PXIe-5170R Calibration Procedure

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Contents

PXIe-5170R Calibration Procedure

This document contains the verification and adjustment procedures for the PXIe-5170R. Refer to *ni.com/calibration* for more information about calibration solutions.

Please review and become familiar with the entire procedure before beginning the calibration process.

Required Software

Calibrating the PXIe-5170R requires you to install the following software on the calibration system:

- LabVIEW Instrument Design Libraries for Reconfigurable Oscilloscopes. The PXIe-5170R was first supported in LabVIEW Instrument Design Libraries for Reconfigurable Oscilloscopes 14.0 .

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-5170R Getting Started Guide*
- *NI Reconfigurable Oscilloscopes Help*
- *PXIe-5170R Specifications*

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

Test Equipment

This section lists the equipment required to calibrate the PXIe-5170R.

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

Table 1 : PXIe-5170R Test Equipment

Equipment	Recommended Model	Where Used	Minimum Requirements
Oscilloscope calibrator	Fluke 9500B/600 with Fluke 9530 Active Head	Verifications: • Timebase accuracy • DC accuracy Adjustments: • Timebase • DC	Sine Wave Amplitude: 0.9 V$_{pk-pk}$ at 11 MHz into 50 Ω Sine Wave Frequency Accuracy: 0.25 ppm at 11 MHz DC Output Range: ±40 mV to ±2.5 V into 50 Ω DC Output Accuracy: ±(0.025% of output + 25 μV) into 50 Ω
SMA (m)-to-BNC (f) adapter	Fairview Microwave SM4723	Verifications: • Timebase accuracy • DC accuracy Adjustments: • Timebase • DC	Frequency range: DC to 11 MHz Impedance: 50 Ω
DMM	NI PXI-4071	Verifications: • AC amplitude accuracy	AC voltage accuracy: ±0.1% of reading at 50 kHz AC Input Range: 0.1 V$_{pk-pk}$ to 3.5 V$_{pk-pk}$ AC Input Impedance: ≥10 MΩ Bandwidth: ≥100 kHz
Function generator	NI PXI-5402 or Agilent 33220A	Verifications: • AC amplitude accuracy	Sine Wave Frequency: 50 kHz Sine Wave Amplitude Range: 0.1 V$_{pk-pk}$ to 3.5 V$_{pk-pk}$ into 50 Ω

Table 1 : PXIe-5170R Test Equipment (Continued)

Equipment	Recommended Model	Where Used	Minimum Requirements
SMA Tee (f-f-f)	Fairview Microwave SM4942	Verifications: • AC amplitude accuracy	Impedance: 50 Ω
SMA (m)-to-SMA (m) adapter (x2)	Fairview Microwave SM4960	Test system characterization Verifications: • AC amplitude accuracy • Flatness and bandwidth	Frequency range: DC to 275 MHz VSWR: ≤1.05 Impedance: 50 Ω
Double banana plug to BNC (f)	Pasternak PE9008	Verifications: • AC amplitude accuracy	Impedance: 50 Ω
SMA (m)-to-BNC (m) cable (x2)	—	Verifications: • AC amplitude accuracy	Frequency range: DC to 275 MHz Impedance: 50 Ω Length: <1 meter
Power sensor	Rohde & Schwarz (R&S) NRP-Z91	Test system characterization Verifications: • Flatness and bandwidth	Range: -15 dBm to 5 dBm Frequency range: 50 kHz to 275 MHz Absolute Power Accuracy: <0.048 dB for <100 MHz, <0.063 dB for 100 MHz to 275 MHz Relative Power Accuracy: <0.022 dB for <100 MHz, <0.031 dB for 100 MHz to 275 MHz VSWR: ≤1.13

Table 1 : PXIe-5170R Test Equipment (Continued)

Equipment	Recommended Model	Where Used	Minimum Requirements
Signal generator	Rhode & Schwartz SMA100A	Test system characterization Verifications: • Flatness and bandwidth	Frequency range: 50 kHz to 275 MHz Amplitude range: -7 dBm to 8 dBm Harmonics: <-30 dBc
Power splitter	Aeroflex/Weinschel 1593	Test system characterization Verifications: • Flatness and bandwidth	Frequency range: 50 kHz to 275 MHz VSWR: ≤1.35 Amplitude tracking: <0.5 dB
50 Ω SMA terminator (f)	Fairview Microwave ST1825F	Test system characterization	Frequency range: DC to 275 MHz VSWR: ≤1.05 Impedance: 50 Ω
SMA (f)-to-N (m) adapter	Fairview Microwave SM4226	Test system characterization Verifications: • Flatness and bandwidth	Frequency range: DC to 275 MHz VSWR: ≤1.05 Impedance: 50 Ω
SMA (f)-to-N (f) adapter	Fairview Microwave SM4236	Test system characterization Verifications: • Flatness and bandwidth	Frequency range: DC to 275 MHz VSWR: ≤1.05 Impedance: 50 Ω

