CALIBRATION PROCEDURE

PXIe-5164

This document contains the verification and adjustment procedures for the PXIe-5164. Refer to *ni.com/calibration* for more information about calibration solutions.

Contents

NATIONAL INSTRUMENTS™

Required Software

Calibrating the PXIe-5164 requires you to install the following software on the calibration system:

- NI-SCOPE 16.1 or later. PXIe-5164 was first supported in NI-SCOPE 16.1.
- NI LabVIEW Instrument Design Libraries for Reconfigurable Oscilloscopes 16.1 or later. PXIe-5164 was first supported in NI LabVIEW Instrument Design Libraries for Reconfigurable Oscilloscopes 16.1.

  Note To perform adjustment procedures, you must use NI LabVIEW Instrument Design Libraries for Reconfigurable Oscilloscopes 16.2 or later.
- Supported application development environment (ADE)—LabVIEW

You can download all required software from *ni.com/downloads*.

Related Documentation

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

- *PXIe-5164 Getting Started Guide*
- *NI High-Speed Digitizers Help*
- *NI Reconfigurable Oscilloscopes Help*
- *PXIe-5164 Specifications*

Visit *ni.com/manuals* for the latest versions of these documents.

Test Equipment

Refer to the following table for a list of necessary equipment and model recommendations for calibration of the PXIe-5164.

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

Table 1. PXIe-5164 Test Equipment

Equipment	Recommended Model	Where Used	Minimum Requirements
Oscilloscope calibrator	Fluke 9500B/600 with Fluke 9530 Active Head	Verifications: • Timebase accuracy • DC accuracy • Input capacitance Adjustment	Sine wave generation: • Amplitude: 0.9 $V_{pk\text{-}pk}$ into 50 Ω • Frequency: 11 MHz and 99 MHz • Frequency accuracy: ±0.25 ppm
			Square wave generation: • Amplitude: 0.5 $V_{pk\text{-}pk}$ to 45 Vpk-pk into 1 MΩ symmetrical to ground (0 V) • Frequency: 500 Hz • Abberations: <2% of peak for the first 500 ns
			DC generation: • Amplitude: ±2.5 V into 50 Ω, ±200 V into 1 MΩ • Accuracy: ±(0.025% of output + 25 µV)
			Capacitance measurement: • Range: 15 pF to 25 pF • Accuracy: ±(2% of reading ± 0.25 pF)

Table 1. PXIe-5164 Test Equipment (Continued)

Equipment	Recommended Model	Where Used	Minimum Requirements
DMM	NI PXI-4071	Verifications: • AC amplitude accuracy	AC voltage measurement: • Range: 0.125 $V_{pk\text{-}pk}$ to 20 $V_{pk\text{-}pk}$ • Input impedance: ≥10 MΩ • Bandwidth: ≥50 kHz • Accuracy at 50 kHz – ±(0.07% of reading + 14 µV) for 0.125 $V_{pk\text{-}pk}$ test point – ±(0.06% of reading + 71 µV) for 0.25 $V_{pk\text{-}pk}$ to 1.25 $V_{pk\text{-}pk}$ test points – ±(0.06% of reading + 707 µV) for 2.5 $V_{pk\text{-}pk}$ to 12.5 $V_{pk\text{-}pk}$ test points – ±(0.12% of reading + 35 mV) for 20.0 $V_{pk\text{-}pk}$ test point
Function generator	NI PXI-5402/5406 or Agilent 33220A	Verifications: • AC amplitude accuracy	Sine wave generation: • Amplitude: – 0.125 $V_{pk\text{-}pk}$ to 2.5 $V_{pk\text{-}pk}$ into 50 Ω – 0.125 $V_{pk\text{-}pk}$ to 20 $V_{pk\text{-}pk}$ into 1 MΩ • Frequency: 50 kHz
BNC Tee (m-f-f)	Pasternack PE9174	Verifications: • AC amplitude accuracy	Impedance: 50 Ω
Double banana plug to BNC (f)	Pasternack PE9008	Verifications: • AC amplitude accuracy	Impedance: 50 Ω

Table 1. PXIe-5164 Test Equipment (Continued)

Equipment	Recommended Model	Where Used	Minimum Requirements
BNC (m)-to-BNC (m) cable (x2)	Pasternack PE308	Verifications: • AC amplitude accuracy	Length: ≤1 meter
Power sensor	Rohde & Schwarz NRP-Z91	Test system characterization Adjustment Verifications: • Passband amplitude flatness and bandwidth	Power measurement: • Frequency range: 50 kHz to 401 MHz • Power range: -16 dBm to 10 dBm • VSWR: <1.11 • Absolute accuracy – <0.048 dB for 50 kHz to <100 MHz – <0.063 dB for 100 MHz to 401 MHz • Relative accuracy at -4 dBm – <0.022 dB for 50 kHz to <100 MHz – <0.022 dB for 100 MHz to 401 MHz
Signal generator	Rohde & Schwarz SMA100A	Test system characterization Adjustment Verifications: • Passband amplitude flatness and bandwidth	Sine wave generation: • Amplitude: -10 dBm to 16 dBm • Frequency: 50 kHz to 401 MHz • Harmonics: <-30 dBc • Frequency accuracy: ±100.0 ppm

Table 1. PXIe-5164 Test Equipment (Continued)

Equipment	Recommended Model	Where Used	Minimum Requirements
Power splitter	Aeroflex/Weinschel 1593	Test system characterization Adjustment Verifications: • Passband amplitude flatness and bandwidth	• Amplitude: -16 dBm to 16 dBm • Frequency: 50 kHz to 401 MHz • VSWR: <1.09
50 Ω BNC terminator (f)	Fairview Microwave ST3B-F	Test system characterization	• Amplitude: 10 dBm • Frequency: DC to 401 MHz • VSWR: <1.1
50 Ω BNC terminator (m)	Fairview Microwave ST2B	Verifications: • RMS noise	• Frequency: DC to 500 MHz • VSWR: <1.15
SMA (m)-to-SMA (m) cable	—	Test system characterization Adjustment Verifications: • Passband amplitude flatness and bandwidth	• Frequency: DC to 401 MHz • VSWR: <1.1 • Length: ≤1 meter
SMA (f)-to-N (m) adapter	Fairview Microwave SM4226	Test system characterization Adjustment Verifications: • Passband amplitude flatness and bandwidth	• Frequency range: DC to 401 MHz • VSWR: <1.05

Table 1. PXIe-5164 Test Equipment (Continued)

Equipment	Recommended Model	Where Used	Minimum Requirements
BNC (f)-to-N (f) adapter	Fairview Microwave SM3526	Test system characterization Adjustment Verifications: • Passband amplitude flatness and bandwidth	• Frequency range: DC to 401 MHz • VSWR: <1.1 • Impedance: 50 Ω
SMA (m)-to-BNC (m) adapter (x2)	Fairview Microwave SM4716	Test system characterization Adjustment Verifications: • Passband amplitude flatness and bandwidth	• Frequency range: DC to 401 MHz • VSWR: <1.1 • Impedance: 50 Ω
SMA feed-thru terminator	Pasternack PE6026	Adjustment Verifications: • Passband amplitude flatness and bandwidth	• Amplitude: 10 dBm • Frequency: 50 kHz to 301 MHz • VSWR: – <1.1 at 100 MHz – <1.25 at 301 MHz • Impedance: 50 Ω

Test Conditions

The following setup and environmental conditions are required to ensure the PXIe-5164 meets published specifications:

- Allow a warm-up time of at least 15 minutes after the chassis is powered on. The warm-up time ensures that the PXIe-5164 is at a stable operating temperature.
- Allow all test instruments a warm-up time of at least the stated amount of time in their specification document. 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-5164, 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 filler panels. For more information about cooling, refer to the *Maintain Forced-Air Cooling Note to Users* document available at *ni.com/manuals*.
- Plug the chassis and the instrument standard into the same power strip to avoid ground loops.

Password

The default password for password-protected operations is `NI`.

Calibration Interval

Recommended calibration interval	2 years

As-Found and As-Left Limits

The as-found limits are the published specifications for the PXIe-5164. NI uses these limits to determine whether the PXIe-5164 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-5164, 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.

Measurement Uncertainty

Measurement uncertainty was calculated in accordance with the method described in ISO GUM (Guide to the Expression of Uncertainty in Measurement), for a confidence level of 95%. The expressed uncertainty is based on the recommended measurement methodology, standards, metrology best practices and environmental conditions of the National Instruments laboratory. It should be considered as a guideline for the level of measurement uncertainty that can be achieved using the recommended method. It is not a replacement for the user uncertainty analysis that takes into consideration the conditions and practices of the individual user.

Calibration Overview

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

Calibration includes the following steps:

1. Self-calibration—Adjust the self-calibration constants of the device.
2. Test system characterization—Characterize the amplitude balance of the output ports on your power splitter and amplitude loss through your power splitter.

   The results of this step are used as a correction in the following procedures:
   - *Verifying 50 Ω Passband Amplitude Flatness and Bandwidth*
   - *Verifying 1 MΩ Passband Amplitude Flatness and Bandwidth*
   - *Adjusting 50 Ω Passband Amplitude Flatness and Bandwidth*
   - *Adjusting 1 MΩ Passband Amplitude Flatness and Bandwidth*
3. Verification—Verify the existing operation of the device. This step confirms whether the device is operating within the published specification prior to adjustment.
4. Adjustment—Perform an external adjustment of the calibration constants of the device. The adjustment procedure automatically stores the calibration date and temperature in the nonvolatile memory to allow traceability.
5. Re-verification—Repeat the Verification procedure to ensure that the device is operating within the published specifications after adjustment.

Test System Characterization

The following procedures characterize the test equipment used during verification.

Caution The connectors on the device under test (DUT) and test equipment are fragile. Perform the steps in these procedures with great care to prevent damaging any DUTs or test equipment.

Zeroing the Power Sensor

1. Ensure that the power sensor is not connected to any signals.
2. Zero the power sensor using the built-in function, according to the power sensor documentation.

Characterizing Power Splitter Amplitude Balance and Loss

This procedure characterizes the amplitude balance of the two output ports of the power splitter and amplitude loss through the power splitter over a range of frequencies.

The results of the characterization are later used as a correction in the following procedures:

- *Verifying 50 Ω Passband Amplitude Flatness and Bandwidth*
- *Verifying 1 MΩ Passband Amplitude Flatness and Bandwidth*
- *Adjusting 50 Ω Passband Amplitude Flatness and Bandwidth*
- *Adjusting 1 MΩ Passband Amplitude Flatness and Bandwidth*

Table 2. Power Splitter Characterization

Config	Test Point: Frequency (MHz)
1	0.05
2	1.1
3	6.1
4	10.1
5	30.1
6	45.1
7	60.1
8	75.1
9	90.1
10	100.1
11	120.1
12	150.1
13	170.1
14	190.1
15	200.1
16	210.1
17	230.1
18	245.1

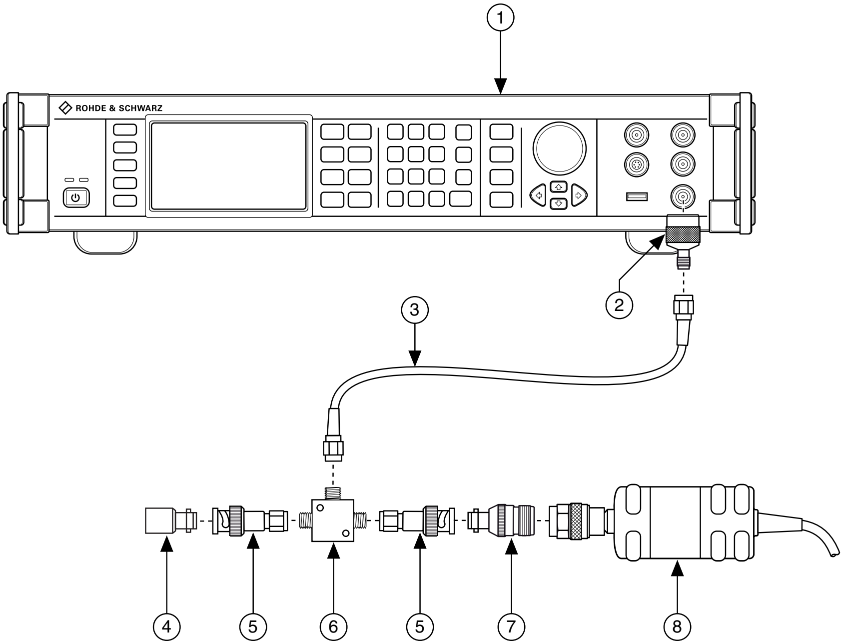
Table 2. Power Splitter Characterization (Continued)

Config	Test Point: Frequency (MHz)
19	250.1
20	270.1
21	285.1
22	290.1
23	330.1
24	350.1
25	370.1
26	390.1
27	400.1
28	420.1
29	450.1
30	460.1
31	470.1
32	480.1
33	485.1
34	490.1
35	495.1

1. Connect the BNC (f)-to-N (f) adapter to the power sensor. Refer to this assembly as the *power sensor*.
2. Zero the power sensor as described in the *Zeroing the Power Sensor* section.
3. Connect the RF OUT connector of the signal generator to the input port of the power splitter using an SMA (f)-to-N (m) adapter and an SMA (m)-to-SMA (m) cable.
4. Connect an SMA (m)-to-BNC (m) adapter to one of the power splitter output ports. Refer to this assembly as *splitter output 1*.
5. Connect the 50 Ω BNC terminator (f) to splitter output 1.
6. Connect the other SMA (m)-to-BNC (m) adapter to the other output port of the power splitter. Refer to this assembly as *splitter output 2*.
7. Connect the power sensor to splitter output 2.

