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CALIBRATION PROCEDURE
NI 5122/5124/5142

This document contains information for calibrating NI 5122/5124/5142 high-speed digitizers. For more information on calibration, visit `ni.com/calibration`.

Contents

Software Requirements

Calibrating the NI 5122/5124/5142 requires installing NI-SCOPE on the calibration system. Refer to Table 1 for the hardware-specific version to use with your device. You can download the NI-SCOPE instrument driver from the Instrument Driver Network Web site at `ni.com/idnet`. NI-SCOPE supports programming a Self-Calibration and an External Calibration in the LabVIEW and C application development environments (ADEs). When you install NI-SCOPE, you only need to install support for the ADE that you intend to use.

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LabVIEW support is in the `niScopeCal.llb` file, and all calibration functions appear in the NI-SCOPE Calibration palette. For LabWindows™/CVI™ users, the NI -SCOPE function panel `niScopeCal.fp` provides access to the available functions.

For the locations of files you may need to calibrate your device, refer to the *NI High-Speed Digitizers Help*, which is available on the NI-SCOPE DVD and from `ni.com/manuals`.

Table 1. Required Software for NI 5122/5124/5142 Calibration

Device	NI-SCOPE Version
NI PXI-5122	2.5 or later
NI PCI-5122	2.6 or later
NI PXIe-5122	3.3.1 or later
NI PXI/PCI-5124	2.7 or later
NI PXI/PCI-5142	3.0 or later

Documentation Requirements

For information about NI-SCOPE and the NI 5122/5124/5142, you can consult the following documents:

- *NI High-Speed Digitizers Getting Started Guide*—provides instructions for installing and configuring the digitizer.
- *NI High-Speed Digitizers Help*—includes detailed information about the digitizer and NI-SCOPE VIs and functions.
- *NI PXI/PXIe/PCI-5122 Specifications*, *NI PXI/PCI-5142 Specifications*, or *NI PXI/PCI-5124 Specifications*—includes detailed information about the digitizer and provides the published specification values. Refer to the most recent specifications documents online at `ni.com/manuals`.
- NI-SCOPE programming references—includes information about creating applications using LabVIEW, C/C++, or CVI. These references are located within the *NI High-Speed Digitizers Help*.

These documents are installed with NI-SCOPE. You also can find the latest versions of the documentation at `ni.com/manuals`.

Password

The default calibration password is `NI`.

Calibration Interval

National Instruments recommends a minimum calibration interval of two years for the NI 5122/5124/5142. You should adjust the recommended calibration interval based on the measurement accuracy demands of your application.

Test Equipment

National Instruments recommends that you use the equipment in Table 2 for calibrating the NI 5122/5124/5142.

📝 **Note** The delay times indicated in this procedure apply specifically to the Fluke 9500B calibrator. If you use a different calibrator, you may need to adjust these delay times.

Table 2. Test Equipment

Equipment	Recommended Model	Parameter Measured	Requirements
Signal generator	Fluke 9500B oscilloscope calibrator OR Wavetek 9500 with high-stability reference option	DC Accuracy	DC ±(0.025% + 25 µV) into 1 MΩ or 50 Ω
		Bandwidth, trigger sensitivity	±2% output amplitude flatness for leveled sine wave up to 150 MHz relative to 50 kHz into 1 MΩ or 50 Ω
	Fluke 9510 test head	Timing Accuracy	±2 ppm frequency accuracy
BNC cable	—	—	50 Ω

Test Conditions

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

• Always connect the calibrator test head directly to the input BNC of the digitizer, or use a short 50 Ω BNC coaxial cable if necessary. Long cables and wires act as antennae, picking up extra noise that can affect measurements.

• Verify that all connections to the device, including front panel connections, are secure.

• Maintain an ambient temperature of 23 ±5 °C. The device temperature will be greater than the ambient temperature.

• Keep relative humidity below 80%.

- Allow a warm-up time of at least 15 minutes to ensure that the measurement circuitry is at a stable operating temperature. Unless manually disabled, the NI-SCOPE driver automatically loads with the operating system and enables the device. This warm-up time ensures the digitizer is at a stable operating temperature.
- Ensure that the PXI/PXIe chassis fan speed is set to HIGH, that the fan filters are clean, and that the empty slots contain filler panels. For more information, refer to the *Maintain Forced-Air Cooling Note to Users* document available at `ni.com/manuals`.
- Plug the chassis/PC and the calibrator into the same power strip to avoid ground loops.

Calibration Procedures

The calibration process includes the following steps:

1. *Initial Setup*—Install the device and configure it in Measurement & Automation Explorer (MAX).
2. *Self-Calibration*—Adjust the self-calibration constants of the device.
3. *Verification*—Verify the existing operation of the device. This step confirms whether the device is operating within the published specifications prior to adjustment.
4. *Adjustment*—Perform an external adjustment of the device that adjusts the calibration constants of the device. The adjustment procedure automatically stores the calibration date on the EEPROM to allow traceability.
5. Reverification—Repeat the *Verification* procedure to ensure that the device is operating within the published specifications after adjustment.

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

Initial Setup

Refer to the *NI High-Speed Digitizers Getting Started Guide* for information about how to install the software and hardware and how to configure the device in MAX.

Self-Calibration

The NI 5122/5124/5142 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 15-minute warm-up period before you begin self-calibration.

Self-calibration can be initiated from MAX, NI-SCOPE Soft Front Panel (SFP), and NI-SCOPE.

MAX

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

1. Disconnect or disable any AC inputs to the digitizer.
2. Launch MAX.
3. Select **My System»Devices and Interfaces**.

4. Select the device that you want to calibrate.

5. Initiate self-calibration in one of the following ways:

   - Click **Self-Calibrate** in the upper right corner of the window.

   - Right-click the device name under Devices and Interfaces and select **Self-Calibrate** from the drop-down menu.

NI-SCOPE Soft Front Panel

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

1. Disconnect or disable any AC inputs to the digitizer.

2. Launch the NI-SCOPE SFP.

3. Select the device you want to calibrate using the Device Configuration dialog box by selecting **Edit»Device Configuration**.

4. Launch the Calibration dialog box by selecting **Utility»Self Calibration**.

5. Click **OK** to begin self-calibration.

NI-SCOPE

To self-calibrate the digitizer programmatically using NI-SCOPE, complete the following steps:

1. Disconnect or disable all AC inputs to the digitizer.

2. Open a session and obtain a session handle using the niScope Initialize VI.

3. Self-calibrate the digitizer using niScope Cal Self Calibrate VI.

4. End the session using the niScope Close VI.

Verification

Note After the 15-minute warm-up time, always self-calibrate the digitizer before beginning a verification procedure.

This section describes the program you must write to verify either the calibration test limits or the published specifications for the digitizer. Refer to *Appendix A: Calibration Options* to determine which limits to use in these procedures.

Note If any of these tests fail immediately after you perform an external adjustment, make sure that you have met the requirements listed in the *Test Equipment* and *Test Conditions* sections before you return the digitizer to National Instruments for repair.

Vertical Offset and Vertical Gain Accuracy

Table 3 contains the input parameters for verifying both vertical offset accuracy and vertical gain accuracy of the digitizer.

To verify vertical offset accuracy, complete the procedures described in the *Vertical Offset Accuracy* section for each of the 39 iterations in Table 3 for channel 0, then repeat the procedures for channel 1. The *Calibration Test Limits* and *Published Specifications* for vertical offset accuracy are shown in Table 4 (NI 5122), Table 5 (NI 5124), and Table 6 (NI 5142).

To verify vertical gain accuracy, complete the procedures described in the *Vertical Gain Accuracy* section for each of the 39 iterations in Table 3 for channel 0, then repeat the procedures for channel 1. The *Calibration Test Limits* and *Published Specifications* for vertical gain accuracy are shown in Table 7 (NI 5122/5142) and Table 8 (NI 5124).