🔗 | **RELATED INFORMATION**

Verification on page 12

Test Conditions

The following setup and environmental conditions are required to ensure the PXIe-5170R meets published specifications:

- The PXIe-5170R is warmed up for 15 minutes at ambient temperature. Warm-up begins after the chassis is powered, the device is recognized by the host, and the ADC clock is configured using either instrument design libraries or the NI-SCOPE device driver.

- 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-5170R, including front panel connections and screws, are secure.

- Use shielded copper wire for all cable connections to the module. 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-5170R. NI uses these limits to determine whether the PXIe-5170R 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-5170R, 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.

Calibration Overview

Before you begin

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

About this task

Calibration includes the following steps:

Procedure

1. Test system characterization—Characterize the amplitude imbalance of the output ports on your power splitter. The results of this step are used as a correction in the flatness and bandwidth verification procedure.

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. Re-verification—Repeat the Verification procedure to ensure that the device is operating within the published specifications after adjustment.

What to do next

Refer to the following sections to complete each procedure.

Test System Characterization

The following procedures characterize the test equipment used during verification.

About this task

> ⊙ **NOTICE**
> 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

Procedure

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.

About this task

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

- Verifying Flatness and Bandwidth

Table 2 : Power Splitter Characterization

Configuration	Test Point	
	Frequency (MHz)	Amplitude (dBm)
1	0.05	-0.5
2	50.1	-0.5
3	90.1	-0.5
4	100.1	-0.5

Procedure

1. Connect the SMA (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-SMA (m) adapter to one of the power splitter output ports. Refer to this assembly as *splitter output 1*.

5. Connect the 50 Ω SMA terminator (f) to splitter output 1.

6. Connect the other SMA (m)-to-S<A (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
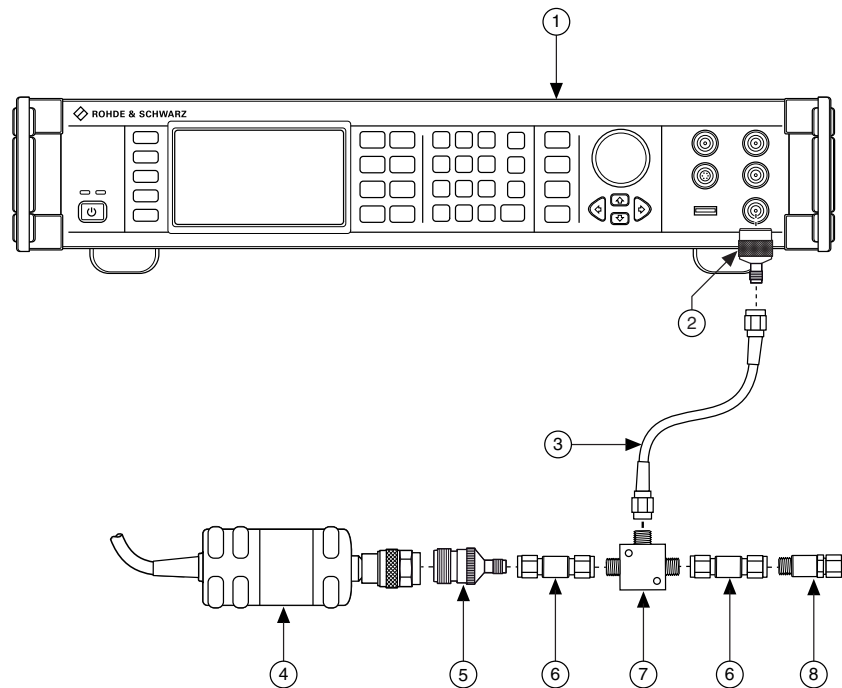
1. Signal Generator	**5.** SMA (f)-to-N (f) Adapter
2. SMA (f)-to-N (m) Adapter	**6.** SMA (m)-to-SMA (m) Adapter
3. SMA (m)-to-SMA (m) Cable	**7.** Power Splitter
4. Power Sensor	**8.** 50 Ω SMA Terminator (f)

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: the *Test Point Amplitude* value from the *Power Splitter Characterization* table

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 SMA terminator (f) from splitter output 2 and splitter output 1.

