CALIBRATION PROCEDURE

NI 5622

This document contains instructions for writing an external calibration procedure for National Instruments PXIe-5622 digitizers. This calibration procedure is intended for metrology labs. For more information about calibration, visit `ni.com/calibration`.

Contents

NATIONAL INSTRUMENTS™

Conventions

The following conventions are used in this document:

» — The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **Options»Settings»General** directs you to pull down the **Options** menu, select the **Settings** item, and select **General** from the last dialog box.

This icon denotes a note, which alerts you to important information.

This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash.

bold — Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names.

italic — Italic text denotes variables, emphasis, a cross-reference, or an introduction to a key concept. Italic text also denotes text that is a placeholder for a word or value that you must supply.

`monospace` — Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions.

Platform — Text in this font denotes a specific platform and indicates that the text following it applies only to that platform.

Software Requirements

Calibrating the NI 5622 requires installing the following software on the calibration system.

Table 1. Required Software Specifications for NI 5622 Calibration

LabVIEW	LabWindows/CVI and C/C++
NI-SCOPE 3.5 or later	NI-SCOPE 3.5 or later
NI LabVIEW Digital Filter Design Toolkit 8.2.1 or later	NI Modulation Toolkit for LabWindows/CVI 2.0 or later
NI Modulation Toolkit for LabVIEW 3.0 or later	—

You can download NI-SCOPE from the National Instruments web site at `ni.com/updates`. NI-SCOPE supports programming the *Self-Calibration* and *Verification* sections in a number of programming languages; however, only LabVIEW and C are supported for the *Adjustment* section.

NI-SCOPE includes all the functions and attributes necessary for calibrating the NI 5622. LabVIEW support is installed in `niScopeCal.llb`, and all calibration functions appear in the function palette. For LabWindows™/CVI™, the NI-SCOPE function panel `niScopeCal.fp` provides further help on the functions available in CVI. Refer to Table 2 for installed file locations.

Calibration functions are LabVIEW VIs or C function calls in the NI-SCOPE driver. The C function calls are valid for any compiler capable of calling a 32-bit DLL. Many of the functions use constants defined in the `niScopeCal.h` file. To use these constants in C, you must include `niScopeCal.h` in your code when you write the calibration procedure.

For more information on the calibration VIs and functions, refer to the *NI-SCOPE LabVIEW Reference Help* or the *NI-SCOPE Function Reference Help*. These references can be found in the *NI High-Speed Digitizers Help*. Refer to the *NI-SCOPE Readme* for the installed locations of these documents.

Table 2. Calibration File Locations after Installing NI-SCOPE

File Name and Location	Description
IVI\Bin\niscope_32.dll	NI-SCOPE driver containing the entire NI-SCOPE API, including calibration functions
IVI\Lib\msc\niscope.lib	NI-SCOPE library for Microsoft C containing the entire NI-SCOPE API, including calibration functions
<*LabVIEW*>\examples\instr\niScope	Directory of LabVIEW NI-SCOPE example VIs, including self-calibration.
<*LabVIEW*>\instr.lib\niScope\Calibrate\niScopeCal.llb	LabVIEW VI library containing VIs for calling the NI-SCOPE calibration API.
IVI\Drivers\niScope\niScopeCal.fp	CVI function panel file that includes external calibration function prototypes and information about using NI-SCOPE in the CVI environment.
IVI\Include\niScopeCal.h	Calibration header file, which you must include in any C program accessing calibration functions. This file automatically includes niScope.h, which defines the rest of the NI-SCOPE interface.
IVI\Drivers\niScope\Examples	Directory of NI-SCOPE examples for CVI, C, Visual C++, and Visual Basic.

Documentation Requirements

You may find the following documentation helpful as you write your calibration procedure:

- *NI High-Speed Digitizers Getting Started Guide*
- *NI High-Speed Digitizers Help*
  - *NI-SCOPE LabVIEW Reference Help (NI-SCOPE VIs* and *NI-SCOPE Properties)*
  - *NI-SCOPE Function Reference Help*
- *NI PXIe-5622 Specifications*

These documents are installed with NI-SCOPE. You can also download the latest versions from ni.com/manuals.

Password

A password is required to open an external calibration session. If the password has not been changed since manufacturing, the password is `NI`.

Calibration Interval

External Calibration

The measurement accuracy requirements of your application determine how often you should externally calibrate the NI 5622. NI recommends that you perform a complete external calibration at least once every year. You can shorten this interval based on the accuracy demands of your application.

Self-Calibration

You can perform self-calibration whenever necessary to compensate for environmental changes.

Caution Although you can repeatedly self-calibrate, self-calibrating the NI 5622 more than a few times a day may cause excessive wear on the relays over time.

Test Equipment

Table 3 lists the equipment required for externally calibrating the NI 5622. If you do not have the recommended instruments, use these specifications to select a substitute calibration standard.

Table 3. Required Equipment Specifications for NI 5622 External Calibration

<table>
<tr><th>Required Equipment</th><th>Recommended Equipment</th><th>Calibration Procedure</th><th colspan="4">Specification</th></tr>
<tr><td rowspan="6">Signal Generator</td><td rowspan="6">Rohde and Schwarz SMA-B103 with SMA-B22 option, enhanced phase noise performance</td><td rowspan="4">SSB Phase Noise</td><th rowspan="2">Carrier Frequency</th><th colspan="3">Carrier Offset</th></tr>
<tr><th>100 Hz</th><th>1 kHz</th><th>10 kHz</th></tr>
<tr><td>53 MHz</td><td>–108 dBc/Hz</td><td>–146 dBc/Hz</td><td>–158 dBc/Hz</td></tr>
<tr><td>187 MHz</td><td>–98 dBc/Hz</td><td>–135 dBc/Hz</td><td>–148 dBc/Hz</td></tr>
<tr><td>Bandpass Amplitude Flatness, Absolute Amplitude Accuracy, SSB Phase Noise, Timing Accuracy, Adjustment</td><td colspan="4">Frequency Range: 900 kHz to 820 MHz
Power Measurement Level Setting Range: –4 dBm to 10 dBm</td></tr>
<tr><td>Timing Accuracy, Adjustment</td><td colspan="4">±0.1 ppm frequency accuracy</td></tr>
<tr><td>Power Meter</td><td>Rohde and Schwarz NRP-Z91 with NRP-Z4 USB adapter</td><td>Absolute Amplitude Accuracy, Bandpass Amplitude Flatness, Adjustment</td><td colspan="4">Frequency Range: 900 kHz to 820 MHz
Power Measurement Range: –4 dBm to 3 dBm
Maximum VSWR: 1.11 (23 ±5 °C)
Absolute Power Measurement Uncertainty: 0.1 dB (23 ±5 °C)
Relative Power Measurement Uncertainty: 0.05 dB (23 ±5 °C)</td></tr>
</table>

Table 3. Required Equipment Specifications for NI 5622 External Calibration (Continued)

Required Equipment	Recommended Equipment	Calibration Procedure	Specification
SMA Cable	Mini-Circuits CBL-1.5FT-SMSM+	*Bandpass Amplitude Flatness*, *Absolute Amplitude Accuracy*, *SSB Phase Noise*, *Timing Accuracy*, *Adjustment*	50 Ω, Maximum VSWR: 1.20 Frequency Range: 900 kHz to 820 MHz Power Measurement Range: –4 dBm to 3 dBm Relative Shielding: –100 dB
Attenuator	Mini-Circuits VAT-3+	*SSB Phase Noise*	Frequency Range: 900 kHz to 820 MHz Minimum Power (W): 10 mW Maximum VSWR: 1.20 Nominal Attenuation: 3 dB
SMA Termination	Mini-Circuits ANNE-50+	*Average Noise Density*	50 Ω
Power Splitter	Weinschel WA1507R	*Absolute Amplitude Accuracy*, *Bandpass Amplitude Flatness*, *Adjustment*	Frequency Range: 900 kHz to 820 MHz Input Power Range: –4 dBm to 3 dBm Maximum VSWR (Output ports): 1.15 Maximum Amplitude Tracking: 0.15 dBm

Test Conditions

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

- Keep cables as short as possible. Long cables act as antennae, picking up noise that can affect measurements.
- Verify that all connections, including front panel connections, are secure.