   The following figure illustrates the hardware setup.

Figure 1. Connection Diagram for Measuring at Splitter Output 2



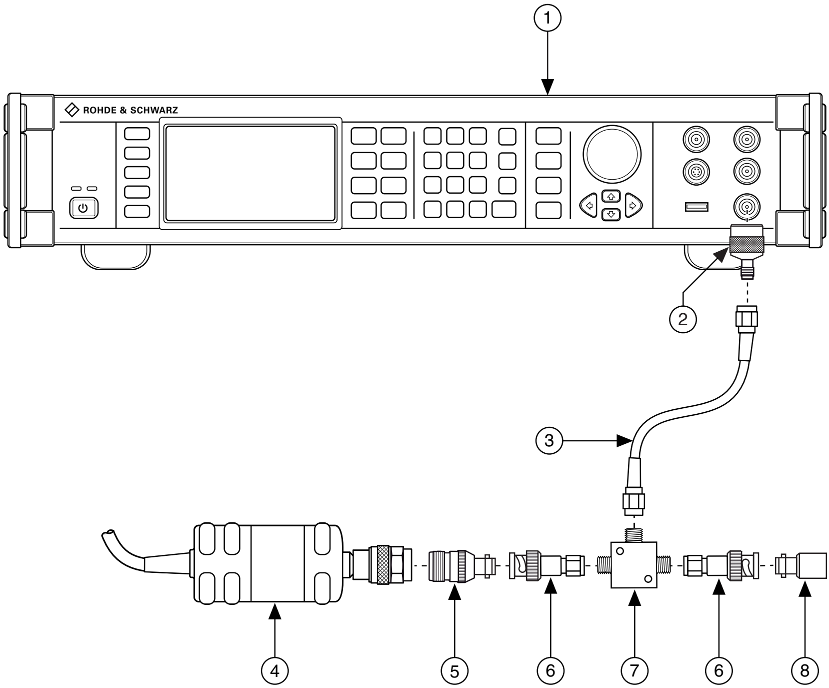
1. Signal generator
2. SMA (f)-to-N (m) adapter
3. SMA (m)-to-SMA (m) cable
4. 50 Ω BNC terminator (f)
5. SMA (m)-to-BNC (m) adapter
6. Power splitter
7. BNC (f)-to-N (f) adapter
8. Power sensor

8. Configure the power sensor with the following settings:
   - Power measurement: continuous average
   - Path selection: automatic
   - Averaging: automatic
   - Averaging resolution: 4 (0.001 dB)
   - Aperture: 20 ms
9. Configure the signal generator to generate a sine waveform with the following characteristics:
   - Frequency: the *Test Point Frequency* value from the *Power Splitter Characterization* table
   - Amplitude level: 2.0 dBm
10. Configure the power sensor to correct for the *Test Point Frequency* value using the power sensor frequency correction function.
11. Wait 0.1 second for settling.
12. Use the power sensor to measure the power in dBm.

13. Repeat steps 9 through 12 for each configuration in the *Power Splitter Characterization* table, recording each result as *splitter output 2 power*, where each configuration has a corresponding value.
14. Disconnect the power sensor and 50 Ω BNC terminator (f) from splitter output 2 and splitter output 1.
15. Connect the power sensor to splitter output 1.
16. Connect the 50 Ω BNC terminator (f) to splitter output 2.

    The following figure illustrates the hardware setup.

Figure 2. Connection Diagram for Measuring at Splitter Output 1



1. Signal generator
2. SMA (f)-to-N (m) adapter
3. SMA (m)-to-SMA (m) cable
4. Power sensor
5. BNC (f)-to-N (f) adapter
6. SMA (m)-to-BNC (m) adapter
7. Power splitter
8. 50 Ω BNC terminator (f)

17. Configure the signal generator to generate a sine waveform with the following characteristics:
    - Frequency: the *Test Point Frequency* value from the *Power Splitter Characterization* table
    - Amplitude level: 2.0 dBm
18. Configure the power sensor to correct for the *Test Point Frequency* value using the power sensor frequency correction function.

19. Wait 0.1 second for settling.
20. Use the power sensor to measure the power in dBm.
21. Repeat steps 17 through 20 for each configuration in the *Power Splitter Characterization* table, recording each result as *splitter output 1 power*, where each configuration has a corresponding value.
22. Calculate the splitter balance for each frequency point using the following equation:

    splitter balance = *splitter output 2 power* - *splitter output 1 power*
23. Calculate the splitter loss for each frequency point using the following equation:

    splitter loss = *signal generator amplitude level* - *splitter output 2 power*
24. Disconnect the 50 Ω BNC terminator (f) from splitter output 2. Refer to the remaining assembly as the *power sensor assembly*.

    The power sensor assembly will be used in the following procedures:
    - *Verifying 50 Ω Passband Amplitude Flatness and Bandwidth*
    - *Verifying 1 MΩ Passband Amplitude Flatness and Bandwidth*
    - *Adjusting 50 Ω Passband Amplitude Flatness and Bandwidth*
    - *Adjusting 1 MΩ Passband Amplitude Flatness and Bandwidth*

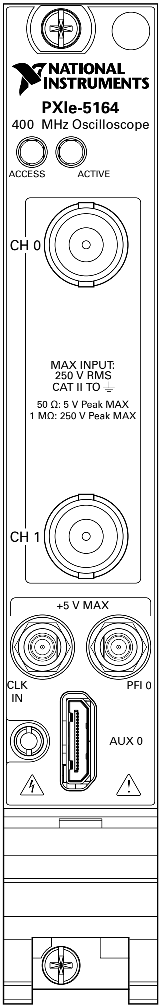
Verification

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

Verification of the PXIe-5164 is complete only after you have successfully completed all tests in this section using the *As-Found Limits*.

Refer to the following figure for the names and locations of the PXIe-5164 front panel connectors. You can find information about the functions of these connectors in the device getting started guide.

Figure 3. PXIe-5164 Front Panel



Verifying DC Accuracy

This procedure verifies the DC accuracy of the PXIe-5164 by comparing the voltage measured by the device to the value sourced by the voltage standard.

Caution Avoid touching the connections when generating a high voltage from the calibrator.

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

Table 3. DC Accuracy Verification

Config	Input Impedance (Ω)	Vertical Range ($V_{pk\text{-}pk}$)	Vertical Offset (V)	Test Points (V)	As-Found Limits (mV)	As-Left Limits (mV)	Measurement Uncertainty (mV)[1]
1	50	0.25 V	0	0.113	±1.06	±0.87	±0.079
2	50	0.25 V	0	-0.113	±1.06	±0.87	±0.079
3	50	0.5 V	0	0.225	±2.13	±1.72	±0.29
4	50	0.5 V	0	-0.225	±2.13	±1.72	±0.29
5	50	1 V	0	0.450	±4.25	±3.38	±0.23
6	50	1 V	0	-0.450	±4.25	±3.38	±0.23
7	50	2.5 V	0	1.125	±10.6	±8.34	±0.57
8	50	2.5 V	0	-1.125	±10.6	±8.34	±0.57
9	50	5 V	0	2.250	±21.3	±16.5	±0.90
10	50	5 V	0	-2.250	±21.3	±16.5	±0.90
11	1 M	0.25 V	0	0.113	±1.38	±0.83	±0.15
12	1 M	0.25 V	0	-0.113	±1.38	±0.83	±0.15
13	1 M	0.25 V	5	5.113	±21.4	±13.0	±1.5
14	1 M	0.25 V	-5	-5.113	±21.4	±13.0	±1.5
15	1 M	0.5 V	0	0.225	±2.61	±1.75	±0.23
16	1 M	0.5 V	0	-0.225	±2.61	±1.75	±0.23
17	1 M	0.5 V	5	5.225	±22.6	±13.9	±1.6
18	1 M	0.5 V	-5	-5.225	±22.6	±13.9	±1.6
19	1 M	1 V	0	0.450	±5.08	±3.65	±0.5
20	1 M	1 V	0	-0.450	±5.08	±3.65	±0.5
21	1 M	1 V	5	5.450	±25.1	±15.7	±2.0

[1] Measurement uncertainty based on Fluke 9500B with Fluke 9530 test head specifications that apply at T_{cal} ± 5 °C, where Factory T_{cal} = 23 °C. Uncertainty of the 9500B includes long-term stability of 1 year, temperature coefficient, linearity, load, and line regulation and traceability of factory and National Calibration Standard.

Table 3. DC Accuracy Verification (Continued)

Config	Input Impedance (Ω)	Vertical Range (V_{pk-pk})	Vertical Offset (V)	Test Points (V)	As-Found Limits (mV)	As-Left Limits (mV)	Measurement Uncertainty (mV)[1]
22	1 M	1 V	-5	-5.450	±25.1	±15.7	±2.0
23	1 M	2.5 V	0	1.125	±12.5	±8.99	±1.4
24	1 M	2.5 V	0	-1.125	±12.5	±8.99	±1.4
25	1 M	2.5 V	10	11.13	±52.5	±33.3	±4.6
26	1 M	2.5 V	-10	-11.13	±52.5	±33.3	±4.6
27	1 M	5 V	0	2.250	±24.8	±17.8	±1.9
28	1 M	5 V	0	-2.250	±24.8	±17.8	±1.9
29	1 M	5 V	10	12.25	±64.8	±42.1	±5.2
30	1 M	5 V	-10	-12.25	±64.8	±42.1	±5.2
31	1 M	10 V	0	4.500	±49.4	±36.2	±4.0
32	1 M	10 V	0	-4.500	±49.4	±36.2	±4.0
33	1 M	10 V	10	14.50	±89.4	±60.2	±8.0
34	1 M	10 V	-10	-14.50	±89.4	±60.2	±8.0
35	1 M	25 V	0	11.25	±123	±96.4	±4.70
36	1 M	25 V	0	-11.25	±123	±96.4	±4.70
37	1 M	25 V	50	61.25	±323	±225	±25.0
38	1 M	25 V	-50	-61.25	±323	±225	±25.0
39	1 M	50 V	0	22.50	±246	±188	±22.0
40	1 M	50 V	0	-22.50	±246	±188	±22.0
41	1 M	50 V	50	72.50	±446	±310	±45.0
42	1 M	50 V	-50	-72.50	±446	±310	±45.0

[1] Measurement uncertainty based on Fluke 9500B with Fluke 9530 test head specifications that apply at T_{cal} ± 5 °C, where Factory T_{cal} = 23 °C. Uncertainty of the 9500B includes long-term stability of 1 year, temperature coefficient, linearity, load, and line regulation and traceability of factory and National Calibration Standard.