15. Connect the power sensor to splitter output 1.

16. Connect the 50 Ω SMA terminator (f) to splitter output 2.

The following figure illustrates the hardware setup.

Figure 2 : Connection Diagram for Measuring at Splitter Output 1
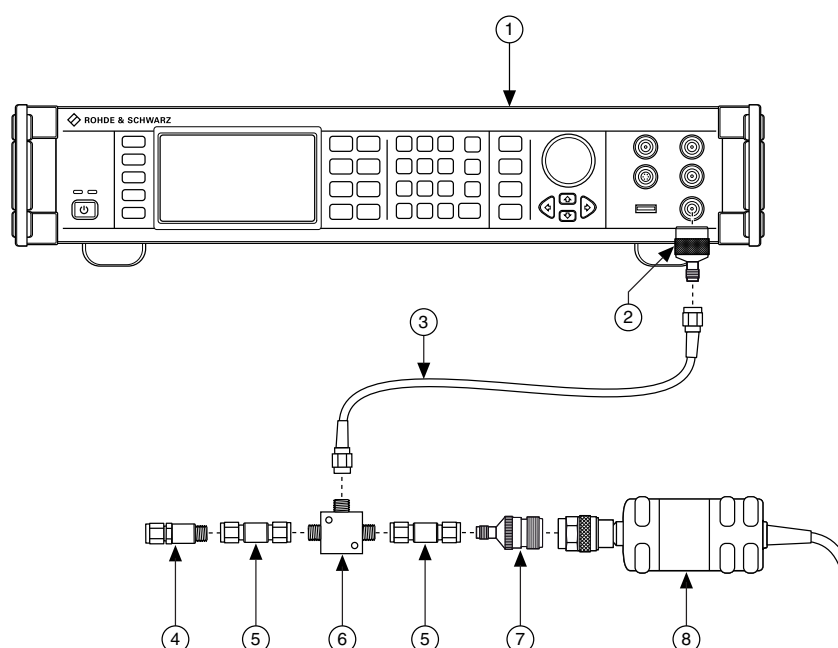
1.	Signal Generator	**5.**	SMA (m)-to-SMA (m) Adapter
2.	SMA (f)-to-N (m) Adapter	**6.**	Power Splitter
3.	SMA (m)-to-SMA (m) Cable	**7.**	SMA (f)-to-N (f) Adapter
4.	50 Ω SMA Terminator (f)	**8.**	Power Sensor

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: the *Test Point Amplitude* value from the *Power Splitter Characterization* table

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 terminator (f) from splitter output 2. Refer to the remaining assembly as the *power sensor assembly*.

    > 📝 **NOTE**
    >
    > Do not disassemble the power sensor assembly. The power splitter amplitude balance and loss characterization is invalid if the power sensor assembly has been disassembled.

    The power sensor assembly will be used in the following procedures:

    - *Verifying Flatness and Bandwidth*
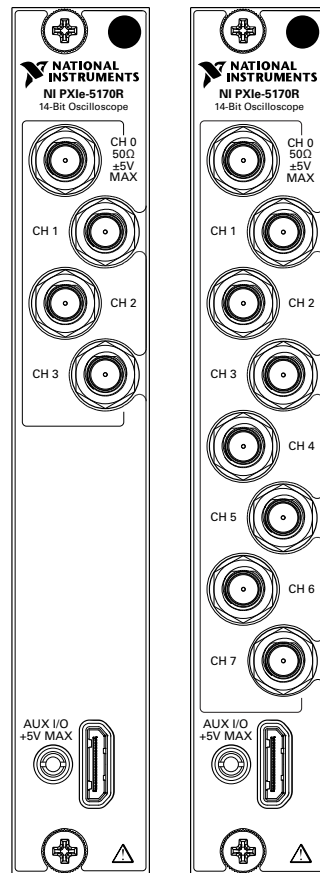
    🔗 **RELATED INFORMATION**

    Verifying Flatness and Bandwidth on page 19

    > Follow this procedure to verify the analog flatness and bandwidth accuracy of the PXIe-5170R by generating a sine wave and comparing the amplitude measured by the PXIe-5170R to the amplitude measured by the power sensor.

Verification

Verification of the PXIe-5170R 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-5170R front panel connectors. You can find information about the functions of these connectors in the device getting started guide.