- Ensure that the 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*, available at `ni.com/manuals`.
- Keep relative humidity between 10% and 90% noncondensing, or consult the *NI PXIe-5622 Specifications* for the optimum relative humidity.
- Maintain an ambient temperature of 23 ±5 °C.
- Allow a warm-up time of at least 15 minutes after the NI-SCOPE driver is loaded. Unless manually disabled, NI-SCOPE automatically loads with the operating system and enables the device. The warm-up time ensures that the measurement circuitry of the digitizer is at a stable operating temperature.
- Plug the PXI Express chassis and the test equipment 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).

Note Allow a 15-minute warm-up time before beginning self-calibration.

2. *Self-Calibration*—Adjust the self-calibration constants of the device.
3. *Test Equipment Adjustment*—Zero the power meter and calculate power splitter imbalance.
4. *Verification*—Verify the existing operation of the device. This step confirms whether the device is operating within its specified range prior to calibration.
5. *Adjustment*—Perform an external adjustment of the device that adjusts the calibration constants with respect to a known voltage source. The adjustment procedure automatically stores the calibration date on the EEPROM to allow traceability.
6. *Reverification*—Repeat the verification procedure to ensure that the device is operating within its specifications after adjustment.

These steps 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 5622 includes precise internal circuits and references used during self-calibration to adjust for time and temperature drift.

Note Allow a 15 minute warm-up period before you begin self-calibration.

Note Always self-calibrate the digitizer before you perform verification. NI-SCOPE includes self-calibration example programs for LabVIEW, CVI, and Microsoft Visual C.

You can initiate self-calibration using the following methods:

- MAX
- NI-SCOPE Soft Front Panel (SFP)
- 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. Expand **My System»Devices and Interfaces»PXI System**.
4. Select the device that you want to calibrate.
5. Initiate self-calibration using one of the following methods:
   - Click **Self-Calibrate** in the upper right corner of MAX.
   - Right-click the name of the device in the MAX configuration tree and select **Self-Calibrate** from the drop-down menu.

NI-SCOPE SFP

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

1. Disconnect or disable any AC inputs to the digitizer.
2. Launch the NI-SCOPE SFP, which is available at **Start»All Programs» National Instruments»NI-SCOPE»SCOPE Soft Front Panel**.
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 NI 5622 programmatically using NI-SCOPE, complete the following steps:

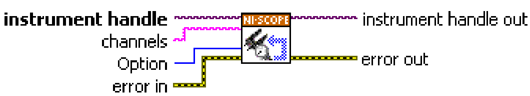
1. Disconnect or disable any AC inputs to the digitizer.

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

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

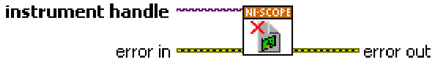
LabVIEW VI	C/C++ Function Call
	Call `niScope_init` with the following parameters: **vi**: The returned session handle that you use to identify the instrument in all subsequent NI-SCOPE driver function calls **resourceName**: The device name assigned by MAX **idQuery**: `VI_FALSE` **resetDevice**: `VI_TRUE`

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

LabVIEW VI	C/C++ Function Call
	Call `niScope_CalSelfCalibrate` with the following parameters: **sessionHandle**: The instrument handle from `niScope_init` **channelList**: `VI_NULL` **option**: `VI_NULL`

Note Because the session is a standard session rather than an external calibration session, the new calibration constants are immediately stored in the EEPROM. Therefore, you can include this procedure in any application that uses the digitizer.

4. 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`

Test Equipment Adjustment

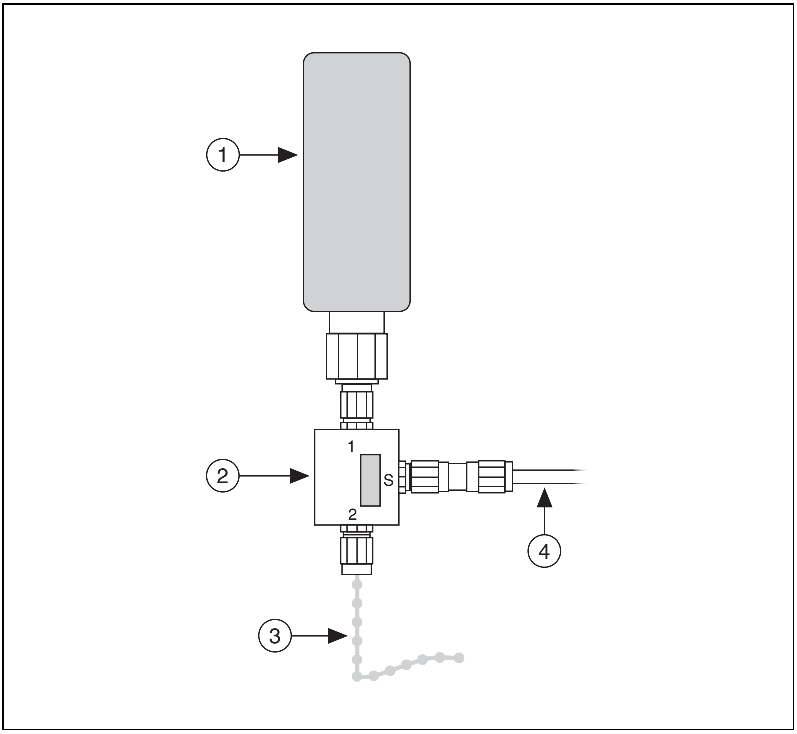
Zero Power Meter

Zero the power meter by following the manufacturer's recommended procedure.

Power Splitter Amplitude Imbalance Correction

Complete the following steps to determine the power splitter amplitude imbalance correction factor used to verify and adjust the NI 5622.

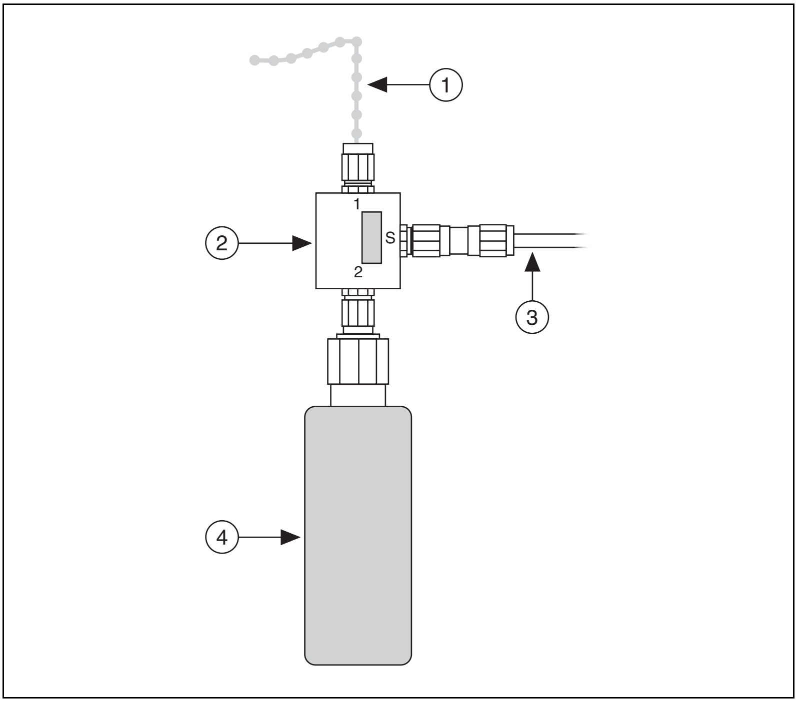
1. Make the following connections:
   a. Connect the signal generator to the source input port of the power splitter.
   b. Connect the power meter to output port 1 of the power splitter.
   c. Connect the 50 ohm terminator to output port 2 of the power splitter.



1	R&S NRP-Z91 Power Meter	3	50 Ω Termination
2	Weinschel WA 1507R Splitter	4	To Signal Generator

Figure 1. Initial Connections for Power Splitter Amplitude Imbalance Correction

2. Configure the signal generator to generate a 100 MHz, 0.6325 $V_{pk\text{-}pk}$ sine wave.
3. Wait the amount of time the manufacturer recommends for the output to settle.
4. Measure the power (in watts) of the sine wave using the power meter. This value is the *Measured Sine Wave Power of Port 1* used in step 7.
5. Make the following connection changes:
   a. Connect the power meter to input port 2 of the power splitter.
   b. Connect the 50 Ω terminator to input port 1 of the power splitter.



