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CALIBRATION PROCEDURE

NI 5412

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Conventions

The following conventions are used in this manual:

» The **»** symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** 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. When this symbol is marked on a product, refer to the *Read Me First: Safety and Radio-Frequency Interference* for information about precautions to take.

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. This font 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.

Introduction

This document contains instructions for calibrating the NI 5412 arbitrary waveform generator. This calibration procedure is intended for metrology labs. It describes specific programming steps for writing an external calibration procedure for the NI 5412.

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Refer to ni.com/calibration for additional information about calibration solutions from National Instruments.

Software and Documentation Requirements

This section describes the software and documentation required for both self-calibration and external calibration of the NI 5412.

Software

Calibrating the NI 5412 requires installing NI-FGEN version 2.3 or later on the calibration system. You can download NI-FGEN from the Instrument Driver Network at ni.com/idnet. NI-FGEN supports programming the *Self-Calibration Procedures* and the *External Calibration Procedures* in the LabVIEW, LabWindows™/CVI™, and C application development environments (ADEs). When you install NI-FGEN, you only need to install support for the ADE that you intend to use.

NI-FGEN 2.3 or later includes all the functions and attributes necessary for calibrating the NI 5412. For LabWindows/CVI, the NI-FGEN function panel (niFgen.fp) provides help about the functions available. LabVIEW support is in the niFgen.llb file, and all calibration functions appear in the function palette.

Calibration functions are C function calls or LabVIEW VIs in NI-FGEN. In this document, the C function call is shown first, followed by the corresponding LabVIEW VI, or NI-FGEN LabVIEW property node, in parentheses. 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 niFgen.h file. To use these constants in C, you must include niFgen.h in your code when you write the calibration procedure. Refer to Table 1 for file locations.

Table 1. Calibration File Locations

File Name and Location	Description
IVI\Bin\niFgen_32.dll	The NI-FGEN library, which provides the functionality for calibrating the NI 5412.
IVI\Lib\msc\niFgen.lib IVI\Lib\bc\niFgen.lib	Allows you to create applications that call functions in the niFgen_32.dll: • For Microsoft Visual C/C++, link to msc\niFgen.lib. • For LabWindows/CVI, link to the library appropriate to your current compatibility mode (msc for Microsoft Visual C/C++).

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Table 1. Calibration File Locations (Continued)

File Name and Location	Description
`IVI\Include\niFgen.h`	A header file for the accessible functions in the `niFgen_32.dll`. You must include this file in any C code that you write to call these functions.
`<LabVIEW>\instr.lib\niFgen\niFgen.llb` (LabVIEW)	Contains VIs that correspond to the functions in the `niFgen_32.dll`.
`IVI\Drivers\niFgen\niFgen.fp` (CVI)	Contains the function panels for the functions in `niFgen32.dll`.

The calibration process is described in the *Self-Calibration Procedures* and the *External Calibration Procedures* sections, including step-by-step instructions on calling the appropriate calibration functions.

Documentation

For information about NI-FGEN and the NI 5412, you may find the following documents helpful:

- *NI Signal Generators Getting Started Guide*
- *NI Signal Generators Help*
- *NI 5412 Specifications*
- *NI-FGEN Instrument Driver Quick Reference Guide*

The *NI Signal Generators Getting Started Guide* provides instructions for installing and configuring NI signal generators.

The *NI Signal Generators Help* includes detailed information about the NI 5412 and the NI-FGEN functions. You can access this help file by selecting **Start»Programs»National Instruments»NI-FGEN» Documentation»NI Signal Generators Help**. For the latest versions of NI documentation, refer to `ni.com/manuals`.

Self-Calibration Procedures

The NI 5412 is capable of performing self-calibration, which adjusts the gain and offset of the main analog path. Self-calibration uses only an onboard ADC to measure the output voltage. You can implement self-calibration on the NI 5412 by following procedures similar to the *Verifying the DC Gain and Offset Accuracy* and the *Adjusting the Analog Output* procedures. However, output impedance, oscillator frequency, and the calibration ADC cannot be adjusted during self-calibration.

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You can initiate self-calibration interactively from Measurement & Automation Explorer (MAX) or from the FGEN Soft Front Panel (SFP). Alternnatively, you can initiate self-calibration programmatically using NI-FGEN.

MAX

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

1. Launch MAX.
2. Select **My System»Devices and Interfaces»NI-DAQmx Devices**.
3. Select the device that you want to calibrate.
4. Initiate self-calibration in one of the following ways:
   - Click **Self-Calibrate** in the upper right corner.
   - Right-click the device name under Devices and Interfaces, and select **Self-Calibrate** from the drop-down menu.

FGEN Soft Front Panel

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

1. Select the device that you want to calibrate using the Device Configuration dialog box (**Edit»Device Configuration**).
2. Open the Calibration dialog box (**Utility»Calibration**).
3. Click **Perform self-calibration**.

NI-FGEN

To self-calibrate the NI 5412 programmatically using NI-FGEN, complete the following steps:

1. Call `niFgen_init` (niFgen Initialize VI) to open an NI-FGEN session using the following parameters:
   - **resourceName**: The name of the device that you want to calibrate. You can find this name under Devices and Interfaces in MAX.
   - **IDQuery**: `VI_TRUE`
   - **resetDevice**: `VI_TRUE`
   - **vi**: A pointer to a ViSession. The variable passed by reference through this parameter receives the value that identifies the session created by this function. This value acts as the session handle and is passed as the first parameter to all subsequent NI-FGEN functions.

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2. Call `niFgen_SelfCal` (niFgen Self Cal VI) using the following parameter:
   - **vi**: The session handle returned from `niFgen_init`
3. Call `niFgen_close` (niFgen Close VI) to close the NI-FGEN session using the following parameter:
   - **vi**: The session handle returned from `niFgen_init`

External Calibration Options

External calibration involves both verification and adjustment. Verification is the process of testing the device to ensure that the output accuracy is within certain specifications. You can use verification to ensure that the adjustment process was successful or to determine if the adjustment process needs to be performed.

Adjustment is the process of measuring and compensating for device performance to improve the output accuracy. Performing an adjustment updates the calibration date, resetting the calibration interval. The device is guaranteed to meet or exceed its published specifications for the duration of the calibration interval.

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 output 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 output errors determined during verification fall within the published specifications, but not within the calibration test limits, the device meets its published specifications. However, the device may not remain within these specifications for another two years. The device will meet published specifications for the rest of the current calibration interval. In this case, you can perform an adjustment if you want to improve the output accuracy or reset the calibration interval. If some output 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 alternate procedures that allow you to skip adjustment if the device already meets its calibration test limits or published specifications.

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Complete Calibration

Performing a complete calibration is the recommended way to guarantee that the NI 5412 meets or exceeds its published specifications for a two-year calibration interval. At the end of the complete calibration procedure, you verify that the output error falls within the calibration test limits. Figure 1 shows the programming flow for complete calibration.

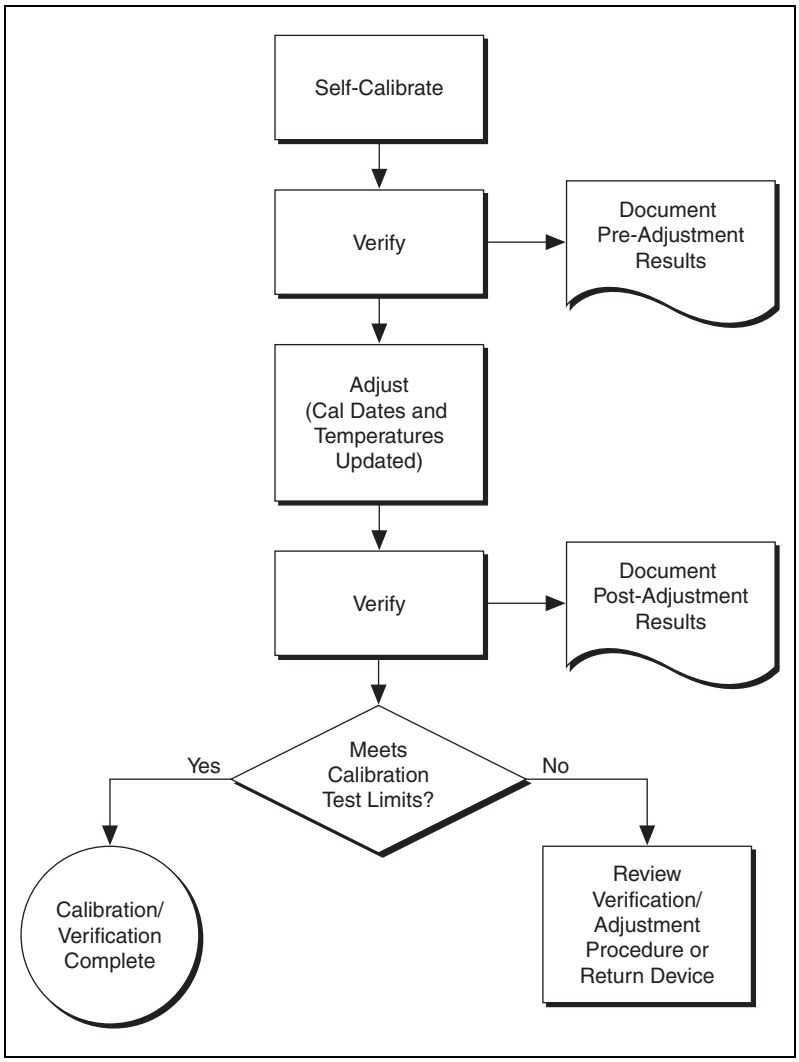


Figure 1. Complete Calibration Programming Flow

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Optional Calibration

You can choose to skip the adjustment steps of the calibration procedure if the output error is within the calibration test limits or the published specifications during the first verification. If all of the output 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 *Adjusting the NI 5412* section for more information.

