

## CALIBRATION PROCEDURE

# PXIe-5413

## PXIe, 20 MHz Bandwidth, 16-Bit PXI Waveform Generator

This document contains the verification and adjustment procedures for the PXIe-5413. Refer to [ni.com/calibration](http://ni.com/calibration) for more information about calibration solutions.

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## Required Software

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Calibrating the PXIe-5413 requires you to install the following software on the calibration system:

- NI-FGEN 17.1 or later  
The PXIe-5413 was first supported in NI-FGEN 17.1.
- LabVIEW 2016 or later, Full Development System or Professional Development System

You can download all required software from [ni.com/downloads](http://ni.com/downloads).

# Related Documentation

For additional information, refer to the following documents as you perform the calibration procedure:

- *PXIe-5413 Getting Started Guide*
- *PXIe-5413 Specifications*
- *NI Signal Generators Help*
- *LabVIEW Help*

Visit [ni.com/manuals](http://ni.com/manuals) for the latest versions of these documents.

# Test Equipment

Refer to the following table for a list of necessary test equipment, minimum requirements for the test equipment, and model recommendations for calibration of the PXIe-5413.

If you do not have the recommended equipment, select a substitute calibration standard using the minimum requirements specifications listed in the table.

**Table 1.** PXIe-5413 Test Equipment

<b>Equipment</b>	<b>Recommended Model</b>	<b>Where Used</b>	<b>Minimum Requirements</b>
Oscilloscope	PXIe-5160 or PXIe-5171	Verifications: <ul style="list-style-type: none"><li>• Timebase accuracy</li></ul> Adjustments: <ul style="list-style-type: none"><li>• Timebase</li></ul>	Frequency resolution: 0.1 Hz  The ability to measure sine waves $\geq 10$ MHz with amplitudes of $2 V_{pk-pk}$ to $5 V_{pk-pk}$ with $50 \Omega$ input impedance.
SMA (m)-to-SMA (m) cable	—	Verifications: <ul style="list-style-type: none"><li>• Timebase accuracy</li></ul> Adjustments: <ul style="list-style-type: none"><li>• Timebase</li></ul>	Frequency range: DC to 100 MHz  Impedance: $50 \Omega$  Length: $< 1$ m

**Table 1. PXIe-5413 Test Equipment (Continued)**

<b>Equipment</b>	<b>Recommended Model</b>	<b>Where Used</b>	<b>Minimum Requirements</b>
Precision frequency reference	PXIe-6674T or Rubidium reference	Verifications: <ul style="list-style-type: none"><li>• Timebase accuracy</li></ul> Adjustments: <ul style="list-style-type: none"><li>• Timebase</li></ul>	Frequency accuracy: 100 ppb The ability to PLL lock to the oscilloscope.
DMM	PXI-4071	Verifications: <ul style="list-style-type: none"><li>• DC voltage accuracy</li><li>• AC amplitude accuracy</li></ul> Adjustments: <ul style="list-style-type: none"><li>• DC voltage</li></ul>	DC voltage range: $\pm 5$ V DC voltage accuracy: <40 ppm AC voltage accuracy: $\pm 0.1\%$ of reading at 50 kHz AC Input Range: 0.05 $V_{RMS}$ to 5 $V_{RMS}$ AC Input Impedance: $\geq 10$ M $\Omega$ Bandwidth: $\geq 100$ kHz
Double banana plug-to-BNC (f)	Pasternak PE9008	Verifications: <ul style="list-style-type: none"><li>• DC voltage accuracy</li><li>• AC amplitude accuracy</li></ul> Adjustments: <ul style="list-style-type: none"><li>• DC voltage</li></ul>	Impedance: 50 $\Omega$
SMA (m)-to-BNC (m) cable	—	Verifications: <ul style="list-style-type: none"><li>• DC voltage accuracy</li><li>• AC amplitude accuracy</li></ul> Adjustments: <ul style="list-style-type: none"><li>• DC voltage</li></ul>	Frequency range: DC to 1 MHz Impedance: 50 $\Omega$ Length: <1 m

