

CALIBRATING NI 4451/4452/4551/4552 WITH CALIBRATION EXECUTIVE

Introduction

This document contains information and step-by-step instructions for calibrating NI 4451/4452 dynamic signal acquisition devices and NI 4551/4552 dynamic signal analyzers with Calibration Executive.

What Is Calibration?

Calibration consists of verifying the measurement accuracy of a device and adjusting for any measurement error. *Verification* is measuring performance of a device and comparing the results to the factory specifications. National Instruments Calibration Executive automates the verification and adjustment of your National Instruments measurement devices.

Why Should You Calibrate?

The accuracy of electronic components may drift with time and temperature, which could invalidate the factory-set calibration constants. Calibration restores the specified accuracy of your device and ensures that it still meets National Instruments standards.

How Often Should You Calibrate?

The measurement accuracy requirements of your application determine how often you should calibrate your 4451/4452/4551/4552 device. National Instruments 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 equipment, software, documentation, and test conditions required for calibration.

Test Equipment

Calibration of NI 4451/4452/4551/4552 devices requires using standards with the specifications listed in Table 1.

If you do not have the recommended instruments, use the accuracy requirements listed below to select substitute calibration standards.

Table 1. Recommended Test Equipment Specifications

Instrument	Critical Specifications	Suggested Model	Use
Calibrator	Frequency Range: 20 Hz–95 kHz Voltage Range: 5 mV _{rms} –15 V _{rms} AC Accuracy: $\pm 0.1\%^1$, 20 Hz–95 kHz DC Accuracy: $\pm 115 \text{ ppm}^2$ at 5 V	Fluke 5700A	Verification and calibration
Function Generator	Frequency range: 20 Hz–95 kHz Frequency accuracy: $\pm 6 \text{ ppm}^3$ Voltage range: 3 V _{rms}	HP 3324	Verification
Digital Multimeter (DMM)—required for 4451/4551 only	Voltage range: 5 mV _{rms} –5 V _{rms} AC accuracy: $\pm 0.2\%^1$, 20 Hz–95 kHz DC accuracy: $\pm 500 \mu\text{V}^2$ at 0 V	HP 3458A	Verification
Frequency Counter	Frequency Range: 20 Hz–5 MHz Frequency Accuracy: $\pm 6 \text{ ppm}^3$ 20 Hz–20 kHz Frequency Accuracy: $\pm 25 \text{ ppm}^3$ 20 Hz–5 MHz Input Voltage: 3 V _{rms}	HP 53131A	Verification
<p>¹ AC accuracy is the sum of all errors including percent of reading error and temperature error but excluding percent of range error.</p> <p>² DC accuracy is the sum of all errors including percent of reading error, percent of range error, and temperature error</p> <p>³ Frequency accuracy is the sum of all errors including initial accuracy and stability errors.</p>			

Connectors

Calibration of NI 4451/4452/4551/4552 devices requires the following National Instruments connectors:

- BNC-2140 connector assembly
- SHC-68-C68-A1 cable
- SCB-68 shielded I/O connector block
- SHC-50-68 cable
- 50 Ω BNC terminator
- BNC T-connectors—for 4451 and 4551 devices, you need one T-connector; for 4452 and 4552 devices, you need three T-connectors



Note Use the BNC-2140 for analog input and output calibration and the SCB-68 for counter verification.

Software and Documentation

This section describes the software and documentation you will need to calibrate your 4451/4452/4551/4552.

Software

The 4451/4452/4551/4552 calibration procedure requires Calibration Executive Software and the latest version of the National Instruments NI-DAQ driver on the calibration system. You can download the latest version of the NI-DAQ driver from digital.ni.com/softlib.nsf/current

Documentation

The following documents contain information on installing and using Calibration Executive and installing and configuring your 4451/4452 or 4551/4552 device:

- *Calibration Executive Software User Manual*
- *PCI 4451/4452/4453/4454 User Manual* or *NI 4551/4552 User Manual*
- *DAQ Quick Start Guide*

The following documents contain information on using the NI-DAQ driver:

- *NI-DAQ Function Reference Online Help*
- *NI-DAQ User Manual for PC Compatibles*

You can download these documents from ni.com/manuals

The function reference online help file includes detailed information on the driver functions. You can access the online help by clicking **Start»Programs»National Instruments DAQ»NI-DAQ Help**.