Table 3. DC Accuracy Verification (Continued)

Config	Input Impedance (Ω)	Vertical Range (V_{pk-pk})	Vertical Offset (V)	Test Points (V)	As-Found Limits (mV)	As-Left Limits (mV)	Measurement Uncertainty (mV)[1]
43	1 M	100 V	0	45.00	±493	±392	±34.0
44	1 M	100 V	0	-45.00	±493	±392	±34.0
45	1 M	100 V	50	95.00	±693	±502	±66.0
46	1 M	100 V	-50	-95.00	±693	±502	±66.0
47	1 M	100 V	-155.0	-200.0	±1113	±802	±87.0
48	1 M	50 V	-177.5	-200.0	±956	±658	±72.0
49	1 M	25 V	-188.8	-200.0	±878	±597	±54.0
50	1 M	10 V	-195.5	-200.0	±831	±552	±55.0
51	1 M	5 V	-197.8	-200.0	±816	±540	±48.0
52	1 M	2.5 V	-198.9	-200.0	±808	±534	±48.0
53	1 M	100 V	155 .0	200.0	±1113	±802	±87.0
54	1 M	50 V	177.5	200.0	±956	±658	±72.0
55	1 M	25 V	188.8	200.0	±878	±597	±54.0
56	1 M	10 V	195.5	200.0	±831	±552	±55.0
57	1 M	5 V	197.8	200.0	±816	±540	±48.0
58	1 M	2.5 V	198.9	200.0	±808	±534	±48.0

1. Connect the calibrator test head to channel 0 of the PXIe-5164.
2. Configure the PXIe-5164 with the following settings:
   - Input impedance: the Input Impedance value from the *DC Accuracy Verification* table
   - Maximum input frequency: (1 MΩ) 300 MHz, (50 Ω) 400 MHz
   - Vertical offset: the Vertical Offset value from the *DC Accuracy Verification* table
   - Vertical range: the Vertical Range value from the *DC Accuracy Verification* table

[1] Measurement uncertainty based on Fluke 9500B with Fluke 9530 test head specifications that apply at T_{cal} ± 5 °C, where Factory T_{cal} = 23 °C. Uncertainty of the 9500B includes long-term stability of 1 year, temperature coefficient, linearity, load, and line regulation and traceability of factory and National Calibration Standard.

- Sample rate: 1 GS/s
- Minimum number of points: 8,500,000 samples
- NI-SCOPE scalar measurement: Voltage Average

3. Configure the calibrator output impedance to match the impedance of the PXIe-5164.
4. Configure the calibrator to output the Test Point value from the *DC Accuracy Verification* table.
5. Enable the calibrator output.
6. Wait one second for settling, then record the measured voltage.
7. Use the following formula to calculate the voltage error:

   $DC\ voltage\ error = V_{\text{measured}} - Test\ Point$
8. Compare the voltage error to the appropriate limit from the *DC Accuracy Verification* table.
9. Repeat steps 2 through 8 for each configuration listed in the *DC Accuracy Verification* table.
10. Disable the calibrator output.
11. Connect the calibrator test head to channel 1 of the PXIe-5164 and repeat steps 2 through 8 for each configuration listed in the *DC Accuracy Verification* table.
12. Disable the calibrator output.

Verifying AC Amplitude Accuracy

Follow this procedure to verify the AC amplitude accuracy of the PXIe-5164 by comparing the voltage measured by the PXIe-5164 to the voltage measured by the DMM.

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

Table 4. AC Amplitude Accuracy Verification

Config	Input Impedance (Ω)	Vertical Range ($V_{pk\text{-}pk}$)	Test Point ($V_{pk\text{-}pk}$)	DMM Range (Vrms)	As-Found Limits (dB)	As-Left Limits (dB)	Measurement Uncertainty (dB)[2]
1	50	0.25 V	0.125	0.05	0.2	0.16	±0.013
2	50	0.5 V	0.25	0.5	0.2	0.16	±0.012
3	50	1 V	0.5	0.5	0.2	0.16	±0.013

[2] *Measurement Uncertainty* is based on the following equipment and conditions:

- NI PXI-4071 specifications apply after self-calibration is performed and in an ambient temperature of 23 °C ± 5 °C.
- The cable from the BNC Tee to the DMM must be 1 meter or less.
- Pasternack BNC Tee PE9174.

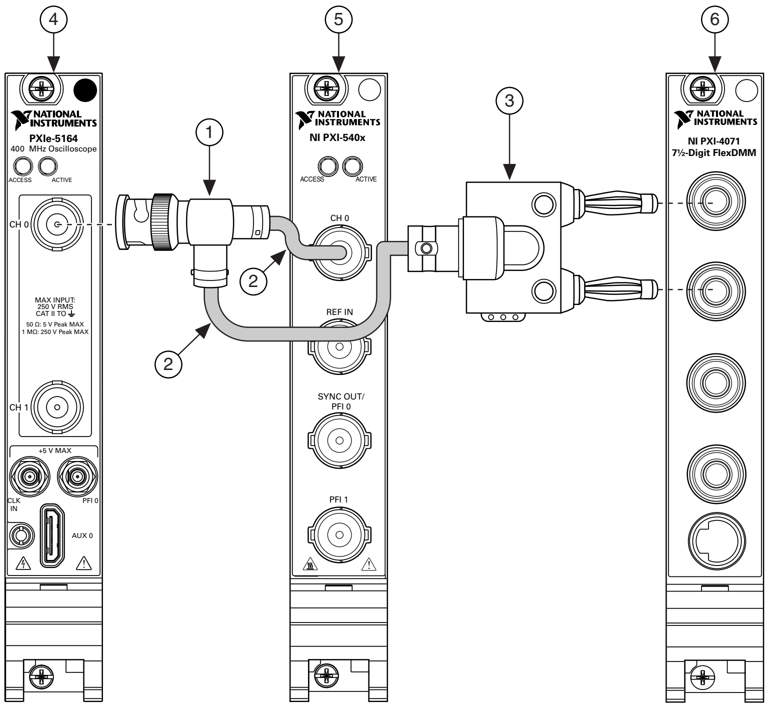
Table 4. AC Amplitude Accuracy Verification (Continued)

Config	Input Impedance (Ω)	Vertical Range (V_{pk-pk})	Test Point (V_{pk-pk})	DMM Range (Vrms)	As-Found Limits (dB)	As-Left Limits (dB)	Measurement Uncertainty (dB)[2]
4	50	2.5 V	1.25	0.5	0.2	0.16	±0.012
5	50	5 V	2.5	5.0	0.2	0.16	±0.012
6	1 M	0.25 V	0.125	0.05	0.2	0.126	±0.013
7	1 M	0.5 V	0.25	0.5	0.2	0.13	±0.012
8	1 M	1 V	0.5	0.5	0.2	0.13	±0.013
9	1 M	2.5 V	1.25	0.5	0.2	0.13	±0.012
10	1 M	5 V	2.5	5.0	0.2	0.13	±0.012
11	1 M	10 V	5	5.0	0.2	0.13	±0.013
12	1 M	25 V	12.5	5.0	0.2	0.1	±0.013
13	1 M	50 V	20	50.0	0.2	0.1	±0.048
14	1 M	100 V	20	50.0	0.2	0.1	±0.048

[2] *Measurement Uncertainty* is based on the following equipment and conditions:

- NI PXI-4071 specifications apply after self-calibration is performed and in an ambient temperature of 23 °C ± 5 °C.
- The cable from the BNC Tee to the DMM must be 1 meter or less.
- Pasternack BNC Tee PE9174.

Figure 4. AC Verification Test Connections



1. BNC tee (m-f-f)
2. BNC (m)-to-BNC (m) cable
3. BNC (f) to Double Banana Plug
4. PXIe-5164
5. Function Generator
6. DMM

1. Connect the DMM and function generator to channel 0 of the PXIe-5164 as shown in the *AC Verification Test Connections* figure.
2. Configure the DMM with the following settings:
   - Function: AC voltage
   - Resolution: 6.5 digits
   - Min frequency: 49 kHz
   - Auto Zero: Enabled
   - Aperture: 0.02 second
   - Range: the DMM Range value from the *AC Amplitude Accuracy Verification* table
3. Configure the PXIe-5164 with the following settings:
   - Input impedance: the Input Impedance value from the *AC Amplitude Accuracy Verification* table
   - Maximum input frequency: (1 MΩ) 300 MHz, (50 Ω) 400 MHz
   - Vertical offset: 0 V
   - Vertical range: the Vertical Range value from the *AC Amplitude Accuracy Verification* table

- Sample rate: 125 MS/s
- Minimum number of points: 1,048,576 samples

4. Configure the function generator and generate a waveform with the following characteristics:
   - Waveform: Sine wave
   - Amplitude: the Test Point value from the *AC Amplitude Accuracy Verification* table
   - Frequency: 50 kHz
   - Load impedance: the Input Impedance value from the *AC Amplitude Accuracy Verification* table

   Note These values assume you are using a NI 5402/5406 function generator. For other function generators, the output voltage varies with load output impedance, up to doubling the voltage for a high impedance load.
5. Wait 0.1 second for the output of the function generator to settle.
6. Acquire and measure the amplitude of the sine wave using the PXIe-5164 and the Extract Single Tone Information VI. Convert the result from V_{pk} to V_{rms}. Record the result as $V_{\text{PXIe-5164 Measured}}$.
7. Measure the amplitude of the sine wave in V_{rms} using the DMM. Record the result as $V_{\text{DMM Measured}}$.
8. Calculate the amplitude error using the following formula:

   $$\textit{AC Voltage Error} = 20 \times \log_{10}(V_{\text{PXIe-5164 Measured}}/V_{\text{DMM Measured}})$$
9. Compare the amplitude error to the appropriate Limit from the *AC Amplitude Accuracy Verification* table.
10. Repeat steps 2 through 9 for each configuration listed in the *AC Amplitude Accuracy Verification* table.
11. Disable the function generator output.
12. Connect the DMM and function generator to channel 1 of the PXIe-5164 as shown in the *AC Verification Test Connections* figure and repeat steps 2 through 9 for each configuration listed in the *AC Amplitude Accuracy Verification* table.
13. Disable the function generator output.

Verifying 50 Ω Passband Amplitude Flatness and Bandwidth

Follow this procedure to verify the 50 Ω analog passband amplitude flatness and bandwidth accuracy of the PXIe-5164 by generating a sine wave and comparing the amplitude measured by the PXIe-5164 to the amplitude measured by the power sensor.

Before performing this procedure, complete the *Test System Characterization* procedures and calculate the *splitter balance* and *splitter loss* of your power splitter.

Table 5. 50 Ω Passband Amplitude Flatness and Bandwidth Verification

Config	Sample Rate (S/s)	Vertical Range (V_{pk-pk})	Test Point Frequency (MHz)	Test Point Amplitude (dBm)	As-Found Limits (dB)	As-Left Limits (dB)	Measurement Uncertainty (dB)[3]
1	125 M	0.25 V	0.05	-11	—	—	—
2	1 G	0.25 V	1.1	-11	±0.5	±0.38	±0.103
3	1 G	0.25 V	10.1	-11	±0.5	±0.38	±0.103
4	1 G	0.25 V	30.1	-11	±0.5	±0.37	±0.104
5	1 G	0.25 V	60.1	-11	±0.5	±0.35	±0.105
6	1 G	0.25 V	90.1	-11	±0.5	±0.33	±0.110
7	1 G	0.25 V	120.1	-11	±0.5	±0.31	±0.118
8	1 G	0.25 V	170.1	-11	±0.5	±0.29	±0.117
9	1 G	0.25 V	190.1	-11	±0.5	±0.28	±0.120
10	1 G	0.25 V	210.1	-11	±0.5	±0.27	±0.124
11	1 G	0.25 V	230.1	-11	±0.5	±0.26	±0.126
12	1 G	0.25 V	245.1	-11	±0.5	±0.25	±0.127
13	1 G	0.25 V	270.1	-11	±0.5	±0.25	±0.124
14	1 G	0.25 V	290.1	-11	±0.5	±0.25	±0.120
15	1 G	0.25 V	330.1	-11	±0.5	±0.24	±0.122
16	1 G	0.25 V	400.1	-11	-3.0 to 1.0	-2.38 to -0.1	±0.126
17	125 M	0.5 V	0.05	-5	—	—	—
18	1 G	0.5 V	1.1	-5	±0.5	±0.38	±0.103
19	1 G	0.5 V	10.1	-5	±0.5	±0.38	±0.103
20	1 G	0.5 V	30.1	-5	±0.5	±0.37	±0.104

[3] Measurement uncertainty is based on the following equipment and conditions:

- Rohde & Schwarz NRP-Z91 at 20 °C to 25 °C.
- Harmonics from the signal generator are less than -30 dBc.