If all of the output 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 output error falls within the calibration test limits at the end of the calibration procedure.

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Figure 2 shows the programming flow for the optional calibration.

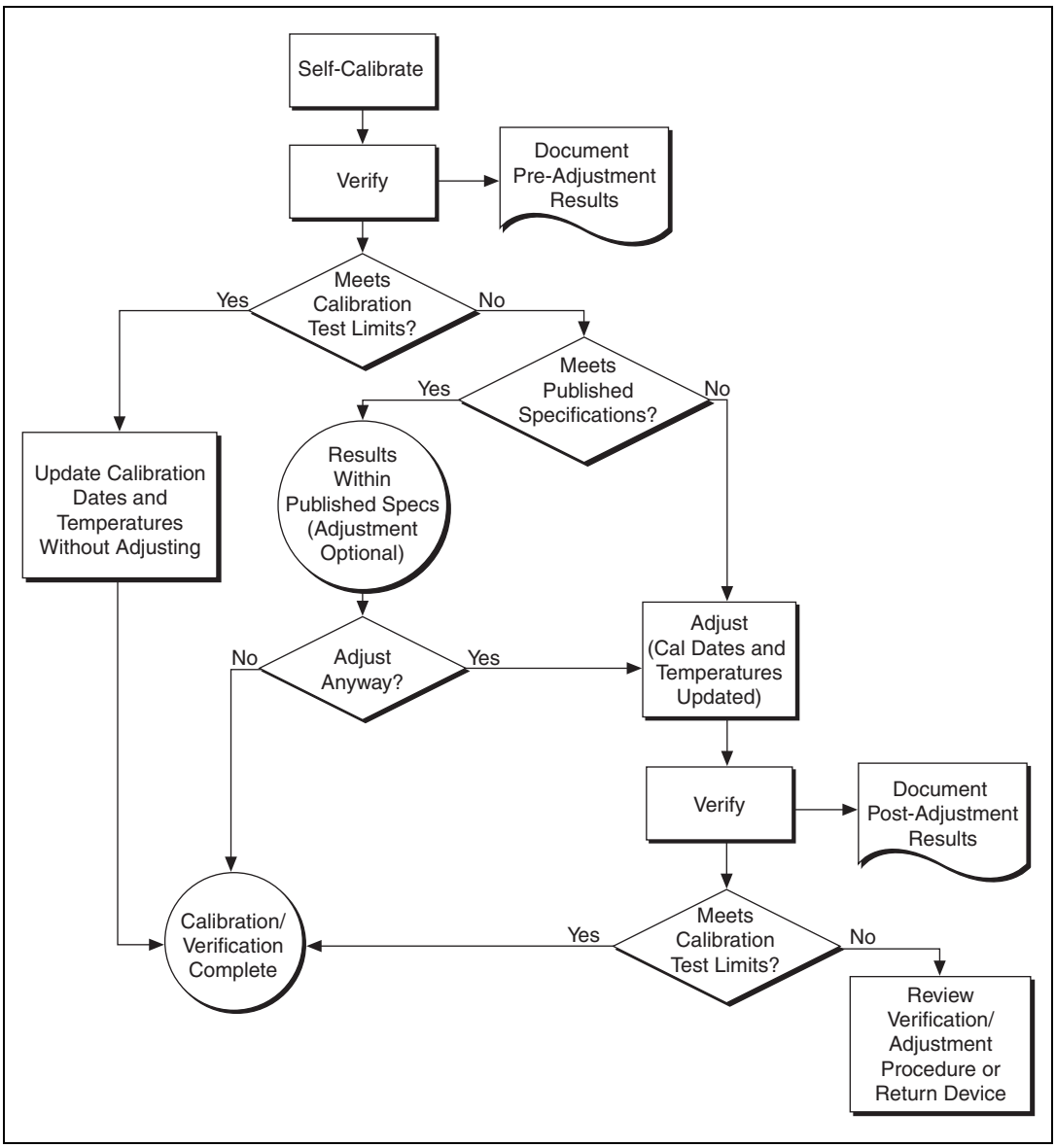


Figure 2. Optional Calibration Programming Flow

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External Calibration Requirements

This section describes the test equipment and test conditions required for calibration.

Test Equipment

External calibration requires different equipment for each applicable specification. Refer to Table 2 for a list of equipment.

Table 2. Equipment Required for Calibrating the NI 5412

Instrument	Applicable Specification	Minimum Specifications	Recommended Instrument
Digital multimeter (DMM)	DC gain and offset	DC accuracy ≤ ±50 ppm Resolution ≤1 µV	NI PXI-4070 Agilent HP 34401A Keithley 2000
Male banana to female BNC adapter		—	—
Male BNC to female SMB cable		50 Ω, RG-223	—
Spectrum analyzer or frequency meter	Frequency accuracy	Ability to measure 10 MHz or higher sine waves Frequency accuracy to ±500 ppb	NI PXI-5660 Agilent HP 8560E Agilent HP 53131A or HP 53132A with timebase option 001, 010, or 012
Male BNC to female SMB cable		50 Ω, RG-223	—

Test Conditions

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

- Keep connections to the NI 5412 short.
- Keep relative humidity below 80%.
- Maintain a temperature between 18 °C and 28 °C.
- Observe the 15-minute warm-up time.

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External Calibration Procedures

The complete external calibration procedure consists of self-calibrating, verifying the performance of the NI 5412, adjusting the calibration constants, and verifying again after the adjustments. In some cases, the complete calibration procedure may not be required. Refer to the *External Calibration Options* section for more information.

The external calibration procedure automatically stores the calibration date to allow traceability.

Writing the Calibration Procedure

Before you begin to write the calibration program, review the programming flows in Figures 1 and 2.

Calibration Procedures in LabVIEW

To write calibration procedures in LabVIEW, you must use the VIs included in the `niFgen.llb` file. After installation, these VIs appear within the NI-FGEN Calibration palette under **Functions»Instrument I/O»Instrument Drivers»NI-FGEN»Calibration**.

Calibration Procedures in LabWindows/CVI

To write calibration procedures in LabWindows/CVI, you must use the functions included in the `niFgen.fp` file. After installation, you can locate the calibration functions under the Calibration class node.

Calibration Procedures in C

To write calibration procedures in C, you must include the `niFgen.h` file in the code that calls the calibration functions, and you must link the `niFgen.lib` file into the build of your executable.

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Verifying NI 5412 Specifications

Note Always self-calibrate the NI 5412 before beginning a verification procedure.

This section provides instructions for verifying the NI 5412 specifications and for updating the calibration cycle.

Verification determines whether the device is performing within its specifications prior to external adjustment. Verification and external adjustment together comprise a complete calibration. To verify that the NI 5412 still meets its specifications, you must use NI-FGEN to control the NI 5412.

The steps in the verification procedures describe the code that you use to generate the appropriate signals, as well as the NI-FGEN function calls that you make to verify specifications.

You can verify the following specifications for the NI 5412:

- Oscillator frequency accuracy
- DC gain and offset accuracy

The verification procedure for each of these specifications includes setting up, programming, and cleaning up.

Note If any of these tests fail immediately after you perform an external adjustment, verify that you have met the required test conditions before you return the NI 5412 to NI for repair.

Refer to Table 2 for information about which instrument to use for verifying each specification. Refer to Figure 3 for the names and locations of the NI PXI-5412 and the NI PCI-5412 front panel connectors.

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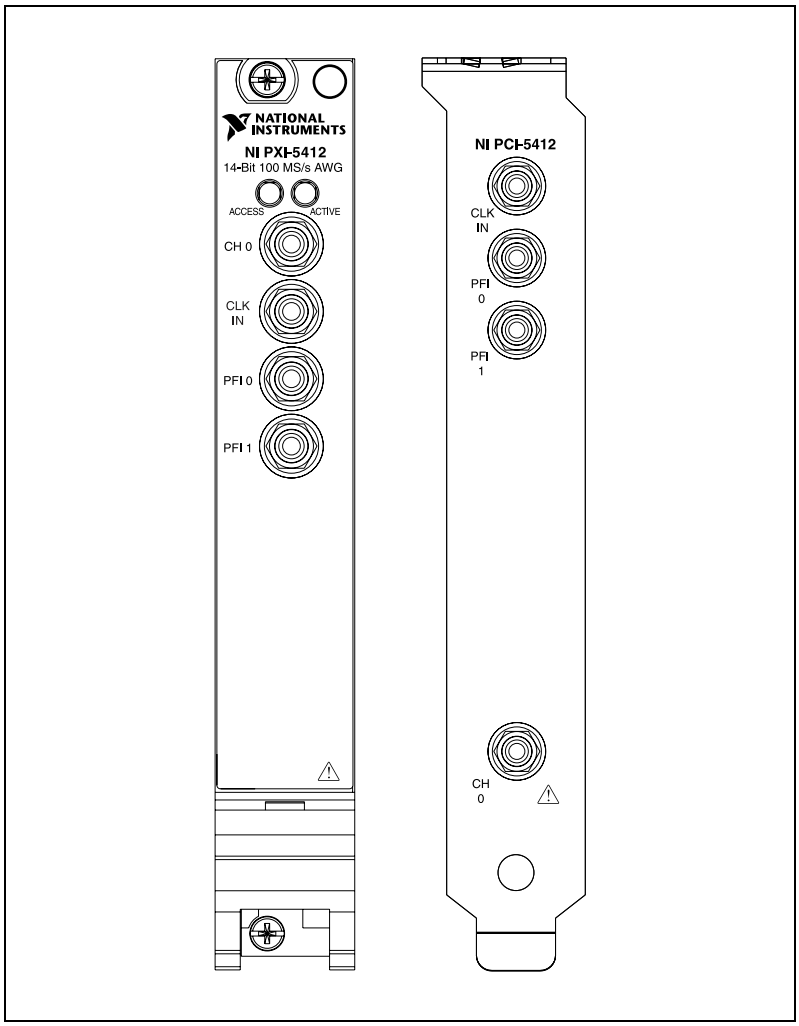


Figure 3. NI PXI-5412 and NI PCI-5412 Front Panel Connectors

Verifying the Oscillator Frequency Accuracy

This test verifies the frequency accuracy of the oscillator on the NI 5412. The verification involves generating a 10 MHz sine wave with the NI 5412 and measuring the sine wave frequency with one of the instruments from Table 2.