Table 3. NI 5122/5124/5142 Input Parameters for Vertical Offset Accuracy and Vertical Gain Accuracy Verification

| Iteration | Input Impedance | Max Input Frequency (Hz) | | Range |
		NI 5122/5142	NI 5124	
1	50 Ω	100,000,000	150,000,000	0.2
2	50 Ω	100,000,000	150,000,000	0.4
3	50 Ω	100,000,000	150,000,000	1
4	50 Ω	100,000,000	150,000,000	2
5	50 Ω	100,000,000	150,000,000	4
6	50 Ω	100,000,000	150,000,000	10
7	50 Ω	35,000,000	60,000,000	0.2
8	50 Ω	35,000,000	60,000,000	0.4
9	50 Ω	35,000,000	60,000,000	1
10	50 Ω	35,000,000	60,000,000	2
11	50 Ω	35,000,000	60,000,000	4
12	50 Ω	35,000,000	60,000,000	10
13	50 Ω	20,000,000	20,000,000	0.2
14	50 Ω	20,000,000	20,000,000	0.4
15	50 Ω	20,000,000	20,000,000	1
16	50 Ω	20,000,000	20,000,000	2
17	50 Ω	20,000,000	20,000,000	4

Iteration	Input Impedance	Max Input Frequency (Hz)		Range
		NI 5122/5142	**NI 5124**	
18	50 Ω	20,000,000	20,000,000	10
19	1 MΩ	100,000,000	150,000,000	0.2
20	1 MΩ	100,000,000	150,000,000	0.4
21	1 MΩ	100,000,000	150,000,000	1
22	1 MΩ	100,000,000	150,000,000	2
23	1 MΩ	100,000,000	150,000,000	4
24	1 MΩ	100,000,000	150,000,000	10
25	1 MΩ	100,000,000	150,000,000	20
26	1 MΩ	35,000,000	60,000,000	0.2
27	1 MΩ	35,000,000	60,000,000	0.4
28	1 MΩ	35,000,000	60,000,000	1
29	1 MΩ	35,000,000	60,000,000	2
30	1 MΩ	35,000,000	60,000,000	4
31	1 MΩ	35,000,000	60,000,000	10
32	1 MΩ	35,000,000	60,000,000	20
33	1 MΩ	20,000,000	20,000,000	0.2
34	1 MΩ	20,000,000	20,000,000	0.4
35	1 MΩ	20,000,000	20,000,000	1
36	1 MΩ	20,000,000	20,000,000	2
37	1 MΩ	20,000,000	20,000,000	4
38	1 MΩ	20,000,000	20,000,000	10
39	1 MΩ	20,000,000	20,000,000	20

Vertical Offset Accuracy

Complete the following steps to verify vertical offset accuracy of the NI 5122/5124/5142. You must verify both channels with each iteration in Table 3.

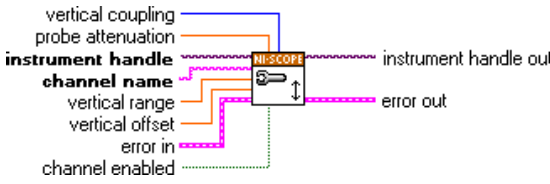1. Open a session and obtain a session handle using the niScope Initialize VI.

Note Throughout the procedure, refer to the C/C++ function call parameters for the LabVIEW input values.

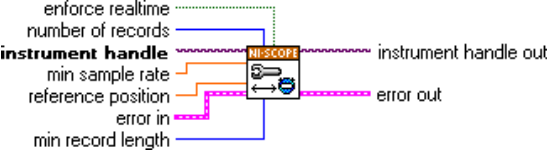| LabVIEW VI	C/C++ Function Call
resource name, id query, reset device, error in, instrument handle, error out	Call `niScope_init` with the following parameters: **resourceName**: The device name assigned by MAX **idQuery**: `VI_FALSE` **resetDevice**: `VI_TRUE`

2. Configure the input impedance and the maximum input frequency using the niScope Configure Chan Characteristics VI.

LabVIEW VI	C/C++ Function Call
instrument handle, channel name, input impedance, max input frequency, error in, instrument handle out, error out	Call `niScope_ConfigureChan Characteristics` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **inputImpedance**: The *Input Impedance* value in Table 3 for the current iteration **maxInputFrequency**: The *Maximum Input Frequency* value in Table 3 for the current iteration

3. Configure the common vertical properties using the niScope Configure Vertical VI.

LabVIEW VI	C/C++ Function Call
	Call niScope_ConfigureVertical with the following parameters: **coupling**: NISCOPE_VAL_DC **probeAttenuation**: 1.0 **vi**: The instrument handle from niScope_init **channelList**: "0" **range**: The *Range* value in Table 3 for the current iteration **offset**: 0.0 **enabled**: NISCOPE_VAL_TRUE

4. Configure the horizontal properties using the niScope Configure Horizontal Timing VI.

LabVIEW VI	C/C++ Function Call
	Call niScope_ConfigureHorizontalTiming with the following parameters: **enforceRealtime**: NISCOPE_VAL_TRUE **numRecords**: 1 **vi**: The instrument handle from niScope_init **minSampleRate**: 10,000,000 **refPosition**: 50.0 **minNumPts**: 100,000

5. Commit all the parameter settings to hardware using the niScope Commit VI.

LabVIEW VI	C/C++ Function Call
	Call niScope_Commit with the following parameter: **vi**: The instrument handle from niScope_init

6. Short-circuit the channel 0 input of the digitizer by connecting the calibrator test head directly to the digitizer and grounding the output of the calibrator.

7. Wait 500 ms for the calibrator to ground its output.

8. Initiate a waveform acquisition using the niScope Initiate Acquisition VI.

LabVIEW VI	C/C++ Function Call
	Call niScope_Initiate Acquisition with the following parameter: **vi**: The instrument handle from niScope_init

9. Fetch a waveform from the digitizer and perform a voltage average measurement using the niScope Fetch Measurement (poly) VI. Select the Measurement Scalar DBL instance of the VI.

LabVIEW VI	C/C++ Function Call
	Call niScope_Fetch Measurement with the following parameters: **timeout**: 1.0 **vi**: The instrument handle from niScope_init **channelList**: "0" **scalarMeasFunction**: NISCOPE_VAL_VOLTAGE_AVERAGE

Compare the resulting average voltage to the value listed in the *Calibration Test Limits* column or the *Published Specifications* column in Table 4 (NI 5122), Table 5 (NI 5124), or Table 6 (NI 5142) that corresponds to the vertical range used.

📝 **Note** The **inputImpedance** and **maxInputFrequency** do not affect the test limit value.

If the result is within the selected test limit, the device has passed this portion of the verification.

10. Repeat steps 2 through 9 for each iteration in Table 3.

11. Move the calibrator test head to the digitizer input channel 1 and repeat steps 2 through 10 for every configuration in Table 3, changing the value of the **channelList** parameter from "0" to "1".

12. End the session using the niScope Close VI.

LabVIEW VI	C/C++ Function Call
instrument handle — NI-SCOPE — error in — error out	Call `niScope_close` with the following parameter: **vi**: The instrument handle from `niScope_init`

You have finished verifying the vertical offset accuracy of the NI 5122/5124/5142.

Table 4. NI 5122 Vertical Offset Limits

	NI PXI/PXIe-5122		NI PCI-5122	
Range	Calibration Test Limits (V)	Published Specifications (V)	Calibration Test Limits (V)	Published Specifications (V)
0.2	±0.00058	±0.001	±0.00114	±0.002
0.4	±0.00056	±0.001	±0.00114	±0.002
1	±0.00076	±0.0012	±0.00114	±0.002
2	±0.0008	±0.0016	±0.00114	±0.002
4	±0.0033	±0.008	±0.0033	±0.008
10	±0.0036	±0.008	±0.0036	±0.008
20	±0.005	±0.013	±0.005	±0.013

Table 5. NI 5124 Vertical Offset Limits

	NI PXI-5124		NI PCI-5124	
Range	Calibration Test Limits (V)	Published Specifications (V)	Calibration Test Limits (V)	Published Specifications (V)
0.2	±0.0008	±0.0013	±0.0013	±0.0018
0.4	±0.0008	±0.0013	±0.0013	±0.0018
1	±0.0011	±0.0015	±0.0016	±0.0021
2	±0.0011	±0.0015	±0.0016	±0.0021
4	±0.00575	±0.01	±0.005	±0.010

Table 5. NI 5124 Vertical Offset Limits (Continued)

Range	NI PXI-5124		NI PCI-5124	
	Calibration Test Limits (V)	Published Specifications (V)	Calibration Test Limits (V)	Published Specifications (V)
10	±0.00575	±0.01	±0.005	±0.01
20	±0.00575	±0.01	±0.005	±0.01

Table 6. NI 5142 Vertical Offset Limits

Range	NI PXI-5142		NI PCI-5142	
	Calibration Test Limits (V)	Published Specifications (V)	Calibration Test Limits (V)	Published Specifications (V)
0.2	±0.00058	±0.001	±0.00114	±0.002
0.4	±0.00056	±0.001	±0.00114	±0.002
1	±0.00076	±0.0012	±0.00114	±0.002
2	±0.0008	±0.0016	±0.00114	±0.0022
4	±0.0033	±0.008	±0.0033	±0.008
10	±0.0036	±0.008	±0.0036	±0.010
20	±0.005	±0.013	±0.005	±0.015

Vertical Gain Accuracy

Complete the following steps to verify the vertical gain accuracy of the digitizer. You must verify both channels with each iteration in Table 3.