1	50 Ω Termination	3	To Signal Generator
2	Weinschel WA 1507R Splitter	4	R&S NRP-Z91 Power Meter

Figure 2. Connection Changes for Power Splitter Amplitude Imbalance Correction

6. Measure the power (in watts) of the sine wave using the power meter. This value is the *Measured Sine Wave Power of Port 2* used in step 7.
7. Calculate the amplitude imbalance between the two output ports of the power splitter using the following formula:

$$\textit{Splitter Power Correction} = 10 \times \log_{10}\left(\frac{b}{a}\right)$$

where

a = *Measured Sine Wave Power of Port 1*

b = *Measured Sine Wave Power of Port 2*

The *Splitter Power Correction* (in dB) is used in the *Absolute Amplitude Accuracy*, and *Adjustment* sections of this document.

Note Make note of which output port of the power splitter is port 1 and which is port 2. Refer to the power splitter documentation for information on port designations. Reversing the connection in the adjustment and verification steps may invalidate the calibration of the NI 5622.

Verification

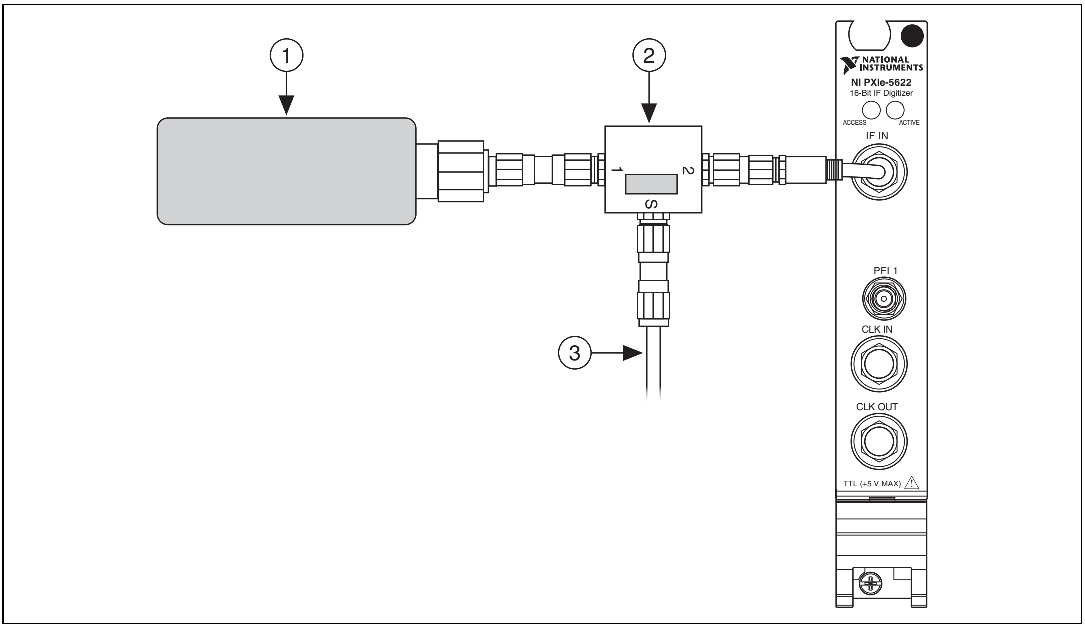
This section describes the program you must write to verify the performance of the NI 5622 to the published specifications for the device.

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.

Absolute Amplitude Accuracy

Complete the following steps to verify the absolute amplitude accuracy of the NI 5622.

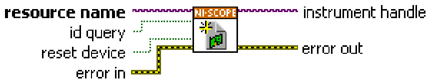
1. Make the following connections:
   a. Connect the signal generator to the source input port of the power splitter using the SMA cable.
   b. Connect the power meter to output port 1 of the of the power splitter.
   c. Connect channel 0 (IF IN) of the digitizer to output port 2 of the power splitter.



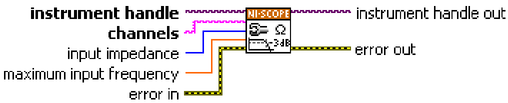
1	R&S NRP-Z91 Power Meter	3	To Signal Generator
2	Weinschel WA 1507R Splitter		

Figure 3. NI 5622 Absolute Amplitude Accuracy Connections

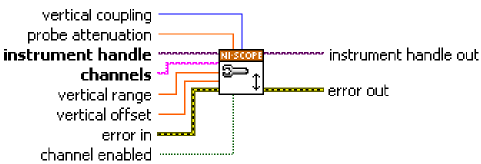
2. Open a session and obtain a session handle using the niScope Initialize VI.

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`

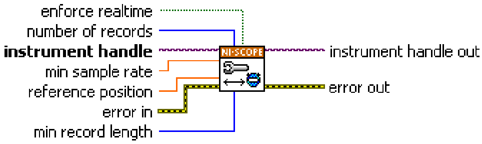
3. Configure the input impedance and the maximum input frequency using the niScope Configure Chan Characteristics VI.

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**: `250,000,000`

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

LabVIEW VI	C/C++ Function Call
	Call `niScope_ConfigureVertical` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **range**: The *Range* value listed in Table 4 for the current iteration **offset**: `0.0` **coupling**: `NISCOPE_VAL_AC` **probeAttenuation**: `1.0` **enabled**: `NISCOPE_VAL_TRUE`

5. 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: **vi**: The instrument handle from `niScope_init` **enforceRealtime**: `NISCOPE_VAL_TRUE` **numRecords**: `1` **minSampleRate**: `150,000,000` **refPosition**: `0.0` **minNumPts**: `524,288`

6. Configure the bandpass filter using the niScope Property Node.

LabVIEW VI	C/C++ Function Call
	Call `niScope_SetAttributeViBoolean` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **attributeId**: `NISCOPE_ATTR_BANDPASS_FILTER_ENABLED` **value**: The *Bandpass Filter* value listed in Table 4 for the current iteration

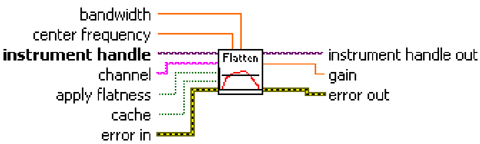
7. Commit all the parameter settings to hardware using the niScope Commit VI.

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

8. This step varies depending on the programming language used.

(LabVIEW) Configure the frequency response compensation using the Apply Frequency Response Compensation VI. The value returned is the *Reference Flatness Gain Correction Factor* used in step 15.

Note You can download the Apply Frequency Response Compensation VI from the NI Web site at `ni.com/info`. Use the Info Code `ex6vhg`.

LabVIEW VI	Input Parameters
	Set the following parameters: **bandwidth**: `-1` **center frequency**: The *Reference Frequency* value in Table 4 for the current iteration **channel**: `"0"` **apply flatness**: `TRUE` **cache**: `FALSE`

(C/C++) Configure the custom coefficients for the equalization FIR filter of the digitizer. Use the following function and attribute calls to calculate the customer coefficients.

a. To get the frequency response of the digitizer, call `niScope_GetFrequencyResponse`.

b. To get the number of coefficients the FIR filter can accept, call the `NISCOPE_ATTR_EQUALIZATION_NUM_COEFFICIENTS` attribute.

c. To configure the custom coefficients for the FIR filter, call `niScope_ConfigureEqualizationFilterCoefficients`.

9. Configure the signal generator to generate an *Input Frequency, Input Voltage* sine wave for the current iteration in Table 4.

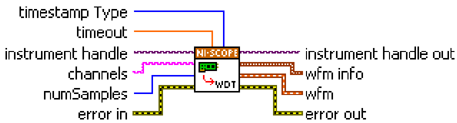
10. Wait the amount of time the manufacturer recommends for the output to settle.

11. Measure the power (in watts) of the sine wave using the power meter. This value is the *Power Meter Measured Sine Wave Power* used in step 15.

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

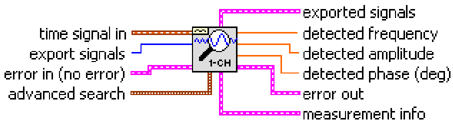
LabVIEW VI	C/C++ Function Call
	Call `niScope_Initiate Acquisition` with the following parameter: **vi**: The instrument handle from `niScope_init`

13. Acquire 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
	Call `niScope_Fetch` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **timeout**: `5.0` **numSamples**: `-1`

14. This step varies depending on the programming language used.

(LabVIEW) Measure the peak voltage of the sine wave being generated using the Extract Single Tone Information VI. This value is the *Digitizer Measured Sine Wave Amplitude* used in step 15.

