage provides gains of 1, 2, 5, 10, and 20. Table 1 shows the jumpers for gain selection associated with each channel. Table 2 shows how to position each jumper to select the desired gain for each channel.

Table 1. Gain Jumper Allocation

Input Channel Number	First Stage Gain Jumper	Second Stage Gain Jumper
0	W1	W9
1	W2	W10
2	W3	W11
3	W4	W12
4	W5	W13
5	W6	W14
6	W7	W15
7	W8	W16

Table 2. Gain Jumper Positions

Gain	Setting	Jumper Position
First Stage	1	D
	10	C
	50	B
	100	A
Second Stage	1	A
	2	B
	5	C
	10	D
	20	E

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.

Note The SCXI-1120D has an additional fixed pre-stage gain of 0.5.

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—multiplied by 0.5 when using the SCXI-1120D—equals the desired final gain value.

- SCXI-1120—To determine the overall gain of a given channel on the SCXI-1120, multiply the gain selection of the first stage by the gain selection of the second stage.
- SCXI-1120D—To determine the overall gain of a given channel on the SCXI-1120D, multiply the gain selection of the first stage by the gain selection of the second stage and then multiply that product by 0.5.

Table 3. SCXI-1120 Filter Jumper Allocation

Input Channel Number	First Filter Jumper		Second Filter Jumper	
	4 Hz (Factory Default)	10 kHz	4 Hz (Factory Default)	10 kHz
0	W17-A	W17-B	W25	W26
1	W18-A	W18-B	W27	W28
2	W19-A	W19-B	W29	W30
3	W20-A	W20-B	W31	W32
4	W21-A	W21-B	W33	W34
5	W22-A	W22-B	W35	W36
6	W23-A	W23-B	W37	W38
7	W24-A	W24-B	W39	W40

Table 4. SCXI-1120D Filter Jumper Allocation

Input Channel Number	First Filter Jumper		Second Filter Jumper	
	4.5 kHz (Factory Default)	22.5 kHz	22.5 kHz	4.5 kHz (Factory Default)
0	W17-A	W17-B	W25	W26
1	W18-A	W18-B	W27	W28
2	W19-A	W19-B	W29	W30
3	W20-A	W20-B	W31	W32
4	W21-A	W21-B	W33	W34
5	W22-A	W22-B	W35	W36
6	W23-A	W23-B	W37	W38
7	W24-A	W24-B	W39	W40

Note Your SCXI-1120D is shipped in the 4.5 kHz position. Verify that both stages are set to the same bandwidth to ensure the required bandwidth is achieved. Notice that one jumper block is available for each filter stage.

Verifying the Operation of Your Module

The verification procedure determines how well the SCXI-1120/1120D module is meeting its specifications. You can use this information to select the appropriate calibration interval for your application.

Complete the following steps to verify the operation of your SCXI-1120/1120D:

1. Read the *Test Conditions* section earlier in this document.
2. Refer to Table 6 for the SCXI-1120 or Table 7 for the SCXI-1120D for the specification limits you will test. This table shows all acceptable settings for the module. National Instruments recommends verifying all ranges and gains. However, you may want to save time by checking only those ranges that are 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. Available gains are shown in Table 6 and Table 7. 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 to be tested, starting with channel 0. If you do not have an SCXI connector block such as the SCXI 1320, 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–.
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 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 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* values, 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 now completed verifying the analog input offset.

Adjusting Offset Null Values of Your Module

Complete the following steps to adjust the offset null value of the SCXI-1120/1120D module:

1. Set the channel gain on all channels to a gain of 1. Set the filter value to 4 Hz for the SCXI-1120 or 4.5 kHz for the SCXI-1120D.
2. Connect the calibrator to the analog input channel you want to adjust, starting with channel 0. 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 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 input for channel 0 is pin 4, which is labeled MCH0–.
4. Set the calibrator to output 0.0 V.
5. Adjust the output potentiometer of the channel until the reading on the DMM is 0 ±3 mV. The potentiometer locations and functions are listed in Table 5.
6. Set the channel gain on all channels to 1000.0. Refer to the *Setting Up Your Module* section earlier in this document for information on how to do this.
7. Adjust the input potentiometer of the channel 0 until the reading on the DMM is 0 ±6 mV. The potentiometer locations and functions are listed in Table 5.
8. Repeat steps 1 through 7 for the remaining analog inputs.