**Table 1. PXIe-5413 Test Equipment (Continued)**

<b>Equipment</b>	<b>Recommended Model</b>	<b>Where Used</b>	<b>Minimum Requirements</b>
Power sensor	Rohde & Schwarz (R&S) NRP-Z91	Verifications: <ul style="list-style-type: none"> <li>• Passband flatness accuracy</li> </ul> Adjustments: <ul style="list-style-type: none"> <li>• Passband flatness</li> </ul>	Range: -30 dBm to 23 dBm Frequency range: 50 kHz to 100 MHz Absolute Power Accuracy: <0.048 dB for <100 MHz Relative Power Accuracy: <0.022 dB for <100 MHz VSWR: <1.11
SMA (m)-to-N (f) adapter	—	Verifications: <ul style="list-style-type: none"> <li>• Passband flatness accuracy</li> </ul> Adjustments: <ul style="list-style-type: none"> <li>• Passband flatness</li> </ul>	Frequency range: DC to 100 MHz Impedance: 50 Ω

## Test Conditions

The following setup and environmental conditions are required to ensure the PXIe-5413 meets published specifications:

- The PXIe-5413 is warmed up for 15 minutes at ambient temperature. Warm up begins after the chassis is powered and the PXIe-5413 is recognized by the host and configured using NI-FGEN.
- All test instruments are warmed up for at least the period of time stated in the documentation for each instrument and self-calibration is performed. The warm-up time ensures that the test instruments are at a stable operating temperature.
- Keep cabling as short as possible. Long cables act as antennas, picking up extra noise that can affect measurements.
- Verify that all connections to the PXIe-5413, including front panel connections and screws, are secure.
- Use shielded copper wire for all cable connections to the device. Use twisted-pair wire to eliminate noise and thermal offsets.
- Maintain an ambient temperature of 23 °C ± 3 °C.
- Keep relative humidity between 10% and 90%, noncondensing.

- Ensure that the PXI chassis fan speed is set to HIGH, that the fan filters (if present) are clean, and that the empty slots contain slot blockers and filler panels. For more information about cooling, refer to the *Maintain Forced-Air Cooling Note to Users* document available at [ni.com/manuals](http://ni.com/manuals).
- Plug the PXI chassis and any other instrument standards into the same power strip to avoid ground loops.

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## Password

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The default password for password-protected operations is NI.

### Related Information

[Adjusting the PXIe-5413](#) on page 14

[Setting the Calibration Date and Due Date](#) on page 18

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## Calibration Interval

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Recommended calibration interval	2 years
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## As-Found and As-Left Limits

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The as-found limits are the published specifications for the PXIe-5413. NI uses these limits to determine whether the PXIe-5413 meets the specifications when it is received for calibration. Use the as-found limits during initial verification.

The as-left calibration limits are equal to the published NI specifications for the PXIe-5413, less guard bands for measurement uncertainty, temperature drift, and drift over time. NI uses these limits to reduce the probability that the instrument will be outside the published specification limits at the end of the calibration cycle. Use the as-left limits when performing verification after adjustment.

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## Calibration Overview

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Install the PXIe-5413 and configure it in NI Measurement & Automation Explorer (MAX) before calibrating.

Calibration includes the following steps:

1. Self-calibration—Let the PXIe-5413 warm up for 15 minutes before self-calibrating the PXIe-5413 by clicking the **Self-Calibrate** button in MAX or calling niFgen Self Cal.
2. Verification—Verify the existing operation of the device. This step confirms whether the device is operating within the published specification prior to adjustment.
3. Adjustment—Perform an external adjustment of the calibration constants of the device. The adjustment procedure automatically stores the calibration date and temperature on the EEPROM to allow traceability.

4. Self-calibration—Let the PXIe-5413 warm up for 15 minutes before self-calibrating the PXIe-5413 by clicking the **Self-Calibrate** button in MAX or calling niFgen Self Cal.
5. Reverification—Repeat the Verification procedure to ensure that the device is operating within the published specifications after adjustment.

Refer to the following sections to complete each procedure.

### Related Information

[Verifying the PXIe-5413](#) on page 6

[Adjusting the PXIe-5413](#) on page 14

## Verifying the PXIe-5413

The performance verification procedures assume that adequate traceable uncertainties are available for the calibration references.

Self-calibrate the PXIe-5413 and all test instruments before beginning the verification procedures.