Figure 3 : PXIe-5170R (4CH) and PXIe-5170R (8CH) Front Panels

🔗 **RELATED INFORMATION**

Test Equipment on page 3

This section lists the equipment required to calibrate the PXIe-5170R.

Verifying Timebase Accuracy

Follow this procedure to verify the frequency accuracy of the PXIe-5170R onboard timebase using an oscilloscope calibrator.

About this task

Table 3 : Timebase Accuracy Verification

As-Found Limit	As-Left Limit
25 PPM	1.6 PPM

Procedure

1. Connect the SMA (m)-to-BNC (f) adapter to channel 0 of the PXIe-5170R.

2. Connect the calibrator test head to the SMA (m)-to-BNC (f) adapter.

3. Configure the PXIe-5170R with the following settings:

   - Bandwidth: Full Bandwidth
   - Vertical range: 1 V$_{pk\text{-}pk}$
   - Sample rate: 250 MS/s
   - Number of samples: 1,048,576 samples

4. Configure the calibrator and generate a waveform with the following characteristics:

   - Waveform: Sine wave
   - Amplitude: 0.9 V$_{pk\text{-}pk}$
   - Frequency: 11 MHz
   - Load impedance: 50 Ω

5. Enable the calibrator output.

6. Wait 1 second for settling, then measure and record the peak frequency using the `Extract Single Tone Information VI`.

7. Calculate the timebase error using the following formula:

   Timebase error = (F_{measured} - (11×10^{6}))/11

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

   📝 | **NOTE**
   Timebase verification is only required on one channel.

Verifying DC Accuracy

Follow this procedure to verify the DC accuracy of the PXIe-5170R by comparing the voltage measured by the PXIe-5170R to the value sourced by the voltage standard.

About this task

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

Table 4 : DC Accuracy Verification

Config	Bandwidth	Vertical Range (V$_{pk\text{-}pk}$)	Test Points (V)	As-Found Test Limit (mV)	As-Left Test Limit (mV)
1	Full Bandwidth	0.2	0.09	±2.8	±1.58
2	Full Bandwidth	0.2	-0.09	±2.8	±1.58

Table 4 : DC Accuracy Verification (Continued)

Config	Bandwidth	Vertical Range (V_{pk-pk})	Test Points (V)	As-Found Test Limit (mV)	As-Left Test Limit (mV)
3	Full Bandwidth	0.4	0.18	±3.1	±1.13
4	Full Bandwidth	0.4	-0.18	±3.1	±1.13
5	Full Bandwidth	1	0.45	±6.8	±1.83
6	Full Bandwidth	1	-0.45	±6.8	±1.83
7	Full Bandwidth	2	0.90	±11.1	±3.26
8	Full Bandwidth	2	-0.90	±11.1	±3.26
9	Full Bandwidth	5	2.25	±25.6	±7.15
10	Full Bandwidth	5	-2.25	±25.6	±7.15

Procedure

1. Connect the SMA (m)-to-BNC (f) adapter to channel 0 of the PXIe-5170R.

2. Connect the calibrator test head to the SMA (m)-to-BNC (f) adapter.

3. Configure the PXIe-5170R with the following settings:

   - Bandwidth: the Bandwidth value from the *DC Accuracy Verification* table
   - Vertical range: the Vertical Range value from the *DC Accuracy Verification* table
   - Sample rate: 250 MS/s
   - Number of samples: 1,048,576 samples

4. Configure the calibrator output impedance to 50 Ω.

5. Configure the calibrator to output the Test Point value from the *DC Accuracy Verification* table.

6. Enable the calibrator output.

7. Wait 1 second for settling, then compute the average of the samples acquired and record the measured voltage.

8. Use the following formula to calculate the voltage error:

   DC voltage error = $V_{measured}$ - Test Point

9. Compare the voltage error to the appropriate limit from the *DC Accuracy Verification* table.

10. Repeat steps 3 through 9 for each configuration listed in the *DC Accuracy Verification* table.

11. Connect the calibrator test head to channel 1 of the PXIe-5170R using the SMA (m)-to-BNC (f) adapter and repeat steps 3 through 9 for each configuration listed in the *DC Accuracy Verification* table.

12. Connect the calibrator test head to channel 2 of the PXIe-5170R using the SMA (m)-to-BNC (f) adapter and repeat steps 3 through 9 for each configuration listed in the *DC Accuracy Verification* table.

13. Connect the calibrator test head to channel 3 of the PXIe-5170R using the SMA (m)-to-BNC (f) adapter and repeat steps 3 through 9 for each configuration listed in the *DC Accuracy Verification* table.