Test Conditions

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

- Keep connections to your 4451/4452/4551/4552 device as short as possible. Long cables and wires can act as antennae, which could pick up extra noise and affect measurements.
- Use shielded copper wire for all cable connections to the device. Use twisted-pair wire to eliminate noise and thermal offsets.
- Maintain a temperature between 18 and 28 °C.
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 15 minutes for your device to ensure that the measurement circuitry is at a stable operating temperature.

Calibration Procedure

This section explains how to set up and run the 4451/4452/4551/4552 calibration procedure. In automated mode, the calibration procedure should take approximately 1 hour. In manual mode, the calibration procedure can take as long as 2 hours.



Note The calibration procedure runs in automated mode if you use NI-IVI-supported DMMs and calibrators.

Setting Up Your Device

To set up and configure your device for calibration, complete the following steps:

1. Install the 4451/4452/4551/4552 device in your host computer.
2. Configure the 4451/4452/4551/4552 device with Measurement & Automation Explorer (MAX).
3. Connect the 4451/4452/4551/4552 device and the BNC-2140 using the SHC-68-C68-A1 cable. Refer to Figure 1 for the connector pin assignments on the BNC-2140, Figure 2 for 4451/4452 devices, and Figure 3 for 4551/4552 devices.

-ACH0	1	35	+ACH0
AIGND†	2	36	AIGND
-ACH1	3	37	+ACH1
AIGND†	4	38	AIGND
-ACH2	5	39	+ACH2
AIGND†	6	40	AIGND
-ACH3	7	41	+ACH3
AIGND†	8	42	AIGND
NC	9	43	NC
NC	10	44	NC
NC	11	45	NC
NC	12	46	NC
NC	13	47	NC
NC	14	48	NC
NC	15	49	NC
NC	16	50	NC
NC	17	51	NC
NC	18	52	NC
NC	19	53	NC
NC	20	54	NC
NC	21	55	NC
NC	22	56	NC
NC	23	57	NC
NC	24	58	NC
-DAC0OUT	25	59	+DAC0OUT
AOGND†	26	60	AOGND
-DAC1OUT	27	61	+DAC1OUT
AOGND†	28	62	AOGND
NC	29	63	NC
NC	30	64	NC
NC	31	65	NC
NC	32	66	NC
+5 V	33	67	+5 V
DGND	34	68	DGND

†These AIGND and AOGND pins are not connected in the SHC6868-A1 cable

Figure 1. BNC-2140 External 68-Pin Analog Connector

- For 4451 and 4551 devices, connect analog input channels 0 and 1.

-ACH0	1	35	+ACH0
AIGND [†]	2	36	AIGND
-ACH1	3	37	+ACH1
AIGND [†]	4	38	AIGND
-ACH2 ²	5	39	+ACH2 ²
AIGND [†]	6	40	AIGND
-ACH3 ²	7	41	+ACH3 ²
AIGND [†]	8	42	AIGND
NC	9	43	NC
AIGND [†]	10	44	AIGND [†]
NC	11	45	NC
AIGND [†]	12	46	AIGND [†]
NC	13	47	NC
AIGND [†]	14	48	AIGND [†]
NC	15	49	NC
AIGND [†]	16	50	AIGND [†]
NC	17	51	NC
AIGND [†]	18	52	AIGND [†]
NC	19	53	NC
AIGND [†]	20	54	AIGND [†]
NC	21	55	NC
AIGND [†]	22	56	AIGND [†]
NC	23	57	NC
AIGND [†]	24	58	AIGND [†]
-DAC0OUT ¹	25	59	+DAC0OUT ¹
AOGND ^{1†}	26	60	AOGND ¹
-DAC1OUT ¹	27	61	+DAC1OUT ¹
AOGND ^{1†}	28	62	AOGND ¹
NC	29	63	NC
AOGND ^{1†}	30	64	AOGND ^{1†}
NC	31	65	NC
AOGND ^{1†}	32	66	AOGND ^{1†}
+5 V	33	67	+5 V
DGND	34	68	DGND