**Note** Verification of the PXIe-5413 is complete only after you have successfully completed all verification tests in this section using the as-found limits.

### Related Information

[Calibration Overview](#) on page 5

## Verifying Timebase Accuracy

Follow this procedure to verify the frequency accuracy of the PXIe-5413 onboard timebase (TCXO) using an oscilloscope.

Refer to the following table as you complete the following steps.

**Table 3.** Timebase Accuracy Verification

As-Found Limit	As-Left Limit
$\pm(1.5 \text{ ppm} + 1 \text{ ppm per year}^1)$	$\pm 0.28 \text{ ppm}$

1. Connect one end of the SMA (m)-to-SMA (m) cable to a channel of the PXIe-5413 and the other end to a channel of the oscilloscope.



**Note** Timebase accuracy verification can be performed on either channel of the two-channel PXIe-5413.

2. Lock the oscilloscope to the precision frequency reference using the PXI Clock.

<sup>1</sup> Where time drift starts at the latest external calibration date.

3. Configure the oscilloscope to acquire a 10 MHz sine wave with the following settings:
  - **Vertical range:** 5 V<sub>pk-pk</sub>
  - **Sample rate:** 250 MS/s
  - **Input impedance:** 50 Ω
  - **Minimum number of points:** 1,048,576 samples
4. Configure the PXIe-5413 with the following settings:
  - **Channel:** Channel of the PXIe-5413 connected to the oscilloscope
  - **Output impedance:** 50 Ω
  - **Output mode:** Standard Function
  - **Waveform type:** Sine
  - **Frequency:** 10 MHz
  - **Amplitude:** 2.5 V<sub>pk-pk</sub>
  - **Offset:** 0 V
  - **Reference Clock source:** Onboard Reference Clock
5. Wait 1 second for settling.
6. Measure the peak frequency (Hz) using the oscilloscope and the Extract Single Tone Information VI and record this as  $F_{\text{Measured}}$ .
7. Calculate the timebase error using the following formula:

$$\text{Timebase Error (ppm)} = \left( \frac{F_{\text{Measured}} - 10^7}{10} \right)$$

8. Compare the frequency error to the appropriate limit from the [Timebase Accuracy Verification](#) table.



**Note** Timebase accuracy verification is only required on one channel of the two-channel PXIe-5413.

## Verifying DC Voltage Accuracy

Follow this procedure to verify the DC voltage accuracy of the PXIe-5413 by comparing the voltage sourced by the PXIe-5413 to the value measured by the DMM.

Refer to the following table as you complete the following steps.

**Table 4. DC Voltage Accuracy Verification**

	<b>DMM Range (V)</b>	<b>Amplitude Range (V<sub>pk-pk</sub>)</b>	<b>Offset (V)</b>	<b>Expected Amplitude (V)</b>	<b>As-Found Test Limit (mV)</b>	<b>As-Left Test Limit (mV)</b>
1	10	7.340	3.670	3.670	±39.04	±11.17
2		2.268	1.134	1.134	±12.41	±3.45
3		2.185	1.092	1.092	±11.97	±3.33
4		2.102	1.051	1.051	±11.54	±3.20
5		2.019	1.009	1.009	±11.10	±3.07
6	1	1.936	0.968	0.968	±10.66	±2.95
7		1.854	0.927	0.927	±10.23	±2.82
8		1.770	0.885	0.885	±9.79	±2.69
9		1.686	0.843	0.843	±9.35	±2.57
10		0.696	0.348	0.348	±4.15	±1.06
11		0.214	0.107	0.107	±1.62	±0.68
12	0.1	0.066	0.033	0.033	±0.85	±0.53
13	10	7.340	-3.670	-3.670	±39.04	±11.17
14		2.268	-1.134	-1.134	±12.41	±3.45
15		2.185	-1.092	-1.092	±11.97	±3.33
16		2.102	-1.051	-1.051	±11.54	±3.20
17		2.019	-1.009	-1.009	±11.10	±3.07
18	1	1.936	-0.968	-0.968	±10.66	±2.95
19		1.854	-0.927	-0.927	±10.23	±2.82
20		1.770	-0.885	-0.885	±9.79	±2.69
21		1.686	-0.843	-0.843	±9.35	±2.57
22		0.696	-0.348	-0.348	±4.15	±1.06
23		0.214	-0.107	-0.107	±1.62	±0.68
24	0.1	0.066	-0.033	-0.033	±0.85	±0.53