1. Open a session and obtain a session handle using the niScope Initialize VI.

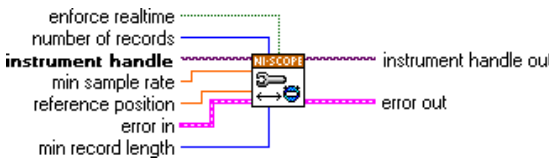| LabVIEW VI	C/C++ Function Call
	Call `niScope_init` with the following parameters: **resourceName**: The device name assigned by MAX **idQuery**: VI_FALSE **resetDevice**: VI_TRUE

2. Configure the input impedance and the maximum input frequency using the niScope Configure Chan Characteristics VI.

LabVIEW VI	C/C++ Function Call
	Call `niScope_ConfigureChan Characteristics` with the following parameters: **channelList**: `"0"` **inputImpedance**: The *Input Impedance* value in Table 3 for the current iteration **maxInputFrequency**: The *Maximum Input Frequency* value in Table 3 for the current iteration

3. Configure the common vertical properties using the niScope Configure Vertical VI.

LabVIEW VI	C/C++ Function Call
	Call `niScope_Configure Vertical` with the following parameters: **coupling**: `NISCOPE_VAL_DC` **probeAttenuation**: `1.0` **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **range**: The *Range* value in Table 3 for the current iteration **offset**: `0.0` **enabled**: `NISCOPE_VAL_TRUE`

4. Configure the horizontal properties using the niScope Configure Horizontal Timing VI.

LabVIEW VI	C/C++ Function Call
enforce realtime number of records **instrument handle** min sample rate reference position error in min record length instrument handle out error out	Call `niScope_Configure HorizontalTiming` with the following parameters: **enforceRealtime**: `NISCOPE_VAL_TRUE` **numRecords**: 1 **vi**: The instrument handle from `niScope_init` **minSampleRate**: `10,000,000` **refPosition**: `50.0` **minNumPts**: `100,000`

5. Commit all the parameter settings to hardware using the niScope Commit VI.

LabVIEW VI	C/C++ Function Call
instrument handle error in instrument handle out error out	Call `niScope_Commit` with the following parameter: **vi**: The instrument handle from `niScope_init`

6. Connect the calibrator test head directly to the channel 0 input of the digitizer and output the *Positive Input* voltage from Table 7 (NI 5122/5142) or Table 8 (NI 5124) that corresponds to the vertical range used. Be sure to configure the load impedance of the calibrator to match the input impedance of the digitizer.

7. Wait 2,500 ms for the impedance matching and frequency of the calibrator to settle.

8. Initiate a waveform acquisition using the niScope Initiate Acquisition VI.

LabVIEW VI	C/C++ Function Call
instrument handle error in instrument handle out error out	Call `niScope_Initiate Acquisition` with the following parameter: **vi**: The instrument handle from `niScope_init`

9. Fetch a waveform from the digitizer and perform a voltage average measurement using the niScope Fetch Measurement (poly) VI. Select the Measurement Scalar DBL instance of the VI. This value is the *Measured Positive Voltage* used in step 14.

LabVIEW VI	**C/C++ Function Call**
timeout **instrument handle** channel array measurement error in meas waveform size —instrument handle out —meas wfm info —meas waveform —error out	Call `niScope_Fetch Measurement` with the following parameters: **timeout**: `1.0` **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **scalarMeasFunction**: `NISCOPE_ VAL_VOLTAGE_AVERAGE`

10. Using the calibrator, output the *Negative Input* voltage listed in Table 7 (NI 5122/5142) or Table 8 (NI 5124) that corresponds to the vertical range used.

11. Wait 2,500 ms for the impedance matching and frequency of the calibrator to settle.

12. Initiate a waveform acquisition using the niScope Initiate Acquisition VI.

LabVIEW VI	**C/C++ Function Call**
instrument handle error in —instrument handle out —error out	Call `niScope_Initiate Acquisition` with the following parameter: **vi**: The instrument handle from `niScope_init`

13. Fetch a waveform from the digitizer and perform a voltage average measurement using the niScope Fetch Measurement (poly) VI. Select the Measurement Scalar DBL instance of the VI. This value is the *Measured Negative Voltage* used in step 14.

LabVIEW VI	**C/C++ Function Call**
timeout **instrument handle** channel array measurement error in meas waveform size —instrument handle out —meas wfm info —meas waveform —error out	Call `niScope_FetchMeasureme nt` with the following parameters: **timeout**: `1.0` **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **scalarMeasFunction**: `NISCOPE_ VAL_VOLTAGE_AVERAGE`

14. Calculate the error in the vertical gain as a percentage of input using the following formula:

$$error = \left(\left(\frac{a - b}{c - d}\right) - 1\right) \times 100$$

where

      a = the *Measured Positive Voltage*

      b = the *Measured Negative Voltage*

      c = the applied *Positive Voltage*

      d = the applied *Negative Voltage*

Compare the resulting percent error to the *Calibration Test Limits* or the *Published Specifications* listed in Table 7 (NI 5122/5142) or Table 8 (NI 5124). If the result is within the selected test limit, the device has passed this portion of the verification.

15. Repeat steps 2 through 14 for each iteration in Table 3.

Table 7. NI 5122/5142 Vertical Gain Stimuli and Limits

Range (V)	Positive Input (V)	Negative Input (V)	Calibration Test Limits	Published Specifications
0.2	0.09	-0.09	±0.37%	±0.65%
0.4	0.18	-0.18	±0.37%	±0.65%
1	0.45	-0.45	±0.37%	±0.65%
2	0.9	-0.9	±0.37%	±0.65%
4	1.8	-1.8	±0.37%	±0.65%
10	4.5	-4.5	±0.37%	±0.65%
20	9	-9	±0.37%	±0.65%

Table 8. NI 5124 Vertical Gain Stimuli, Calibration Test Limits, and Published Specifications

Range (V)	Positive Input (V)	Negative Input (V)	Calibration Test Limits	Published Specifications
0.2	0.09	-0.09	±0.3975%	±0.65%
0.4	0.18	-0.18	±0.3975%	±0.65%
1	0.45	-0.45	±0.3975%	±0.65%
2	0.9	-0.9	±0.3975%	±0.65%
4	1.8	-1.8	±0.3975%	±0.65%

Table 8. NI 5124 Vertical Gain Stimuli, Calibration Test Limits,
and Published Specifications

Range (V)	Positive Input (V)	Negative Input (V)	Calibration Test Limits	Published Specifications
10	4.5	-4.5	±0.3975%	±0.65%
20	9	-9	±0.3975%	±0.65%

16. Move the calibrator test head to the digitizer input channel 1 and repeat steps 2 through 15 for every configuration in Table 3, changing the value of the **channelList** parameter from "0" to "1".

17. End the session using the niScope Close VI.

LabVIEW VI	C/C++ Function Call
instrument handle ——— NI-SCOPE error in ———————— error out	Call `niScope_close` with the following parameter: **vi**: The instrument handle from `niScope_init`

You have finished verifying the vertical gain accuracy of the NI 5122/5124/5142.

Programmable Vertical Offset Accuracy

Complete the following steps to verify the programmable vertical offset accuracy for each digitizer channel.

1. Open a session and obtain a session handle using the niScope Initialize VI.

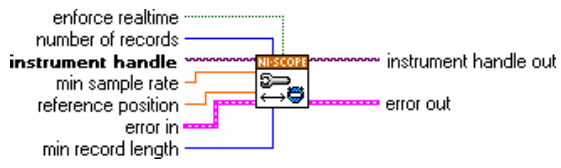| LabVIEW VI	C/C++ Function Call
resource name ——— NI-SCOPE ——— instrument handle id query ····· reset device ·····———————— error out error in ———	Call `niScope_init` with the following parameters: **resourceName**: The device name assigned by MAX **idQuery**: `VI_FALSE` **resetDevice**: `VI_TRUE`

2. Configure the input impedance and the maximum input frequency using the niScope Configure Chan Characteristics VI.

LabVIEW VI	C/C++ Function Call
instrument handle — instrument handle out channel name input impedance max input frequency error in — error out	Call niScope_ConfigureChan Characteristics with the following parameters: **vi**: The instrument handle from niScope_init **channelList**: "0" **inputImpedance**: NISCOPE_VAL_1_MEG_OHM **maxInputFrequency**: 100,000,000 (for NI 5122/5142), 150,000,000 (for NI 5124)

3. Configure the common vertical properties using the niScope Configure Vertical VI.

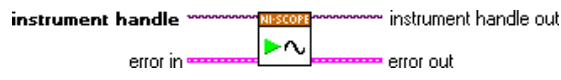| LabVIEW VI	C/C++ Function Call
vertical coupling probe attenuation instrument handle — instrument handle out channel name vertical range — error out vertical offset error in channel enabled	Call niScope_Configure Vertical with the following parameters: **coupling**: NISCOPE_VAL_DC **probeAttenuation**: 1.0 **vi**: The instrument handle from niScope_init **channelList**: "0" **range**: 2.0 **offset**: 0.75 **enabled**: NISCOPE_VAL_TRUE

4. Configure the horizontal properties using the niScope Configure Horizontal Timing VI.

LabVIEW VI	C/C++ Function Call
enforce realtime number of records **instrument handle** min sample rate reference position error in min record length → [NI-SCOPE] → instrument handle out error out	Call niScope_Configure HorizontalTiming with the following parameters: **enforceRealtime**: NISCOPE_VAL_TRUE **numRecords**: 1 **vi**: The instrument handle from niScope_init **minSampleRate**: 10,000,000 **refPosition**: 50.0 **minNumPts**: 100,000

5. Commit all the parameter settings to hardware using the niScope Commit VI.

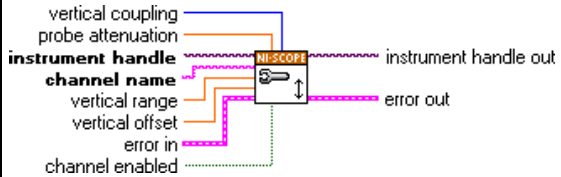| LabVIEW VI	C/C++ Function Call
instrument handle → [NI-SCOPE] → instrument handle out error in → error out	Call niScope_Commit with the following parameter: **vi**: The instrument handle from niScope_init

6. Connect the calibrator test head directly to the channel 0 input of the digitizer and output 0.75 V with a 1 MΩ load impedance.