Table 5. 50 Ω Passband Amplitude Flatness and Bandwidth Verification (Continued)

Config	Sample Rate (S/s)	Vertical Range (V_{pk-pk})	Test Point		As-Found Limits (dB)	As-Left Limits (dB)	Measurement Uncertainty (dB)[3]
			Frequency (MHz)	Amplitude (dBm)			
21	1 G	0.5 V	60.1	-5	±0.5	±0.35	±0.105
22	1 G	0.5 V	90.1	-5	±0.5	±0.33	±0.110
23	1 G	0.5 V	120.1	-5	±0.5	±0.31	±0.118
24	1 G	0.5 V	170.1	-5	±0.5	±0.29	±0.117
25	1 G	0.5 V	190.1	-5	±0.5	±0.28	±0.120
26	1 G	0.5 V	210.1	-5	±0.5	±0.27	±0.124
27	1 G	0.5 V	230.1	-5	±0.5	±0.26	±0.126
28	1 G	0.5 V	245.1	-5	±0.5	±0.25	±0.127
29	1 G	0.5 V	270.1	-5	±0.5	±0.25	±0.124
30	1 G	0.5 V	290.1	-5	±0.5	±0.25	±0.120
31	1 G	0.5 V	330.1	-5	±0.5	±0.24	±0.122
32	1 G	0.5 V	400.1	-5	-3.0 to 1.0	-2.38 to -0.1	±0.126
33	125 M	1 V	0.05	1	—	—	—
34	1 G	1 V	1.1	1	±0.5	±0.38	±0.103
35	1 G	1 V	10.1	1	±0.5	±0.38	±0.103
36	1 G	1 V	30.1	1	±0.5	±0.37	±0.104
37	1 G	1 V	60.1	1	±0.5	±0.35	±0.105
38	1 G	1 V	90.1	1	±0.5	±0.33	±0.110
39	1 G	1 V	120.1	1	±0.5	±0.31	±0.118
40	1 G	1 V	170.1	1	±0.5	±0.29	±0.117

[3] Measurement uncertainty is based on the following equipment and conditions:
- Rohde & Schwarz NRP-Z91 at 20 °C to 25 °C.
- Harmonics from the signal generator are less than -30 dBc.

Table 5. 50 Ω Passband Amplitude Flatness and Bandwidth Verification (Continued)

Config	Sample Rate (S/s)	Vertical Range (V_{pk-pk})	Test Point		As-Found Limits (dB)	As-Left Limits (dB)	Measurement Uncertainty (dB)[3]
			Frequency (MHz)	Amplitude (dBm)			
41	1 G	1 V	190.1	1	±0.5	±0.28	±0.120
42	1 G	1 V	210.1	1	±0.5	±0.27	±0.124
43	1 G	1 V	230.1	1	±0.5	±0.26	±0.126
44	1 G	1 V	245.1	1	±0.5	±0.25	±0.127
45	1 G	1 V	270.1	1	±0.5	±0.25	±0.124
46	1 G	1 V	290.1	1	±0.5	±0.25	±0.120
47	1 G	1 V	330.1	1	±0.5	±0.24	±0.122
48	1 G	1 V	400.1	1	-3.0 to 1.0	-2.38 to -0.1	±0.126
49	125 M	2.5 V	0.05	9	—	—	—
50	1 G	2.5 V	1.1	9	±0.5	±0.38	±0.103
51	1 G	2.5 V	10.1	9	±0.5	±0.38	±0.103
52	1 G	2.5 V	30.1	9	±0.5	±0.37	±0.104
53	1 G	2.5 V	60.1	9	±0.5	±0.35	±0.105
54	1 G	2.5 V	90.1	9	±0.5	±0.33	±0.110
55	1 G	2.5 V	120.1	9	±0.5	±0.31	±0.118
56	1 G	2.5 V	170.1	9	±0.5	±0.29	±0.117
57	1 G	2.5 V	190.1	9	±0.5	±0.28	±0.120
58	1 G	2.5 V	210.1	9	±0.5	±0.27	±0.124
59	1 G	2.5 V	230.1	9	±0.5	±0.26	±0.126
60	1 G	2.5 V	245.1	9	±0.5	±0.25	±0.127

[3] Measurement uncertainty is based on the following equipment and conditions:
- Rohde & Schwarz NRP-Z91 at 20 °C to 25 °C.
- Harmonics from the signal generator are less than -30 dBc.

Table 5. 50 Ω Passband Amplitude Flatness and Bandwidth Verification (Continued)

Config	Sample Rate (S/s)	Vertical Range ($V_{pk\text{-}pk}$)	Test Point Frequency (MHz)	Test Point Amplitude (dBm)	As-Found Limits (dB)	As-Left Limits (dB)	Measurement Uncertainty (dB)[3]
61	1 G	2.5 V	270.1	9	±0.5	±0.25	±0.124
62	1 G	2.5 V	290.1	9	±0.5	±0.25	±0.120
63	1 G	2.5 V	330.1	9	±0.5	±0.24	±0.122
64	1 G	2.5 V	400.1	9	-3.0 to 1.0	-2.38 to -0.1	±0.126
65	125 M	5 V	0.05	9	—	—	—
66	1 G	5 V	1.1	9	±0.5	±0.38	±0.103
67	1 G	5 V	10.1	9	±0.5	±0.38	±0.103
68	1 G	5 V	30.1	9	±0.5	±0.37	±0.104
69	1 G	5 V	60.1	9	±0.5	±0.35	±0.105
70	1 G	5 V	90.1	9	±0.5	±0.33	±0.110
71	1 G	5 V	120.1	9	±0.5	±0.31	±0.118
72	1 G	5 V	170.1	9	±0.5	±0.29	±0.117
73	1 G	5 V	190.1	9	±0.5	±0.28	±0.120
74	1 G	5 V	210.1	9	±0.5	±0.27	±0.124
75	1 G	5 V	230.1	9	±0.5	±0.26	±0.126
76	1 G	5 V	245.1	9	±0.5	±0.25	±0.127
77	1 G	5 V	270.1	9	±0.5	±0.25	±0.124
78	1 G	5 V	290.1	9	±0.5	±0.25	±0.120
79	1 G	5 V	330.1	9	±0.5	±0.24	±0.122
80	1 G	5 V	400.1	9	-3.0 to 1.0	-2.38 to -0.1	±0.126

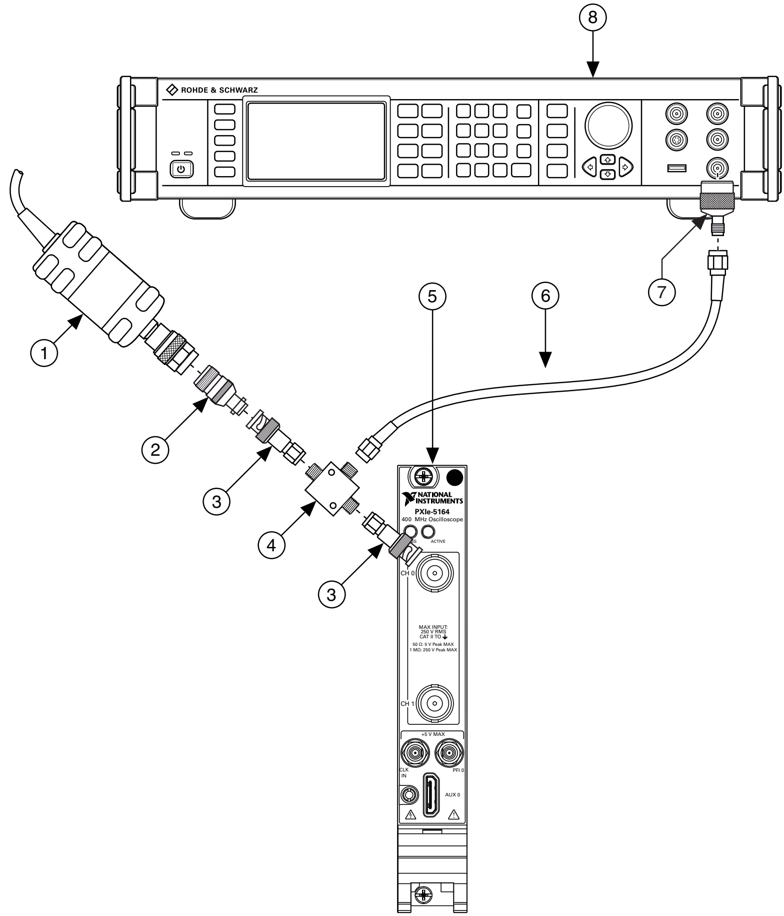
[3] Measurement uncertainty is based on the following equipment and conditions:
- Rohde & Schwarz NRP-Z91 at 20 °C to 25 °C.
- Harmonics from the signal generator are less than -30 dBc.

1. Connect splitter output 2 of the power sensor assembly from the *Test System Characterization* section to channel 0 of the PXIe-5164.

> **Note** The power sensor assembly must match the configuration used in the *Test System Characterization* section, in which the power sensor is connected to splitter output 1 and the signal generator is connected to the input port of the power splitter.

The following figure illustrates the hardware setup.

Figure 5. 50 Ω Passband Amplitude Flatness and Bandwidth Verification Cabling Diagram



1. Power Sensor
2. BNC (f)-to-N (f) Adapter
3. SMA (m)-to-BNC (m) Adapter
4. Power Splitter
5. PXIe-5164
6. SMA (m)-to-SMA (m) Cable
7. SMA (f)-to-N (m) Adapter
8. Signal Generator

2. Configure the power sensor with the following settings:
   - Power measurement: continuous average
   - Path selection: automatic
   - Averaging: automatic
   - Averaging resolution: 4 (0.001 dB)
   - Aperture: 20 ms

3. Configure the PXIe-5164 with the following settings:
   - Input impedance: 50 Ω
   - Maximum input frequency: 400 MHz
   - Vertical offset: 0 V
   - Vertical range: the Vertical Range value from the *50 Ω Passband Amplitude Flatness and Bandwidth Verification* table
   - Sample rate: the Sample Rate value from the *50 Ω Passband Amplitude Flatness and Bandwidth Verification* table
   - Minimum number of points: 1,048,576 samples
4. Configure the signal generator to generate a sine waveform with the following characteristics into a 50 Ω load:
   - Frequency: the Test Point Frequency value from the *50 Ω Passband Amplitude Flatness and Bandwidth Verification* table
   - Amplitude: the Test Point Amplitude value from the *50 Ω Passband Amplitude Flatness and Bandwidth Verification* table plus splitter loss

   Note Select the *splitter loss* value from the list of test points from the *Test System Characterization* section for the current Test Point Frequency.
5. Configure the power sensor to correct for the Test Point Frequency using the power sensor frequency correction function.
6. Wait 0.1 second for settling.
7. Use the power sensor to measure the power in dBm. Record the result as *measured input power*.
8. Calculate the corrected input power using the following equation:

   corrected input power = measured input power + splitter balance

   Note Select the *splitter balance* value from the list of test points from the *Test System Characterization* section for the current Test Point Frequency.
9. Use the PXIe-5164 to acquire and measure the power using the Extract Single Tone Information VI, converting the result from Vpk to dBm. Record the result as *device input power*.
10. If the Test Point Frequency value from the *50 Ω Passband Amplitude Flatness and Bandwidth Verification* table is 50 kHz, proceed to the following step. Otherwise, go to step 13.
11. Calculate the *power reference* using the following equation:

    power reference = device input power - corrected input power
12. Go to step 14. The power error is not calculated for this configuration.
13. Calculate the *power error* using the following equation:

    power error = device input power - corrected input power - power reference
14. Compare the power error to the appropriate Limit from the *50 Ω Passband Amplitude Flatness and Bandwidth Verification* table.
15. Repeat steps 2 through 14 for each configuration in the *50 Ω Passband Amplitude Flatness and Bandwidth Verification* table.