1. Connect one end of the SMA (m)-to-BNC (m) cable to CH 0 of the PXIe-5413. Connect the other end to the double banana plug-to-BNC (f) adapter, and connect the double banana plug-to-BNC (f) adapter to the HI and LO connectors of the DMM.
2. Configure the DMM with the following settings:
  - **Function:** DC Voltage
  - **Resolution:** 7.5 digits
  - **Aperture time:** 100 ms
  - **Number of averages:** 4
  - **Auto zero:** Enabled
  - **ADC calibration:** Enabled
  - **Vertical range:** *DMM range* listed in the *DC Voltage Accuracy Verification* table
3. Configure the PXIe-5413 with the following settings:
  - **Channel:** Channel of the PXIe-5413 connected to the DMM
  - **Load impedance:** 1 M $\Omega$
  - **Output mode:** Standard Function
  - **Waveform type:** User
  - **Amplitude:** *Amplitude range* listed in the *DC Voltage Accuracy Verification* table
  - **Offset:** *Offset* listed in the *DC Voltage Accuracy Verification* table
  - **Waveform data:** Array of zeros
  - **Waveform size:** 8,192 samples
4. Wait 1 second for settling.
5. Measure the DC voltage (V) using the DMM and record this as *DC Voltage*<sub>Measured</sub>.
6. Calculate the DC voltage error using the following formula:
 
$$DC\ Voltage\ Error\ (mV) = (DC\ Voltage_{Measured} - Expected\ Amplitude) * 10^3$$
 where *Expected Amplitude* is the expected amplitude (V) listed in the *DC Voltage Accuracy Verification* table.
7. Compare the DC voltage error to the appropriate limit from the *DC Voltage Accuracy Verification* table.
8. Repeat steps 2 through 7 for each configuration listed in the *DC Voltage Accuracy Verification* table.
9. If you are verifying a two-channel PXIe-5413, complete the following steps to verify CH 1:
  - a) Abort waveform generation on the PXIe-5413.
  - b) Disconnect the SMA (m)-to-BNC (m) cable from CH 0 and connect it to CH 1 of the PXIe-5413.
  - c) Repeat steps 2 through 8.

## Verifying AC Amplitude Accuracy

Follow this procedure to verify the AC amplitude accuracy of the PXIe-5413 by comparing the amplitude sourced by the PXIe-5413 to the amplitude measured by the DMM.

Refer to the following table as you complete the following steps.

**Table 5. AC Amplitude Accuracy Verification**

	<b>DMM Range (V<sub>RMS</sub>)</b>	<b>Amplitude Range (V<sub>pk-pk</sub>)</b>	<b>Expected Amplitude (V<sub>pk-pk</sub>)</b>	<b>As-Found Test Limit (mV)</b>	<b>As-Left Test Limit (mV)</b>
1	5	7.34	7.34	±74.40	±32.66
2		2.27	2.27	±23.70	±10.10
3		2.18	2.18	±22.80	±9.70
4		2.1	2.1	±22.00	±9.35
5		2.02	2.02	±21.20	±8.99
6		1.94	1.94	±20.40	±8.63
7		1.85	1.85	±19.50	±8.23
8		1.77	1.77	±18.70	±7.88
9		1.68	1.68	±17.80	±7.48
10	0.5	0.69	0.69	±7.90	±3.07
11		0.21	0.21	±3.10	±1.50
12	0.05	0.065	0.065	±1.65	±0.81

- Connect one end of the SMA (m)-to-BNC (m) cable to CH 0 of the PXIe-5413. Connect the other end to the double banana plug-to-BNC (f) adapter, and connect the double banana plug-to-BNC (f) adapter to the HI and LO connectors of the DMM.
- Configure the DMM with the following settings:
  - **Function:** AC Voltage
  - **Resolution:** 6.5 digits
  - **Aperture time:** 100 ms
  - **Number of averages:** 4
  - **Minimum frequency:** 49 kHz
  - **Auto zero:** Enabled
  - **ADC calibration:** Enabled
  - **Vertical range:** *DMM range* listed in the *AC Amplitude Accuracy Verification* table
- Configure the PXIe-5413 with the following settings:
  - **Channel:** Channel of the PXIe-5413 connected to the DMM
  - **Load impedance:** 1 MΩ
  - **Output mode:** Standard Function
  - **Waveform type:** Sine
  - **Frequency:** 50 kHz