7. Wait 2,500 ms for the impedance matching and frequency of the calibrator to settle.

8. Initiate a waveform acquisition using the niScope Initiate Acquisition VI.

LabVIEW VI	C/C++ Function Call
instrument handle → [NI-SCOPE] → instrument handle out error in → error out	Call niScope_Initiate Acquisition with the following parameter: **vi**: The instrument handle from niScope_init

9. Fetch a waveform from the digitizer and perform a voltage average measurement using the niScope Fetch Measurement (poly) VI. Select the Measurement Scalar DBL instance of the VI. This value is the *Measured Positive Voltage* used in step 16.

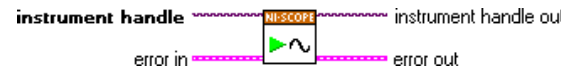| LabVIEW VI	C/C++ Function Call
	Call niScope_FetchMeasuremen t with the following parameters: **timeout**: 1.0 **vi**: The instrument handle from niScope_init **channelList**: "0" **scalarMeasFunction**: NISCOPE_VAL_VOLTAGE_AVE RAGE

10. Set the calibrator to output -0.75 V.
11. Configure the common vertical properties using the niScope Configure Vertical VI.

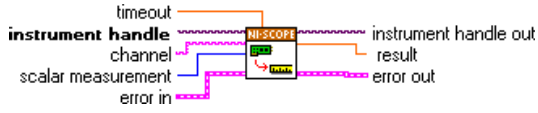| LabVIEW VI	C/C++ Function Call
	Call niScope_ConfigureVertic al with the following parameters: **coupling**: NISCOPE_VAL_DC **probeAttenuation**: 1.0 **vi**: The instrument handle from niScope_init **channelList**: "0" **range**: 2.0 **offset**: -0.75 **enabled**: NISCOPE_VAL_TRUE

12. Commit all the parameter settings to hardware using the niScope Commit VI.

LabVIEW VI	C/C++ Function Call
	Call niScope_Commit with the following parameter: **vi**: The instrument handle from niScope_init

13. Wait 2,500 ms for the impedance matching and frequency of the calibrator to settle.
14. Initiate a waveform acquisition using the niScope Initiate Acquisition VI.

LabVIEW VI	C/C++ Function Call
instrument handle ⟶ [NI-SCOPE ▶∼] ⟶ instrument handle out error in ⟶ ⟶ error out	Call `niScope_Initiate Acquisition` with the following parameter: **vi**: The instrument handle from `niScope_init`

15. Fetch a waveform from the digitizer and perform a voltage average measurement using the niScope Fetch Measurement (poly) VI. Select the Measurement Scalar DBL instance of the VI. This value is the *Measured Negative Voltage* used in step 16.

LabVIEW VI	C/C++ Function Call
timeout **instrument handle** [NI-SCOPE] ⟶ instrument handle out channel ⟶ result scalar measurement ⟶ error out error in	Call `niScope_FetchMeasurement` with the following parameters: **timeout**: `1.0` **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **scalarMeasFunction**: `NISCOPE_VAL_VOLTAGE_AVERAGE`

16. Calculate the error in the programmable vertical offset as a percentage of input using the following formula:

$$error = (((a - b) / 1.5) - 1) * 100$$

where

   a = the *Measured Positive Voltage*

   b = the *Measured Negative Voltage*

Compare the resulting percent to the *Calibration Test Limits* or the *Published Specifications* listed in Table 9 (NI 5122/5142) and Table 10 (NI 5124). If the result is within the selected test limit, the device has passed this portion of the verification.

Table 9. NI 5122/5142 Programmable Vertical Offset Accuracy Limits

NI PXI/PXIe-5122 and NI PXI-5142		NI PCI-5122/5142	
Calibration Test Limits	**Published Specifications**	**Calibration Test Limits**	**Published Specifications**
±0.36%	±0.4%	±0.36%	±0.5%

Table 10. NI 5124 Programmable Vertical Offset Accuracy Limits

Calibration Test Limits	Published Specifications
±0.36%	±0.4%

17. Move the calibrator test head to the digitizer input channel 1 and repeat steps 2 through 16, changing the value of the **channelList** parameter from `"0"` to `"1"`.

18. End the session using the niScope Close VI.

LabVIEW VI	C/C++ Function Call
instrument handle ~~~~ NI-SCOPE error in ======= error out	Call `niScope_close` with the following parameter: **vi**: The instrument handle from `niScope_init`

You have finished verifying the programmable vertical offset accuracy of the NI 5122/5124/5142.
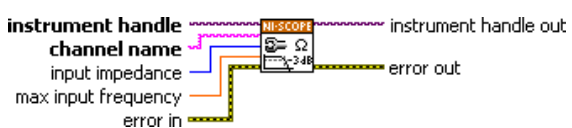
Timing Accuracy

Complete the following steps to verify the timing accuracy for the NI 5122/5124/5142.
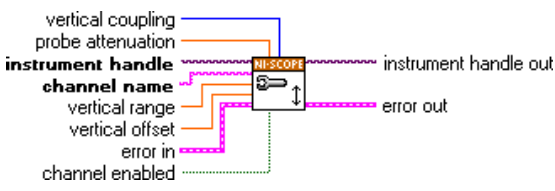
1. Open a session and obtain a session handle using the niScope Initialize VI.

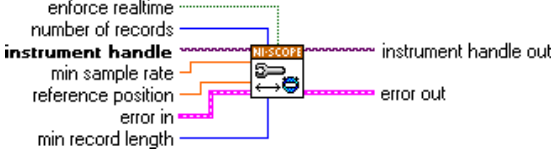| LabVIEW VI	C/C++ Function Call
resource name ~~~~ NI-SCOPE ~~~~ instrument handle id query reset device ======= error out error in	Call `niScope_init` with the following parameters: **resourceName**: The device name assigned by MAX **idQuery**: `VI_FALSE` **resetDevice**: `VI_TRUE`

2. Configure the input impedance and the maximum input frequency using the niScope Configure Chan Characteristics VI.

LabVIEW VI	C/C++ Function Call
instrument handle ⸺ instrument handle out **channel name** input impedance max input frequency error in ⸺ error out	Call `niScope_ConfigureChan Characteristics` with the following parameters: **channelList**: `"0"` **inputImpedance**: `NISCOPE_VAL_50_OHM` **maxInputFrequency**: `20,000,000`

3. Configure the common vertical properties using the niScope Configure Vertical VI.

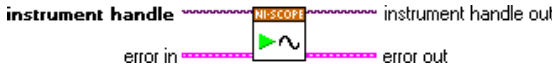| LabVIEW VI	C/C++ Function Call
vertical coupling probe attenuation **instrument handle** ⸺ instrument handle out **channel name** vertical range vertical offset error in ⸺ error out channel enabled	Call `niScope_Configure Vertical` with the following parameters: **coupling**: `NISCOPE_VAL_DC` **probeAttenuation**: `1.0` **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **range**: `2.0` **offset**: `0.0` **enabled**: `NISCOPE_VAL_TRUE`

4. Configure the horizontal properties using the niScope Configure Horizontal Timing VI.

LabVIEW VI	C/C++ Function Call
enforce realtime number of records **instrument handle** min sample rate reference position error in min record length → instrument handle out → error out	Call `niScope_Configure HorizontalTiming` with the following parameters: **enforceRealtime**: `NISCOPE_VAL_TRUE` **numRecords**: 1 **vi**: The instrument handle from `niScope_init` **minSampleRate**: `100,000,000` **refPosition**: `50.0` **minNumPts**: `1,000,000`

5. Commit all the parameter settings to hardware using the niScope Commit VI.

LabVIEW VI	C/C++ Function Call
instrument handle error in → instrument handle out → error out	Call `niScope_Commit` with the following parameter: **vi**: The instrument handle from `niScope_init`

6. Connect the scope calibrator test head directly to the channel 0 input of the digitizer. Configure the calibrator to output an 11 MHz sine wave with 1 Vpk-pk amplitude and 50 Ω load impedance.