14. Connect the calibrator test head to channel 4 of the PXIe-5170R using the SMA (m)-to-BNC (f) adapter and repeat steps 3 through 9 for each configuration listed in the *DC Accuracy Verification* table.

15. Connect the calibrator test head to channel 5 of the PXIe-5170R using the SMA (m)-to-BNC (f) adapter and repeat steps 3 through 9 for each configuration listed in the *DC Accuracy Verification* table.

16. Connect the calibrator test head to channel 6 of the PXIe-5170R using the SMA (m)-to-BNC (f) adapter and repeat steps 3 through 9 for each configuration listed in the *DC Accuracy Verification* table.

17. Connect the calibrator test head to channel 7 of the PXIe-5170R using the SMA (m)-to-BNC (f) adapter and repeat steps 3 through 9 for each configuration listed in the *DC Accuracy Verification* table.

Verifying AC Amplitude Accuracy

Follow this procedure to verify the AC amplitude accuracy of the PXIe-5170R by comparing the 50 kHz AC voltage measured by the PXIe-5170R to the 50 kHz AC voltage measured by the DMM.
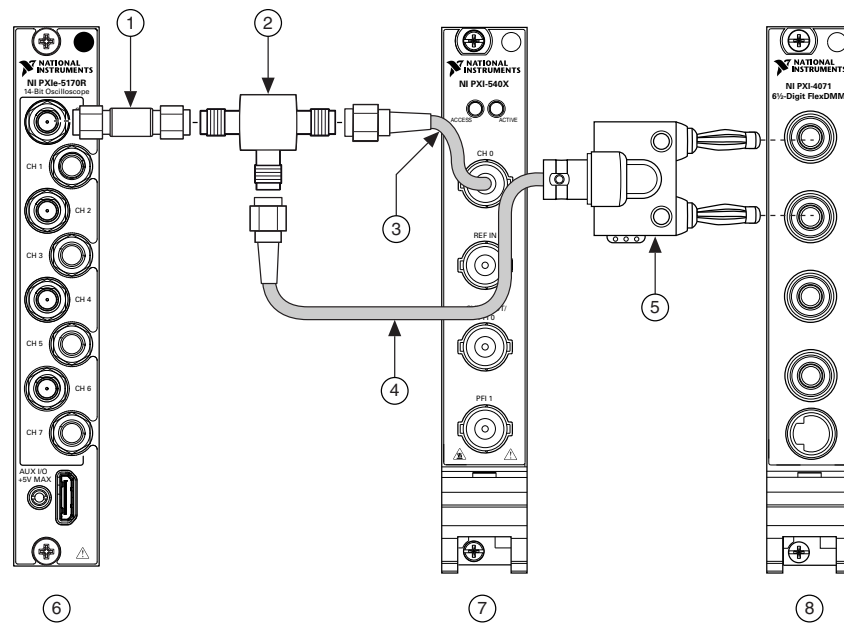
About this task

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

Table 5 : AC Amplitude Accuracy Verification

Config	Bandwidth	Vertical Range ($V_{pk\text{-}pk}$)	DMM Range (V_{rms})	Test Point ($V_{pk\text{-}pk}$)	As Found Limit (dB)	As Left Limit (dB)
1	Full Bandwidth	0.2	0.05	0.14	±0.15	±0.025
2	Full Bandwidth	0.4	0.5	0.34	±0.15	±0.025
3	Full Bandwidth	1	0.5	0.70	±0.15	±0.025
4	Full Bandwidth	2	0.5	1.40	±0.15	±0.025

Table 5 : AC Amplitude Accuracy Verification (Continued)

Config	Bandwidth	Vertical Range (V_{pk-pk})	DMM Range (V_{rms})	Test Point (V_{pk-pk})	As Found Limit (dB)	As Left Limit (dB)
5	Full Bandwidth	5	5.0	3.50	±0.15	±0.025

Figure 4 : AC Verification Test Connections

1. SMA (m)-to-SMA (m) adapter
2. SMA Tee (f-f-f)
3. SMA (m)-to-BNC (m) cable
4. SMA (m)-to-BNC (m) cable
5. BNC (f) to Double Banana Plug
6. PXIe-5170R
7. NI 5402
8. DMM

Procedure

1. Connect the DMM and function generator to channel 0 of the PXIe-5170R 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
   - Range: the DMM Range value from the *AC Amplitude Accuracy Verification* table

3. Configure the PXIe-5170R with the following settings:

    - Bandwidth: the Bandwidth value from the *AC Amplitude Accuracy Verification* table

    - Vertical range: the Vertical Range value from the *AC Amplitude Accuracy Verification* table

    - Sample rate: 250 MS/s

    - Number of samples: 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: 50 Ω

    NOTE
    These values assume you are using a NI 5402 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 1 second for the output of the function generator to settle.