- **Amplitude:** *Amplitude range* listed in the [AC Amplitude Accuracy Verification](#) table
  - **Offset:** 0 V
4. Wait 1 second for settling.
  5. Measure the AC amplitude ( $V_{RMS}$ ) using the DMM and record this as  $AC\ Amplitude_{Measured}$ .
  6. Convert the recorded  $AC\ Amplitude_{Measured}$  voltage from  $V_{RMS}$  to  $V_{pk-pk}$  using the following formula:
 
$$V_{pk-pk} = V_{RMS} * 2\sqrt{2}$$
  7. Calculate the AC amplitude error using the following formula:
 
$$AC\ Amplitude\ Error\ (mV) = (AC\ Amplitude_{Measured} - Expected\ Amplitude) * 10^3$$
 where *Expected Amplitude* is the expected amplitude ( $V_{pk-pk}$ ) listed in the [AC Amplitude Accuracy Verification](#) table.
  8. Compare the AC amplitude error to the appropriate limit from the [AC Amplitude Accuracy Verification](#) table.
  9. Repeat steps 2 through 8 for each configuration listed in the [AC Amplitude Accuracy Verification](#) table.
  10. If you are verifying a two-channel PXIe-5413, complete the following steps to verify CH 1:
    - a) Abort waveform generation on the PXIe-5413.
    - b) Disconnect the SMA (m)-to-BNC (m) cable from CH 0 and connect it to CH 1 of the PXIe-5413.
    - c) Repeat steps 2 through 9.

## Verifying Passband Flatness Accuracy

Follow this procedure to verify the passband flatness accuracy of the PXIe-5413 by comparing the flatness sourced by the PXIe-5413 to the value measured by the power sensor.

Refer to the following table as you complete the following steps.

**Table 6.** Passband Flatness Accuracy Verification

	<b>Amplitude Range (<math>V_{pk-pk}</math>)</b>	<b>Frequency (MHz)</b>	<b>As-Found Test Limit (dB)</b>	<b>As-Left Test Limit (dB)</b>
1	3.500	0.05	—	—
2		1	±0.40	±0.25
3		20	±0.60	±0.14

**Table 6. Passband Flatness Accuracy Verification (Continued)**

	<b>Amplitude Range (V<sub>pk-pk</sub>)</b>	<b>Frequency (MHz)</b>	<b>As-Found Test Limit (dB)</b>	<b>As-Left Test Limit (dB)</b>
5	1.040	0.05	—	—
6		1	±0.40	±0.25
7		20	±0.40	±0.11
11	0.956	0.05	—	—
12		1	±0.40	±0.25
13		20	±0.40	±0.11
17	0.867	0.05	—	—
18		1	±0.40	±0.25
19		20	±0.40	±0.11
23	0.780	0.05	—	—
24		1	±0.40	±0.25
25		20	±0.40	±0.11
29	0.321	0.05	—	—
30		1	±0.40	±0.25
31		20	±0.40	±0.11
35	0.099	0.05	—	—
36		1	±0.40	±0.25
37		20	±0.40	±0.11

1. Connect the SMA (m)-to-N (f) adapter to the power sensor.
2. Zero the power sensor.
  - a) Ensure that the power sensor is not connected to any signals.
  - b) Zero the power sensor using the built-in function, according to the power sensor documentation.
3. Connect the power sensor with the SMA (m)-to-N (f) adapter attached to CH 0 of the PXIe-5413.



**Note** Ensure the power sensor is supported to the extent that excessive strain is not applied to the connected channel of the PXIe-5413 or to the power sensor connector.