7. Wait 2,500 ms for the impedance matching and frequency of the calibrator to settle.

8. Initiate a waveform acquisition using the niScope Initiate Acquisition VI.

LabVIEW VI	C/C++ Function Call
instrument handle error in → instrument handle out → error out	Call `niScope_Initiate Acquisition` with the following parameter: **vi**: The instrument handle from `niScope_init`

9. Retrieve a waveform using the niScope Fetch (poly) VI. Select the WDT instance of the VI. Use the default value for the **timestamp Type** parameter.

LabVIEW VI	C/C++ Function Call
timestamp type / timeout / instrument handle / channel / numSamples / error in — NI-SCOPE WDT — instrument handle out / wfm info / wfm / error out	Call `niScope_Fetch` with the following parameters: **timeout**: `5.0` **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **numSamples**: `-1`

10. Measure the exact frequency of the peak around 11 MHz using the Extract Single Tone Information VI with the following inputs.

   • **advanced search»approx freq.**: -1
   • **advanced search»search**: 5
   • **export signals**: 0 (none)

LabVIEW VI	C/C++ Function Call
time signal in / export signals / error in (no error) / advanced search — 1-CH — exported signals / detected frequency / detected amplitude / detected phase (deg) / error out / measurement info	Perform an FFT on the array of data from step 9.

11. Calculate the error in timing as parts per million (ppm) using the following formula:

$$error = (a - 11{,}000{,}000) / 11$$

where *a* is the measured frequency.

Compare the result to the *Calibration Test Limits* or the *Published Specifications* listed in Table 11. If the result is within the selected test limit, the device has passed this portion of the verification.
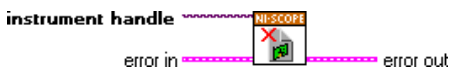
Table 11. NI 5122/5124/5142 Timing Accuracy Limits

Calibration Test Limits	Published Specifications
±5.3 ppm	±25 ppm

📝 **Note** The same time source is used for both channel 0 and channel 1, so you only need to verify the timing accuracy on one channel.

12. End the session using the niScope Close VI.

LabVIEW VI	C/C++ Function Call
instrument handle ～～～ [NI-SCOPE icon] error in ━━━━━ ━━━━━ error out	Call `niScope_close` with the following parameter: **vi**: The instrument handle from `niScope_init`

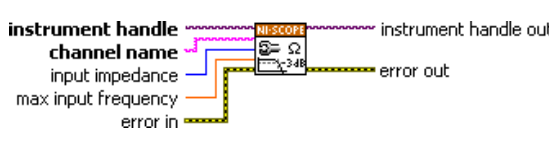You have finished verifying the timing accuracy of the NI 5122/5124/5142.

Bandwidth and Flatness

Complete the following steps to verify the bandwidth and flatness of the NI 5122/5124/5142. You must verify both channels with each iteration listed in Table 12 (NI 5122/5142) or Table 13 (NI 5124).
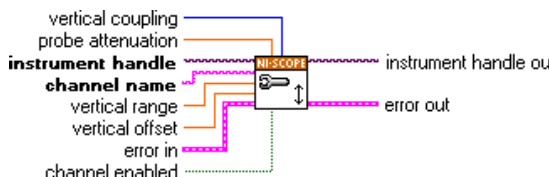
1. Open a session and obtain a session handle using the niScope Initialize VI.

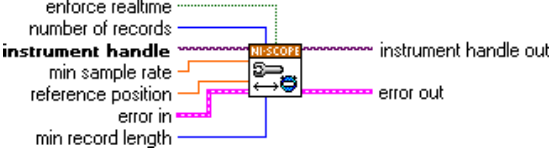| LabVIEW VI	C/C++ Function Call
resource name ～～ [NI-SCOPE icon] ～～ instrument handle id query ┄┄┘ reset device ┄┄┘ ━━━ error out error in ━━━┘	Call `niScope_init` with the following parameters: **resourceName**: The device name assigned by MAX **idQuery**: `VI_FALSE` **resetDevice**: `VI_TRUE`

2. Configure the input impedance and the maximum input frequency using the niScope Configure Chan Characteristics VI.

LabVIEW VI	C/C++ Function Call
	Call `niScope_ConfigureChan Characteristics` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **inputImpedance**: The *Input Impedance* value in Table 12 (NI 5122/5142) or Table 13 (NI 5124) for the current iteration **maxInputFrequency**: The *Maximum Input Frequency* value in Table 12 (NI 5122/5142) or Table 13 (NI 5124) for the current iteration

3. Configure the common vertical properties using the niScope Configure Vertical VI.

LabVIEW VI	**C/C++ Function Call**
	Call `niScope_Configure Vertical` with the following parameters: **coupling**: `NISCOPE_VAL_DC` **probeAttenuation**: `1.0` **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **range**: The *Range* value in Table 12 (NI 5122/5142) or Table 13 (NI 5124) for the current iteration **offset**: `0.0` **enabled**: `NISCOPE_VAL_TRUE`

4. Configure the horizontal properties using the niScope Configure Horizontal Timing VI.

LabVIEW VI	C/C++ Function Call

enforce realtime
number of records
instrument handle
min sample rate
reference position
error in
min record length
→ instrument handle out
→ error out
	Call `niScope_Configure`
	`HorizontalTiming` with the
	following parameters:
	
	enforceRealtime:
	`NISCOPE_VAL_TRUE`
	numRecords: `1`
	vi: The instrument handle from
	`niScope_init`
	minSampleRate: `10,000,000`
	refPosition: `50.0`
	minNumPts: `30,000`

5. Commit all the parameter settings to hardware using the niScope Commit VI.

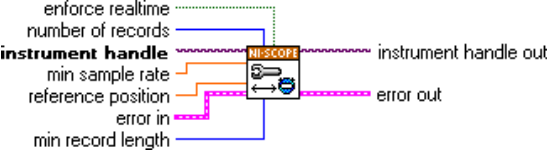| LabVIEW VI	C/C++ Function Call
instrument handle ~~~~ instrument handle out error in ===== error out	Call `niScope_Commit` with the following parameter: **vi**: The instrument handle from `niScope_init`

6. Connect the calibrator test head directly to the channel 0 input of the digitizer. Configure the calibrator to output a 50 kHz sine wave with peak-to-peak voltage amplitude set to half the vertical range of the digitizer. Configure the load impedance of the calibrator to match the input impedance of the digitizer.

7. Wait 2,500 ms for the impedance matching and frequency of the calibrator to settle.

8. Initiate a waveform acquisition using the niScope Initiate Acquisition VI.

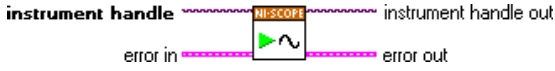| LabVIEW VI	C/C++ Function Call
instrument handle ~~~~ instrument handle out error in ===== error out	Call `niScope_Initiate` `Acquisition` with the following parameter: **vi**: The instrument handle from `niScope_init`

9. Fetch a waveform from the digitizer and perform a voltage RMS measurement using the niScope Fetch Measurement (poly) VI. Select the Measurement Scalar DBL instance of the VI. This value is the *Measured RMS Voltage of 50 kHz Sine Wave* used in step 11e.

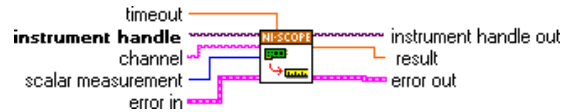| LabVIEW VI	C/C++ Function Call
	Call niScope_Fetch Measurement with the following parameters: **timeout**: 1.0 **vi**: The instrument handle from niScope_init **channelList**: "0" **scalarMeasFunction**: NISCOPE_VAL_VOLTAGE_R MS

10. Configure the horizontal properties using the niScope Configure Horizontal Timing VI.

LabVIEW VI	C/C++ Function Call
	Call niScope_Configure HorizontalTiming with the following parameters: **enforceRealtime**: NISCOPE_VAL_TRUE **numRecords**: 1 **vi**: The instrument handle from niScope_init **minSampleRate**: 100,000,000 (for NI 5122/5142), 200,000,000 (for NI 5124) **refPosition**: 50.0 **minNumPts**: 300,000

11. Repeat steps 11a through 11e for each *Input Frequency* listed for the current iteration in Table 12 (NI 5122/5142) or Table 13 (NI 5124).

　　a.　Configure the calibrator to output the *Input Frequency* for the current iteration in Table 12 (NI 5122/5142) or Table 13 (NI 5124).

　　b.　Wait 2,500 ms for the impedance matching and frequency of the calibrator to settle.

　　c.　Initiate a waveform acquisition using the niScope Initiate Acquisition VI.

LabVIEW VI	C/C++ Function Call
instrument handle ··· NI-SCOPE ··· instrument handle out error in ··· error out	Call `niScope_Initiate` `Acquisition` with the following parameter: **vi**: The instrument handle from `niScope_init`

    d.   Fetch a waveform from the digitizer and perform a voltage RMS measurement using the niScope Fetch Measurement (poly) VI. Select the Measurement Scalar DBL instance of the VI. This value is the *Measured RMS Voltage of Generated Sine Wave* used in step 11e.