LabVIEW Block Diagram	Input Parameters
	Set the following parameters: **advanced search»approx freq.**: `-1` **advanced search»search**: `5` **export signals**: `0` (none)

(C/C++) Perform an FFT on the array of data from step 13.

15. Calculate the absolute amplitude accuracy error using the following formula:

$$error = 10 \times \log_{10}\left(\frac{(a \times b)^2}{c}\right) - 20 + d$$

where

a = Digitizer Measured Sine Wave Amplitude

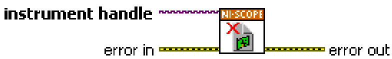
b = Reference Flatness Gain Correction Factor

c = Power Meter Measured Sine Wave Power

d = Splitter Power Correction

Compare the result to the *Published Specifications* for the current iteration listed in Table 4. If the results are within the selected test limit, the device has passed this portion of the verification.

16. Repeat steps 4 through 15 for each iteration in Table 4.
17. 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 absolute amplitude accuracy for the NI 5622.

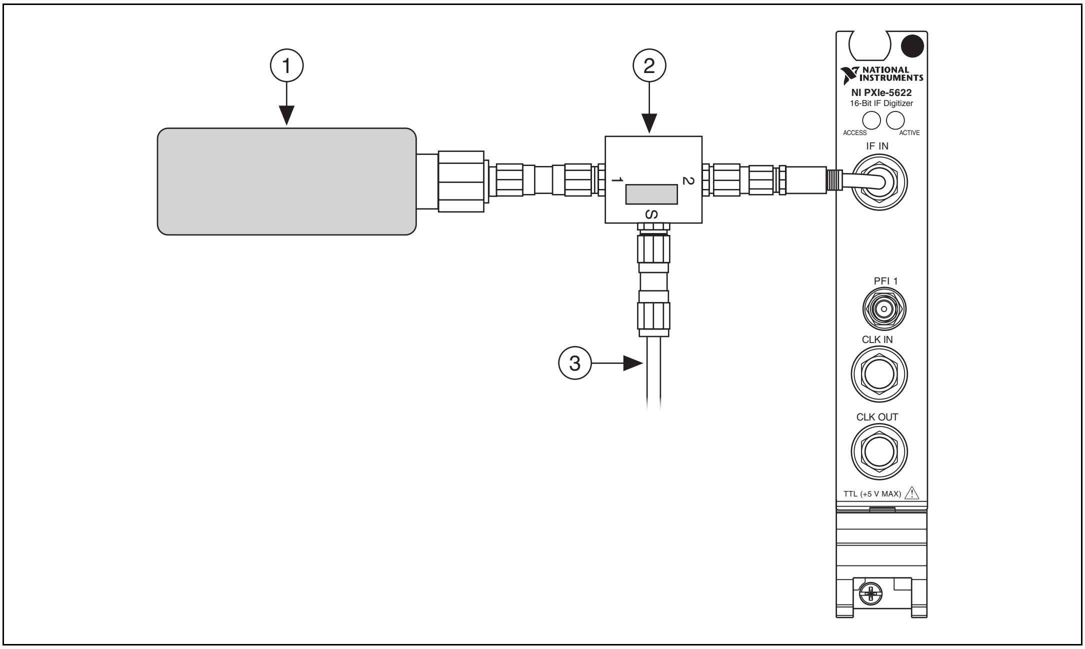
Table 4. NI 5622 Absolute Amplitude Accuracy Specifications Limits

Iteration	Range (V_{pk-pk})	Bandpass Filter	Input Voltage (V_{pk-pk})	Reference Frequency (MHz)	Specifications Limits	
					Max Level (dB)	Min Level (dB)
1	0.7	NISCOPE _VAL_ FALSE	0.35	53	0.4	–0.4
2			1.05			
3	1		0.5		0.4	–0.4
4			1.5			
5	1.4		0.7		0.4	–0.4
6			2.1			
7	0.7	NISCOPE VAL _TRUE	0.35	187.55	0.5	–0.5
8			1.05			
9	1		0.5		0.5	–0.5
10			1.5			
11	1.4		0.7		0.5	–0.5
12			2.1			

Bandpass Amplitude Flatness

Complete the following steps to verify the bandpass amplitude flatness of the NI 5622.

1. Make the following connections:
   a. Connect the signal generator to the source input port of the power splitter using the SMA cable.
   b. Connect the power meter to output port 1 of the power splitter.
   c. Connect channel 0 (IF IN) of the digitizer to output port 2 of the power splitter.



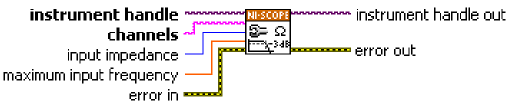
1	R&S NRP-Z91 Power Meter	3	To Signal Generator
2	Weinschel WA 1507R Splitter		

Figure 4. NI 5622 Bandpass Amplitude Flatness Connections

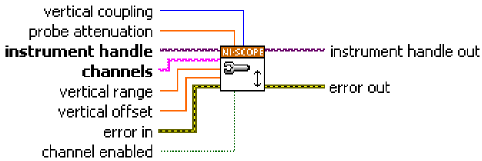
2. Open a session and obtain a session handle using the niScope Initialize VI.

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`

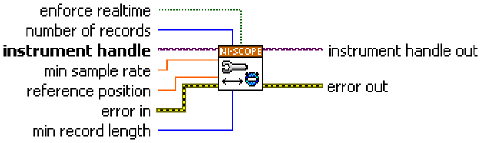
3. Configure the input impedance and the maximum input frequency using the niScope Configure Chan Characteristics VI.

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**: `250,000,000`

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

LabVIEW VI	C/C++ Function Call
	Call `niScope_ConfigureVertical` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **range**: `1.0` **offset**: `0.0` **coupling**: `NISCOPE_VAL_AC` **probeAttenuation**: `1.0` **enabled**: `NISCOPE_VAL_TRUE`

5. 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: **vi**: The instrument handle from `niScope_init` **enforceRealtime**: `NISCOPE_VAL_TRUE` **numRecords**: `1` **minSampleRate**: `150,000,000` **refPosition**: `0.0` **minNumPts**: `524,288`

6. Configure the bandpass filter using the niScope Property Node.

LabVIEW VI	C/C++ Function Call
	Call `niScope_SetAttributeViBoolean` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **attributeId**: `NISCOPE_ATTR_BANDPASS_FILTER_ENABLED` **value**: The *Bandpass Filter* value listed in Table 5 for the current iteration

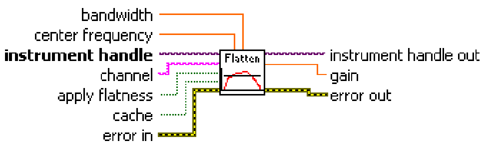
7. Commit all the parameter settings to hardware using the niScope Commit VI.

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

8. This step varies depending on the programming language used.

(LabVIEW) Configure the frequency response compensation using the Apply Frequency Response Compensation VI. The value returned is the *Reference Flatness Gain Correction Factor* used in step 23.

Note The Apply Frequency Response Compensation VI is available for download from the NI Web site at `ni.com/info`. Use the Info Code `ex6vhg`.

LabVIEW VI	Input Parameters
	Set the following parameters: **bandwidth**: `-1` **center frequency**: The *Reference Frequency* value in Table 5 for the current iteration **channel**: `"0"` **apply flatness**: `TRUE` **cache**: `FALSE`

(C/C++) Configure the custom coefficients for the equalization FIR filter of the digitizer. Use the following function and attribute calls to calculate the customer coefficients.

a. To get the frequency response of the digitizer, call `niScope_GetFrequencyResponse`.

b. To get the number of coefficients the FIR filter can accept, query the `NISCOPE_ATTR_EQUALIZATION_NUM_COEFFICIENTS` attribute.

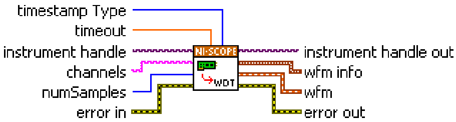
c. To configure the custom coefficients for the FIR filter, call `niScope_ConfigureEqualizationFilterCoefficients`.