16. Connect splitter output 2 of the power sensor assembly to channel 1 of the PXIe-5164 and repeat steps 2 through 14 for each configuration listed in the *50 Ω Passband Amplitude Flatness and Bandwidth Verification* table.
17. Disable the signal generator output.

Verifying 1 MΩ Passband Amplitude Flatness and Bandwidth

Follow this procedure to verify the 1 MΩ analog passband amplitude flatness and bandwidth accuracy of the PXIe-5164 by generating a sine wave and comparing the amplitude measured by the PXIe-5164 to the amplitude measured by the power sensor.

Before performing this procedure, complete the *Test System Characterization* procedures and calculate the *splitter balance* and *splitter loss* of your power splitter.

Table 6. 1 MΩ Passband Amplitude Flatness and Bandwidth Verification

Config	Sample Rate (S/s)	Vertical Range (V_{pk-pk})	Test Point		As-Found Limits (dB)	As-Left Limits (dB)	Measurement Uncertainty (dB)[4]
			Frequency (MHz)	Amplitude (dBm)			
1	125 M	0.25 V	0.05	-11	—	—	—
2	1 G	0.25 V	1.1	-11	±0.7	±0.57	±0.109
3	1 G	0.25 V	6.1	-11	±0.7	±0.57	±0.109
4	1 G	0.25 V	10.1	-11	±0.7	±0.57	±0.109
5	1 G	0.25 V	30.1	-11	±0.7	±0.57	±0.109
6	1 G	0.25 V	45.1	-11	±0.7	±0.55	±0.110
7	1 G	0.25 V	60.1	-11	±0.7	±0.53	±0.110
8	1 G	0.25 V	75.1	-11	±0.7	±0.51	±0.113
9	1 G	0.25 V	90.1	-11	±0.7	±0.5	±0.111
10	1 G	0.25 V	100.1	-11	±0.7	±0.48	±0.118
11	1 G	0.25 V	120.1	-11	±0.7	±0.43	±0.148
12	1 G	0.25 V	150.1	-11	±0.7	±0.42	±0.130
13	1 G	0.25 V	170.1	-11	±0.7	±0.41	±0.129

[4] Measurement uncertainty is based on the following equipment and conditions:
- Rohde & Schwarz NRP-Z91 at 20 °C to 25 °C.
- Harmonics from the signal generator are less than -30 dBc.

Table 6. 1 MΩ Passband Amplitude Flatness and Bandwidth Verification (Continued)

Config	Sample Rate (S/s)	Vertical Range (V_{pk-pk})	Test Point		As-Found Limits (dB)	As-Left Limits (dB)	Measurement Uncertainty (dB)[4]
			Frequency (MHz)	Amplitude (dBm)			
14	1 G	0.25 V	190.1	-11	±0.7	±0.37	±0.130
15	1 G	0.25 V	200.1	-11	±0.7	±0.33	±0.136
16	1 G	0.25 V	285.1	-11	-3.0 to 1.0	-2.07 to 0	±0.152
17	125 M	0.5 V	0.05	-5	—	—	—
18	1 G	0.5 V	1.1	-5	±0.7	±0.57	±0.109
19	1 G	0.5 V	6.1	-5	±0.7	±0.57	±0.109
20	1 G	0.5 V	10.1	-5	±0.7	±0.57	±0.109
21	1 G	0.5 V	30.1	-5	±0.7	±0.57	±0.109
22	1 G	0.5 V	45.1	-5	±0.7	±0.55	±0.110
23	1 G	0.5 V	60.1	-5	±0.7	±0.53	±0.110
24	1 G	0.5 V	75.1	-5	±0.7	±0.51	±0.113
25	1 G	0.5 V	90.1	-5	±0.7	±0.5	±0.111
26	1 G	0.5 V	100.1	-5	±0.7	±0.48	±0.118
27	1 G	0.5 V	120.1	-5	±0.7	±0.43	±0.148
28	1 G	0.5 V	150.1	-5	±0.7	±0.42	±0.130
29	1 G	0.5 V	170.1	-5	±0.7	±0.41	±0.129
30	1 G	0.5 V	190.1	-5	±0.7	±0.37	±0.130
31	1 G	0.5 V	200.1	-5	±0.7	±0.33	±0.136
32	1 G	0.5 V	285.1	-5	-3.0 to 1.0	-2.07 to 0	±0.152
33	125 M	1 V	0.05	1	—	—	—

[4] Measurement uncertainty is based on the following equipment and conditions:

- Rohde & Schwarz NRP-Z91 at 20 °C to 25 °C.
- Harmonics from the signal generator are less than -30 dBc.

Table 6. 1 MΩ Passband Amplitude Flatness and Bandwidth Verification (Continued)

Config	Sample Rate (S/s)	Vertical Range (V_{pk-pk})	Test Point Frequency (MHz)	Test Point Amplitude (dBm)	As-Found Limits (dB)	As-Left Limits (dB)	Measurement Uncertainty (dB)[4]
34	1 G	1 V	1.1	1	±0.7	±0.57	±0.109
35	1 G	1 V	6.1	1	±0.7	±0.57	±0.109
36	1 G	1 V	10.1	1	±0.7	±0.57	±0.109
37	1 G	1 V	30.1	1	±0.7	±0.57	±0.109
38	1 G	1 V	45.1	1	±0.7	±0.55	±0.110
39	1 G	1 V	60.1	1	±0.7	±0.53	±0.110
40	1 G	1 V	75.1	1	±0.7	±0.51	±0.113
41	1 G	1 V	90.1	1	±0.7	±0.5	±0.111
42	1 G	1 V	100.1	1	±0.7	±0.48	±0.118
43	1 G	1 V	120.1	1	±0.7	±0.43	±0.148
44	1 G	1 V	150.1	1	±0.7	±0.42	±0.130
45	1 G	1 V	170.1	1	±0.7	±0.41	±0.129
46	1 G	1 V	190.1	1	±0.7	±0.37	±0.130
47	1 G	1 V	200.1	1	±0.7	±0.33	±0.136
48	1 G	1 V	285.1	1	-3.0 to 1.0	-2.07 to 0	±0.152
49	125 M	2.5 V	0.05	9	—	—	—
50	1 G	2.5 V	1.1	9	±0.7	±0.57	±0.109
51	1 G	2.5 V	6.1	9	±0.7	±0.57	±0.109
52	1 G	2.5 V	10.1	9	±0.7	±0.57	±0.109
53	1 G	2.5 V	30.1	9	±0.7	±0.57	±0.109

[4] Measurement uncertainty is based on the following equipment and conditions:

- Rohde & Schwarz NRP-Z91 at 20 °C to 25 °C.
- Harmonics from the signal generator are less than -30 dBc.

Table 6. 1 MΩ Passband Amplitude Flatness and Bandwidth Verification (Continued)

Config	Sample Rate (S/s)	Vertical Range (V_{pk-pk})	Test Point		As-Found Limits (dB)	As-Left Limits (dB)	Measurement Uncertainty (dB)[4]
			Frequency (MHz)	Amplitude (dBm)			
54	1 G	2.5 V	45.1	9	±0.7	±0.55	±0.110
55	1 G	2.5 V	60.1	9	±0.7	±0.53	±0.110
56	1 G	2.5 V	75.1	9	±0.7	±0.51	±0.113
57	1 G	2.5 V	90.1	9	±0.7	±0.5	±0.111
58	1 G	2.5 V	100.1	9	±0.7	±0.48	±0.118
59	1 G	2.5 V	120.1	9	±0.7	±0.43	±0.148
60	1 G	2.5 V	150.1	9	±0.7	±0.42	±0.130
61	1 G	2.5 V	170.1	9	±0.7	±0.41	±0.129
62	1 G	2.5 V	190.1	9	±0.7	±0.37	±0.130
63	1 G	2.5 V	200.1	9	±0.7	±0.33	±0.136
64	1 G	2.5 V	285.1	9	-3.0 to 1.0	-2.07 to 0	±0.152
65	125 M	5 V	0.05	9	—	—	—
66	1 G	5 V	1.1	9	±0.7	±0.57	±0.109
67	1 G	5 V	6.1	9	±0.7	±0.57	±0.109
68	1 G	5 V	10.1	9	±0.7	±0.57	±0.109
69	1 G	5 V	30.1	9	±0.7	±0.57	±0.109
70	1 G	5 V	45.1	9	±0.7	±0.55	±0.110
71	1 G	5 V	60.1	9	±0.7	±0.53	±0.110
72	1 G	5 V	75.1	9	±0.7	±0.51	±0.113
73	1 G	5 V	90.1	9	±0.7	±0.5	±0.111

[4] Measurement uncertainty is based on the following equipment and conditions:

- Rohde & Schwarz NRP-Z91 at 20 °C to 25 °C.
- Harmonics from the signal generator are less than -30 dBc.

Table 6. 1 MΩ Passband Amplitude Flatness and Bandwidth Verification (Continued)

Config	Sample Rate (S/s)	Vertical Range ($V_{pk\text{-}pk}$)	Test Point		As-Found Limits (dB)	As-Left Limits (dB)	Measurement Uncertainty (dB)[4]
			Frequency (MHz)	Amplitude (dBm)			
74	1 G	5 V	100.1	9	±0.7	±0.48	±0.118
75	1 G	5 V	120.1	9	±0.7	±0.43	±0.148
76	1 G	5 V	150.1	9	±0.7	±0.42	±0.130
77	1 G	5 V	170.1	9	±0.7	±0.41	±0.129
78	1 G	5 V	190.1	9	±0.7	±0.37	±0.130
79	1 G	5 V	200.1	9	±0.7	±0.33	±0.136
80	1 G	5 V	285.1	9	-3.0 to 1.0	-2.07 to 0	±0.152
81	125 M	10 V	0.05	9	—	—	—
82	1 G	10 V	1.1	9	±0.7	±0.57	±0.109
83	1 G	10 V	6.1	9	±0.7	±0.57	±0.109
84	1 G	10 V	10.1	9	±0.7	±0.57	±0.109
85	1 G	10 V	30.1	9	±0.7	±0.57	±0.109
86	1 G	10 V	45.1	9	±0.7	±0.55	±0.110
87	1 G	10 V	60.1	9	±0.7	±0.53	±0.110
88	1 G	10 V	75.1	9	±0.7	±0.51	±0.113
89	1 G	10 V	90.1	9	±0.7	±0.5	±0.111
90	1 G	10 V	100.1	9	±0.7	±0.48	±0.118
91	1 G	10 V	120.1	9	±0.7	±0.43	±0.148
92	1 G	10 V	150.1	9	±0.7	±0.42	±0.130
93	1 G	10 V	170.1	9	±0.7	±0.41	±0.129

[4] Measurement uncertainty is based on the following equipment and conditions:
- Rohde & Schwarz NRP-Z91 at 20 °C to 25 °C.
- Harmonics from the signal generator are less than -30 dBc.