You have now completed adjusting your module.

Table 5. Calibration Potentiometers Reference Designators

Input Channel Number	Input Null	Output Null
0	R08	R24
1	R10	R25
2	R12	R26
3	R14	R27

Table 5. Calibration Potentiometers Reference Designators

Input Channel Number	Input Null	Output Null
4	R16	R28
5	R18	R29
6	R20	R30
7	R21	R31

Verifying Adjusted Values

After completing the adjustments, it is important to verify the analog input operation again by repeating the steps listed in the section *Verifying the Operation of Your Module*. Verifying the adjusted values ensures your module is now operating within its specifications.

Specifications

The following tables contain test specifications for SCXI-1120/1120D signal conditioning modules. Table 6 contains test specifications for SCXI-1120 modules and Table 7 contains test specifications for SCXI-1120D modules. 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 6. SCXI-1120 Specifications

Gain	Test Point (V)	4 Hz Filter		10 kHz Filter	
		Upper Limit (V)	Lower Limit (V)	Upper Limit (V)	Lower Limit (V)
0.01[1]	232.5	2.340165	2.309835	2.340196	2.309804
0.01[1]	0	0.000058	–0.000058	0.000088	–0.000088
0.01[1]	–232.5	–2.309835	–2.340165	–2.309804	–2.340196
0.02[1]	186	3.744230	3.695770	3.744261	3.695739
0.02[1]	0	0.000057	–0.000057	0.000088	–0.000088
0.02[1]	–186	–3.695770	–3.744230	–3.695739	–3.744261
0.05[1]	93	4.685468	4.614532	4.685499	4.614501
0.05[1]	0	0.005253	–0.005253	0.005283	–0.005283
0.05[1]	–93	–4.614532	–4.685468	–4.614501	–4.685499
0.1[1]	46.5	4.685468	4.614532	4.685499	4.614501
0.1[1]	0	0.005252	–0.005252	0.005283	–0.005283
0.1[1]	–46.5	–4.614532	–4.685468	–4.614501	–4.685499
0.2[1]	23.25	4.685468	4.614532	4.685499	4.614501
0.2[1]	0	0.005252	–0.005252	0.005283	–0.005283
0.2[1]	–23.25	–4.614532	–4.685468	–4.614501	–4.685499
0.5[1]	9.3	4.685568	4.614432	4.685599	4.614401
0.5[1]	0	0.005353	–0.005353	0.005383	–0.005383
0.5[1]	–9.3	–4.614432	–4.685568	–4.614401	–4.685599
1	4.65	4.685668	4.614332	4.685699	4.614301

Table 6. SCXI-1120 Specifications

Gain	Test Point (V)	4 Hz Filter		10 kHz Filter	
		Upper Limit (V)	Lower Limit (V)	Upper Limit (V)	Lower Limit (V)
1	0	0.005452	–0.005452	0.005483	–0.005483
1	–4.65	–4.614332	–4.685668	–4.614301	–4.685699
2	2.325	4.685868	4.614132	4.685899	4.614101
2	0	0.005652	–0.005652	0.005683	–0.005683
2	–2.325	–4.614132	–4.685868	–4.614101	–4.685899
5	0.93	4.686518	4.613482	4.686549	4.613451
5	0	0.006303	–0.006303	0.006333	–0.006333
5	–0.93	–4.613482	–4.686518	–4.613451	–4.686549
10	0.465	4.687435	4.612565	4.687466	4.612534
10	0	0.007312	–0.007312	0.007343	–0.007343
10	–0.465	–4.612565	–4.687435	–4.612534	–4.687466
20	0.2325	4.689495	4.610505	4.689526	4.610474
20	0	0.009372	–0.009372	0.009403	–0.009403
20	–0.2325	–4.610505	–4.689495	–4.610474	–4.689526
50	0.093	4.696148	4.603852	4.696453	4.603547
50	0	0.016025	–0.016025	0.016330	–0.016330
50	–0.093	–4.603852	–4.696148	–4.603547	–4.696453
100	0.0465	4.705975	4.594025	4.706006	4.593994
100	0	0.025852	–0.025852	0.025883	–0.025883
100	–0.0465	–4.594025	–4.705975	–4.593994	–4.706006
200	0.02325	4.726575	4.573425	4.726633	4.573367
200	0	0.046452	–0.046452	0.046510	–0.046510
200	–0.02325	–4.573425	–4.726575	–4.573367	–4.726633
500	0.0093	4.788175	4.4511825	4.788246	4.511754
500	0	0.108053	–0.108053	0.108124	–0.108124
500	–0.0093	–4.4511825	–4.788175	–4.511754	–4.788246