9. Configure the signal generator to output a *Reference Frequency*, 1.25 $V_{pk\text{-}pk}$ sine wave for the current iteration in Table 5.
10. Wait the amount of time the manufacturer recommends for the output to settle.
11. Measure the power (in watts) of the sine wave using the power meter. This value is the *Power Meter Measured Sine Wave Reference Power* used in step 23.

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

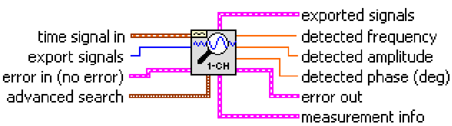
LabVIEW VI	C/C++ Function Call
	Call `niScope_InitiateAcquisition` with the following parameter: **vi**: The instrument handle from `niScope_init`

13. Acquire 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
	Call `niScope_Fetch` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **timeout**: `5.0` **numSamples**: `-1`

14. This step varies depending on the programming language used.

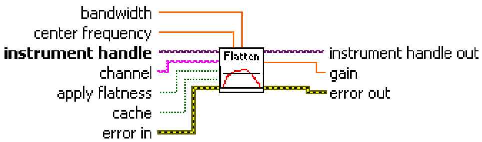
(LabVIEW) Measure the $V_{pk\text{-}pk}$ of the sine wave being generated using the LabVIEW Extract Single Tone Information VI. This value is the *Digitizer Measured Sine Wave Reference Amplitude* used in step 23.

LabVIEW Block Diagram	Input Parameters
	Set the following parameters: **advanced search»approx freq.**: `-1` **advanced search»search**: `5` **export signals**: `0` (none)

(C/C++) Perform an FFT on the array of data from step 13.

15. Repeat steps 16 through 23 for each *Input Frequency* listed for the current iteration in Table 5.
16. This step varies depending on the programming language used.

(LabVIEW) Configure the frequency response compensation using the Apply Frequency Response Compensation VI. The **gain** value returned is the *Flatness Gain Correction Factor* used in step 23.

<table>
<tr><th>LabVIEW VI</th><th>Input Parameters</th></tr>
<tr><td>
</td><td>Set the following parameters:

bandwidth: <code>-1</code>
center frequency: The Input Frequency value in Table 5 for the current iteration
channel: <code>"0"</code>
apply flatness: <code>TRUE</code>
cache: <code>FALSE</code></td></tr>
</table>

(C/C++) Configure the custom coefficients for the equalization FIR filter of the digitizer. Use the following function and attribute calls to calculate the customer coefficients.

a. To get the frequency response of the digitizer, call `niScope_GetFrequencyResponse`.

b. To get the number of coefficients the FIR filter can accept, query the `NISCOPE_ATTR_EQUALIZATION_NUM_COEFFICIENTS` attribute.

c. To configure the custom coefficients for the FIR filter, call `niScope_ConfigureEqualizationFilterCoefficients`.

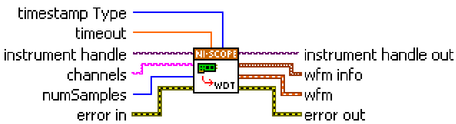
17. Configure the signal generator to generate an *Input Frequency* of a 1.25 $V_{pk\text{-}pk}$ sine wave for the current iteration in Table 5.
18. Wait the amount of time the manufacturer recommends for the output to settle.
19. Measure the power (in watts) of the sine wave using the power meter. This value is the *Power Meter Measured Sine Wave Power* used in step 23.

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

<table>
<tr><th>LabVIEW VI</th><th>C/C++ Function Call</th></tr>
<tr><td>
</td><td>Call `niScope_Initiate Acquisition` with the following parameter:

vi: The instrument handle from `niScope_init`</td></tr>
</table>

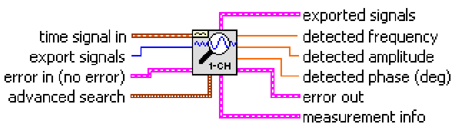
21. Acquire a waveform using the niScope Fetch (poly) VI. Select the WDT instance of the VI. Use the default value for the **timestamp Type** parameter.

<table>
<tr><th>LabVIEW VI</th><th>C/C++ Function Call</th></tr>
<tr><td>
</td><td>Call `niScope_Fetch` with the following parameters:

vi: The instrument handle from `niScope_init`
channelList: `"0"`
timeout: `5.0`
numsamples: `-1`</td></tr>
</table>

22. This step varies depending on the programming language used.

(LabVIEW) Measure the V_{pk-pk} of the sine wave being generated using the LabVIEW Extract Single Tone Information VI. This value is the *Digitizer Measured Sine Wave Amplitude* used in step 23.

<table>
<tr><th>LabVIEW Block Diagram</th><th>Input Parameters</th></tr>
<tr><td>
</td><td>Set the following parameters:

advanced search»approx freq.: `-1`
advanced search»search: `5`
export signals: `0` (none)</td></tr>
</table>

(C/C++) Perform an FFT on the array of data from step 21.

23. Calculate the power difference using the following formula:

$$power = 10 \times \log_{10}\left(\frac{(a \times b)^2 \times f}{(d \times e)^2 \times c}\right)$$

where

a = Digitizer Measured Sine Wave Amplitude

b = Flatness Gain Correction Factor

c = Power Meter Measured Sine Wave Power

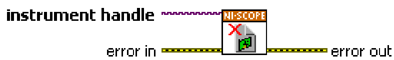
d = Digitizer Measured Sine Wave Reference Amplitude

e = Reference Flatness Gain Correction Factor

f = Power Meter Measured Sine Wave Reference Power

Compare the result to the *Published Specifications* for the current iteration listed in Table 5. If the results are within the selected test limit, the device has passed this portion of the verification.

24. Repeat steps 6 through 23 for each iteration in Table 5.
25. 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 bandpass amplitude flatness for the NI 5622.

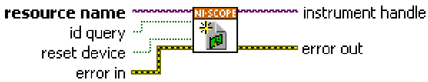
Table 5. NI 5622 Bandpass Amplitude Flatness Published Specifications

Iteration	Range (V_{pk-pk})	Bandpass Filter	Reference Frequency (MHz)	Input Frequency (MHz)	Published Specifications	
					Max Level (dB)	Min Level (dB)
1	1	NISCOPE_VAL_FALSE	53	34	0.35	–0.35
				43		
				62		
				72		
2	1	NISCOPE_VAL_FALSE	100.1	9.9	0.6	–0.6
				37		
				64		
				91		
				118		
				144.5		
				172		
				199		
				226		
				250.1		
3	1	NISCOPE_VAL_TRUE	187.55	162.4	0.35	–0.6
				174.4		
				200.4		
				212.6		

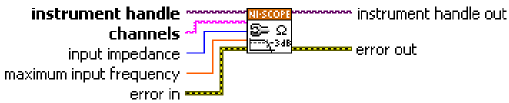
Timing Accuracy

Complete the following steps to verify the timing accuracy of the NI 5622.

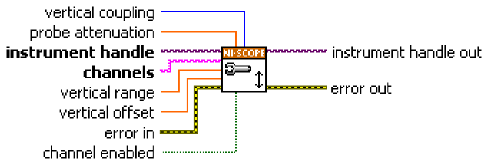
1. Connect the signal generator to channel 0 of the digitizer.
2. Open a session and obtain a session handle using the niScope Initialize VI.

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`

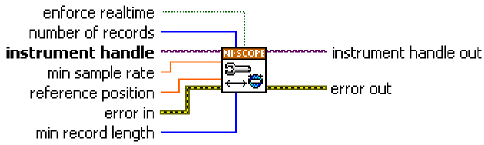
3. Configure the input impedance and the maximum input frequency using the niScope Configure Chan Characteristics VI.

LabVIEW VI	C/C++ Function Call
	Call `niScope_ConfigureChan Characteristics` with the following parameters: **vi**: The instrument handle from `niScope_init` **inputImpedance**: `NISCOPE_VAL_50_OHM` **maxInputFrequency**: `250,000,000`

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

LabVIEW VI	C/C++ Function Call
	Call `niScope_ConfigureVertical` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **range**: `1.0` **offset**: `0.0` **coupling**: `NISCOPE_VAL_AC` **probeAttenuation**: `1.0` **enabled**: `NISCOPE_VAL_TRUE`

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

LabVIEW VI	C/C++ Function Call
	Call `niScope_ConfigureHorizontalTiming` with the following parameters: **vi**: The instrument handle from `niScope_init` **enforceRealtime**: `NISCOPE_VAL_TRUE` **numRecords**: `1` **minSampleRate**: `150,000,000` **refPosition**: `0` **minNumPts**: `524,288`

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`

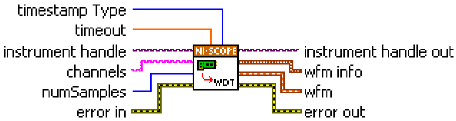
7. Configure the signal generator to generate a 11 MHz, 1.0 $V_{pk\text{-}pk}$ sine wave.