4. Configure the power sensor with the following settings:
  - **Maximum noise ratio:** 0.005 dB
  - **Auto range:** Enabled
  - **Power measurement:** Continuous average
  - **Path selection:** Automatic
  - **Averaging:** Automatic
  - **Aperture:** 20 ms
  - **Timeout:** 10 s
  - **Frequency:** *Frequency* listed in the [Passband Flatness Accuracy Verification](#) table
5. Configure the PXIe-5413 with the following settings:
  - **Load impedance:** 50  $\Omega$
  - **Output mode:** Standard Function
  - **Waveform type:** Sine
  - **Amplitude:** *Amplitude range* listed in the [Passband Flatness Accuracy Verification](#) table
  - **Frequency:** *Frequency* listed in the [Passband Flatness Accuracy Verification](#) table
  - **Offset:** 0 V
6. Wait 1 second for settling.
7. Measure and record the power (dBm) using the power sensor.
  - When the power is measured at 0.05 MHz, record this as  $P_{\text{Measured at 0.05 MHz}}$ .
  - When the power is measured at all frequencies other than 0.05 MHz, record this as  $P_{\text{Measured at Current Test Frequency}}$ .
8. Skip this step if the PXIe-5413 frequency is configured to 0.05 MHz. Calculate the passband flatness error using the following formula:
 
$$\text{Passband Flatness Error (dB)} = P_{\text{Measured at 0.05 MHz}} - P_{\text{Measured at Current Test Frequency}}$$
 where  $P_{\text{Measured at 0.05 MHz}}$  (dBm) and  $P_{\text{Measured at Current Test Frequency}}$  (dBm) are values for power measured at the same amplitude range listed in the [Passband Flatness Accuracy Verification](#) table.
9. Repeat steps 4 through 8 for each configuration listed in the [Passband Flatness Accuracy Verification](#) table.
10. For each configuration, compare the passband flatness error to the appropriate limit from the [Passband Flatness Accuracy Verification](#) table.
11. If you are verifying a two-channel PXIe-5413, complete the following steps to verify CH 1:
  - a) Abort waveform generation on the PXIe-5413.
  - b) Disconnect the SMA (m)-to-N (f) adapter and power sensor assembly from CH 0 and connect the assembly to CH 1 of the PXIe-5413.
  - c) Repeat steps 4 through 10.

# Adjusting the PXIe-5413

Follow this procedure to adjust the PXIe-5413 to meet published specifications.



**Note** All adjustments must be completed in the same external calibration session.

1. Call niFgen ni5433 Open Ext Cal Session to obtain an external calibration session.
2. Complete the [Adjusting Timebase](#) procedure.
3. Complete the [Adjusting DC Voltage](#) procedure.
4. Complete the [Adjusting Passband Flatness](#) procedure.
5. Call niFgen ni5433 Close Ext Cal Session with the following settings:
  - **Action:** If the external adjustment procedure completed without any errors, set this control to Commit to store the new calibration constants, adjustment time, adjustment date, and adjustment temperature to the onboard memory. If any errors occurred during the external adjustment procedure, or if you want to abort the operation, set the control to Abort to discard the new calibration constants without changing any of the calibration data stored in the onboard memory.

Self-calibrate the PXIe-5413 after completing adjustment and before reverification.

## Related Information

[Password](#) on page 5

[Calibration Overview](#) on page 5

## Adjusting Timebase

Follow this procedure to adjust the internal timebase reference (TCXO) of the PXIe-5413.

1. Connect one end of the SMA (m)-to-SMA (m) cable to a channel of the PXIe-5413 and the other end to a channel of the oscilloscope.



**Note** Timebase adjustment can be performed on either channel of the two-channel PXIe-5413.

2. Lock the oscilloscope to the precision frequency reference using the PXI Clock.
3. Configure the oscilloscope with the following settings:
  - **Vertical range:** 5 V<sub>pk-pk</sub>
  - **Sample rate:** 250 MS/s
  - **Input impedance:** 50 Ω
  - **Minimum number of points:** 1,048,576 samples
4. Call niFgen ni5433 Timebase Cal Initialize with the following settings:
  - **Channel:** Channel of the PXIe-5413 connected to the oscilloscope
5. Call niFgen ni5433 Timebase Cal Configure.
6. Wait 1 second for settling.
7. Measure the frequency of the signal using the oscilloscope and the Extract Single Tone Information VI.