Table 6. SCXI-1120 Specifications

Gain	Test Point (V)	4 Hz Filter		10 kHz Filter	
		Upper Limit (V)	Lower Limit (V)	Upper Limit (V)	Lower Limit (V)
1000	0.00465	4.891175	4.408825	4.891435	4.408565
1000	0	0.211052	–0.211052	0.211312	–0.211312
1000	–0.00465	–4.408825	–4.891175	–4.408565	–4.891435
2000	0.002325	5.098175	4.201825	5.098715	4.201285
2000	0	0.418052	–0.418052	0.418592	–0.418592
2000	–0.002325	–4.201825	5.098175	–4.201285	5.098715

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

Table 7. SCXI-1120D Specifications

Gain	Test Point (V)	4.5 kHz Filter		22.5 kHz Filter	
		Upper Limit (V)	Lower Limit (V)	Upper Limit (V)	Lower Limit (V)
0.01[1]	232.5	2.346072	2.303928	2.346226	2.303774
0.01[1]	0	0.005266	–0.005266	0.005421	–0.005421
0.01[1]	–232.5	–2.303928	–2.346072	–2.303774	–2.346226
0.025[1]	186	4.688194	4.611806	4.688386	4.611614
0.025[1]	0	0.006583	–0.006583	0.006775	–0.006775
0.025[1]	–186	–4.611806	–4.688194	–4.611614	–4.688386
0.05[1]	93	4.686877	4.613123	4.687032	4.612968
0.05[1]	0	0.005267	–0.005267	0.005421	–0.005421
0.05[1]	–93	–4.613123	–4.686877	–4.612968	–4.687032
0.1[1]	46.5	4.686897	4.613103	4.687052	4.612948
0.1[1]	0	0.005286	–0.005286	0.005441	–0.005441
0.1[1]	–46.5	–4.613103	–4.686897	–4.612948	–4.687052
0.25[1]	18.6	4.686927	4.613073	4.687081	4.612919
0.25[1]	0	0.005317	–0.005317	0.005471	–0.005471

Table 7. SCXI-1120D Specifications

Gain	Test Point (V)	4.5 kHz Filter		22.5 kHz Filter	
		Upper Limit (V)	Lower Limit (V)	Upper Limit (V)	Lower Limit (V)
0.25[1]	–18.6	–4.613073	–4.686927	–4.612919	–4.687081
0.5	9.3	4.686884	4.613116	4.687039	4.612961
0.5	0	0.005367	–0.005367	0.005521	–0.005521
0.5	–9.3	–4.613116	–4.686884	–4.612961	–4.687039
1	4.65	4.686984	4.613016	4.687139	4.612861
1	0	0.005466	–0.005466	0.005621	–0.005621
1	–4.65	–4.613016	–4.686984	–4.612861	–4.687139
2.5	1.86	4.687284	4.612716	4.687438	4.612562
2.5	0	0.005767	–0.005767	0.005921	–0.005921
2.5	–1.86	–4.612716	–4.687284	–4.612562	–4.687438
5	0.93	4.687834	4.612166	4.689978	4.610022
5	0	0.006317	–0.006317	0.008460	–0.008460
5	–0.93	–4.612166	–4.687834	–4.610022	–4.689978
10	0.465	4.688885	4.611115	4.688976	4.611024
10	0	0.007367	–0.007367	0.007458	–0.007458
10	–0.465	–4.611115	–4.688885	–4.611024	–4.688976
25	0.186	4.692040	4.607960	4.692195	4.607805
25	0	0.010523	–0.010523	0.010678	–0.010678
25	–0.186	–4.607960	–4.692040	–4.607805	–4.692195
50	0.093	4.697329	4.602671	4.697608	4.602392
50	0	0.015811	–0.015811	0.016090	–0.016090
50	–0.093	–4.602671	–4.697329	–4.602392	–4.697608
100	0.0465	4.707698	4.592302	4.707988	4.592012
100	0	0.026180	–0.026180	0.026470	0.026470
100	–0.0465	–4.592302	–4.707698	–4.592012	–4.707988
250	0.0186	4.739130	4.560870	4.739825	4.560175