8. Wait the amount of time the manufacturer recommends for the output to settle.

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

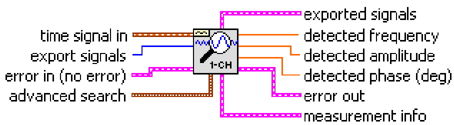
LabVIEW VI	C/C++ Function Call
	Call `niScope_InitiateAcquisition` with the following parameter: **vi**: The instrument handle from `niScope_init`

10. Acquire 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
	Call `niScope_Fetch` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **timeout**: `5.0` **numsamples**: `-1`

11. This step varies depending on the programming language used.

(LabVIEW) Measure the frequency of the sine wave being generated using the Extract Single Tone Information VI.

LabVIEW Block Diagram	Input Parameters
	Set the following parameters: **advanced search»approx freq.**: `-1` **advanced search»search**: `5` **export signals**: `0` (none)

(C/C++) Perform an FFT on the array of data from step 10.

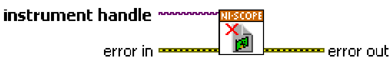
12. Calculate the error in timing as parts per million (ppm) using the following formula:

$$error = \left|\frac{(a - 11,000,000)}{11}\right|$$

where *a* is the measured frequency.

Compare the result to the *Published Specification* listed in Table 6. If the result is within the selected test limit, the device has passed this portion of the verification.

13. 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 timing accuracy for the NI 5622.

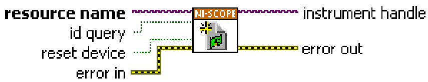
Table 6. NI 5622 Timing Accuracy Specification Limit

Input Frequency	Specification
11 MHz	5 ppm

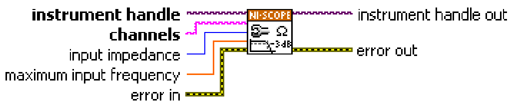
SSB Phase Noise

Complete the following steps to verify the single sideband phase noise of the NI 5622.

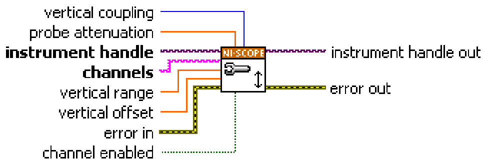
1. Make the following connections:
   a. Connect the 3 dB attenuator to the signal generator.
   b. Connect the SMA cable to the 3 dB attenuator.
   c. Connect channel 0 (IF IN) of the digitizer to the other end of the SMA cable.
2. Open a session and obtain a session handle using the niScope Initialize 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`

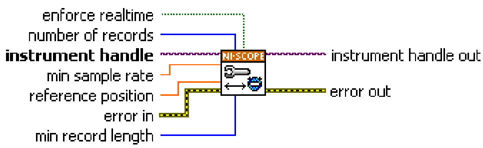
3. Configure the input impedance and the maximum input frequency using the niScope Configure Chan Characteristics VI.

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**: `250,000,000`

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

LabVIEW VI	C/C++ Function Call
	Call `niScope_ConfigureVertical` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **range**: `1.0` **offset**: `0.0` **coupling**: `NISCOPE_VAL_AC` **probeAttenuation**: `1.0` **enabled**: `NISCOPE_VAL_TRUE`

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

LabVIEW VI	C/C++ Function Call
	Call `niScope_ConfigureHorizontalTiming` with the following parameters: **vi**: The instrument handle from `niScope_init` **enforceRealtime**: `NISCOPE_VAL_TRUE` **numRecords**: `1` **minSampleRate**: `150,000,000` **refPosition**: `0.0` **minNumPts**: `31,000,000`

6. Configure the analog dither using the niScope Property Node.

LabVIEW VI	C/C++ Function Call
	Call `niScope_ SetAttributeViBoolean` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **attributeId**: `NISCOPE_ATTR_DITHER_ENABLED` **value**: `NISCOPE_VAL_TRUE`

7. Configure the bandpass filter using the niScope Property Node.

LabVIEW VI	C/C++ Function Call
	Call `niScope_SetAttributeViBoolean` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **attributeId**: `NISCOPE_ATTR_BANDPASS_FILTER_ENABLED` **value**: The *Bandpass Filter* value listed in Table 7 for the current iteration

8. 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`

9. Configure the signal generator to generate an *Input Frequency* of a 1.3 $V_{pk\text{-}pk}$ sine wave for the current iteration in Table 7.
10. Wait the amount of time the manufacturer recommends for the output of the signal generator to settle.
11. Initiate a waveform acquisition using the niScope Initiate Acquisition VI.

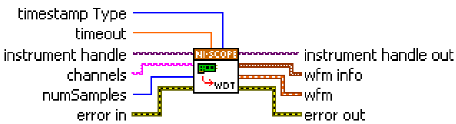
LabVIEW VI	C/C++ Function Call
	Call `niScope_InitiateAcquisition` with the following parameter: **vi**: The instrument handle from `niScope_init`

12. Fetch in chunks the waveform in digitizer memory by repeating steps 12a through 12e thirty-one times. The result is a downconverted, resampled waveform used in step 13.

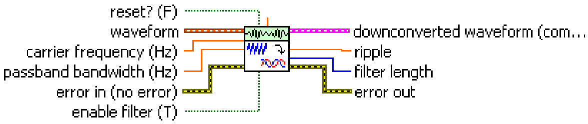
    a. Configure which point in the acquired waveform is the first to be fetched using the niScope Property Node.

LabVIEW VI	C/C++ Function Call
	Call `niScope_SetAttributeViInt32` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **attributeId**: `NISCOPE_ATTR_` `FETCH_RELATIVE_TO` **value**: `NISCOPE_VAL_START` (for iteration 1), `NISCOPE_VAL_READ_POINTER` (for iterations 2 through 31)

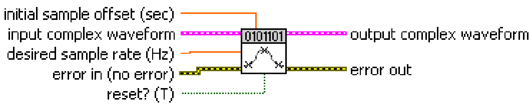
    b. Acquire a waveform using the niScope Fetch (poly) VI. Select the WDT instance of the VI. Use the default value for the **timestamp Type** parameter.

LabVIEW VI	C/C++ Function Call
	Call `niScope_Fetch` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **timeout**: `5.0` **numSamples**: `1,000,000`

c. Downconvert the acquired waveform using the MT Downconvert Passband VI located: `<LabVIEW Directory>\vi.lib\addons\Modulation\Analog`. Select the Real Input instance of this VI.

LabVIEW VI	C/C++ Function Call
	Call `ModtDownconvertPassband` with the following parameters: **Handle**: The handle you obtained from `ModtCreateSession Handle` **t0**: Trigger (start) time of the acquired waveform **dt**: Time interval between data points in the acquired waveform **inputData**: Acquired waveform data array **inputDataNumElements**: `1,000,000` **carrierFrequency**: The *Alias Frequency* value in Table 7 for the current iteration **passbandBandwidth**: `1,000,000` **initialPhase**: `0` **reset**: `TRUE` (for iteration 1), `FALSE` (for iterations 2 through 31) **enableFilter**: `TRUE`

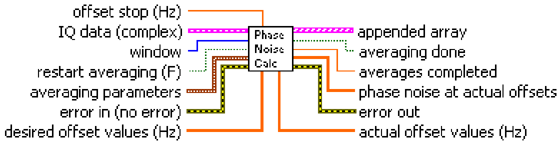
d. Resample the complex waveform using the MT Resample (Complex Cluster) VI located at `<LabVIEW Directory>\vi.lib\addons\Modulation\Analog`.