¹PCI-4451 only
²PCI-4452 only
[†]These AIGND and AOGND pins are not connected in the SHC68-C68-A1 cable.

Figure 2. 4451/4452 Analog Pin Assignments

- For 4452 and 4552 devices, connect analog input channels 0 through 3.

-ACH0	1	35	+ACH0
AIGND [†]	2	36	AIGND
-ACH1	3	37	+ACH1
AIGND [†]	4	38	AIGND
-ACH2 ¹	5	39	+ACH2 ¹
AIGND [†]	6	40	AIGND
-ACH3 ¹	7	41	+ACH3 ¹
AIGND [†]	8	42	AIGND
NC	9	43	NC
AIGND [†]	10	44	AIGND [†]
NC	11	45	NC
AIGND [†]	12	46	AIGND [†]
NC	13	47	NC
AIGND [†]	14	48	AIGND [†]
NC	15	49	NC
AIGND [†]	16	50	AIGND [†]
NC	17	51	NC
AIGND [†]	18	52	AIGND [†]
NC	19	53	NC
AIGND [†]	20	54	AIGND [†]
NC	21	55	NC
AIGND [†]	22	56	AIGND [†]
NC	23	57	NC
AIGND [†]	24	58	AIGND [†]
-DAC0OUT ²	25	59	+DAC0OUT ²
AOGND [†]	26	60	AOGND
-DAC1OUT ²	27	61	+DAC1OUT ²
AOGND [†]	28	62	AOGND
NC	29	63	NC
AOGND [†]	30	64	AOGND [†]
NC	31	65	NC
AOGND [†]	32	66	AOGND [†]
+5 V	33	67	+5 V
DGND	34	68	DGND

¹Not available on NI 4551
²Not available on NI 4552
[†]These AIGND and AOGND pins are not connected in the SHC68-C68-A1 cable.

Figure 3. 4551/4552 Analog Pin Assignments

4. Using the BNC T-connectors, tie all analog input channels together and connect them to the 50 Ω terminator.
5. While the calibration procedure is running, you will be prompted to make further connections to the analog outputs on the BNC-2140. Follow the onscreen instructions at each prompt.
6. Refer to Figure 4 to configure the switches as follows:
 - a. Set the ICP Power switch and ICP Enable switches to OFF.
 - b. Set the SE/DIFF switches in the analog input area to SE. If you use a function generator other than the HP 3324, ensure that the negative output of your function generator is floating. If the negative output is tied to earth ground, set the SE/DIFF switches in the analog input area to DIFF.
 - c. Set the SE/DIFF switches in the analog output area to DIFF. If you use a frequency counter other than the HP 53131A, ensure that the negative input of your counter is tied to earth ground. If the negative input is floating, set the SE/DIFF switches in the analog output area to SE.