LabVIEW VI	C/C++ Function Call

timeout
instrument handle ··· NI-SCOPE ··· instrument handle out
channel ··· result
scalar measurement ··· error out
error in
	Call `niScope_Fetch`
	`Measurement` with the
	following parameters:
	
	timeout: `1.0`
	vi: The instrument handle from
	`niScope_init`
	channelList: `"0"`
	scalarMeasFunction:
	`NISCOPE_VAL_VOLTAGE_R`
	`MS`

    e.   Calculate the power difference using the following formula:

$$power = (20\log_{10} a) - (20\log_{10} b)$$

    where

        a = the *Measured RMS Voltage of Generated Sine Wave*

        b = the *Measured RMS Voltage of 50 kHz Sine Wave*

    If the result is within the test limits from Table 12 (NI 5122/5142) or Table 13 (NI 5124), the device has passed this portion of the verification.

12.   Repeat steps 2 through 11 for each iteration in Table 12 (NI 5122/5142) or Table 13 (NI 5124).

13.   Move the calibrator test head to the digitizer input channel 1 and repeat steps 2 through 12, changing the value of the **channelList** parameter from `"0"` to `"1"`.

14.   End the session using the niScope Close VI.

LabVIEW VI	C/C++ Function Call
instrument handle — NI-SCOPE error in ——— error out	Call `niScope_close` with the following parameter: **vi**: The instrument handle from `niScope_init`

You have finished verifying the bandwidth and flatness of the NI 5122/5124/5142.

Table 12. NI 5122/5142 Bandwidth and Flatness Stimuli
and Published Specifications

Iteration	Max Input Frequency	Input Impedance	Range (V)	Input Frequency (Hz)	NI 5122/5142 Published Specifications	
					Max Level (dB)	Min Level (dB)
1	100 MHz	50 Ω	0.2	20,100,000	0.4	-0.4
				40,100,000	1	-1
				80,100,000	3[†]	-3[†]
2	100 MHz	50 Ω	0.4	20,100,000	0.4	-0.4
				50,100,000	1	-1
				100,100,000	3[†]	-3[†]
3	100 MHz	1 MΩ	0.2	20,100,000	0.4	-0.4
				40,100,000	1	-1
				80,100,000	3[†]	-3[†]
4	100 MHz	1 MΩ	0.4	20,100,000	0.4	-0.4
				50,100,000	1	-1
				100,100,000	3[†]	-3[†]

Table 12. NI 5122/5142 Bandwidth and Flatness Stimuli
and Published Specifications (Continued)

Iteration	Max Input Frequency	Input Impedance	Range (V)	Input Frequency (Hz)	NI 5122/5142 Published Specifications	
					Max Level (dB)	Min Level (dB)
5	35 MHz	50 Ω	0.4	16,000,000	1.2	-1.2
				32,000,000	1.6	-1.6
				35,000,000	3[†]	-3[†]
6	20 MHz	50 Ω	0.4	15,100,000	—	-3.5[*]
				25,100,000	-2.5[*]	—

[*] Published specifications value listed for validation of noise filter only. The specification is not included in device specifications documents.

[†] Warranted value. Other values are typical. For definitions of warranted specifications and typical specifications, refer to the specifications document for your device available online at `ni.com/manuals`.

Table 13. NI 5124 Bandwidth and Flatness Stimuli
and Published Specifications

Iteration	Max Input Frequency	Input Impedance	Range (V)	Input Frequency (Hz)	NI 5124 Published Specifications	
					Max Level (dB)	Min Level (dB)
1	150 MHz	50 Ω	0.2	20,100,000	0.6	-0.6
				40,100,000	1.5	-1.5
				85,000,000	3†	-3†
2	150 MHz	50 Ω	0.4	20,100,000	0.5	-0.5
				50,100,000	1	-1
				100,100,000	1.7	-1.7
				150,000,000	3†	-3†
3	150 MHz	1 MΩ	0.2	20,100,000	0.6	-0.6
				40,100,000	1.5	-1.5
				75,000,000	3†	-3†
4	150 MHz	1 MΩ	0.4	20,100,000	0.5	-0.5
				50,100,000	1	-1
				100,100,000	1.7	-1.7
				145,000,000	3†	-3†
5	60 MHz	50 Ω	4	22,100,000	2.0	-1.0
				55,000,000	2.0	-1.0
6	20 MHz	50 Ω	0.4	15,100,000	—	-3.5*
				25,100,000	-2.5*	—

* Published specifications value listed for validation of noise filter only. The specification is not included in device specifications documents.

† Warranted value. Other values are typical. For definitions of warranted specifications and typical specifications, refer to the *NI PXI/PCI-5124 Specifications* document available online at `ni.com/manuals`.

Trigger Sensitivity

Complete the following steps to verify the trigger sensitivity of the NI 5122/5124/5142. You must verify channel 0, channel 1, and the external trigger channel using the corresponding iterations in Table 14.
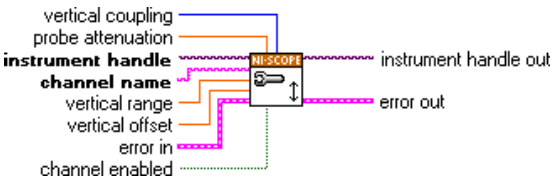
1. Open a session and obtain a session handle using the niScope Initialize VI.

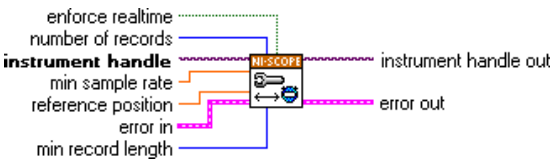| LabVIEW VI	C/C++ Function Call
	Call `niScope_init` with the following parameters: **resourceName**: The device name assigned by MAX **idQuery**: `VI_FALSE` **resetDevice**: `VI_TRUE`

2. Configure the input impedance and the maximum input frequency using the niScope Configure Chan Characteristics VI.

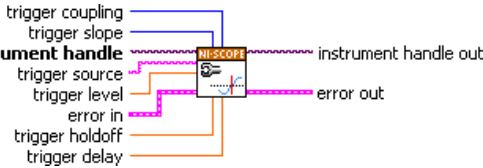| LabVIEW VI	C/C++ Function Call
	Call `niScope_ConfigureChan Characteristics` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **inputImpedance**: `NISCOPE_VAL_50_OHM` **maxInputFrequency**: `100,000,000`

3. Configure the common vertical properties using the niScope Configure Vertical VI.

LabVIEW VI	C/C++ Function Call
vertical coupling probe attenuation **instrument handle** **channel name** vertical range vertical offset error in channel enabled instrument handle out error out	Call `niScope_Configure` `Vertical` with the following parameters: **coupling**: `NISCOPE_VAL_DC` **probeAttenuation**: `1.0` **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **range**: `0.2` **offset**: `0.0` **enabled**: `NISCOPE_VAL_TRUE`

4. Configure the horizontal properties using the niScope Configure Horizontal Timing VI.

LabVIEW VI	C/C++ Function Call

enforce realtime
number of records
instrument handle
min sample rate
reference position
error in
min record length
 	
instrument handle out
error out
	Call `niScope_Configure`
	`HorizontalTiming` with the
	following parameters:
	
	enforceRealtime:
	`NISCOPE_VAL_TRUE`
	numRecords: `50`
	vi: The instrument handle from
	`niScope_init`
	minSampleRate:
	`100,000,000`
	refPosition: `50.0`
	minNumPts: `1,000`

5. Configure an edge trigger using the niScope Configure Trigger (poly) VI. Select the Analog Edge Ref Trigger instance of the VI.

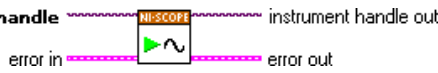| LabVIEW VI	C/C++ Function Call
	Call `niScope_Configure TriggerEdge` with the following parameters: **triggerCoupling**: `NISCOPE_VAL_DC` **slope**: The *Slope* value in Table 14 for the current iteration **vi**: The instrument handle from `niScope_init` **triggerSource**: The *Trigger Source* value in Table 14 for the current iteration **level**: The *Level* value in Table 14 for the current iteration **holdoff**: 0 **delay**: 0

> **Note** The trigger level is set to center the trigger hysteresis window at 0.0 V.

6. Commit all the parameter settings to hardware using the niScope Commit VI.

LabVIEW VI	C/C++ Function Call
	Call `niScope_Commit` with the following parameter: **vi**: The instrument handle from `niScope_init`

7. Connect the scope calibrator test head directly to the digitizer input for the channel you are testing. Configure the calibrator to output the appropriate signal in Table 14.

8. Wait 2,500 ms for the impedance matching and frequency of the calibrator to settle.

9. Initiate a waveform acquisition using the niScope Initiate Acquisition VI.

LabVIEW VI	C/C++ Function Call
	Call `niScope_Initiate Acquisition` with the following parameter: **vi**: The instrument handle from `niScope_init`

10. Acquire a waveform using the niScope Fetch (poly) VI. Select the Cluster instance of the VI.

LabVIEW VI	C/C++ Function Call
	Call `niScope_Fetch` with the following parameters: **timeout**: `2.0` **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **numSamples**: `-1`

11. If the digitizer does not time out, the digitizer has passed this portion of the verification. If the digitizer does time out, you must call the niScope Abort VI to end the acquisition.