LabVIEW VI	C/C++ Function Call
	Call `ModtFractionalResample` with the following parameters: **Handle**: The handle you obtained from `ModtCreateSessionHandle` **t0**: Trigger (start) time of the downconverted I/Q signal data **dt**: Time interval between data points in the downconverted I/Q signal data **inputData**: Complex value time-domain data array **inumInputDataSamples**: Number of samples in the complex value time-domain data array **initialSampleOffset**: `0` **desiredSampleRate**: `5,000,000` **reset**: `TRUE` (for iteration 1), `FALSE` (for iterations 2 through 31) **numResampledComplexDataSamples**: ceil (dt × numInputDataSamples × desiredSampleRate)

e. Concatenate the complex value time-domain data array returned in step 12d to the end of the previous result.

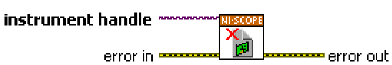
13. This step varies depending on the programming language used.

(LabVIEW) Calculate the SSB phase noise of the acquired signal using the mod_Phase Noise Calculation VI located at: <LabVIEW Directory>\vi.lib\addons\Modulation\Analog\support.

LabVIEW VI	Input Parameters
	Set the following parameters: **offset stop (Hz)**: 1,000,000 **IQ data (complex)**: Complex waveform from step 12 e **window**: Hanning **restart averaging (F)**: TRUE for iteration 1; FALSE for iterations 2 through 10 **averaging parameters»averaging mode:** RMS averaging **averaging parameters»weighting mode**: Linear **averaging parameters»number of averages**: 15 **desired offset values (Hz)**: [100, 1000, 10000]

(C/C++) Calculate the SSB phase noise of the acquired signal.

14. Repeat steps 11 through 13 fifteen times to obtain an average SSB phase noise spectrum.
15. Compare the last phase noise results to the *Published Specifications* for the current iteration listed in Table 7. If the results are within the selected test limit, the device has passed this portion of the verification.
16. Repeat steps 7 through 15, for each iteration in Table 7.
17. 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 SSB phase noise for the NI 5622.

Table 7. NI 5622 SSB Phase Noise Specifications Limits

Iteration	Bandpass Filter	Input Frequency (MHz)	Alias Frequency (MHz)	Specifications Limits		
				Carrier Offset		
				100 Hz	1 kHz	10 kHz
1	`NISCOPE_VAL_FALSE`	53.1	53.1	–90 dBc/Hz	–128 dBc/Hz	–141 dBc/Hz
2	`NISCOPE_VAL_TRUE`	187.1	37.1	–80 dBc/Hz	–117 dBc/Hz	–134 dBc/Hz

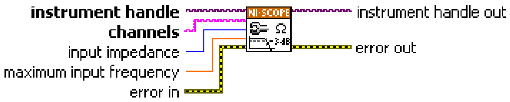
Average Noise Density

Complete the following steps to verify the average noise density of the NI 5622.

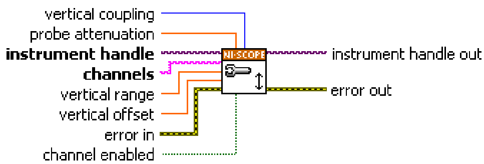
1. Connect the 50 ohm terminator directly to channel 0 of the digitizer.
2. Open a session and obtain a session handle using the niScope Initialize VI.

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`

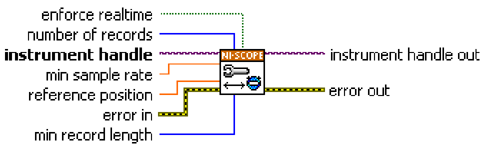
3. Configure the input impedance and the maximum input frequency using the niScope Configure Chan Characteristics VI.

LabVIEW VI	C/C++ Function Call
	Call `niScope_ConfigureChanCharacteristics` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **inputImpedance**: `NISCOPE_VAL_50_OHM` **maxInputFrequency**: `250,000,000`

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

LabVIEW VI	C/C++ Function Call
	Call `niScope_ConfigureVertical` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **range**: The *Range* value in Table 8for the current iteration **offset**: `0.0` **coupling**: `NISCOPE_VAL_AC` **probeAttenuation**: `1.0` **enabled**: `NISCOPE_VAL_TRUE`

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

LabVIEW VI	C/C++ Function Call
	Call `niScope_ConfigureHorizontalTiming` with the following parameters: **vi**: The instrument handle from `niScope_init` **enforceRealtime**: `NISCOPE_VAL_TRUE` **numRecords**: `1` **minSampleRate**: `150,000,000` **refPosition**: `50.0` **minNumPts**: `524,288`

6. Configure the bandpass filter using the niScope Property Node.

LabVIEW VI	C/C++ Function Call
	Call `niScope_SetAttributeViBoolean` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **attributeId**: `NISCOPE_ATTR_BANDPASS_FILTER_ENABLED` **value**: The *Bandpass Filter* value listed in Table 8 for the current iteration

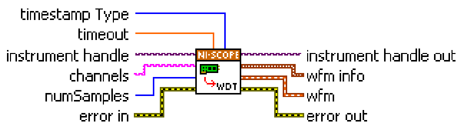
7. Commit all the parameter settings to hardware using the niScope Commit VI.

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

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

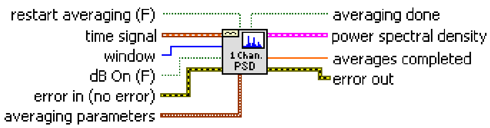
LabVIEW VI	C/C++ Function Call
	Call `niScope_InitiateAcquisition` with the following parameter: **vi**: The instrument handle from `niScope_init`

9. Acquire 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
	Call `niScope_Fetch` with the following parameters: **vi**: The instrument handle from `niScope_init` **channelList**: `"0"` **timeout**: `5.0` **numSamples**: `-1`

10. This step varies depending on the programming language used.

(LabVIEW) Compute the averaged power spectral density in V_{rms}^2/Hz using the FFT Power Spectral Density for 1 Chan VI.

LabVIEW VI	Input Parameters
	Set the following parameters: **restart averaging (F)**: TRUE for iteration 1; FALSE for iterations 2 through 10 **window**: Rectangle **dB On (F)**: FALSE **averaging parameters»averaging mode**: RMS averaging **averaging parameters»weighting mode**: Linear **averaging parameters»number of averages**: `10`

(C/C++) Calculate the power spectral density on the array of data from step 9.

11. Repeat steps 8 through 10 ten times to obtain an averaged power spectral density.
12. Compute the average noise density from the averaged power spectral density data using the following formula:

$$average\ noise\ density = 10 \times \log_{10}\left(\frac{\left(\frac{\sum_{k=1}^{n}\sqrt{x_k \times df}}{n}\right)^2 \times 20}{df}\right)$$

where

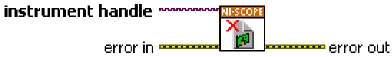
df = frequency resolution of the spectrum, in Hz

x = average power spectral density data, in V_{rms}^2/Hz

Compare the result to the *Published Specifications* for the current iteration listed in Table 8. If the result is within the selected test limit, the device has passed this portion of the verification.

13. Repeat steps 4 through 12 for each iteration in Table 8.

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 average noise density for the NI 5622.

Table 8. NI 5622 Average noise Density Published Specifications

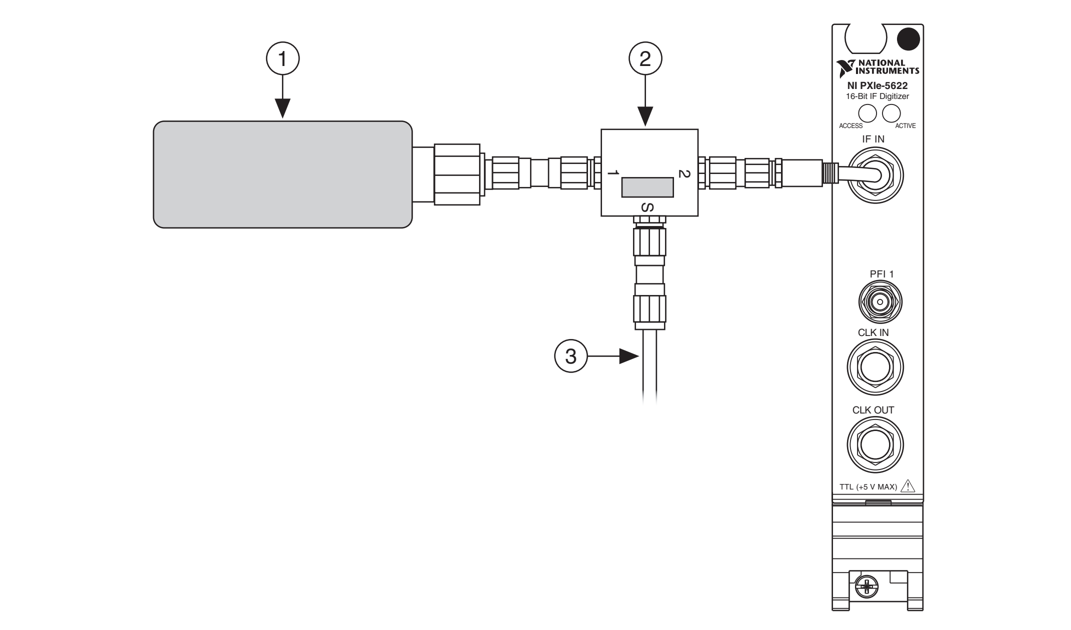
Iteration	Range (Vpp)	Bandpass Filter	Published Specifications (dBm/Hz)
1	0.7	`NISCOPE_VAL_FALSE`	–146
2	1	`NISCOPE_VAL_FALSE`	–143
3	1.4	`NISCOPE_VAL_FALSE`	–140
4	0.7	`NISCOPE_VAL_TRUE`	–146
5	1	`NISCOPE_VAL_TRUE`	–143
6	1.4	`NISCOPE_VAL_TRUE`	–140