6. Measure and record the amplitude using the `Extract Single Tone Information VI` for the PXIe-5170R.

7. Measure and record the amplitude for the DMM.

    NOTE
    The `Extract Single Tone Information VI` returns an amplitude result in V_{pk}, but the DMM will return the amplitude as V_{rms}. Convert the results to the same unit before calculating error.

8. Calculate the amplitude error using the following formula:

    AC Voltage Error = $20 \times \log_{10}(V_{\text{PXIe-5170R Measured}}/V_{\text{DMM Measured}})$

9. Compare the amplitude error to the appropriate Limit from the *AC Amplitude Accuracy Verification* table.

10. Repeat steps 2 through 8 for each configuration listed in the *AC Amplitude Accuracy Verification* table.

11. Connect the DMM and function generator to channel 1 of the PXIe-5170R 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.

12. Connect the DMM and function generator to channel 2 of the PXIe-5170R 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. Connect the DMM and function generator to channel 3 of the PXIe-5170R 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.

14. Connect the DMM and function generator to channel 4 of the PXIe-5170R 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.

15. Connect the DMM and function generator to channel 5 of the PXIe-5170R 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.

16. Connect the DMM and function generator to channel 6 of the PXIe-5170R 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.

17. Connect the DMM and function generator to channel 7 of the PXIe-5170R 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.

Verifying Flatness and Bandwidth

Follow this procedure to verify the analog flatness and bandwidth accuracy of the PXIe-5170R by generating a sine wave and comparing the amplitude measured by the PXIe-5170R to the amplitude measured by the power sensor.

Before you begin

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

About this task

Table 6 : Flatness and Bandwidth Verification

Config	Bandwidth	Vertical Range (V_{pk-pk})	Test Point		As-Found Limit (dB)	As-Left Limit (dB)
			Frequency[†] (MHz)	Amplitude (dBm)		
1	Full Bandwidth	1	0.05	7.5	—	—
2	Full Bandwidth	1	50.1	7.5	-1.00 to 0.50	-0.63 to 0.25
3	Full Bandwidth	1	90.1	7.5	-1.00 to 0.50	-0.63 to 0.25
4	Full Bandwidth	1	100.1	7.5	-3.00 to 0.50	-2.63 to 0.13

† The 0.05 MHz test point is used to normalize the remaining test points.

Procedure

1. Connect splitter output 2 of the power sensor assembly from the *Test System Characterization* section to channel 0 of the PXIe-5170R.

   > ✎ **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 : Flatness and Bandwidth Verification Cabling Diagram
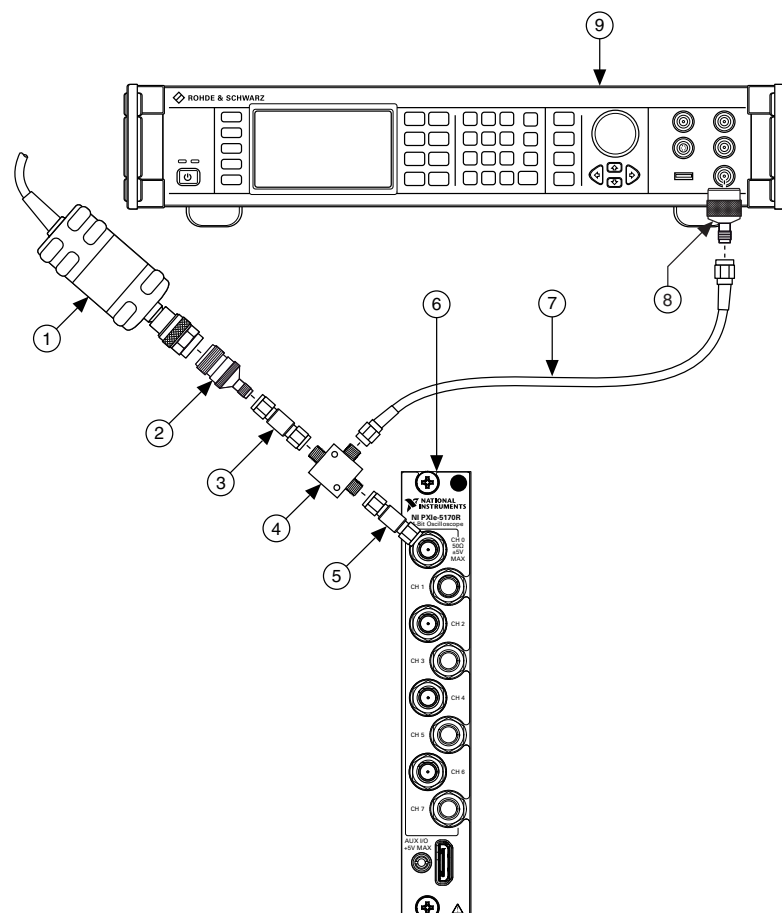
1. Power Sensor
2. SMA (f)-to-N (f) Adapter
3. SMA (m)-to-SMA (m) Adapter
4. Power Splitter
5. SMA (m)-to-SMA (m) Adapter
6. PXIe-5170R
7. SMA (m)-to-SMA (m) Cable
8. SMA (f)-to-N (m) adapter
9. Signal Generator