LabVIEW VI	C/C++ Function Call
	Call `niScope_Abort` with the following parameter: **vi**: The instrument handle from `niScope_init`

12. To verify the trigger sensitivity on channel 1, repeat steps 2 through 11 using the values in Table 14, iterations 5 through 8. Make the following changes:
    • Change **channelList** to `"1"` in steps 2, 3, and 10
    • Connect the calibrator test head to channel 1 in step 7

13. To verify the trigger sensitivity on the external trigger channel, repeat steps 2 through 11 using the values in Table 14, iterations 9 through 12. Make the following changes:
    • Change the **channelList** to `"0"`
    • Connect the calibrator test head to the external trigger channel (TRIG) in step 7.

14. End the session using the niScope Close VI.

LabVIEW VI	C/C++ Function Call
	Call `niScope_close` with the following parameter: **vi**: The instrument handle from `niScope_init`

You have finished verifying the trigger sensitivity for the NI 5122/5124/5142.

Table 14. NI 5122/5124/5142 Trigger Sensitivity Inputs

Iteration	Trigger Source	Level (mV)	Slope	Calibrator Signal	
				NI 5122/5142	**NI 5124**
1	0	1.25	`NISCOPE_VAL_ POSITIVE`	4.84 mV$_{pk-pk}$ 50 MHz sine wave with 50 Ω load impedance	6.84 mV$_{pk-pk}$ 50 MHz sine wave with 50 Ω load impedance
2	0	-1.25	`NISCOPE_VAL_ NEGATIVE`		
3	0	1.25	`NISCOPE_VAL_ POSITIVE`	9.70 mV$_{pk-pk}$ 100 MHz sine wave with 50 Ω load impedance	19.0 mV$_{pk-pk}$ 150 MHz sine wave with 50 Ω load impedance
4	0	-1.25	`NISCOPE_VAL_ NEGATIVE`		
5	1	1.25	`NISCOPE_VAL_ POSITIVE`	4.84 mV$_{pk-pk}$ 50 MHz sine wave with 50 Ω load impedance	6.84 mV$_{pk-pk}$ 50 MHz sine wave with 50 Ω load impedance
6	1	-1.25	`NISCOPE_VAL_ NEGATIVE`		
7	1	1.25	`NISCOPE_VAL_ POSITIVE`	9.70 mV$_{pk-pk}$ 100 MHz sine wave with 50 Ω load impedance	19.0 mV$_{pk-pk}$ 150 MHz sine wave with 50 Ω load impedance
8	1	-1.25	`NISCOPE_VAL_ NEGATIVE`		
9	`VAL_ EXTERN AL`	62.5	`NISCOPE_VAL_ POSITIVE`	240 mV$_{pk-pk}$ 100 MHz sine wave with 1 MΩ load impedance	240 mV$_{pk-pk}$ 100 MHz sine wave with 1 MΩ load impedance
10	`VAL_ EXTERN AL`	-62.5	`NISCOPE_VAL_ NEGATIVE`		
11	`VAL_ EXTERN AL`	62.5	`NISCOPE_VAL_ POSITIVE`	940 mV$_{pk-pk}$ 200 MHz sine wave with 1 MΩ load impedance	940 mV$_{pk-pk}$ 200 MHz sine wave with 1 MΩ load impedance
12	`VAL_ EXTERN AL`	-62.5	`NISCOPE_VAL_ NEGATIVE`		

Adjustment

If the NI 5122/5124/5142 successfully passed each of the verification procedures within the calibration test limits, then an adjustment is recommended but not required to guarantee its published specifications for the next two years. If the digitizer was not within the calibration test limits for each of the verification procedures, you can perform the adjustment procedure to improve the accuracy of the digitizer. Refer to *Appendix A: Calibration Options* to determine which procedures to perform.

An adjustment is required only once every two years. Following the adjustment procedure automatically updates the calibration date and temperature in the EEPROM of the digitizer.
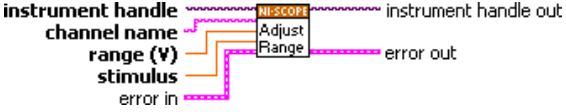
📝 **Note** If the digitizer passed the entire verification procedure within the calibration test limits and you do not want to perform an adjustment, you can update the calibration date and onboard calibration temperature without making any adjustments by completing *only* steps 2 and 12 in this section.

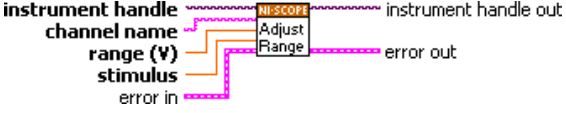Complete all of the following steps to externally adjust the NI 5122/5124/5142.

1. Connect the scope calibrator test head directly to the channel 1 input of the digitizer. Configure the calibrator to output an exact 4 V DC signal into a 1 MΩ load impedance.
2. Obtain an instrument session handle using the niScope Cal Start VI.

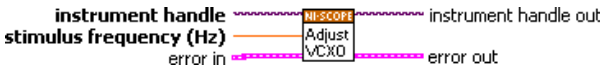| LabVIEW VI	C/C++ Function Call
	Call `niScope_CalStart` with the following parameters: **resourceName**: The name of the device to calibrate. You can find this name under Devices and Interfaces in MAX. **password**: The password required to open an external calibration session. If this password has not been changed since manufacturing, the password is `"NI"`.

3. Wait 2,500 ms for the impedance matching and frequency of the calibrator to settle.
4. Adjust the vertical range using the niScope Cal Adjust Range VI.

LabVIEW VI	C/C++ Function Call
	Call `niScope_CalAdjust Range` with the following parameters: **sessionHandle**: The instrument handle from `niScope_CalStart` **channelName**: "1" **range**: 0 **stimulus**: 4.0

5. Ground the calibrator.
6. Wait 500 ms for the calibrator to ground its output to channel 1 of the digitizer.
7. Adjust the vertical range using the niScope Cal Adjust Range VI.

LabVIEW VI	C/C++ Function Call
	Call `niScope_CalAdjust Range` with the following parameters: **sessionHandle**: The session handle from `niScope_CalStart` **channelName**: "1" **range**: 0 **stimulus**: 0.0

8. Using a BNC cable, connect REF FREQUENCY OUTPUT on the back of the calibrator to the channel 0 input of the digitizer. Make sure the output of the reference frequency is enabled and set to 10 MHz. If you are not using a Fluke 9500B/Wavetek 9500 calibrator, connect a precise 10 MHz, 1 Vpk-pk sine or square wave source to channel 0.
9. Adjust the sample rate using the niScope Cal Adjust VCXO VI.

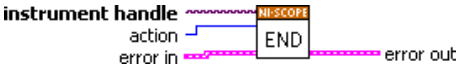| LabVIEW VI	C/C++ Function Call
instrument handle ~~~~ instrument handle out stimulus frequency (Hz) ──── Adjust VCXO error in ═══ error out	Call niScope_CalAdjust VCXO with the following parameters: **sessionHandle**: The instrument handle from niScope_CalStart **stimulusFreq**: 10,000,000

> 📝 **Note** The 10 MHz stimulus is automatically taken from channel 0.

10. Disconnect or disable all inputs to the digitizer.

11. Self-calibrate the digitizer using niScope Cal Self Calibrate VI.

LabVIEW VI	C/C++ Function Call
instrument handle ~~~~ instrument handle out Channel Name ──┐ Option ───── error out error in ═══	Call niScope_CalSelf Calibrate with the following parameters: **sessionHandle**: The instrument handle from niScope_CalStart **channelList**: VI_NULL **option**: VI_NULL

12. End the session and save the results using the niScope Cal End VI.

LabVIEW VI	C/C++ Function Call
instrument handle ~~~~ action ──┐ END error in ═══ error out	Call niScope_CalEnd with the following parameters: **sessionHandle**: The instrument handle you obtained from niScope_CalStart **action**: NISCOPE_VAL_ACTION_STORE

You have finished adjusting the NI 5122/5124/5142. It is not necessary to adjust each channel individually; however, you should repeat the entire verification procedure to verify a successful adjustment.