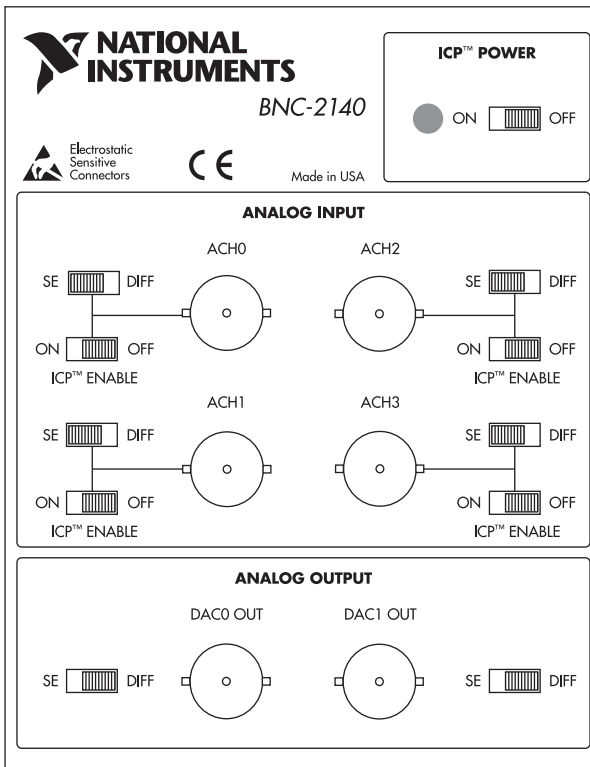


Figure 4. BNC-2140 Switch Settings

7. Disable the temperature sensor on the SCB-68 by setting switches S4 and S5 in the down position, as shown in Figure 5. Refer to Figure 6 to locate these switches on the SCB-68.

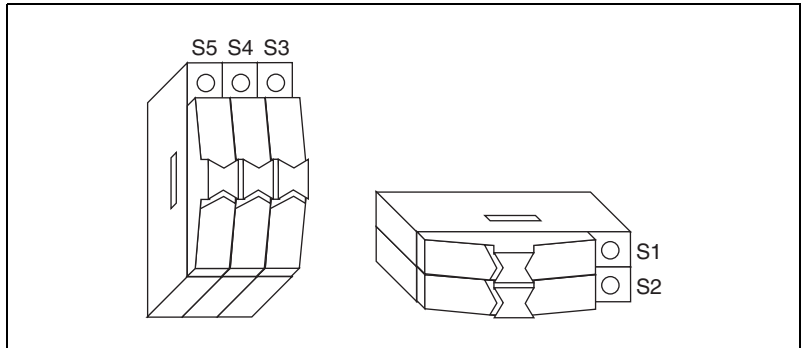


Figure 5. SCB-68 Switches Diagram

8. Connect the 4451/4452/4551/4552 device to the SCB-68 using the SHC-50-68 cable. Refer to Figure 3 to locate the parts on the SCB-68.
9. If you are calibrating a 4551 or 4552 device, connect inputs as follows:
 - a. Connect the positive input of your frequency counter to pin 30 of the SCB-68.
 - b. Connect the negative input of your frequency counter to pin 63 of the SCB-68.

Use only the pin number designations to locate the correct pins—disregard the descriptive labels on the pins of the SCB-68. Refer to Figure 6 to determine the correct pin numbers. Calibration Executive will prompt you when to make the connections.

10. If you are calibrating a 4451 or 4452 device, connect the inputs as follows:
 - a. Connect the positive input of your frequency counter to pin 3 of the SCB-68.
 - b. Connect the negative input of your frequency counter to pin 35 of the SCB-68.

Use only the pin number designations to locate the correct pins—disregard the descriptive labels on the pins of the SCB-68. Refer to Figure 6 to determine the correct pin numbers. Calibration Executive will prompt you when to make the connections.