To verify the frequency accuracy of the oscillator on the NI 5412, complete the following steps:

1. Connect the NI 5412 CH 0 front panel connector to the instrument measuring the frequency accuracy with a male BNC to female SMB cable.

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2. Call `niFgen_init` (niFgen Initialize VI) using the following parameters:
   - **resourceName**: The name of the device that you want to verify. You can find this name under Devices and Interfaces in MAX.
   - **IDQuery**: `VI_TRUE`
   - **resetDevice**: `VI_TRUE`
   - **vi**: A pointer to a ViSession. The variable passed by reference through this parameter receives the value that identifies the session created by this function. This value acts as the session handle and is passed as the first parameter to all subsequent NI-FGEN functions.
3. Call `niFgen_SetAttributeViReal64` to set the sample rate (niFgen property node: **Arbitrary Waveform Output»Sample Rate**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_init`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_ARB_SAMPLE_RATE`
   - **value**: `100000000`
4. Call `niFgen_SetAttributeViReal64` to set the gain (niFgen property node: **Arbitrary Waveform Output»Arbitrary Waveform Gain**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_init`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_ARB_GAIN`
   - **value**: `1`

Note You can adjust the gain value based on which measuring device you use.

5. Call `niFgen_SetAttributeViReal64` to set the offset (niFgen property node: **Arbitrary Waveform Output»Arbitrary Waveform Offset**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_init`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_ARB_OFFSET`
   - **value**: `0`

Note You can adjust the offset value based on which measuring device you use.

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6. Call `niFgen_SetAttributeViBoolean` to set the digital filter state (niFgen property node: **Output Attributes»Digital Filter Enabled**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_init`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_DIGITAL_FILTER_ENABLED`
   - **value**: `VI_TRUE`
7. Call `niFgen_SetAttributeViReal64` to set the digital filter interpolation factor (niFgen property node: **Output Attributes» Digital Filter Interpolation Factor**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_init`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_DIGITAL_FILTER_INTERPOLATION_FACTOR`
   - **value**: `4`
8. Generate an array of waveform samples. Each waveform should have 10 samples per cycle with a total of 500 samples and 50 sine wave cycles. Because you set the sample rate to 100 MS/s and because you are using 10 samples per cycle, the resulting waveform is a 10 MHz sine wave.

Note The sample values of this waveform must fall between –1.0 and 1.0.

9. Call `niFgen_CreateArbWaveform` (niFgen Create Arbitrary Waveform VI) using the following parameters:
   - **vi**: The session handle returned from `niFgen_init`
   - **wfmSize**: The size in samples (`500`) of the waveform you created in step 8
   - **wfmData**: The array of waveform samples that you created in step 8
   - **wfmHandle**: The variable passed by reference through this parameter receives the value (waveform handle) that identifies the waveform created by this function.
10. Call `niFgen_InitiateGeneration` (niFgen Initiate Generation VI) to initiate the waveform generation using the following parameter:
    - **vi**: The session handle returned from `niFgen_init`

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11. Measure the frequency out of the NI 5412.

    A frequency error of 45 Hz for a 10 MHz signal corresponds to an error of 4.5 ppm. This limit accounts for the initial accuracy and the frequency deviation caused by temperature and aging. Refer to Table 3 for frequency ranges.

Table 3. Frequency Ranges

Calibration Test Limit		Published Specifications ±25 ppm	
Low	**High**	**Low**	**High**
9,999,955 Hz	10,000,045 Hz	9,999,750 Hz	10,000,250 Hz

12. Call `niFgen_AbortGeneration` (niFgen Abort Generation VI) to abort the waveform generation using the following parameter:
    - **vi**: The session handle returned from `niFgen_init`
13. Call `niFgen_close` (niFgen Close VI) to close the instrument driver session, to destroy the instrument driver session and all of its properties, and to release any memory resources NI-FGEN uses. Use the following parameter:
    - **vi**: The session handle returned from `niFgen_init`

Verifying the DC Gain and Offset Accuracy

This test verifies the DC gain and offset accuracy of the NI 5412 into a high-impedance load by generating a number of DC voltages and offsets, measuring the voltage with a DMM, and comparing the NI 5412 to the error limits.

The DC gain and offset accuracy verification procedure has two sub-procedures that verify the following:

- Main analog path gain
- Main analog path offset

Verifying the Main Analog Path Gain

To verify the gain of the NI 5412 main analog path, complete the following steps:

1. Connect the NI 5412 CH 0 front panel connector to the DMM for measuring DC gain and offset accuracy.
2. Call `niFgen_init` (niFgen Initialize VI) using the following parameters:
    - **resourceName**: The name of the device that you want to verify. You can find this name under Devices and Interfaces in MAX.

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- **IDQuery**: `VI_TRUE`
- **resetDevice**: `VI_TRUE`
- **vi**: A pointer to a ViSession. The variable passed by reference through this parameter receives the value that identifies the session created by this function. This value acts as the session handle and is passed as the first parameter to all subsequent NI-FGEN functions.

3. Call `niFgen_SetAttributeViReal64` to set the load impedance (niFgen property node: **Output Attributes»Load Impedance**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_init`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_LOAD_IMPEDANCE`
   - **value**: `10000000000`
4. Call `niFgen_SetAttributeViInt32` to set the analog path (niFgen property node: **Output Attributes»Analog Path**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_init`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_ANALOG_PATH`
   - **value**: `NIFGEN_VAL_MAIN_ANALOG_PATH`
5. Call `niFgen_SetAttributeViReal64` to set the output impedance (niFgen property node: **Basic Operation»Output Impedance**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_init`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_OUTPUT_IMPEDANCE`
   - **value**: `50`
6. Call `niFgen_SetAttributeViBoolean` to enable the analog output (niFgen property node: **Basic Operation»Output Enabled**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_init`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_OUTPUT_ENABLED`
   - **value**: `VI_TRUE`
7. Create an array of waveform samples for the positive full-scale DC waveform. This array should contain 500 samples with each sample having the value `1.0` (representation: double).

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8. Call `niFgen_CreateArbWaveform` (niFgen Create Arbitrary Waveform VI) using the following parameters:
   - **vi**: The session handle returned from `niFgen_init`
   - **wfmSize**: The size in samples (`500`) of the waveform you created in step 7
   - **wfmData**: The array of waveform samples that you created in step 7
   - **wfmHandle**: The variable passed by reference through this parameter receives the value (waveform handle) that identifies the waveform created by this function (positive full-scale handle).
9. Create an array of waveform samples for the negative full-scale DC waveform. This array should contain 500 samples with each sample having the value `-1.0` (representation: double).
10. Call `niFgen_CreateArbWaveform` (niFgen Create Arbitrary Waveform VI) using the following parameters:
    - **vi**: The session handle returned from `niFgen_init`
    - **wfmSize**: The size in samples (`500`) of the waveform that you created in step 9
    - **wfmData**: The array of waveform samples that you created in step 9
    - **wfmHandle**: The variable passed by reference through this parameter receives the value (waveform handle) that identifies the waveform created by this function (negative full-scale handle).
11. Call `niFgen_SetAttributeViReal64` to set the offset (niFgen property node: **Arbitrary Waveform Output»Arbitrary Waveform Offset**) using the following parameters:
    - **vi**: The session handle returned from `niFgen_init`
    - **channelName**: `"0"`
    - **attributeID**: `NIFGEN_ATTR_ARB_OFFSET`
    - **value**: `0`

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Repeat steps 12 through 22 for each of the 24 iterations listed in Table 4, changing the *Gain* value for each iteration.