2. Configure the PXIe-5170R with the following settings:

- Bandwidth: the Bandwidth value from the *Flatness and Bandwidth Verification* table

- Vertical range: the Vertical Range value from the *Flatness and Bandwidth Verification* table

- Sample rate: 250 MS/s

- Number of samples: 1,048,576 samples

3. Configure the signal generator to generate a sine waveform with the following characteristics:

   - Frequency: the Test Point Frequency value from the *Flatness and Bandwidth Verification* table

   - Amplitude level: the Test Point Amplitude value from the *Flatness and Bandwidth Verification* table

4. Configure the power sensor to correct for the Test Point Frequency using the power sensor frequency correction function.

5. Use the power sensor to measure the power in dBm. Record the result as *measured input power*.

6. Calculate the corrected input power using the following equation:

   corrected input power = measured input power + splitter imbalance

   ✎ **NOTE**
   Select the *splitter imbalance* value from the list of test points from the *Test System Characterization* section for the current Test Point Frequency.

7. Use the PXIe-5170R to acquire and measure the power using the `Extract Single Tone Information VI`, converting the result from V_{pk} to dBm. Record the result as *device input power*.

8. If the Test Point Frequency value from the *Flatness and Bandwidth Verification* table is 50 kHz, proceed to step 9. Otherwise, proceed to step 11.

9. Calculate the *power reference* using the following equation:

   power reference = device input power - corrected input power

10. Proceed to step 13. The power error is not calculated for this configuration.

11. Calculate the *power error* using the following equation:

    power error = device input power - corrected input power - power reference

12. Compare the power error to the appropriate Limit from the *Flatness and Bandwidth Verification* table.

13. Repeat steps 2 through 12 for each configuration in the *Flatness and Bandwidth Verification* table.

14. Connect splitter output 2 of the power sensor assembly to channel 1 of the PXIe-5170R and repeat steps 2 through 12 for each configuration listed in the *Flatness and Bandwidth Verification* table.

15. Connect splitter output 2 of the power sensor assembly to channel 2 of the PXIe-5170R and repeat steps 2 through 12 for each configuration listed in the *Flatness and Bandwidth Verification* table.

16. Connect splitter output 2 of the power sensor assembly to channel 3 of the PXIe-5170R and repeat steps 2 through 12 for each configuration listed in the *Flatness and Bandwidth Verification* table.

17. Connect splitter output 2 of the power sensor assembly to channel 4 of the PXIe-5170R and repeat steps 2 through 12 for each configuration listed in the *Flatness and Bandwidth Verification* table.

18. Connect splitter output 2 of the power sensor assembly to channel 5 of the PXIe-5170R and repeat steps 2 through 12 for each configuration listed in the *Flatness and Bandwidth Verification* table.

19. Connect splitter output 2 of the power sensor assembly to channel 6 of the PXIe-5170R and repeat steps 2 through 12 for each configuration listed in the *Flatness and Bandwidth Verification* table.

20. Connect splitter output 2 of the power sensor assembly to channel 7 of the PXIe-5170R and repeat steps 2 through 12 for each configuration listed in the *Flatness and Bandwidth Verification* table.

🔗 **RELATED INFORMATION**

Characterizing Power Splitter Amplitude Balance and Loss on page 9

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.

Adjustment

This section describes the steps needed to adjust the PXIe-5170R to meet published specifications.

Adjusting DC

Follow this procedure to adjust the DC gain and offset of the PXIe-5170R.