Table 6. 1 MΩ Passband Amplitude Flatness and Bandwidth Verification (Continued)

Config	Sample Rate (S/s)	Vertical Range (V_{pk-pk})	Test Point		As-Found Limits (dB)	As-Left Limits (dB)	Measurement Uncertainty (dB)[4]
			Frequency (MHz)	Amplitude (dBm)			
94	1 G	10 V	190.1	9	±0.7	±0.37	±0.130
95	1 G	10 V	200.1	9	±0.7	±0.33	±0.136
96	1 G	10 V	285.1	9	-3.0 to 1.0	-2.07 to 0	±0.152
97	125 M	25 V	0.05	9	—	—	—
98	1 G	25 V	1.1	9	±0.7	±0.57	±0.109
99	1 G	25 V	6.1	9	±0.7	±0.57	±0.109
100	1 G	25 V	10.1	9	±0.7	±0.57	±0.109
101	1 G	25 V	30.1	9	±0.7	±0.57	±0.109
102	1 G	25 V	45.1	9	±0.7	±0.55	±0.110
103	1 G	25 V	60.1	9	±0.7	±0.53	±0.110
104	1 G	25 V	75.1	9	±0.7	±0.51	±0.113
105	1 G	25 V	90.1	9	±0.7	±0.5	±0.111
106	1 G	25 V	100.1	9	±0.7	±0.48	±0.118
107	1 G	25 V	120.1	9	±0.7	±0.49	±0.148
108	1 G	25 V	150.1	9	±0.7	±0.47	±0.130
109	1 G	25 V	170.1	9	±0.7	±0.45	±0.129
110	1 G	25 V	190.1	9	±0.7	±0.41	±0.130
111	1 G	25 V	200.1	9	±0.7	±0.41	±0.136
112	1 G	25 V	285.1	9	-3.0 to 1.0	-2.4 to 0	±0.152
113	125 M	50 V	0.05	9	—	—	—

[4] Measurement uncertainty is based on the following equipment and conditions:
- Rohde & Schwarz NRP-Z91 at 20 °C to 25 °C.
- Harmonics from the signal generator are less than -30 dBc.

Table 6. 1 MΩ Passband Amplitude Flatness and Bandwidth Verification (Continued)

Config	Sample Rate (S/s)	Vertical Range (V_{pk-pk})	Test Point Frequency (MHz)	Test Point Amplitude (dBm)	As-Found Limits (dB)	As-Left Limits (dB)	Measurement Uncertainty (dB)[4]
114	1 G	50 V	1.1	9	±0.7	±0.57	±0.109
115	1 G	50 V	6.1	9	±0.7	±0.57	±0.109
116	1 G	50 V	10.1	9	±0.7	±0.57	±0.109
117	1 G	50 V	30.1	9	±0.7	±0.57	±0.109
118	1 G	50 V	45.1	9	±0.7	±0.55	±0.110
119	1 G	50 V	60.1	9	±0.7	±0.53	±0.110
120	1 G	50 V	75.1	9	±0.7	±0.51	±0.113
121	1 G	50 V	90.1	9	±0.7	±0.5	±0.111
122	1 G	50 V	100.1	9	±0.7	±0.48	±0.118
123	1 G	50 V	120.1	9	±0.7	±0.49	±0.148
124	1 G	50 V	150.1	9	±0.7	±0.47	±0.130
125	1 G	50 V	170.1	9	±0.7	±0.45	±0.129
126	1 G	50 V	190.1	9	±0.7	±0.41	±0.130
127	1 G	50 V	200.1	9	±0.7	±0.41	±0.136
128	1 G	50 V	285.1	9	-3.0 to 1.0	-2.4 to 0	±0.152
129	125 M	100 V	0.05	9	—	—	—
130	1 G	100 V	1.1	9	±0.7	±0.57	±0.109
131	1 G	100 V	6.1	9	±0.7	±0.57	±0.109
132	1 G	100 V	10.1	9	±0.7	±0.57	±0.109
133	1 G	100 V	30.1	9	±0.7	±0.57	±0.109

[4] Measurement uncertainty is based on the following equipment and conditions:
- Rohde & Schwarz NRP-Z91 at 20 °C to 25 °C.
- Harmonics from the signal generator are less than -30 dBc.

Table 6. 1 MΩ Passband Amplitude Flatness and Bandwidth Verification (Continued)

Config	Sample Rate (S/s)	Vertical Range ($V_{pk\text{-}pk}$)	Test Point Frequency (MHz)	Test Point Amplitude (dBm)	As-Found Limits (dB)	As-Left Limits (dB)	Measurement Uncertainty (dB)[4]
134	1 G	100 V	45.1	9	±0.7	±0.55	±0.110
135	1 G	100 V	60.1	9	±0.7	±0.53	±0.110
136	1 G	100 V	75.1	9	±0.7	±0.51	±0.113
137	1 G	100 V	90.1	9	±0.7	±0.5	±0.111
138	1 G	100 V	100.1	9	±0.7	±0.48	±0.118
139	1 G	100 V	120.1	9	±0.7	±0.49	±0.148
140	1 G	100 V	150.1	9	±0.7	±0.47	±0.130
141	1 G	100 V	170.1	9	±0.7	±0.45	±0.129
142	1 G	100 V	190.1	9	±0.7	±0.41	±0.130
143	1 G	100 V	200.1	9	±0.7	±0.41	±0.136
144	1 G	100 V	285.1	9	-3.0 to 1.0	-2.4 to 0	±0.152

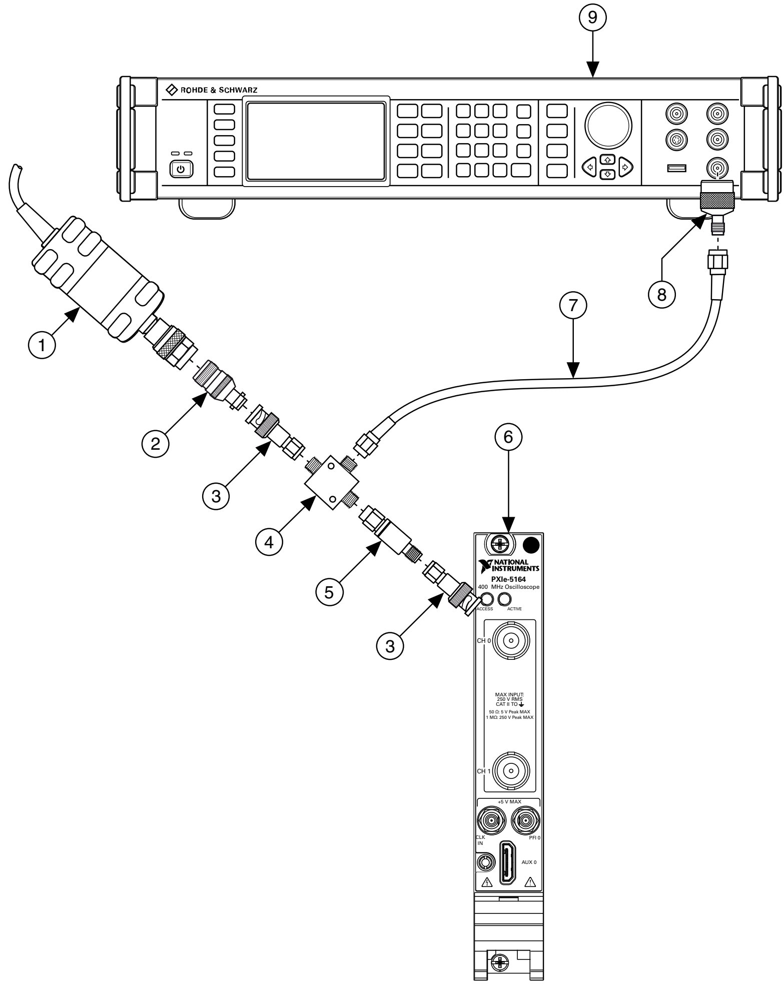
1. Place the 50 Ω SMA feed-thru terminator between the splitter output and the SMA (m)-to-BNC (m) adapter of splitter output 2. Connect splitter output 2 of the power sensor assembly from the *Test System Characterization* section to channel 0 of the PXIe-5164.

Note The power sensor assembly must match the configuration used in the *Test System Characterization* section, in which the power sensor is connected to splitter output 1 and the signal generator is connected to the input port of the power splitter.

The following figure illustrates the hardware setup.

[4] Measurement uncertainty is based on the following equipment and conditions:
- Rohde & Schwarz NRP-Z91 at 20 °C to 25 °C.
- Harmonics from the signal generator are less than -30 dBc.

Figure 6. 1 MΩ Bandwidth Verification Cabling Diagram



1. Power Sensor
2. BNC (f)-to-N (f) Adapter
3. SMA (m)-to-BNC (m) Adapter
4. Power Splitter
5. 50 Ω SMA Feed-Thru Terminator
6. PXIe-5164
7. SMA (m)-to-SMA (m) Cable
8. SMA (f)-to-N (m) Adapter
9. Signal Generator

2. Configure the power sensor with the following settings:
   - Power measurement: Continuous average
   - Path selection: automatic
   - Averaging: automatic

- Averaging resolution: 4 (0.001 dB)
- Aperture: 20 ms

3. Configure the PXIe-5164 with the following settings:
   - Input impedance: 1 MΩ
   - Maximum input frequency: 300 MHz
   - Vertical offset: 0 V
   - Vertical range: the Vertical Range value from the *1 MΩ Passband Amplitude Flatness and Bandwidth Verification* table
   - Minimum number of points: 1,048,576 samples
   - Sample rate: the Sample Rate value from the *1 MΩ Passband Amplitude Flatness and Bandwidth Verification* table
4. Configure the signal generator to generate a sine waveform with the following characteristics into a 50 Ω load:
   - Frequency: the Test Point Frequency value from the *1 MΩ Passband Amplitude Flatness and Bandwidth Verification* table
   - Amplitude: the Test Point Amplitude value from the *1 MΩ Passband Amplitude Flatness and Bandwidth Verification* table plus splitter loss

   Note Select the *splitter loss* value from the list of test points from the *Test System Characterization* section for the current Test Point Frequency.
5. Configure the power sensor to correct for the Test Point Frequency using the power sensor frequency correction function.
6. Wait 0.1 second for settling.
7. Use the power sensor to measure the power in dBm. Record the result as *measured input power*.
8. Calculate the corrected input power using the following equation:

   corrected input power = *measured input power* + *splitter balance*

   Note Select the *splitter balance* value from the list of test points from the *Test System Characterization* section for the current Test Point Frequency.
9. Use the PXIe-5164 to acquire and measure the power using the Extract Single Tone Information VI, converting the result from Vpk to dBm. Record the result as *device input power*.
10. If the Test Point Frequency value from the *1 MΩ Passband Amplitude Flatness and Bandwidth Verification* table is 50 kHz, proceed to the following step. Otherwise, go to step 13.
11. Calculate the *power reference* using the following equation:

    power reference = *device input power* - *corrected input power*
12. Go to step 14. The power error is not calculated for this configuration.
13. Calculate the *power error* using the following equation:

    power error = *device input power* - *corrected input power* - *power reference*
14. Compare the power error to the appropriate Limit from the *1 MΩ Passband Amplitude Flatness and Bandwidth Verification* table.

15. Repeat steps 2 through 14 for each configuration in the *1 MΩ Passband Amplitude Flatness and Bandwidth Verification* table.
16. Connect the splitter output 2 of the power sensor assembly from the *Test System Characterization* section to channel 1 of the PXIe-5164. Repeat steps 2 through 14 for each configuration in the *1 MΩ Passband Amplitude Flatness and Bandwidth Verification* table.
17. Disable the signal generator output.

Verifying Timebase Accuracy

Follow this procedure to verify the frequency accuracy of the PXIe-5164 onboard timebase using an oscilloscope calibrator.