Table 4. Values for Verifying the Gain of the Main Analog Path

Iteration	Gain	Ideal Positive Full-Scale (Volts)	Ideal Negative Full-Scale (Volts)	Calibration Test Limit (Volts)	Published Spec (Volts)
1	12.000000	12.000000	–12.000000	±0.019700	±0.048500
2	10.000000	10.000000	–10.000000	±0.016500	±0.040500
3	7.000000	7.000000	–7.000000	±0.011700	±0.028500
4	5.000000	5.000000	–5.000000	±0.008500	±0.020500
5	3.500000	3.500000	–3.500000	±0.006100	±0.014500
6	2.500000	2.500000	–2.500000	±0.004500	±0.010500
7	2.000000	2.000000	–2.000000	±0.003700	±0.008500
8	1.650000	1.650000	–1.650000	±0.003140	±0.007100
9	1.250000	1.250000	–1.250000	±0.002500	±0.005500
10	0.850000	0.850000	–0.850000	±0.001860	±0.003900
11	0.600000	0.600000	–0.600000	±0.001460	±0.002900
12	0.415000	0.415000	–0.415000	±0.001164	±0.002160
13	0.300000	0.300000	–0.300000	±0.000980	±0.001700
14	0.205000	0.205000	–0.205000	±0.000828	±0.001320
15	0.150000	0.150000	–0.150000	±0.000740	±0.001100
16	0.105000	0.105000	–0.105000	±0.000668	±0.000920
17	0.075000	0.075000	–0.075000	±0.000620	±0.000800
18	0.055000	0.055000	–0.055000	±0.000588	±0.000720
19	0.037500	0.037500	–0.037500	±0.000560	±0.000650
20	0.026000	0.026000	–0.026000	±0.000542	±0.000604
21	0.018500	0.018500	–0.018500	±0.000530	±0.000574
22	0.013000	0.013000	–0.013000	±0.000521	±0.000552
23	0.009000	0.009000	–0.009000	±0.000514	±0.000536
24	0.006500	0.006500	–0.006500	±0.000510	±0.000526

Error Positive Full-Scale Value = (*Measured Positive Full-Scale Value*) – (*Ideal Positive Full-Scale Value*)

Error Negative Full-Scale Value = (*Measured Negative Full-Scale Value*) – (*Ideal Negative Full-Scale Value*)

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12. Call `niFgen_SetAttributeViReal64` to set the gain (niFgen property node: **Arbitrary Waveform Output»Arbitrary Waveform Gain**) using the following parameters:
    - **vi**: The session handle returned from `niFgen_init`
    - **channelName**: `"0"`
    - **attributeID**: `NIFGEN_ATTR_ARB_GAIN`
    - **value**: The *Gain* value listed in Table 4 for the current iteration
13. Call `niFgen_SetAttributeViInt32` to choose the positive full-scale DC waveform (niFgen property node: **Arbitrary Waveform Output»Arbitrary Waveform Handle**) using the following parameters:
    - **vi**: The session handle returned from `niFgen_init`
    - **channelName**: `"0"`
    - **attributeID**: `NIFGEN_ATTR_ARB_WAVEFORM_HANDLE`
    - **value**: The **wfmHandle** from step 8 (positive full-scale handle)
14. Call `niFgen_InitiateGeneration` (niFgen Initiate Generation VI) to initiate the waveform generation using the following parameter:
    - **vi**: The session handle returned from `niFgen_init`
15. Measure the DC voltage out of the NI 5412. This is the *Measured Positive Full-Scale Value*.
16. Determine the error for positive full-scale using the following formula:

    Error Positive Full-Scale =
    (*Measured Positive Full-Scale Value*) – (*Ideal Positive Full-Scale Value*)

    Compare this error to the *Published Spec* or the *Calibration Test Limit*.
17. Call `niFgen_AbortGeneration` (niFgen Abort Generation VI) to abort the waveform generation using the following parameter:
    - **vi**: The session handle returned from `niFgen_init`
18. Call `niFgen_SetAttributeViInt32` to choose the negative full-scale DC waveform (niFgen property node: **Arbitrary Waveform Output»Arbitrary Waveform Handle**) using the following parameters:
    - **vi**: The session handle returned from `niFgen_init`
    - **channelName**: `"0"`
    - **attributeID**: `NIFGEN_ATTR_ARB_WAVEFORM_HANDLE`
    - **value**: The **wfmHandle** from step 10 (negative full-scale handle)
19. Call `niFgen_InitiateGeneration` (niFgen Initiate Generation VI) to initiate the waveform generation using the following parameter:
    - **vi**: The session handle returned from `niFgen_init`

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20. Measure the DC voltage out of the NI 5412. This is the *Measured Negative Full-Scale Value*.
21. Calculate the error for negative full-scale using the following formula:

    Error Negative Full-Scale =
    (*Measured Negative Full-Scale Value*) – (*Ideal Full-Scale Value*)

    Compare this error to the *Published Spec* or the *Calibration Test Limit*.
22. Call `niFgen_AbortGeneration` (niFgen Abort Generation VI) to abort the waveform generation using the following parameter:
    - **vi**: The session handle returned from `niFgen_init`
23. If any of the errors are greater than the *Calibration Test Limit*, perform an external adjustment.

Verifying the Main Analog Path Offset

To verify the offset of the NI 5412 main analog path, complete the following steps:

1. Create an array of waveform samples for the mid-scale DC waveform (0 VDC). This array should contain 500 samples with each sample having the value `0.0` (representation: double).
2. Call `niFgen_CreateArbWaveform` (niFgen Create Arbitrary Waveform VI) using the following parameters:
    - **vi**: The session handle returned from `niFgen_init`
    - **wfmSize**: The size in samples (`500`) of the waveform that you created in step 1
    - **wfmData**: The array of waveform samples that you created in step 1
    - **wfmHandle**: The variable passed by reference through this parameter receives the value (waveform handle) that identifies the waveform created by this function (mid-scale handle).
3. Call `niFgen_SetAttributeViInt32` to choose the mid-scale handle DC waveform (niFgen property node: **Arbitrary Waveform Output»Arbitrary Waveform Handle**) using the following parameters:
    - **vi**: The session handle returned from `niFgen_init`
    - **channelName**: `"0"`
    - **attributeID**: `NIFGEN_ATTR_ARB_WAVEFORM_HANDLE`
    - **value**: The **wfmHandle** from step 2 (mid-scale handle)

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Repeat steps 4 through 14 for each of the 24 iterations listed in Table 5, changing the *Ideal Positive Offset*, *Ideal Negative Offset*, and *Gain* values for each iteration.

Table 5. Values for Verifying the Offset of the Main Analog Path

Iteration	Gain	Ideal Positive Offset (Volts)	Ideal Negative Offset (Volts)	Calibration Test Limit (Volts)	Published Spec (Volts)
1	12.000000	6.000000	–6.000000	±0.021500	±0.051500
2	10.000000	5.000000	–5.000000	±0.018000	±0.043000
3	7.000000	3.500000	–3.500000	±0.012750	±0.030250
4	5.000000	2.500000	–2.500000	±0.009250	±0.021750
5	3.500000	1.750000	–1.750000	±0.006625	±0.015375
6	2.500000	1.250000	–1.250000	±0.004875	±0.011125
7	2.000000	1.000000	–1.000000	±0.004000	±0.009000
8	1.650000	0.825000	–0.825000	±0.003388	±0.007513
9	1.250000	0.625000	–0.625000	±0.002688	±0.005813
10	0.850000	0.425000	–0.425000	±0.001988	±0.004113
11	0.600000	0.300000	–0.300000	±0.001550	±0.003050
12	0.415000	0.207500	–0.207500	±0.001226	±0.002264
13	0.300000	0.150000	–0.150000	±0.001025	±0.001775
14	0.205000	0.102500	–0.102500	±0.000859	±0.001371
15	0.150000	0.075000	–0.075000	±0.000763	±0.001138
16	0.105000	0.052500	–0.052500	±0.000684	±0.000946
17	0.075000	0.037500	–0.037500	±0.000631	±0.000819
18	0.055000	0.027500	–0.027500	±0.000596	±0.000734
19	0.037500	0.018750	–0.018750	±0.000566	±0.000659
20	0.026000	0.013000	–0.013000	±0.000546	±0.000611
21	0.018500	0.009250	–0.009250	±0.000532	±0.000579
22	0.013000	0.006500	–0.006500	±0.000523	±0.000555
23	0.009000	0.004500	–0.004500	±0.000516	±0.000538
24	0.006500	0.003250	–0.003250	±0.000511	±0.000528

Error Positive Offset Value = (*Measured Positive Offset Value*) – (*Ideal Positive Offset Value*)

Error Negative Offset Value = (*Measured Negative Offset Value*) – (*Ideal Negative Offset Value*)

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4. Call `niFgen_SetAttributeViReal64` to set the offset (niFgen property node: **Arbitrary Waveform Output»Arbitrary Waveform Offset**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_init`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_ARB_OFFSET`
   - **value**: The *Ideal Positive Offset* value listed in Table 5 for the current iteration
5. Call `niFgen_SetAttributeViReal64` to set the gain (niFgen property node: **Arbitrary Waveform Output»Arbitrary Waveform Gain**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_init`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_ARB_GAIN`
   - **value**: The *Gain* value listed in Table 5 for the current iteration
6. Call `niFgen_InitiateGeneration` (niFgen Initiate Generation VI) to initiate the waveform generation using the following parameter:
   - **vi**: The session handle returned from `niFgen_init`
7. Measure the positive DC voltage out of the NI 5412. This is the *Measured Positive Offset Value*.
8. Calculate the error for positive offset using the following formula:

   Error Positive Offset =
   (*Measured Positive Offset Value*) – (*Ideal Positive Offset Value*)

   Compare this error to the *Published Spec* or the *Calibration Test Limit*.
9. Call `niFgen_AbortGeneration` (niFgen Abort Generation VI) to abort the waveform generation using the following parameter:
   - **vi**: The session handle returned from `niFgen_init`
10. Call `niFgen_SetAttributeViReal64` to set the offset (niFgen property node: **Arbitrary Waveform Output»Arbitrary Waveform Offset**) using the following parameters:
    - **vi**: The session handle returned from `niFgen_init`
    - **channelName**: `"0"`
    - **attributeID**: `NIFGEN_ATTR_ARB_OFFSET`
    - **value**: The *Ideal Negative Offset* value listed in Table 5 for the current iteration

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11. Call `niFgen_InitiateGeneration` (niFgen Initiate Generation VI) to initiate the waveform generation using the following parameter:
    - **vi**: The session handle returned from `niFgen_init`
12. Measure the negative DC voltage out of the NI 5412. This is the *Measured Negative Offset Value*.
13. Calculate the error for positive offset using the following formula:

    Error Negative Offset =
    (*Measured Negative Offset Value*) – (*Ideal Negative Offset Value*)

    Compare this error to the *Published Spec* or the *Calibration Test Limit*.
14. Call `niFgen_AbortGeneration` (niFgen Abort Generation VI) to abort the waveform generation using the following parameter:
    - **vi**: The session handle returned from `niFgen_init`
15. If any of the errors are greater than the *Calibration Test Limit*, perform an external adjustment.