Procedure

1. Call the `niHSAI Open Ext Cal Session VI` to obtain an external calibration session.

2. Connect the SMA (m)-to-BNC (f) adapter to channel 0 of the PXIe-5170R.

3. Connect the calibrator test head to the SMA (m)-to-BNC (f) adapter.

4. Configure the calibrator output impedance to 50 Ω.

5. Configure the calibrator to a known state by outputting 10 mV of DC voltage.

6. Enable the calibrator output.

7. Call the `niHSAI DC Cal Initialize VI` with the following settings:

   - **Channel**: 0

8. Call the `niHSAI DC Cal Configure VI` to obtain the DC voltage to generate and configure the calibrator to output the specified DC voltage.

9. Wait 1 second for settling.

10. Call the `niHSAI DC Cal Adjust VI` with the following settings:

    - **Actual Voltage Generated**: The DC voltage present on channel 0 of the PXIe-5170R

11. Repeat steps 8 through 10 until the **DC Cal Complete indicator** from the `niHSAI DC Cal Adjust VI` returns TRUE.

12. Connect the calibrator test head to the channel 1 input of the PXIe-5170R using the SMA (m)-to-BNC (f) adapter and repeat steps 5 through 11, changing the value of the **channels** parameter from **0** to **1**.

13. Connect the calibrator test head to the channel 2 input of the PXIe-5170R using the SMA (m)-to-BNC (f) adapter and repeat steps 5 through 11, changing the value of the **channels** parameter from **1** to **2**.

14. Connect the calibrator test head to the channel 3 input of the PXIe-5170R using the SMA (m)-to-BNC (f) adapter and repeat steps 5 through 11, changing the value of the **channels** parameter from **2** to **3**.

15. Connect the calibrator test head to the channel 4 input of the PXIe-5170R using the SMA (m)-to-BNC (f) adapter and repeat steps 5 through 11, changing the value of the **channels** parameter from **3** to **4**.

16. Connect the calibrator test head to the channel 5 input of the PXIe-5170R using the SMA (m)-to-BNC (f) adapter and repeat steps 5 through 11, changing the value of the **channels** parameter from **4** to **5**.

17. Connect the calibrator test head to the channel 6 input of the PXIe-5170R using the SMA (m)-to-BNC (f) adapter and repeat steps 5 through 11, changing the value of the **channels** parameter from **5** to **6**.

18. Connect the calibrator test head to the channel 7 input of the PXIe-5170R using the SMA (m)-to-BNC (f) adapter and repeat steps 5 through 11, changing the value of the **channels** parameter from **6** to **7**.

19. Disable the calibrator output.

20. Call the `niHSAI Close Ext Cal Session VI` 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 EEPROM. 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 EEPROM.

Adjusting Timebase

Follow this procedure to adjust the internal timebase reference of the PXIe-5170R.

Procedure

1. Call the `niHSAI Open Ext Cal Session VI` to obtain an external calibration session.

2. Connect the calibrator test head to channel 0 of the PXIe-5170R using the SMA (m)-to-BNC (f) adapter.

3. Configure the calibrator to a known state by outputting an 11 MHz, 0.9 V_{pk-pk} sine wave.

4. Enable the calibrator output.

5. Call the `niHSAI Timebase Cal Initialize VI` with the following settings:

   - **Channel**: 0

6. Call the `niHSAI Timebase Cal Configure VI` to obtain the frequency to generate and configure the calibrator to output a 0.9 V_{pk-pk} sine wave at the specified frequency.

7. Wait 1 second for settling.

8. Call the `niHSAI Timebase Cal Adjust VI` with the following settings:

   - **Actual Frequency Generated**: The frequency of the sine wave present on channel 0 of the PXIe-5170R

9. Repeat steps 6 through 8 until the **Timebase Cal Complete** indicator from the `Timebase Cal Adjust VI` returns TRUE.

10. Disable the calibrator output.

11. Call the `niHSAI Close Ext Cal Session VI` 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 EEPROM. 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 EEPROM.

Reverification

Repeat the *Verification* procedures to determine the as-left status of the PXIe-5170R.

About this task

> 🖉 | **NOTE**
> If any test fails reverification after performing an adjustment, verify that you have met the test conditions before returning your PXIe-5170R to NI. Refer to the *NI 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-5170R verification.

Before you begin

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

Procedure

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`.

NI Services

Visit *ni.com/support* to find support resources including documentation, downloads, and troubleshooting and application development self-help such as tutorials and examples.

Visit *ni.com/services* to learn about NI service offerings such as calibration options, repair, and replacement.

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

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