Table 7. Timebase Accuracy Verification

As-Found Limits	As-Left Limits	Measurement Uncertainty
±5.0 PPM (±495 Hz)	±1.0 PPM (±99 Hz)	±0.2 PPM (±19.8 Hz)

1. Connect the calibrator test head to channel 0 of the PXIe-5164.
2. Configure the PXIe-5164 with the following settings:
   - Input impedance: 50 Ω
   - Maximum input frequency: 400 MHz
   - Vertical range: 1 $V_{pk\text{-}pk}$
   - Sample rate: 1 GS/s
   - Minimum number of points: 1,048,576 samples
3. Configure the calibrator and generate a waveform with the following characteristics:
   - Waveform: Sine wave
   - Amplitude ($V_{pk\text{-}pk}$): 0.9 V
   - Frequency: 99 MHz
   - Load impedance: 50 Ω
4. Enable the calibrator output.
5. Wait 1 second for settling, then measure and record the peak frequency using the Extract Single Tone Information VI.
6. Calculate the timebase error using the following formula:

   $$\textit{Timebase error} = (F_{measured} - (99 \times 10^6))/99$$

7. Compare the timebase error to the appropriate limit from the *Timebase Accuracy Verification* table.

   Note Timebase verification is only required on one channel.

[5] Measurement uncertainty based on Fluke 9500B with Fluke 9530 test head specifications that apply at T_{cal} ±5 °C, where Factory T_{cal} = 23 °C. Uncertainty of the 9500B includes long-term stability of 1 year (5 years for frequency), temperature coefficient, linearity, load, and line regulation and traceability of factory and National Calibration Standard.

8. Disable the calibrator output.

Verifying Input Capacitance

Follow this procedure to verify in the input capacitance of the PXIe-5164 using an oscilloscope calibrator.

Table 8. Input Capacitance Verification

Config	Vertical Range ($V_{pk\text{-}pk}$)	Test Limit (pF)	Measurement Uncertainty (pF)[6]
0	0.25 V	17.7 to 22.7	±0.52
1	2.5 V	17.7 to 22.7	±0.52
2	25 V	17.7 to 22.7	±0.52

1. Connect the calibrator test head to channel 0 of the PXIe-5164.
2. Configure the PXIe-5164 with the following settings:
   - Input impedance: 1 MΩ
   - Maximum input frequency: 300 MHz
   - Vertical offset: 0 V
   - Vertical range: the Vertical Range value from the *Input Capacitance Verification* table
   - Sample rate: 1 GS/s
   - Minimum number of points: 50,000 samples
3. Configure the calibrator to measure capacitance.
4. Enable the calibrator.
5. Wait 1 second for settling, then record the measured capacitance.
6. Compare the measured capacitance to the appropriate Limit from the *Input Capacitance Verification* table.
7. Repeat steps 2 through 6 for each configuration listed in the *Input Capacitance Verification* table.
8. Connect the calibrator test head to channel 1 of the PXIe-5164 and repeat steps 2 through 6 for each configuration listed in the *Input Capacitance Verification* table.
9. Disable the calibrator output.

[6] Measurement uncertainty based on Fluke 9500B with Fluke 9530 test head specifications that apply at T_{cal} ± 5 °C, where Factory T_{cal} = 23 °C. Uncertainty of the 9500B includes long-term stability of 1 year, temperature coefficient, linearity, load, and line regulation and traceability of factory and National Calibration Standard.

Verifying RMS Noise

Follow this procedure to verify the RMS noise of the PXIe-5164 using a 50 Ω terminator.

Table 9. RMS Noise Verification

Config	Input Impedance (Ω)	Vertical Range ($V_{pk\text{-}pk}$)	Test Limit (% of FS)	Measurement Uncertainty (% of FS)
1	50	0.25 V	0.045	±188E-6
2	50	0.5 V	0.040	±163E-6
3	50	1 V	0.035	±144E-6
4	50	2.5 V	0.030	±127E-6
5	50	5 V	0.030	±124E-6
6	1 M	0.25 V	0.110	±2.64E-3
7	1 M	0.5 V	0.060	±1.24E-3
8	1 M	1 V	0.050	±712E-6
9	1 M	2.5 V	0.100	±1.97E-3
10	1 M	5 V	0.060	±723E-6
11	1 M	10 V	0.050	±327E-6
12	1 M	25 V	0.080	±620E-6
13	1 M	50 V	0.060	±377E-6
14	1 M	100 V	0.050	±272E-6

1. Connect the 50 Ω BNC terminator (m) to channel 0 of the PXIe-5164.
2. Configure the PXIe-5164 with the following settings:
   - Input impedance: the Input Impedance value from the *RMS Noise Verification* table
   - Maximum input frequency: (50 Ω) 400 MHz, (1 MΩ) 300 MHz
   - Vertical offset: 0 V
   - Vertical range: the Vertical Range value from the *RMS Noise Verification* table
   - Sample rate: 1 GS/s
   - Minimum number of points: 1,048,576 samples
3. Use the PXIe-5164 to acquire a waveform, then calculate the standard deviation of the acquired waveform. Use the standard deviation to compute the RMS noise using the following formula:

   RMS noise (% of FS) = (100 × σ)/*Vertical range*
   where σ is the standard deviation of the acquired waveform.

4. Compare the RMS noise to the appropriate Limit from the *RMS Noise Verification* table.
5. Repeat steps 2 through 4 for each configuration listed in the *RMS Noise Verification* table.
6. Connect the 50 Ω terminator to channel 1 of the PXIe-5164 and repeat steps 2 through 4 for each configuration listed in the *RMS Noise Verification* table.

Adjustment

This section describes the steps needed to adjust the PXIe-5164 to meet published specifications.

Adjusting the PXIe-5164

Before performing this procedure, complete the *Test System Characterization* procedures and calculate the splitter balance and splitter loss of your power splitter. Ensure the channels of the PXIe-5164 are not connected.

1. Call the niHsai Group B External Cal API v1 Host.lvclass:Open Ext Cal Session VI to obtain an external calibration session.

   To perform an adjustment, you must specify the **calibration password**. By default, the **calibration password** is `NI`.
2. Complete the *Adjusting 1 MΩ Compensation Attenuator* procedure on channel 0.
3. Complete the *Adjusting 1 MΩ DC Reference* procedure on channel 0.
4. Complete the *Adjusting 50 Ω DC Reference* procedure on channel 0.
5. Complete the *Adjusting Timebase* procedure on channel 0. This procedure only needs to run on one channel.
6. Complete the *Adjusting 1 MΩ Compensation Attenuator* procedure on channel 1.
7. Complete the *Adjusting 1 MΩ DC Reference* procedure on channel 1.
8. Complete the *Adjusting 50 Ω DC Reference* procedure on channel 1.
9. Complete the *Adjusting 50 Ω Passband Amplitude Flatness and Bandwidth* procedure on channel 0.
10. Complete the *Adjusting 50 Ω Passband Amplitude Flatness and Bandwidth* procedure on channel 1.
11. Complete the *Adjusting 1 MΩ Passband Amplitude Flatness and Bandwidth* procedure on channel 0.
12. Complete the *Adjusting 1 MΩ Passband Amplitude Flatness and Bandwidth* procedure on channel 1.
13. Call the niHsai Group B External Cal API v1 Host.lvclass:Close Ext Cal Session VI with the following settings to close the external calibration session:

    action: Set this control to Commit to store the new calibration constants, adjustment time, adjustment date, and adjustment temperature to nonvolatile memory of the oscilloscope. If any errors occurred that were not corrected during any of the external adjustment steps, or if you want to abort the operation, set this control to Cancel to discard the new calibration constants without changing any of the calibration data stored in the nonvolatile memory of the oscilloscope.

14. Call the niScope Initialize VI to obtain an NI-SCOPE session.
15. Self-calibrate the PXIe-5164 using the niScope Cal Self Calibrate VI.
16. Call the niScope Close VI to close the NI-SCOPE session.

Adjusting 1 MΩ Compensation Attenuator

Follow this procedure to adjust the 1 MΩ compensation attenuator of the PXIe-5164.

1. Connect the calibrator test head to the specified channel of the PXIe-5164.
2. Call the niHsai Group B External Cal API v1 Host.lvclass:Compensated Attenuator Cal Initialize VI with the following settings:
   - **channel**: The specified channel
   - **input impedance**: 1 MΩ
3. Call the niHsai Group B External Cal API v1 Host.lvclass:Compensated Attenuator Cal Configure VI to obtain the amplitude and frequency of the square waveform to generate. Configure the calibrator to output a square waveform with symmetrical polarity and with the specified amplitude and frequency into 1 MΩ.
4. Enable the calibrator output if not already enabled.
5. Wait 1 second for settling.
6. Call the niHsai Group B External Cal API v1 Host.lvclass:Compensated Attenuator Cal Adjust VI with the following settings:
   - **frequency generated (Hz)**: The frequency of the square waveform present on the specified channel of the PXIe-5164
   - **amplitude generated (Vpk-pk)**: The amplitude of the square waveform present on the specified channel of the PXIe-5164
7. Repeat steps 3 through 6 until the **compensated attenuator cal complete** indicator from the niHsai Group B External Cal API v1 Host.lvclass:Compensated Attenuator Cal Adjust VI returns TRUE.
8. Disable the calibrator output.

Return to the main *Adjusting the PXIe-5164* task.

Adjusting 1 MΩ DC Reference

Follow this procedure to adjust the DC gain and offset of the 1 MΩ DC reference of the PXIe-5164.

Caution Avoid touching the connections when generating a high voltage from the calibrator.

1. Connect the calibrator test head to the specified channel of the PXIe-5164.
2. Call the niHsai Group B External Cal API v1 Host.lvclass:DC Reference Cal Initialize VI with the following settings:
   - **channel**: The specified channel
   - **input impedance**: 1 MΩ
3. Call the niHsai Group B External Cal API v1 Host.lvclass:DC Reference Cal Configure VI to obtain the DC voltage to generate and configure the calibrator to output the specified DC voltage into 1 MΩ.

4. Enable the calibrator output if not already enabled.
5. Wait 1 second for settling.
6. Call the niHsai Group B External Cal API v1 Host.lvclass:DC Reference Cal Adjust VI with the following settings:
   - **actual voltage generated (V)**: The DC voltage present on the specified channel of the PXIe-5164
7. Repeat steps 3 through 6 until the **DC cal complete** indicator from the niHsai Group B External Cal API v1 Host.lvclass:DC Reference Cal Adjust VI returns TRUE.
8. Disable the calibrator output.

Return to the main *Adjusting the PXIe-5164* task.

Adjusting 50 Ω DC Reference

Follow this procedure to adjust the DC gain and offset of the 50 Ω DC reference of the PXIe-5164.

1. Connect the calibrator test head to the specified channel of the PXIe-5164.
2. Call the niHsai Group B External Cal API v1 Host.lvclass:DC Reference Cal Initialize VI with the following settings:
   - **channel**: The specified channel
   - **input impedance**: 50 Ω
3. Call the niHsai Group B External Cal API v1 Host.lvclass:DC Reference Cal Configure VI to obtain the DC voltage to generate and configure the calibrator to output the specified DC voltage into 50 Ω.
4. Enable the calibrator output if not already enabled.
5. Wait 1 second for settling.
6. Call the niHsai Group B External Cal API v1 Host.lvclass:DC Reference Cal Adjust VI with the following settings:
   - **actual voltage generated (V)**: The DC voltage present on the specified channel of the PXIe-5164
7. Repeat steps 3 through 6 until the **DC cal complete** indicator from the niHsai Group B External Cal API v1 Host.lvclass:DC Reference Cal Adjust VI returns TRUE.
8. Disable the calibrator output.

Return to the main *Adjusting the PXIe-5164* task.

Adjusting Timebase

Follow this procedure to adjust the internal timebase reference of the PXIe-5164.

1. Connect the calibrator test head to the specified channel of the PXIe-5164.
2. Call the niHsai Group B External Cal API v1 Host.lvclass:Timebase Cal Initialize VI with the following settings:
   - **channel**: The specified channel
3. Call the niHsai Group B External Cal API v1 Host.lvclass:Timebase Cal Configure VI to obtain the frequency to generate and configure the calibrator to output a 0.9 $V_{pk\text{-}pk}$ sine wave at the specified frequency into 50 Ω.