Adjusting the NI 5412

If the NI 5412 successfully passes all verification within the calibration test limits, adjustment is recommended, but not required, to guarantee its published specifications for the next two years. If the NI 5412 was not within the calibration test limits for each verification procedure, perform the adjustment procedure to improve the accuracy of the NI 5412. Refer to the *External Calibration Options* section to determine which procedures to perform.

An adjustment is required only once every two years. The adjustment procedure automatically updates the calibration date and temperature in the EEPROM of the NI 5412.

If the NI 5412 passed verification within the calibration test limits and you do not want to do an adjustment, you can update the calibration date and onboard calibration temperature without making any adjustments by completing the following steps:

1. Call `niFgen_InitExtCal` (niFgen Init Ext Cal VI) to open an NI-FGEN external calibration session using the following parameters:
    - **resourceName**: The name of the device you want 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"`.

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- **vi**: A pointer to a ViSession. The variable passed by reference through this parameter receives the value that identifies the external calibration session created by this function. This value acts as the session handle and is passed as the first parameter to all subsequent NI-FGEN functions.

2. Call `niFgen_CloseExtCal` (niFgen Close Ext Cal VI) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **action**: `NIFGEN_VAL_EXT_CAL_COMMIT`

The external calibration procedure adjusts the analog output, the oscillator frequency, and the calibration ADC. Analog output adjustment characterizes the DC gains and the offsets of the analog path to ensure the analog output voltage accuracy. Adjusting the oscillator frequency adjusts the onboard oscillator to ensure frequency accuracy. Calibration ADC adjustment characterizes the onboard ADC gain and offset so that self-calibration results in an accurately calibrated device.

You cannot perform an external calibration using a standard NI-FGEN session. You must create an external calibration session using `niFgen_InitExtCal` (niFgen Init Ext Cal VI). An external calibration session allows you to use NI-FGEN functions and attributes that are specifically for external calibration, while still allowing you to use all the standard NI-FGEN functions and attributes with the external calibration session.

Along with the standard NI-FGEN attributes, the external calibration session uses a set of calibration constants that are determined during the calibration procedure and stored in the device onboard memory when the session is closed. NI-FGEN uses these calibration constants during a standard NI-FGEN session to ensure that the device operates within its specifications.

You must close an external calibration session by using `niFgen_CloseExtCal` (niFgen Close Ext Cal VI).

Figure 4 shows the programming flow for an external calibration procedure.

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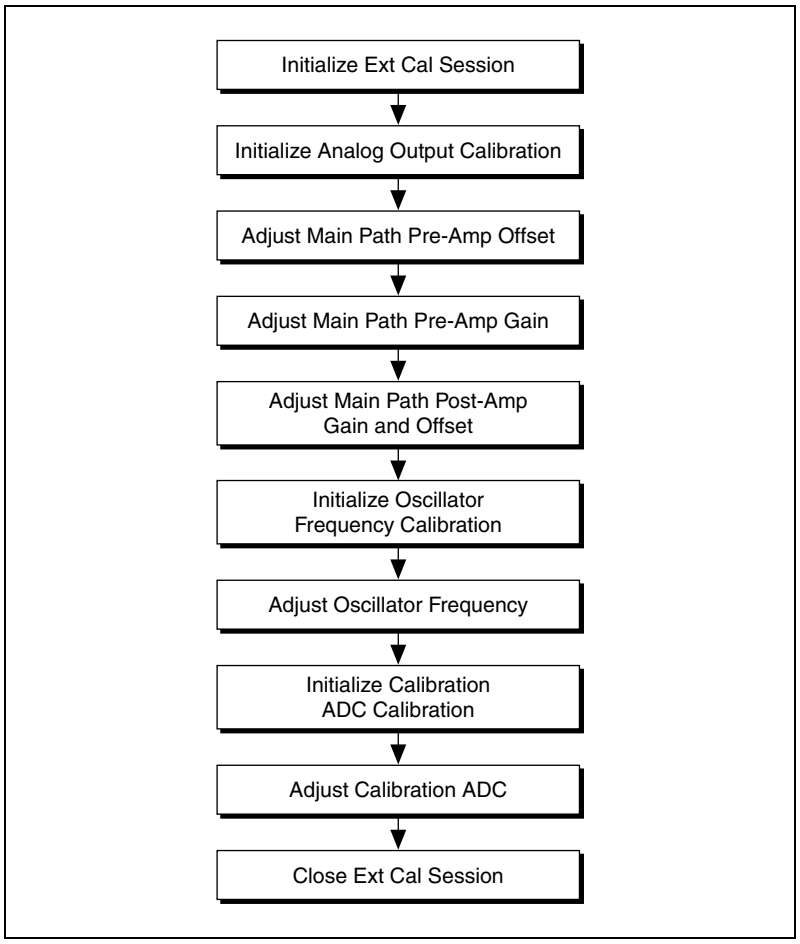


Figure 4. NI 5412 External Calibration Procedure

Initializing the External Calibration Session

Call `niFgen_InitExtCal` (niFgen Init Ext Cal VI) to open an NI-FGEN external calibration session using the following parameters:

- **resourceName**: The name of the device you want to calibrate. This name can be found 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"`.
- **vi**: A pointer to a ViSession. The variable passed by reference through this parameter receives the value that identifies the external calibration session created by this function. This value acts as the session handle and is passed as the first parameter to all subsequent NI-FGEN functions.

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Adjusting the Analog Output

The analog output adjustment procedure has several sub-procedures that adjust the following:

- Main path pre-amplifier offset
- Main path pre-amplifier gain
- Main path post-amplifier gain and offset

In each of these sub-procedures, you put the device in several configurations and take several output measurements. You then pass these measurements to NI-FGEN, which determines the calibration constants for the device.

Initializing Analog Output Calibration

1. Call `niFgen_InitializeAnalogOutputCalibration` (niFgen Initialize Analog Output Calibration VI) using the following parameter:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
2. Call `niFgen_WriteBinary16AnalogStaticValue` (niFgen Write Binary 16 Analog Static Value VI) to set the main DAC value using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **value**: `0`
3. Call `niFgen_SetAttributeViInt32` to set the analog path value (niFgen property node: **Output Attributes»Analog Path**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_ANALOG_PATH`
   - **value**: `NIFGEN_VAL_FIXED_LOW_GAIN_ANALOG_PATH`
4. Call `niFgen_SetAttributeViInt32` to set the gain DAC value (niFgen property node: **Calibration»Gain DAC Value**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_GAIN_DAC_VALUE`
   - **value**: `2000`

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5. Call `niFgen_SetAttributeViInt32` to set the offset DAC value (niFgen property node: **Calibration»Offset DAC Value**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_OFFSET_DAC_VALUE`
   - **value**: `32767`
6. Call `niFgen_SetAttributeViReal64` to set the pre-amplifier attenuation (niFgen property node: **Calibration»Pre-Amplifier Attenuation**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_PRE_AMPLIFIER_ATTENUATION`
   - **value**: `0`
7. Call `niFgen_SetAttributeViReal64` to set the post-amplifier attenuation (niFgen property node: **Calibration»Post-Amplifier Attenuation**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_POST_AMPLIFIER_ATTENUATION`
   - **value**: `0`
8. Call `niFgen_SetAttributeViReal64` to set the output impedance (niFgen property node: **Basic Operation»Output Impedance**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_OUTPUT_IMPEDANCE`
   - **value**: `50`
9. Call `niFgen_SetAttributeViBoolean` to enable the analog output (niFgen property node: **Basic Operation»Output Enabled**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_OUTPUT_ENABLED`
   - **value**: `VI_TRUE`
10. Call `niFgen_Commit` (niFgen Commit VI) to commit the attribute values to the device using the following parameter:
    - **vi**: The session handle returned from `niFgen_InitExtCal`

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Adjusting the Main Path Pre-Amplifier Offset

1. Call `niFgen_SetAttributeViInt32` to set the analog path value (niFgen property node: **Output Attributes»Analog Path**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_ANALOG_PATH`
   - **value**: `NIFGEN_VAL_FIXED_LOW_GAIN_ANALOG_PATH`
2. Call `niFgen_SetAttributeViReal64` to set the post-amplifier attenuation (niFgen property node: **Calibration»Post-Amplifier Attenuation**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_POST_AMPLIFIER_ATTENUATION`
   - **value**: `0`
3. Call `niFgen_WriteBinary16AnalogStaticValue` (niFgen Write Binary 16 Analog Static Value VI) to set the main DAC value using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **value**: `0`

Repeat steps 4 through 6 for each of the 5 iterations listed in Table 6, changing the *Pre-Amplifier Attenuation* and *Current Configuration* values for each iteration.