Table 7. SCXI-1120D Specifications

Gain	Test Point (V)	4.5 kHz Filter		22.5 kHz Filter	
		Upper Limit (V)	Lower Limit (V)	Upper Limit (V)	Lower Limit (V)
250	0	0.057613	–0.057613	0.058308	–0.058308
250	–0.0186	–4.560870	–4.739130	–4.560175	–4.739825
500	0.0093	4.790608	4.509392	4.791423	4.508577
500	0	0.109090	–0.109090	0.109905	–0.109905
500	–0.0093	–4.509392	–4.790608	–4.508577	–4.791423
1000	0.00465	4.893838	4.406162	4.894778	4.405222
1000	0	0.212320	–0.212320	0.213260	–0.213260
1000	–0.00465	–4.406162	–4.893838	–4.405222	–4.894778

[1] Available value only when used with the SCXI-1327 high-voltage terminal block

Front and Rear Panel Diagrams

Figure 1 shows the pin assignments for the SCXI-1120/1120D front panel connector. Figure 2 shows the pin assignments for the SCXI-1120/1120D rear panel connector.

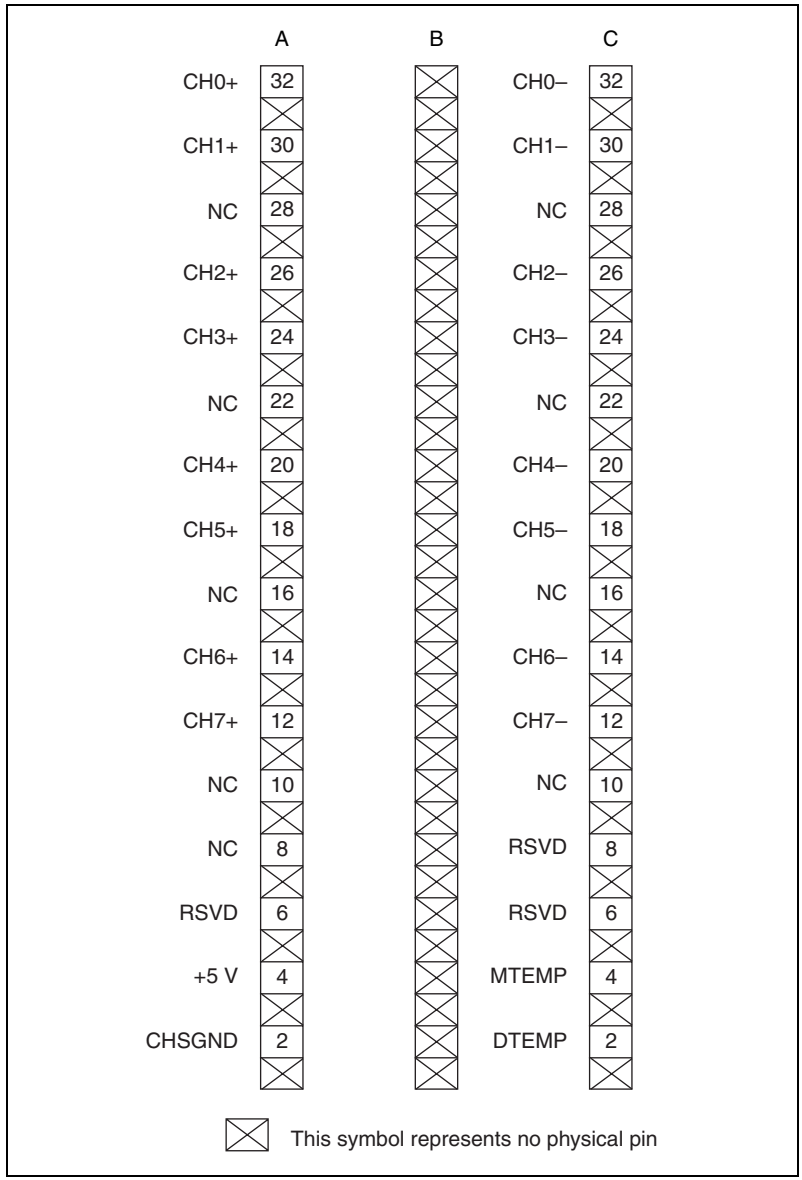
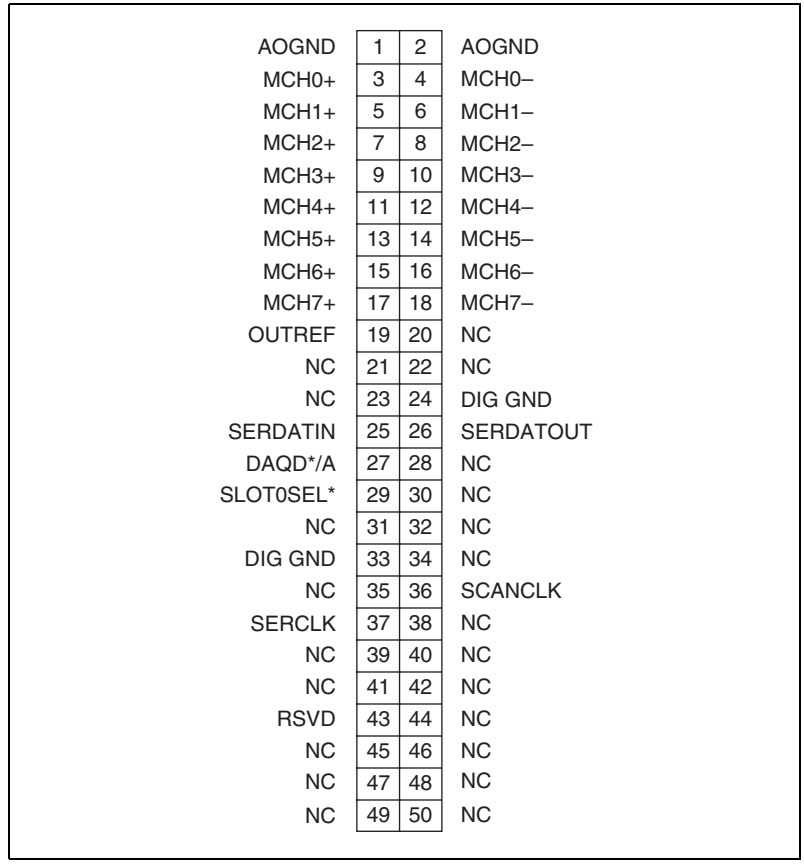


Figure 1. SCXI-1120/1120D Front Connector Pin Assignments



AOGND	1	2	AOGND
MCH0+	3	4	MCH0–
MCH1+	5	6	MCH1–
MCH2+	7	8	MCH2–
MCH3+	9	10	MCH3–
MCH4+	11	12	MCH4–
MCH5+	13	14	MCH5–
MCH6+	15	16	MCH6–
MCH7+	17	18	MCH7–
OUTREF	19	20	NC
NC	21	22	NC
NC	23	24	DIG GND
SERDATIN	25	26	SERDATOUT
DAQD*/A	27	28	NC
SLOT0SEL*	29	30	NC
NC	31	32	NC
DIG GND	33	34	NC
NC	35	36	SCANCLK
SERCLK	37	38	NC
NC	39	40	NC
NC	41	42	NC
RSVD	43	44	NC
NC	45	46	NC
NC	47	48	NC
NC	49	50	NC

Figure 2. SCXI-1120/1120D Rear Connector Pin Assignments