Appendix A: Calibration Options

External calibration involves verification and if necessary, adjustment and reverification. Adjustment is the process of measuring and compensating for device performance to improve the measurement accuracy. Performing an adjustment updates the calibration date, effectively resetting the calibration interval. The device is guaranteed to meet or exceed its published specifications for the duration of the calibration interval. Verification is the process of testing the device to ensure that the measurement accuracy is within certain specifications. Verification can be used to ensure that the adjustment process was successful or to determine if the adjustment process needs to be performed at all. During verification, you must compare the measurement error to the limits given in each section.
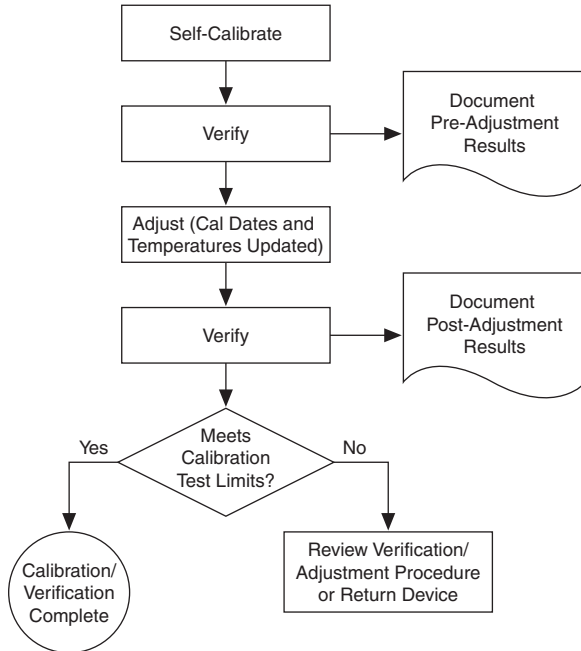
This document provides two sets of test limits for most verification stages—the *calibration test limits* and the *published specifications*. The calibration test limits are more restrictive than the published specifications. If all of the measurement errors determined during verification fall within the calibration test limits, the device is guaranteed to meet or exceed its published specifications for a full calibration interval (two years). For this reason, you must verify against the calibration test limits when performing verification after adjustment. If all of the measurement errors determined during verification fall within the published specifications, but not within the calibration test limits, the device is meeting its published specifications. However, the device will not necessarily remain within these specifications for an additional two years. The device will meet published specifications for the remainder of the current calibration interval. In this case, you can perform an adjustment if you want to further improve the measurement accuracy or reset the calibration interval. If some measurement errors determined during verification do not fall within the published specifications, you must perform an adjustment to restore the device operation to its published specifications.

The *Complete Calibration* section describes the recommended calibration procedure. The *Optional Calibration* section describes alternative procedures that allow you to skip adjustment if the device already meets its calibration test limits or published specifications.

Complete Calibration

Performing a complete calibration is the recommended way to guarantee that the NI 5122/5124/5142 will meet or exceed its published specifications for a two-year calibration interval. At the end of the complete calibration procedure, you verify that the measurement error falls within the calibration test limits. Figure 1 shows the programming flow for complete calibration.

Figure 1. Complete Calibration Programming Flow

```
                    ┌─────────────────┐
                    │  Self-Calibrate │
                    └────────┬────────┘
                             │
                             ▼                        ┌──────────────────┐
                    ┌─────────────────┐──────────────▶│  Document        │
                    │     Verify      │               │  Pre-Adjustment  │
                    └────────┬────────┘               │  Results         │
                             │                        └──────────────────┘
                             ▼
                ┌───────────────────────┐
                │ Adjust (Cal Dates and │
                │ Temperatures Updated) │
                └───────────┬───────────┘
                            │
                            ▼                         ┌──────────────────┐
                    ┌─────────────────┐──────────────▶│  Document        │
                    │     Verify      │               │  Post-Adjustment │
                    └────────┬────────┘               │  Results         │
                             │                        └──────────────────┘
                             ▼
                         ╱ Meets ╲
              Yes       ╱ Calibration╲      No
          ┌────────────▏  Test Limits? ▕────────────┐
          │             ╲           ╱               │
          ▼              ╲         ╱                ▼
   ┌─────────────┐                          ┌──────────────────────┐
   │ Calibration/│                          │ Review Verification/ │
   │ Verification│                          │ Adjustment Procedure │
   │ Complete    │                          │ or Return Device     │
   └─────────────┘                          └──────────────────────┘
```

Optional Calibration

You can choose to skip the adjustment steps of the calibration procedure if the measurement error is within the calibration test limits or the published specifications during the first verification. If all of the measurement errors determined during the first verification fall within the calibration test limits, the device is guaranteed to meet or exceed its published specifications for a full calibration interval. In this case, you can update the calibration date, effectively resetting the calibration interval, without actually performing an adjustment. Refer to the *Adjustment* section for more information.

If all of the measurement errors determined during the first verification fall within the published specifications, but not within the calibration test limits, adjustment is also optional. However, you cannot update the calibration date, because the device will not necessarily operate within the published specifications for an additional two years.

Note Regardless of the results of the first verification, if you choose to perform an adjustment, you must verify that the measurement error falls within the calibration test limits at the end of the calibration procedure.

Figure 2 shows the programming flow for the optional calibration.

Figure 2. Optional Calibration Programming Flow
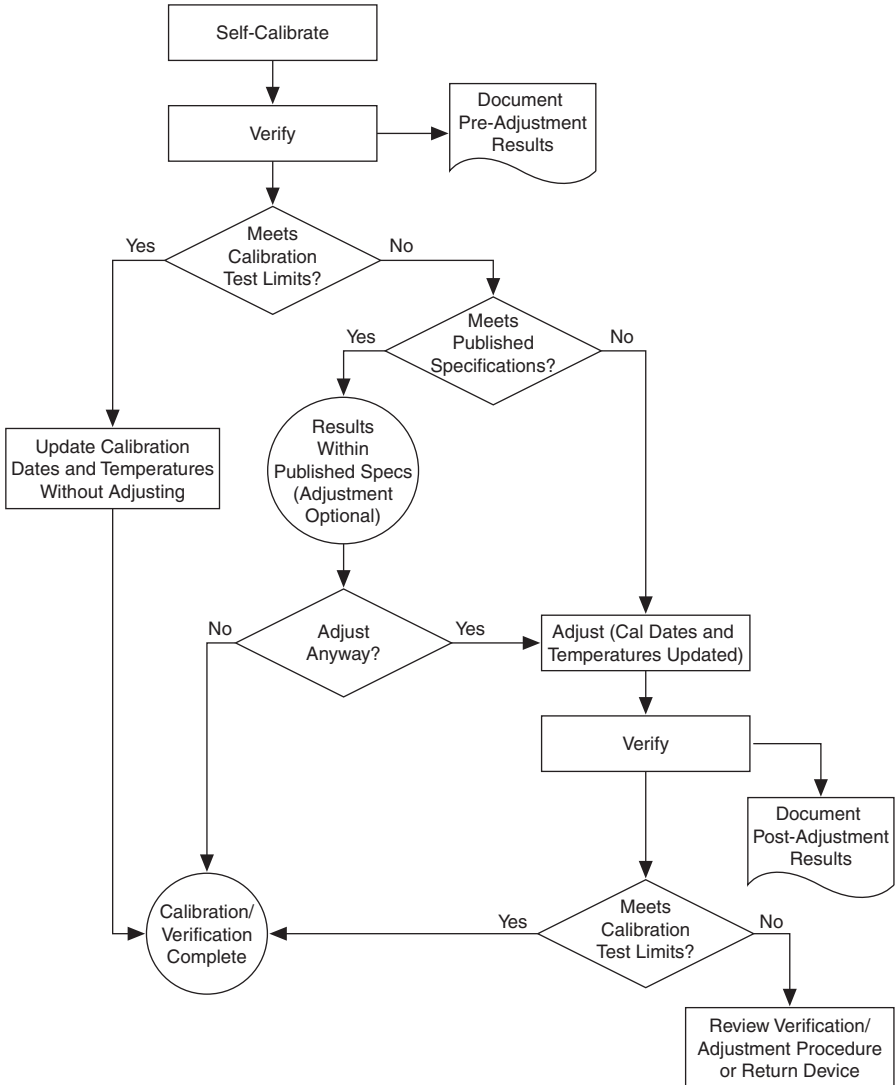
Appendix B: Calibration Utilities

NI-SCOPE supports several calibration utilities that allow you to retrieve information about adjustments performed on the NI 5122/5124/5142, change the external calibration password, and store small amounts of information in the onboard EEPROM. You can retrieve some data using MAX, however, you can retrieve all the data programmatically using NI-SCOPE functions.

MAX

To retrieve data using MAX, complete the following steps:

1. Select the device from which you want to retrieve information from **My System»Devices and Interfaces**.
2. Select the **Calibration** tab in the lower left corner.

You should see information about the last date and temperature for both external and self-calibration.

NI-SCOPE

NI-SCOPE provides a full complement of calibration utility functions and VIs. Refer to the *NI High-Speed Digitizers Help* for the complete function reference and VI reference. The utility functions include:

- niScope Cal Change Password VI (`niScope_CalChangePassword`)
- niScope Cal Fetch Count VI (`niScope_CalFetchCount`)
- niScope Cal Fetch Date VI (`niScope_CalFetchDate`)
- niScope Cal Fetch Misc Info VI (`niScope_CalFetchMiscInfo`)
- niScope Cal Fetch Temperature VI (`niScope_CalFetchTemperature`)
- niScope Cal Store Misc Info VI (`niScope_CalStoreMiscInfo`)

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Visit `ni.com/services` for NI Factory Installation Services, repairs, extended warranty, and other services.

Visit `ni.com/register` to register your NI product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

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