Table 6. Attributes and Values for Main Path Pre-Amplifier Offset

Iteration	Pre-Amplifier Attenuation	Current Configuration
1	0	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_FILTER_OFF_0DB
2	3	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_FILTER_OFF_3DB
3	6	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_FILTER_OFF_6DB
4	9	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_FILTER_OFF_9DB
5	12	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_FILTER_OFF_12DB

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4. Call `niFgen_SetAttributeViReal64` to set the pre-amplifier attenuation (niFgen property node: **Calibration»Pre-Amplifier Attenuation**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_PRE_AMPLIFIER_ATTENUATION`
   - **value**: The *Pre-Amplifier Attenuation* value for the current iteration from Table 6
5. Take the following voltage measurements at the NI 5412 CH 0 front panel connector into a high-impedance load:
   a. Call `niFgen_SetAttributeViInt32` to set the gain DAC value (niFgen property node: **Calibration»Gain DAC Value**) using the following parameters:
      - **vi**: The session handle returned from `niFgen_InitExtCal`
      - **channelName**: `"0"`
      - **attributeID**: `NIFGEN_ATTR_GAIN_DAC_VALUE`
      - **value**: `2000`
   b. Call `niFgen_SetAttributeViInt32` to set the offset DAC value (niFgen property node: **Calibration»Offset DAC Value**) using the following parameters:
      - **vi**: The session handle returned from `niFgen_InitExtCal`
      - **channelName**: `"0"`
      - **attributeID**: `NIFGEN_ATTR_OFFSET_DAC_VALUE`
      - **value**: `50000`
   c. Call `niFgen_Commit` (niFgen Commit VI) to commit the attribute values to the device using the following parameter:
      - **vi**: The session handle returned from `niFgen_InitExtCal`
   d. Wait 500 ms for the output to settle.
   e. Use the DMM to measure the voltage output by the device. This measurement is `measurement 0`, which is used in step 6.
   f. Call `niFgen_SetAttributeViInt32` to set the gain DAC value (niFgen property node: **Calibration»Gain DAC Value**) using the following parameters:
      - **vi**: The session handle returned from `niFgen_InitExtCal`
      - **channelName**: `"0"`
      - **attributeID**: `NIFGEN_ATTR_GAIN_DAC_VALUE`
      - **value**: `1000`

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g. Call `niFgen_Commit` (niFgen Commit VI) to commit the attribute values to the device using the following parameter:
   - **vi**: The session handle returned from `niFgen_InitExtCal`

h. Wait 500 ms for the output to settle.

i. Use the DMM to measure the voltage output by the device. This measurement is `measurement 1`, which is used in step 6.

j. Call `niFgen_SetAttributeViInt32` to set the offset DAC value (niFgen property node: **Calibration»Offset DAC Value**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_OFFSET_DAC_VALUE`
   - **value**: `15000`

k. Call `niFgen_Commit` (niFgen Commit VI) to commit the attribute values to the device using the following parameter:
   - **vi**: The session handle returned from `niFgen_InitExtCal`

l. Wait 500 ms for the output to settle.

m. Use the DMM to measure the voltage output of the device. This measurement is `measurement 2`, which is used in step 6.

6. Call `niFgen_CalAdjustMainPathPreAmpOffset` (niFgen Cal Adjust Main Path Pre Amp Offset VI) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **configuration**: The *Current Configuration* value for the current iteration from Table 6
   - **gainDACValues**: An array containing two elements—the two values (`2000`, `1000`) that you set as the gain DAC in the order that you measured them
   - **offsetDACValues**: An array containing two elements—the two values (`50000`, `15000`) that you set as the offset DAC in the order that you measured them
   - **measuredOutputs**: An array containing three elements—the three output voltages (`measurement 0`, `measurement 1`, `measurement 2`) that you measured in the order that you measured them

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Adjusting the Main Path Pre-Amplifier Gain

1. Call `niFgen_SetAttributeViInt32` to set the analog path value (niFgen property node: **Output Attributes»Analog Path**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_ANALOG_PATH`
   - **value**: `NIFGEN_VAL_FIXED_LOW_GAIN_ANALOG_PATH`
2. Call `niFgen_SetAttributeViReal64` to set the post-amplifier attenuation (niFgen property node: **Calibration»Post-Amplifier Attenuation**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_POST_AMPLIFIER_ATTENUATION`
   - **value**: `0`
3. Call `niFgen_SetAttributeViInt32` to set the offset DAC value (niFgen property node: **Calibration»Offset DAC Value**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_OFFSET_DAC_VALUE`
   - **value**: `32000`

Repeat steps 4 through 6 for each of the 5 iterations listed in Table 7, changing the *Pre-Amplifier Attenuation* and *Current Configuration* values for each iteration.

Table 7. Attributes and Values for Main Path Pre-Amplifier Gain

Iteration	Pre-Amplifier Attenuation	Current Configuration
1	0	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_FILTER_OFF_0DB
2	3	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_FILTER_OFF_3DB
3	6	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_FILTER_OFF_6DB
4	9	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_FILTER_OFF_9DB
5	12	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_FILTER_OFF_12DB

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4. Call `niFgen_SetAttributeViReal64` to set the pre-amplifier attenuation (niFgen property node: **Calibration»Pre-Amplifier Attenuation**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_PRE_AMPLIFIER_ATTENUATION`
   - **value**: The *Pre-Amplifier Attenuation* value for the current iteration from Table 7
5. Take the following voltage measurements at the NI 5412 CH 0 front panel connector into a high-impedance load:
   a. Call `niFgen_SetAttributeViInt32` to set the gain DAC value (niFgen property node: **Calibration»Gain DAC Value**) using the following parameters:
      - **vi**: The session handle returned from `niFgen_InitExtCal`
      - **channelName**: `"0"`
      - **attributeID**: `NIFGEN_ATTR_GAIN_DAC_VALUE`
      - **value**: `1500`
   b. Call `niFgen_WriteBinary16AnalogStaticValue` (niFgen Write Binary 16 Analog Static Value VI) to set the main DAC value using the following parameters:
      - **vi**: The session handle returned from `niFgen_InitExtCal`
      - **channelName**: `"0"`
      - **value**: `25233`
   c. Call `niFgen_Commit` (niFgen Commit VI) to commit the attribute values to the device using the following parameter:
      - **vi**: The session handle returned from `niFgen_InitExtCal`
   d. Wait 500 ms for the output to settle.
   e. Use the DMM to measure the voltage output by the device. This measurement is `measurement 0`, which is used in step 6.
   f. Call `niFgen_SetAttributeViInt32` to set the gain DAC value (niFgen property node: **Calibration»Gain DAC Value**) using the following parameters:
      - **vi**: The session handle returned from `niFgen_InitExtCal`
      - **channelName**: `"0"`
      - **attributeID**: `NIFGEN_ATTR_GAIN_DAC_VALUE`
      - **value**: `2000`

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g. Call `niFgen_WriteBinary16AnalogStaticValue` (niFgen Write Binary 16 Analog Static Value VI) to set the main DAC value using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **value**: `–29232`

h. Call `niFgen_Commit` (niFgen Commit VI) to commit the attribute values to the device using the following parameter:
   - **vi**: The session handle returned from `niFgen_InitExtCal`

i. Wait 500 ms for the output to settle.

j. Use the DMM to measure the voltage output by the device. This measurement is `measurement 1`, which is used in step 6.

6. Call `niFgen_CalAdjustMainPathPreAmpGain` (niFgen Cal Adjust Main Path Pre Amp Gain VI) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **configuration**: The *Current Configuration* value for the current iteration from Table 7
   - **mainDACValues**: An array containing two elements—the two values (`25233`, `–29232`) that you set for the main DAC in the order that you measured them
   - **gainDACValues**: An array containing two elements—the two values (`1500`, `2000`) that you set for the gain DAC in the order that you measured them
   - **offsetDACValues**: An array containing one element—the value (`32000`) that you set for the offset DAC
   - **measuredOutputs**: An array containing two elements—the two output voltages (`measurement 0`, `measurement 1`) that you measured in the order that you measured them

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Adjusting the Main Path Post-Amplifier Gain and Offset

1. Call `niFgen_WriteBinary16AnalogStaticValue` (niFgen Write Binary 16 Analog Static Value VI) to set the main DAC value using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **value**: `0`
2. Call `niFgen_SetAttributeViReal64` to set the pre-amplifier attenuation (niFgen property node: **Calibration»Pre-Amplifier Attenuation**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_PRE_AMPLIFIER_ATTENUATION`
   - **value**: `0`
3. Call `niFgen_SetAttributeViInt32` to set the gain DAC value (niFgen property node: **Calibration»Gain DAC Value**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_GAIN_DAC_VALUE`
   - **value**: `2000`

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Repeat steps 4 through 7 for each of the eight iterations listed in Table 8, changing the *Post-Amplifier Attenuation* and *Current Configuration* values for each iteration.