8. Call niFgen ni5433 Timebase Cal Adjust with the following settings:
  - **Measured Frequency:** Frequency of the waveform present on the connected channel of the PXIe-5413 and measured by the oscilloscope in the previous step
9. If the **Timebase Cal Complete** output of niFgen ni5433 Timebase Cal Adjust returns **FALSE**, repeat steps 5 through 8 until **Timebase Cal Complete** returns **TRUE**.



**Note** Timebase adjustment is only required on one channel of the two-channel PXIe-5413.

## Adjusting DC Voltage

Follow this procedure to adjust the DC voltage of the PXIe-5413.

1. Connect one end of the SMA (m)-to-BNC (m) cable to a channel of the PXIe-5413. Connect the other end to the double banana plug-to-BNC (f) adapter, and connect the double banana plug-to-BNC (f) adapter to the HI and LO connectors of the DMM.
  - **Note** DC voltage adjustment can be performed on either channel of the two-channel PXIe-5413.
2. Call niFgen ni5433 ADC Cal Initialize with the following settings:
  - **Channel:** Channel of the PXIe-5413 connected to the DMM
3. Call niFgen ni5433 ADC Cal Configure to obtain the **Approximate Voltage Generated** ( $V_{pk-pk}$ ) output.
4. Wait 1 second for settling.
5. Configure the DMM with the following settings:
  - **Function:** DC Voltage
  - **Resolution:** 7.5 digits
  - **Aperture time:** 100 ms
  - **Number of averages:** 4
  - **Auto zero:** Enabled
  - **ADC calibration:** Enabled
  - **Range:** Range returned by the **Approximate Voltage Generated** ( $V_{pk-pk}$ ) output of niFgen ni5433 ADC Cal Configure in step 3
6. Measure the voltage of the signal using the DMM.
7. Call niFgen ni5433 ADC Cal Adjust with the following settings:
  - **Measured Voltage:** Voltage of the waveform present on the connected channel of the PXIe-5413 and measured by the DMM in the previous step
8. If the **ADC Cal Complete** output of niFgen ni5433 Timebase Cal Adjust returns **FALSE**, repeat steps 3 through 7 until **ADC Cal Complete** returns **TRUE**.



**Note** DC voltage adjustment is only required on one channel of the two-channel PXIe-5413.

# Adjusting Passband Flatness

Complete one of the following procedures depending on the channel count of the PXIe-5413 you are adjusting:

- [Adjusting Passband Flatness of a One-Channel PXIe-5413](#)
- [Adjusting Passband Flatness of a Two-Channel PXIe-5413](#)

## Adjusting Passband Flatness of a One-Channel PXIe-5413

Follow this procedure to adjust the passband flatness of a one-channel PXIe-5413.



**Note** Ensure the power sensor, with the SMA (m)-to-N (f) adapter attached, has been zeroed within the past hour.

1. Call niFgen ni5433 Flatness Cal Initialize.
2. Call niFgen ni5433 Flatness Cal Configure.
3. Call niFgen ni5433 Flatness Cal Adjust with the following settings:
  - **Measured Power (dBm):** 0 dBm
4. Connect the power sensor with the SMA (m)-to-N (f) adapter attached to CH 0 of the PXIe-5413.
5. Call niFgen ni5433 Flatness Cal Configure to obtain the **Current Configuration** output.
6. Configure the power sensor with the following settings:
  - **Auto range:** Enabled
  - **Maximum noise ratio:** 0.005 dB
  - **Power measurement:** Continuous average
  - **Path selection:** Automatic
  - **Averaging:** Automatic
  - **Aperture:** 20 ms
  - **Timeout:** 10 s
  - **Frequency:** Frequency returned by the **Current Configuration** output of niFgen ni5433 Flatness Cal Configure in the previous step
7. Wait 1 second for settling.
8. Measure the power of the signal using the power sensor.
9. Call niFgen ni5433 Flatness Cal Adjust with the following settings:
  - **Measured Power (dBm):** Power of the waveform present on CH 0 of the PXIe-5413 and measured by the power sensor in the previous step in dBm
10. If the **Flatness Cal Complete** output of niFgen ni5433 Timebase Cal Adjust returns **FALSE**, repeat steps 5 through 9 until **Flatness Cal Complete** returns **TRUE**.