Adjustment

An adjustment is required only once a year. Following the adjustment procedure automatically updates the calibration date and temperature in the digitizer EEPROM.

Complete the following steps to externally adjust the NI 5622.

1. Make the following connections:
   a. Connect the signal generator to the source input port of the power splitter.
   b. Connect the power meter to output port 1 of the power splitter.
   c. Connect channel 0 (IF IN) of the digitizer to output port 2 of the power splitter.



1 R&S NRP-Z91 Power Meter	3 To Signal Generator
2 Weinschel WA 1507R Splitter	

Figure 5. NI 56222 Connections for External Adjustment

2. Obtain a calibration session handle using the niScope Cal Start VI.

LabVIEW VI	C/C++ Function Call
	Call `niScope_CalStart` with the following parameters: **resourceName**: The device name assigned by 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. Configure the signal generator to generate a sine wave with *Input Frequency* and *Input Voltage* for the current iteration in Table 9.
4. Wait the amount of time the manufacturer recommends for the output to settle.

5. Measure the power (in watts) of the sine wave using the power meter. This value is the *Power Meter Measured Sine Wave Power*. Use this value to calculate the *Measure Sine Wave Amplitude* used in step 6.

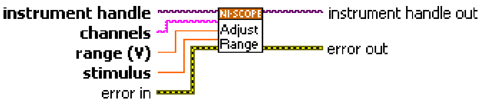
$$\textit{Measured Sine Wave Amplitude} \;=\; 10 \times \sqrt{a} \times 10^{\frac{b}{20}}$$

where

a = *Power Meter Measure Sine Wave Power*

b = *Power Splitter Power Correction*

6. Adjust the vertical range using the niScope Cal Adjust Range VI.

LabVIEW VI	C/C++ Function Call
	Call `niScope_CalAdjustRange` with the following parameters: **sessionHandle**: The session handle from `niScope_CalStart` **channelName**: `"0"` **range**: The *Range* value in Table 9 for the current iteration **stimulus**: The *Measured Sine Wave Amplitude* value

7. Repeat steps 5 and 6. The first iteration configures the digitizer, and the second iteration performs the adjustment.
8. Repeat steps 3 through 7 for each iteration in Table 9.
9. Configure the signal generator to output a 15 MHz, 1.25 $V_{pk\text{-}pk}$ sine wave.
10. Wait the amount of time the manufacturer recommends for the output of the signal generator to settle.
11. Adjust the sample rate using the niScope Cal Adjust VCXO VI.

LabVIEW VI	C/C++ Function Call
	Call `niScope_CalAdjustVCXO` with the following parameters: **sessionHandle**: The session handle from `niScope_CalStart` **stimulusFreq**: `15,000,000`

12. Set Index = 0.

13. Repeat steps 13a through 13e until you reach the *Stop Frequency* for the current iteration in Table 10.

    a. Configure the signal generator to generate a 0.8 $V_{pk\text{-}pk}$ sine wave with a frequency equal to the following formula:

    $$Frequency = (Start\ Frequency + (Index \times Frequency\ Step))$$

    for the current iteration in Table 10.

    b. Wait the amount of time the manufacturer recommends for the output to settle.

    c. Measure the power (in watts) of the sine wave using the power meter. This value is the *Power Meter Measure Sine Wave Power*. Use this value to calculate the *Measured Sine Wave Amplitude* used in step 13d.

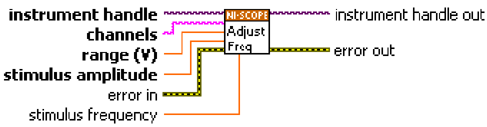
    $$Measured\ Sine\ Wave\ Amplitude \ = \ 10 \times \sqrt{a} \times 10^{\frac{b}{20}}$$

    where

    a = *Power Meter Measure Sine Wave Power*

    b = *Splitter Power Correction*

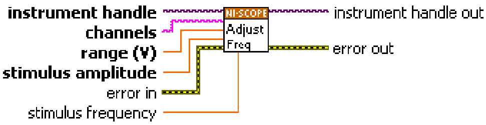
    d. Adjust the frequency response using the niScope Cal Adjust Frequency Response VI.

LabVIEW VI	C/C++ Function Call
	Call `niScope_CalAdjustFrequency Response` with the following parameters: **sessionHandle**: The session handle from `niScope_CalStart` **channelName**: `"0"` **range**: `1` **stimulusAmp**: The *Measured Sine Wave Amplitude* value **stimulusFreq**: The current frequency the signal generator is generating

    e. Increment Index by 1.

14. Repeat steps 12 and 13 for each iteration in Table 10.
15. Disconnect or disable all inputs to the digitizer.

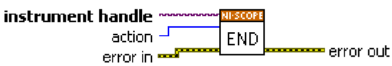
16. Adjust the internal frequency response using the niScope Cal Adjust Frequency Response VI.

LabVIEW VI	C/C++ Function Call
	Call `niScope_CalAdjustFrequencyResponse` with the following parameters: **sessionHandle**: The session handle from `niScope_CalStart` **channelName**: `"0"` **range**: `1` **stimulusFreq**: `187,000,000` **stimulusAmp**: `0.2`

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

LabVIEW VI	C/C++ Function Call
	Call `niScope_CalSelfCalibrate` with the following parameters: **sessionHandle**: The instrument handle from `niScope_CalStart` **channelList**: `VI_NULL` **option**: `VI_NULL`

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

LabVIEW VI	C/C++ Function Call
	Call `niScope_CalEnd` with the following parameters: **sessionHandle**: The instrument handle from `niScope_CalStart` **action**: `NISCOPE_VAL_ACTION_STORE`

You have finished adjusting the NI 5622. You should repeat the entire verification procedure to verify a successful adjustment.

Table 9. Input Parameters for Vertical Range External Adjustment

Iteration	Range (V)	Input Voltage (V_{pk-pk})	Input Frequency (MHz)
1	0.7	1	10
2	1	1.6	10
3	1.4	1.6	10
4	0.7	1	187
5	1	1.6	187
6	1.4	1.6	187

Table 10. Input Parameters for Frequency Range External Adjustment

Iteration	Start Frequency (MHz)	Stop Frequency (MHz)	Frequency Step (MHz)
1	0.9	224.9	1
2	225.9	815.9	10
3	119.9	307.4	0.5

Appendix A: Calibration Utilities

NI-SCOPE supports several calibration utilities you can use to retrieve information about adjustments performed on the NI 5622, change the external calibration password, and store small amounts of information in the onboard EEPROM. Although you can retrieve some data using MAX, 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»PXI System**.
2. Select the **Calibration** tab in the lower right 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`)

Where to Go for Support

The National Instruments Web site is your complete resource for technical support. At `ni.com/support` you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

A Declaration of Conformity (DoC) is our claim of compliance with the Council of the European Communities using the manufacturer's declaration of conformity. This system affords the user protection for electromagnetic compatibility (EMC) and product safety. You can obtain the DoC for your product by visiting `ni.com/certification`. If your product supports calibration, you can obtain the calibration certificate for your product at `ni.com/calibration`.

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