Table 8. Attributes and Values for the Main Path Post-Amplifier Gain and Offset

Iteration	Analog Path	Post-Amp Attenuation	Current Configuration
1	NIFGEN_VAL_FIXED_LOW_GAIN_ANALOG_PATH	0	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_LOW_GAIN_0DB
2	NIFGEN_VAL_FIXED_LOW_GAIN_ANALOG_PATH	12	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_LOW_GAIN_12DB
3	NIFGEN_VAL_FIXED_LOW_GAIN_ANALOG_PATH	24	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_LOW_GAIN_24DB
4	NIFGEN_VAL_FIXED_LOW_GAIN_ANALOG_PATH	36	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_LOW_GAIN_36DB
5	NIFGEN_VAL_FIXED_HIGH_GAIN_ANALOG_PATH	0	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_HIGH_GAIN_0DB
6	NIFGEN_VAL_FIXED_HIGH_GAIN_ANALOG_PATH	12	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_HIGH_GAIN_12DB
7	NIFGEN_VAL_FIXED_HIGH_GAIN_ANALOG_PATH	24	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_HIGH_GAIN_24DB
8	NIFGEN_VAL_FIXED_HIGH_GAIN_ANALOG_PATH	36	NIFGEN_VAL_CAL_CONFIG_MAIN_PATH_HIGH_GAIN_36DB

4. Call `niFgen_SetAttributeViInt32` to set the analog path value (niFgen property node: **Output Attributes»Analog Path**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_ANALOG_PATH`
   - **value**: The *Analog Path* value for the current iteration from Table 8
5. Call `niFgen_SetAttributeViReal64` to set the post-amplifier attenuation (niFgen property node: **Calibration»Post-Amplifier Attenuation**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_POST_AMPLIFIER_ATTENUATION`
   - **value**: The *Post-Amplifier Attenuation* value for the current iteration from Table 8

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6. Take the following voltage measurements at the NI 5412 CH 0 front panel connector into a high-impedance load:
   a. Call `niFgen_SetAttributeViInt32` to set the offset DAC value (niFgen property node: **Calibration»Offset DAC Value**) using the following parameters:
      - **vi**: The session handle returned from `niFgen_InitExtCal`
      - **channelName**: `"0"`
      - **attributeID**: `NIFGEN_ATTR_OFFSET_DAC_VALUE`
      - **value**: `50000`
   b. Call `niFgen_Commit` (niFgen Commit VI) to commit the attribute values to the device using the following parameter:
      - **vi**: The session handle returned from `niFgen_InitExtCal`
   c. Wait 500 ms for the output to settle.
   d. Use the DMM to measure the voltage output by the device. This measurement is `measurement 0`, which is used in step 7.
   e. Call `niFgen_SetAttributeViInt32` to set the offset DAC value (niFgen property node: **Calibration»Offset DAC Value**) using the following parameters:
      - **vi**: The session handle returned from `niFgen_InitExtCal`
      - **channelName**: `"0"`
      - **attributeID**: `NIFGEN_ATTR_OFFSET_DAC_VALUE`
      - **value**: `15000`
   f. Call `niFgen_Commit` (niFgen Commit VI) to commit the attribute values to the device using the following parameter:
      - **vi**: The session handle returned from `niFgen_InitExtCal`
   g. Wait 500 ms for the output to settle.
   h. Use the DMM to measure the voltage output by the device. This measurement is `measurement 1`, which is used in step 7.

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7. Call `niFgen_CalAdjustMainPathPostAmpGainAndOffset` (niFgen Cal Adjust Main Path Post Amp Gain And Offset VI) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **configuration**: The *Current Configuration* value for the current iteration from Table 8
   - **mainDACValues**: An array containing two elements—the values (`0`, `0`) that you set on the main DAC
   - **gainDACValues**: An array containing one element—the value (`2000`) that you set on the gain DAC
   - **offsetDACValues**: An array containing two elements—the two values (`50000`, `15000`) that you set on the offset DAC in order
   - **measuredOutputs**: An array containing two elements—the two output voltages (`measurement 0`, `measurement 1`) that you measured in order

Adjusting the Oscillator Frequency

Adjusting the oscillator frequency involves generating a sine wave at a desired frequency, and then iteratively measuring the frequency, passing the measured value to NI-FGEN so that the oscillator can be adjusted, and then re-measuring the resulting frequency. This process is repeated until the difference between the desired and measured frequency falls within the desired tolerance 4.5 ppm. This adjustment ensures the frequency accuracy of the onboard oscillator.

1. Call `niFgen_InitializeOscillatorFrequencyCalibration` (niFgen Initialize Oscillator Frequency Calibration VI) using the following parameter:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
2. Call `niFgen_SetAttributeViReal64` to set the sample rate (niFgen property node: **Arbitrary Waveform Output»Sample Rate**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_ARB_SAMPLE_RATE`
   - **value**: `100000000`

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3. Call `niFgen_SetAttributeViReal64` to set the gain (niFgen property node: **Arbitrary Waveform Output»Arbitrary Waveform Gain**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_ARB_GAIN`
   - **value**: `1`

Note You can adjust this value based on which measuring device you use.

4. Call `niFgen_SetAttributeViReal64` to set the offset (niFgen property node: **Arbitrary Waveform Output»Arbitrary Waveform Offset**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_ARB_OFFSET`
   - **value**: `0`

Note You can adjust this value based on which measuring device you use.

5. Call `niFgen_SetAttributeViBoolean` to set the digital filter state (niFgen property node: **Output Attributes»Digital Filter Enabled**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_DIGITAL_FILTER_ENABLED`
   - **value**: `VI_TRUE`
6. Call `niFgen_SetAttributeViReal64` to set the digital filter interpolation factor (niFgen property node: **Output Attributes» Digital Filter Interpolation Factor**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_DIGITAL_FILTER_INTERPOLATION_FACTOR`
   - **value**: `4`
7. Call `niFgen_SetAttributeViReal64` to set the output impedance (niFgen property node: **Basic Operation»Output Impedance**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`

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- **attributeID**: `NIFGEN_ATTR_OUTPUT_IMPEDANCE`
- **value**: `50`

8. Call `niFgen_SetAttributeViBoolean` to enable the analog output (niFgen property node: **Basic Operation»Output Enabled**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_OUTPUT_ENABLED`
   - **value**: `VI_TRUE`
9. Generate an array of waveform samples.

   Each waveform should have 10 samples per cycle, with a total of 500 samples and 50 sine wave cycles. Because you set the sample rate to 100 MS/s and because there are 10 samples per cycle, the resulting waveform is a 10 MHz sine wave. The sample values of this waveform must fall between –1.0 and 1.0.
10. Call `niFgen_CreateArbWaveform` (niFgen Create Arbitrary Waveform VI) using the following parameters:
    - **vi**: The session handle returned from `niFgen_InitExtCal`
    - **wfmSize**: The size in samples (`500`) of the waveform you created in step 9
    - **wfmData**: The array of waveform samples that you created in step 9
    - **wfmHandle**: The variable passed by reference through this parameter receives the value (waveform handle) that identifies the waveform created by this function
11. Call `niFgen_SetAttributeViInt32` to choose the sine waveform (niFgen property node: **Arbitrary Waveform Output»Arbitrary Waveform Handle**) using the following parameters:
    - **vi**: The session handle returned from `niFgen_init`
    - **channelName**: `"0"`
    - **attributeID**: `NIFGEN_ATTR_ARB_WAVEFORM_HANDLE`
    - **value**: The **wfmHandle** from step 10 (sine waveform handle)
12. Call `niFgen_InitiateGeneration` (niFgen Initiate Generation VI) to initiate the waveform generation using the following parameter:
    - **vi**: The session handle returned from `niFgen_InitExtCal`
13. Measure the frequency of the generated waveform. This value is the `measured frequency`, which is used in step 14.

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14. Repeat steps 14a through 14d for as long as the difference between the measured frequency and the desired frequency (10 MHz) is greater than the tolerance (4.5 ppm).

    The measured frequency should converge on the desired frequency. If the measured frequency does not converge on the desired frequency within 16 iterations, a problem may exist with your measurement device or the NI 5412.

    a. Call `niFgen_AbortGeneration` (niFgen Abort Generation VI) to abort the waveform generation using the following parameter:

        - **vi**: The session handle returned from `niFgen_InitExtCal`

    b. Call `niFgen_CalAdjustOscillatorFrequency` (niFgen Cal Adjust Oscillator Frequency VI) using the following parameters:

        - **vi**: The session handle returned from `niFgen_InitExtCal`
        - **desiredFrequencyInHz**: The desired frequency (`10000000`) of the generated sinusoid in Hz
        - **measuredFrequencyInHz**: The `measured frequency` of the generated sinusoid in Hz

    c. Call `niFgen_InitiateGeneration` (niFgen Initiate Generation VI) to initiate the waveform generation using the following parameter:

        - **vi**: The session handle returned from `niFgen_InitExtCal`

    d. Measure the frequency of the generated waveform. This value is the `measured frequency`.

15. Call `niFgen_AbortGeneration` (niFgen Abort Generation VI) to abort the waveform generation using the following parameter:

    - **vi**: The session handle returned from `niFgen_InitExtCal`

Adjusting the Calibration ADC

The NI 5412 has an onboard calibration ADC that is used during self-calibration. Adjusting the calibration ADC involves characterizing the gain and offset associated with this ADC so that performing self-calibration results in an accurately calibrated device.