## Adjusting Passband Flatness of a Two-Channel PXIe-5413

Follow this procedure to adjust the passband flatness of a two-channel PXIe-5413.



**Note** Ensure the power sensor, with the SMA (m)-to-N (f) adapter attached, has been zeroed within the past hour.

1. Call niFgen ni5433 Flatness Cal Initialize.



2. Call niFgen ni5433 Flatness Cal Configure.
3. Call niFgen ni5433 Flatness Cal Adjust with the following settings:
  - **Measured Power (dBm):** 0 dBm
4. Connect the power sensor with the SMA (m)-to-N (f) adapter attached to CH 0 of the PXIe-5413.
5. Call niFgen ni5433 Flatness Cal Configure to obtain the **Current Configuration** and **Next Configuration** outputs.
6. Configure the power sensor with the following settings:
  - **Auto range:** Enabled
  - **Maximum noise ratio:** 0.005 dB
  - **Power measurement:** Continuous average
  - **Path selection:** Automatic
  - **Averaging:** Automatic
  - **Aperture:** 20 ms
  - **Timeout:** 10 s
  - **Frequency:** Frequency returned by the **Current Configuration** output of niFgen ni5433 Flatness Cal Configure in the previous step
7. Wait 1 second for settling.
8. Measure the power of the signal using the power sensor.
9. Call niFgen ni5433 Flatness Cal Adjust with the following settings:
  - **Measured Power (dBm):** Power of the waveform present on CH 0 of the PXIe-5413 and measured by the power sensor in the previous step in dBm
10. If the **Next Configuration** output of niFgen ni5433 Flatness Cal Configure obtained in step 5 returns CH 0, repeat steps 5 through 9. If the **Next Configuration** output of niFgen ni5433 Flatness Cal Configure obtained in step 5 returns CH 1, continue to step 11.
11. Connect the SMA (m)-to-N (f) adapter and power sensor assembly to CH 1 of the PXIe-5413.
12. Call niFgen ni5433 Flatness Cal Configure to obtain the **Current Configuration** output.
13. Configure the power sensor with the following settings:
  - **Auto range:** Enabled
  - **Maximum noise ratio:** 0.005 dB
  - **Power measurement:** Continuous average
  - **Path selection:** Automatic
  - **Averaging:** Automatic
  - **Aperture:** 20 ms
  - **Timeout:** 10 s
  - **Frequency:** Frequency returned by the **Current Configuration** output of niFgen ni5433 Flatness Cal Configure in the previous step
14. Wait 1 second for settling.
15. Measure the power of the signal using the power sensor.

16. Call niFgen ni5433 Flatness Cal Adjust with the following settings:
  - **Measured Power (dBm)**: Power of the waveform present on CH 1 of the PXIe-5413 and measured by the power sensor in the previous step in dBm
17. If the **Flatness Cal Complete** output of niFgen ni5433 Timebase Cal Adjust returns **FALSE**, repeat steps 12 through 16 until **Flatness Cal Complete** returns **TRUE**.

## Reverification

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Repeat the [Verification](#) section to determine the as-left status of the PXIe-5413.



**Note** If any test fails reverification after performing an adjustment, verify that you have met the test conditions before returning your PXIe-5413 to NI. Refer to the [Worldwide Support and Services](#) section for information about support resources or service requests.

## Setting the Calibration Date and Due Date

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After completing all verifications or reverifications, set the calibration date and a calibration due date for the PXIe-5413 using either Measurement Automation Explorer (MAX) or the LabVIEW NI System Configuration API.

NI recommends a calibration due date of the date of external calibration plus the external calibration interval for the PXIe-5413.

- MAX—Navigate to the External Calibration section of the Settings tab and update the **Calibration Date** and **Calibration Due Date** entries. Click Save.
- LabVIEW NI System Configuration API—Use the Update Calibration VI to set the **calibration date** and **calibration due date**.

The calibration due date can be either a specific date or an interval in months.

### Related Information

[Password](#) on page 5

## Worldwide Support and Services

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The NI website is your complete resource for technical support. At [ni.com/support](https://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.

Visit [ni.com/services](https://ni.com/services) for NI Factory Installation Services, repairs, extended warranty, and other services.

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