4. Enable the calibrator output if not already enabled.
5. Wait 1 second for settling.
6. Call the niHsai Group B External Cal API v1 Host.lvclass:Timebase Cal Adjust VI with the following settings:
   - **actual frequency generated (Hz)**: The frequency of the sine wave present on channel 0 of the PXIe-5164
7. Repeat steps 3 through 6 until the **Timebase cal complete** indicator from the niHsai Group B External Cal API v1 Host.lvclass:Timebase Cal Adjust VI returns TRUE.
8. Disable the calibrator output.

Return to the main *Adjusting the PXIe-5164* task.

Adjusting 50 Ω Passband Amplitude Flatness and Bandwidth

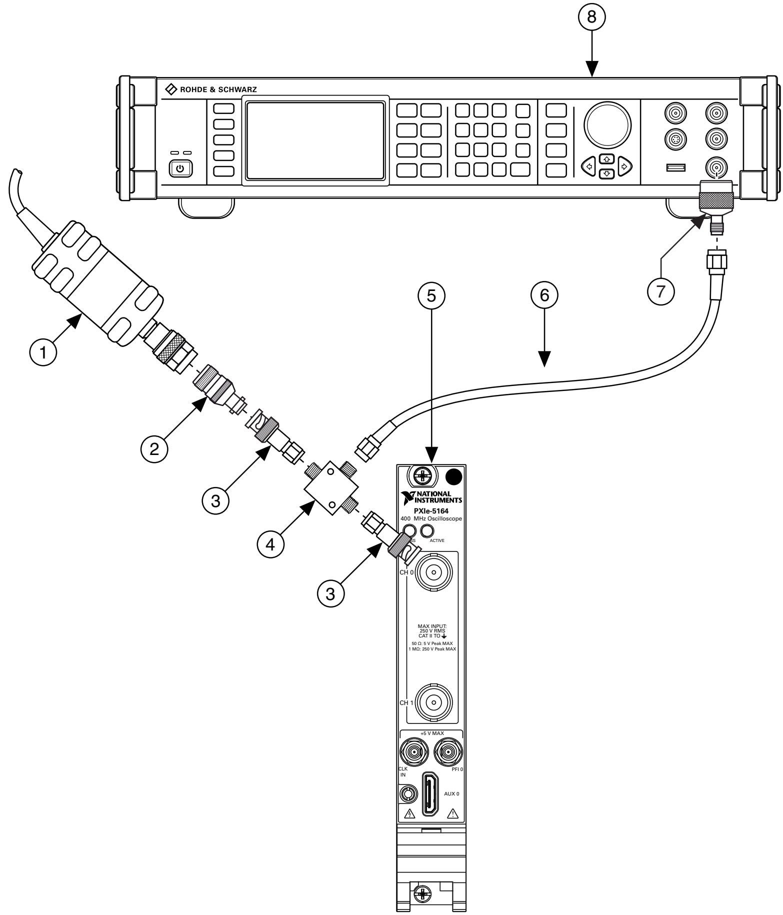
Follow this procedure to adjust the 50 Ω passband amplitude flatness and bandwidth of the PXIe-5164.

1. Connect splitter output 2 of the power sensor assembly from the Test System Characterization section to the specified channel of the PXIe-5164.

   Note The power sensor assembly must match the configuration used in the *Test System Characterization* section, in which the power sensor is connected to splitter output 1 and the signal generator is connected to the input port of the power splitter.

   The following figure illustrates the hardware setup.

Figure 7. 50 Ω Passband Amplitude Flatness and Bandwidth Verification Cabling Diagram



1. Power Sensor
2. BNC (f)-to-N (f) Adapter
3. SMA (m)-to-BNC (m) Adapter
4. Power Splitter
5. PXIe-5164
6. SMA (m)-to-SMA (m) Cable
7. SMA (f)-to-N (m) Adapter
8. Signal Generator

2. Call the niHsai Group B External Cal API v1 Host.lvclass:Passband Flatness Cal Initialize VI with the following settings:
   - **channel**: The specified channel
   - **input impedance**: 50 Ω
3. Configure the power sensor with the following settings:
   - Power measurement: continuous average
   - Path selection: automatic

- Averaging: automatic
- Averaging resolution: 4 (0.001 dB)
- Aperture: 20 ms

4. Call the niHsai Group B External Cal API v1 Host.lvclass:Passband Flatness Cal Configure VI to obtain the amplitude and frequency of the sine waveform to generate. Configure the signal generator to output a sine waveform with the specified amplitude plus *splitter loss* and frequency into a 50 Ω load.

   Note Select the *splitter loss* value from the list of test points from the *Test System Characterization* section for the current Test Point Frequency.

5. Enable the signal generator output if not already enabled.
6. Configure the power sensor to correct for the current sine wave frequency using the power sensor frequency correction function.
7. Wait 0.1 second for settling.
8. Use the power sensor to measure the power in dBm. Record the result as `measured input power`.
9. Calculate the corrected input power using the following equation:

   `corrected input power = measured input power + splitter balance`

   Note Select the `splitter balance` value from the list of test points from the Test System Characterization section for the current Test Point Frequency.

10. Call the niHsai Group B External Cal API v1 Host.lvclass:Passband Flatness Cal Adjust VI with the following settings:
    - **actual frequency generated (Hz)**: The frequency of the sine waveform present on the specified channel of the PXIe-5164
    - **actual amplitude generated (dBm)**: The corrected input power of the sine waveform present on the specified channel of the PXIe-5164
11. Repeat steps 4 through 10 until the **passband flatness cal complete** indicator from the niHsai Group B External Cal API v1 Host.lvclass:Passband Flatness Cal Adjust VI returns TRUE.
12. Disable the signal generator output.

Return to the main *Adjusting the PXIe-5164* task.

Adjusting 1 MΩ Passband Amplitude Flatness and Bandwidth

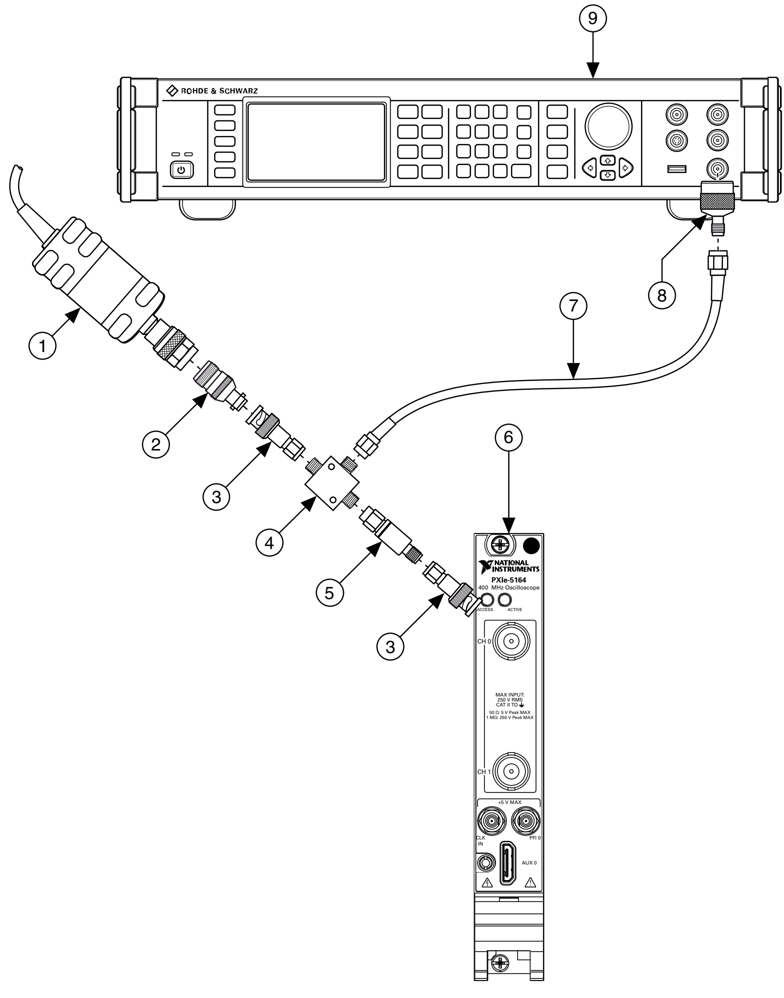
Follow this procedure to adjust the 1 MΩ passband amplitude flatness and bandwidth of the PXIe-5164

1. Place the 50 Ω feed-thru terminator between the splitter output and the SMA (m)-to-BNC (m) adapter of splitter output 2. Connect splitter output 2 of the power sensor assembly from the *Test System Characterization* section to the specified channel of the PXIe-5164.

   Note The power sensor assembly must match the configuration used in the *Test System Characterization* section, in which the power sensor is connected to splitter output 1 and the signal generator is connected to the input port of the power splitter.

The following figure illustrates the hardware setup.

Figure 8. 1 MΩ Bandwidth Verification Cabling Diagram



1. Power Sensor
2. BNC (f)-to-N (f) Adapter
3. SMA (m)-to-BNC (m) Adapter
4. Power Splitter
5. 50 Ω SMA Feed-Thru Terminator
6. PXIe-5164
7. SMA (m)-to-SMA (m) Cable
8. SMA (f)-to-N (m) Adapter
9. Signal Generator

2. Call the niHsai Group B External Cal API v1 Host.lvclass:Passband Flatness Cal Initialize VI with the following settings:
   - **channel**: The specified channel
   - **input impedance**: 1 MΩ
3. Configure the power sensor with the following settings:
   - Power measurement: continuous average
   - Path selection: automatic
   - Averaging: automatic
   - Averaging resolution: 4 (0.001 dB)
   - Aperture: 20 ms
4. Call the niHsai Group B External Cal API v1 Host.lvclass:Passband Flatness Cal Configure VI to obtain the amplitude and frequency of the sine waveform to generate. Configure the signal generator to output a sine waveform with the specified amplitude plus *splitter loss* and frequency into a 50 Ω load.
5. Enable the signal generator output if not already enabled.

   Note Select the splitter loss value from the list of test points from the *Test System Characterization* section for the current Test Point Frequency.
6. Configure the power sensor to correct for the current sine wave frequency using the power sensor frequency correction function.
7. Wait 0.1 second for settling.
8. Use the power sensor to measure the power in dBm. Record the result as `measured input power`.
9. Calculate the corrected input power using the following equation:

   $$corrected\ input\ power = measured\ input\ power + splitter\ balance$$

   Note Select the `splitter balance` value from the list of test points from the Test System Characterization section for the current Test Point Frequency.
10. Call the niHsai Group B External Cal API v1 Host.lvclass:Passband Flatness Cal Adjust VI with the following settings:
    - **actual frequency generated (Hz)**: The frequency of the sine waveform present on the specified channel of the PXIe-5164
    - **actual amplitude generated (dBm)**: The corrected input power of the sine waveform present on the specified channel of the PXIe-5164
11. Repeat steps 4 through 10 until the **passband flatness cal complete** indicator from the niHsai Group B External Cal API v1 Host.lvclass:Passband Flatness Cal Adjust VI returns TRUE.
12. Disable the signal generator output.

Return to the main *Adjusting the PXIe-5164* task.

Reverification

Repeat the *Verification* section to determine the as-left status of the PXIe-5164.

Note If any test fails reverification after performing an adjustment, verify that you have met the test conditions before returning your PXIe-5164 to NI. Refer to the *Worldwide Support and Services* section for information about support resources or service requests.

Updating Verification Date and Time

This procedure updates the date and time of the last PXIe-5164 verification.

Prior to updating the verification date and time, you must successfully complete all required verifications or reverifications following adjustment.

Call the niHSAI Calibration API v1 Host.lvlib:Set Verification Date and Time VI with the following settings:

- Wire the current date and time to the **verification date** parameter.
- Wire the current calibration password to the **calibration password** parameter. The default password is `NI`.

Worldwide Support and Services

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

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

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

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

NI corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. NI also has offices located around the world. For telephone support in the United States, create your service request at *ni.com/support* or dial 1 866 ASK MYNI (275 6964). For telephone support outside the United States, visit the *Worldwide Offices* section of *ni.com/niglobal* to access the branch office websites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

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