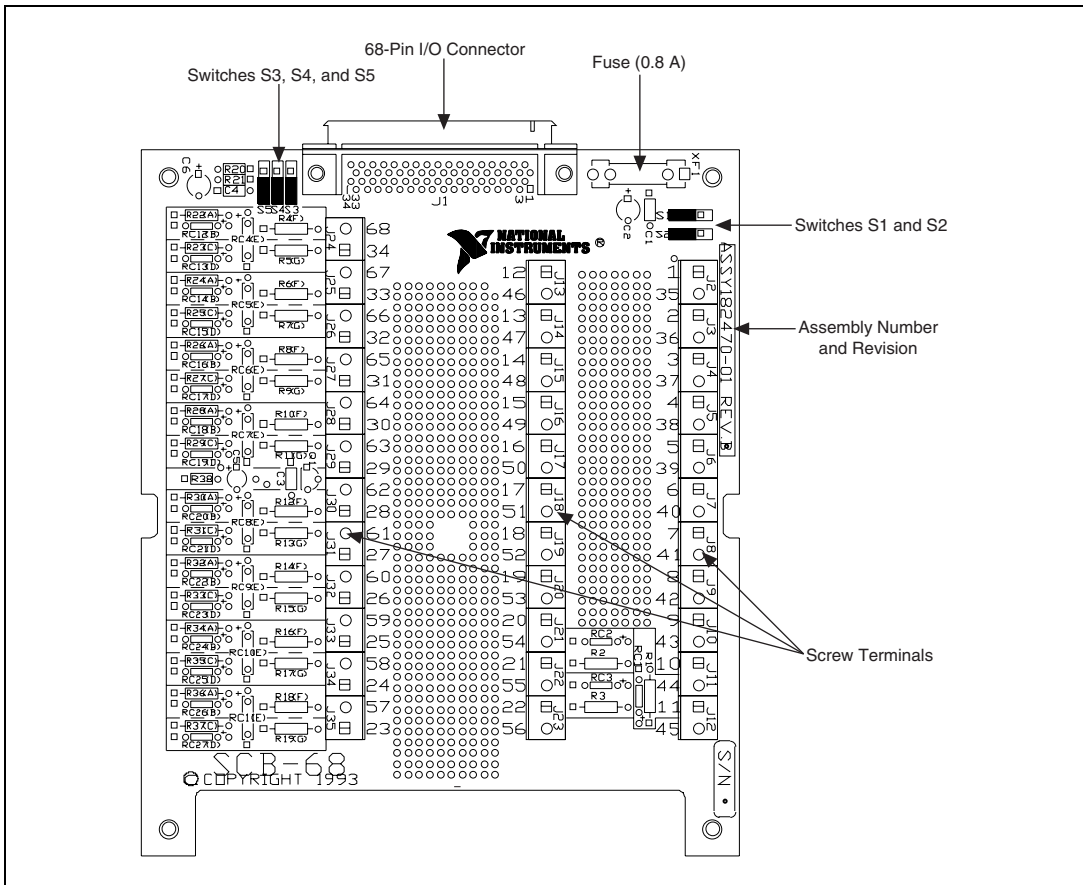


Figure 6. SCB-68 Parts Locator Diagram

The calibration procedure steps you through the connections between the BNC-2140, the SCB-68, the calibrator, the DMM, the function generator, and the counter.



Note Refer to the *PCI 4451/4452/4453/4454 User Manual* or the *NI 4551/4552 User Manual* if you need additional configuration information.

Loading and Running Calibration Procedure

Launch Calibration Executive and follow the steps listed in the Calibration Configuration Wizard to load the 4451/4452/4551/4552 calibration procedure. Refer to Chapter 1, *Introduction to Calibration Executive*, in the *Calibration Executive Software User Manual* if you need more information on loading a calibration procedure.

When the procedure is loaded, click **Run Procedure** to begin. The calibration procedure prompts you to enter information about the type of device you are calibrating (4451, 4452, 4551, or 4552). Follow any additional instructions you receive from Calibration Executive. After the procedure finishes, complete the following steps:

1. Click on **View»Reports**.
2. Select **View** to launch your browser and view your report. Your calibration report appears as a printable HTML file.

If you need more information on running a calibration procedure, refer to the *Calibration Executive Software User Manual*.

You have completed calibrating your 4451/4452/4551/4552 device with Calibration Executive.



Note If your 4451/4452/4551/4552 device fails after calibration, further warm-up time may be required. If the device fails after further warm-up time, return the device to National Instruments for repair.