1. Call `niFgen_InitializeCalADCCalibration` (niFgen Initialize Cal ADC Calibration VI) using the following parameter:

    - **vi**: The session handle returned from `niFgen_InitExtCal`

2. Call `niFgen_WriteBinary16AnalogStaticValue` (niFgen Write Binary 16 Analog Static Value VI) to set the main DAC value using the following parameters:

    - **vi**: The session handle returned from `niFgen_InitExtCal`
    - **channelName**: `"0"`

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- **value**: `0`

3. Call `niFgen_SetAttributeViInt32` to set the analog path value (niFgen property node: **Output Attributes»Analog Path**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_ANALOG_PATH`
   - **value**: `NIFGEN_VAL_FIXED_LOW_GAIN_ANALOG_PATH`
4. Call `niFgen_SetAttributeViInt32` to set the gain DAC value (niFgen property node: **Calibration»Gain DAC Value**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_GAIN_DAC_VALUE`
   - **value**: `1700`
5. Call `niFgen_SetAttributeViInt32` to set the offset DAC value (niFgen property node: **Calibration»Offset DAC Value**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_OFFSET_DAC_VALUE`
   - **value**: `32767`
6. Call `niFgen_SetAttributeViReal64` to set the pre-amplifier attenuation (niFgen property node: **Calibration»Pre-Amplifier Attenuation**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_PRE_AMPLIFIER_ATTENUATION`
   - **value**: `0`
7. Call `niFgen_SetAttributeViReal64` to set the post-amplifier attenuation (niFgen property node: **Calibration»Post-Amplifier Attenuation**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_POST_AMPLIFIER_ATTENUATION`
   - **value**: `0`

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8. Call `niFgen_SetAttributeViReal64` to set the output impedance (niFgen property node: **Basic Operation»Output Impedance**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_OUTPUT_IMPEDANCE`
   - **value**: `50`
9. Call `niFgen_SetAttributeViBoolean` to enable the analog output (niFgen property node: **Basic Operation»Output Enabled**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_OUTPUT_ENABLED`
   - **value**: `VI_TRUE`
10. Call `niFgen_Commit` (niFgen Commit VI) to commit the attribute values to the device using the following parameter:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
11. Wait 500 ms for the output to settle.
12. Call `niFgen_SetAttributeViInt32` to set the calibration ADC input (niFgen property node: **Calibration»Cal ADC Input**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `""` (empty string)
   - **attributeID**: `NIFGEN_ATTR_CAL_ADC_INPUT`
   - **value**: `NIFGEN_VAL_ANALOG_OUTPUT`
13. Call `niFgen_WriteBinary16AnalogStaticValue` (niFgen Write Binary 16 Analog Static Value VI) to set the main DAC value using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **value**: `27232`
14. Call `niFgen_SetAttributeViBoolean` to disable the analog output (niFgen property node: **Basic Operation»Output Enabled**) using the following parameters:
   - **vi**: The session handle returned from `niFgen_InitExtCal`
   - **channelName**: `"0"`
   - **attributeID**: `NIFGEN_ATTR_OUTPUT_ENABLED`
   - **value**: `VI_FALSE`

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15. Call `niFgen_Commit` (niFgen Commit VI) to commit the attribute values to the device using the following parameter:
    - **vi**: The session handle returned from `niFgen_InitExtCal`
16. Wait 500 ms for the output to settle.
17. Call `niFgen_ReadCalADC` (niFgen Read CAL ADC VI) to measure the analog output voltage with the onboard calibration ADC using the following parameters:
    - **vi**: The session handle returned from `niFgen_InitExtCal`
    - **numberOfReadsToAverage**: `3`
    - **returnCalibratedValue**: `VI_FALSE`
    - **calADCValue**: A ViReal64 variable. The variable passed by reference through this parameter receives the voltage measured by the onboard ADC. This value is `cal ADC measurement 0`, which is used in step 31.
18. Call `niFgen_SetAttributeViBoolean` to enable the analog output (niFgen property node: **Basic Operation»Output Enabled**) using the following parameters:
    - **vi**: The session handle returned from `niFgen_InitExtCal`
    - **channelName**: `"0"`
    - **attributeID**: `NIFGEN_ATTR_OUTPUT_ENABLED`
    - **value**: `VI_TRUE`
19. Call `niFgen_Commit` (niFgen Commit VI) to commit the attribute values to the device using the following parameter:
    - **vi**: The session handle returned from `niFgen_InitExtCal`
20. Wait 500 ms for the output to settle.
21. Use the DMM to measure the NI 5412 voltage output directly into the DMM into a high-impedance load. This measurement is `external measurement 0`, which is used in step 31.
22. Call `niFgen_WriteBinary16AnalogStaticValue` (niFgen Write Binary 16 Analog Static Value VI) to set the main DAC value using the following parameters:
    - **vi**: The session handle returned from `niFgen_InitExtCal`
    - **channelName**: `"0"`
    - **value**: `10232`
23. Call `niFgen_SetAttributeViBoolean` to disable the analog output (niFgen property node: **Basic Operation»Output Enabled**) using the following parameters:
    - **vi**: The session handle returned from `niFgen_InitExtCal`
    - **channelName**: `"0"`

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- **attributeID**: NIFGEN_ATTR_OUTPUT_ENABLED
- **value**: VI_FALSE

24. Call niFgen_Commit (niFgen Commit VI) to commit the attribute values to the device using the following parameter:
    - **vi**: The session handle returned from niFgen_InitExtCal
25. Wait 500 ms for the output to settle.
26. Call niFgen_ReadCalADC (niFgen Read CAL ADC VI) to measure the analog output voltage with the onboard calibration ADC using the following parameters:
    - **vi**: The session handle returned from niFgen_InitExtCal
    - **numberOfReadsToAverage**: 3
    - **returnCalibratedValue**: VI_FALSE
    - **calADCValue**: A ViReal64 variable. The variable passed by reference through this parameter receives the voltage measured by the onboard calibration ADC. This value is cal ADC measurement 1, which is used in step 31.
27. Call niFgen_SetAttributeViBoolean to enable the analog output (niFgen property node: **Basic Operation»Output Enabled**) using the following parameters:
    - **vi**: The session handle returned from niFgen_InitExtCal
    - **channelName**: "0"
    - **attributeID**: NIFGEN_ATTR_OUTPUT_ENABLED
    - **value**: VI_TRUE
28. Call niFgen_Commit (niFgen Commit VI) to commit the attribute values to the device using the following parameter:
    - **vi**: The session handle returned from niFgen_InitExtCal
29. Wait 500 ms for the output to settle.
30. Use the DMM to measure the NI 5412 voltage output directly into the DMM (into a high-impedance load). This measurement is external measurement 1, which is used in step 31.
31. Call niFgen_CalAdjustCalADC (niFgen Cal Adjust Cal ADC VI) using the following parameters:
    - **vi**: The session handle returned from niFgen_InitExtCal
    - **voltagesMeasuredExternally**: An array containing two elements—the two voltages (external measurement 0, external measurement 1) that you measured with the DMM in order
    - **voltagesMeasuredWithCalADC**: An array containing two elements—the two voltages (cal ADC measurement 0,

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cal ADC measurement 1) that you measured with the onboard calibration ADC in the order that you measured them

32. Call niFgen_SetAttributeViBoolean to disable the analog output (niFgen property node: **Basic Operation»Output Enabled**) using the following parameters:
    - **vi**: The session handle returned from niFgen_InitExtCal
    - **channelName**: "0"
    - **attributeID**: NIFGEN_ATTR_OUTPUT_ENABLED
    - **value**: VI_FALSE
33. Call niFgen_SetAttributeViInt32 to set the calibration ADC input (niFgen property node: **Calibration»Cal ADC Input**) using the following parameters:
    - **vi**: The session handle returned from niFgen_InitExtCal
    - **channelName**: "" (empty string)
    - **attributeID**: NIFGEN_ATTR_CAL_ADC_INPUT
    - **value**: NIFGEN_VAL_GROUND
34. Call niFgen_Commit (niFgen Commit VI) to commit the attribute values to the device using the following parameter:
    - **vi**: The session handle returned from niFgen_InitExtCal

Closing the External Adjustment Session

When you have completed all the adjustment stages, you must close the external adjustment session to store the new calibration constants in the onboard EEPROM.

Call niFgen_CloseExtCal (niFgen Close Ext Cal VI) using the following parameters:

- **vi**: The session handle returned from niFgen_InitExtCal
- **action**:
  - If the external adjustment procedure completed without any errors, use NIFGEN_VAL_EXT_CAL_COMMIT. This function stores the new calibration constants, updated calibration dates, updated calibration temperatures in the onboard EEPROM.
  - If any errors occurred during the external adjustment procedure, or if you want to abort the operation, use NIFGEN_VAL_EXT_CAL_ABORT. This function discards the new calibration constants and does not change any of the calibration data stored in the onboard EEPROM.

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Calibration Utilities

NI-FGEN supports several calibration utilities that allow you to retrieve information about adjustments performed on the NI 5412, restore an external calibration, change the external calibration password, and store small amounts of information in the onboard EEPROM. You can retrieve some data using MAX or the FGEN SFP; however, you can retrieve all the data using NI-FGEN.

MAX

To retrieve data using MAX, complete the following steps:

1. Launch MAX.
2. Select the device from which you want to retrieve information from **My System»Devices and Interfaces»NI-DAQmx Devices**.
3. Select the **Calibration Tab** on the lower right corner.

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

FGEN SFP

To retrieve data using the FGEN SFP, complete the following steps:

1. Launch the FGEN SFP.
2. Select the device from which you want to retrieve information using the Device Configuration dialog box (**Edit»Device Configuration**).
3. Open the Calibration dialog box (**Utility»Calibration**).

   You should see information about the last dates of both external and self-calibration.

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NI-FGEN

NI-FGEN provides a full complement of calibration utility functions and VIs. Refer to the *NI Signal Generators Help* for the complete function reference. The utility functions include:

- `niFgen_RestoreLastExtCalConstants`
- `niFgen_GetSelfCalSupported`
- `niFgen_GetSelfCalLastDateAndTime`
- `niFgen_GetExtCalLastDateAndTime`
- `niFgen_GetSelfCalLastTemp`
- `niFgen_GetExtCalLastTemp`
- `niFgen_GetExtCalRecommendedInterval`
- `niFgen_ChangeExtCalPassword`
- `niFgen_SetCalUserDefinedInfo`
- `niFgen_GetCalUserDefinedInfo`
- `niFgen_GetCalUserDefinedInfoMaxSize`

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Where to Go for Support

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