CALIBRATION PROCEDURE

NI PXIe-5624R

2 GS/s, 12-Bit IF Digitizer

This document contains the verification and adjustment procedures for the NI PXIe-5624R (NI 5624R) IF digitizer. Refer to `ni.com/calibration` for more information about calibration solutions.

NI LabVIEW Instrument Design Libraries for IF Digitizers includes example FPGA images to use the NI 5624R in two modes of operation:

- **Digitizer Mode**—IF data is captured directly from the ADC without DSP and stored into DRAM. This data is not equalized or calibrated. Use `Interactive IF Acquisition Without DSP (Host).vi` from the Multirecord Acquisition sample project to acquire data in digitizer mode.
- **Digital Downconversion (DDC) Mode**—Signal processing on the FPGA converts data from the ADC into quadrature I/Q data. This DSP shifts the frequency of, decimates, equalizes, and calibrates the data before storing it into DRAM. Use `Interactive Spectrum Acquisition (Host).vi` from the Multirecord Acquisition sample project or `IQ Acquisition (Host).vi` to acquire data in DDC mode.

Contents

Software

Calibrating the NI 5624R requires you to install the following software on the calibration system:

- NI LabVIEW 2014 Full/Pro or later
- A version of the NI LabVIEW Instrument Design Libraries for IF Digitizers that is compatible with your LabVIEW version

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

Documentation

You might find the following documentation helpful as you perform the calibration procedure:

- *NI PXIe-5624R Getting Started Guide*
- *NI IF Digitizers Help*
- *NI PXIe-5624R Specifications*

The latest versions of these documents can be found on `ni.com/manuals`.

Test Equipment

Table 1 lists the equipment NI recommends for the performance verification and adjustment procedures.

If the recommended equipment is not available, select a substitute using the minimum requirements listed in the following table.

Table 1. NI 5624R Required Equipment Specifications for NI 5624R Calibration

Equipment	Recommended Model	Measured Specification	Minimum Requirements
Power sensor	Rohde & Schwarz (R&S) NRP-Z91	Test system characterization Verifying absolute amplitude accuracy Adjusting absolute amplitude accuracy	Range: -15 dBm to +10 dBm Frequency range: 4 MHz to 2.005 GHz Power linearity: <0.1 dB VSWR: <1.11 at 2.005 GHz
Signal generator	Rohde & Schwarz SMA100A	Test system characterization Verifying internal frequency reference (B22 option needed for this procedure) Verifying absolute amplitude accuracy Adjusting internal frequency reference (B22 option needed for this procedure) Adjusting absolute amplitude accuracy	Frequency range: 4 MHz to 2.005 GHz Amplitude range: -10 dBm to 10 dBm Frequency accuracy: $\leq \pm 3.5 \times 10^{-8}$
Power splitter	Aeroflex/Weinschel 1593	Test system characterization Verifying absolute amplitude accuracy Adjusting absolute amplitude accuracy	VSWR: <1.25 at 4 MHz to 2 GHz Amplitude tracking: <0.25 dB Maximum Input Power: >10 dBm CW
6 dB attenuator	Anritsu 41KB-6 or Mini-Circuits BW-S6W2	Test system characterization Verifying absolute amplitude accuracy Adjusting absolute amplitude accuracy	Frequency range: DC to 2 GHz VSWR: <1.2
50 Ω SMA terminator (m)	—	Test system characterization	Frequency range: DC to 2 GHz VSWR: 1.1

Table 1. NI 5624R Required Equipment Specifications for NI 5624R Calibration (Continued)

Equipment	Recommended Model	Measured Specification	Minimum Requirements
SMA (m)-to-SMA (m) cable	—	All procedures	Frequency range: DC to 2 GHz Impedance: 50 Ω Maximum length: 1 meter
SMA (f)-to-N (m) adapter	Fairview Microwave SM4226	All procedures	Frequency range: DC to 2 GHz Impedance: 50 Ω Return loss: ≥23 dB
SMA (m)-to-N (f) adapter	Huber+Suhner 33_SMA_N-50-1/1-_UE or Fairview Microwave SM4241	Test system characterization Verifying absolute amplitude accuracy Adjusting absolute amplitude accuracy	Frequency range: DC to 2 GHz Impedance: 50 Ω Return loss: ≥23 dB
SMA (f)-to-N (f) adapter	Huber+Suhner 31_3-SMA-50-1/1-_UE or Fairview Microwave SM4236	Test system characterization	Frequency range: DC to 2 GHz Impedance: 50 Ω Return loss: ≥23 dB
3.5 mm (m)-to-3.5 mm (m) adapter	Huber+Suhner 32_PC35-50-0-2/199_NE or Fairview Microwave SM4960	Test system characterization Verifying absolute amplitude accuracy Adjusting absolute amplitude accuracy	Frequency range: DC to 2 GHz Impedance: 50 Ω Return loss: ≥30 dB
3.5 mm (f)-to-3.5 mm (f) adapter	Huber+Suhner 31_PC35-50-0-1/199_UE	Test system characterization	Frequency range: DC to 2 GHz Impedance: 50 Ω Return loss: ≥28 dB

Test Conditions

The following setup and environmental conditions are required to ensure the NI 5624R meets published specifications:

- Keep cabling as short as possible. Long cables act as antennas, picking up extra noise that can affect measurements.
- Verify that all connections, including front panel connections and screws, are secure.
- Maintain an ambient temperature of 23 °C ±5 °C.
- Keep relative humidity between 10% and 90%, noncondensing.
- Allow a warm-up time of at least 20 minutes after the chassis is powered on, the NI LabVIEW Instrument Design Libraries for IF Digitizers software is loaded by the host, and the host recognizes the NI 5624R. The warm-up time ensures that the NI 5624R and test instrumentation are at a stable operating temperature.
- Perform self-calibration on the NI 5624R.
- Plug the PXI Express chassis and the test equipment into the same power strip to avoid ground loops.
- Use a torque wrench appropriate for the type of RF connector that you are using.
- In each verification procedure, insert a delay between configuring all devices and acquiring the measurement. Adjust this delay depending on the instruments used but make sure it is at least 5,000 ms for the first iteration and 10 ms for each other iteration.
- Ensure that the PXI Express 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`.

Initial Setup

Refer to the *NI PXIe-5624R Getting Started Guide* for information about how to install the software and hardware and how to configure the device in Measurement & Automation Explorer (MAX).

Connect the SMA (f)-to-N (m) adapter to the RF OUT port of the signal generator.

Characterizing the Test System

You use the measured response of the test system during verification tests.

The power splitter and attenuation response is measured at the RF input frequencies used in the verification and adjustment tests.

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 Balance

Zero the power sensor as described in the *Zeroing the Power Sensor* section prior to starting this procedure.

This procedure characterizes the balance between the two output terminals of the splitter, where the second terminal is connected to an attenuator. The power splitter balance is required for the following procedures:

- Verifying Absolute Amplitude Accuracy
- Adjusting Absolute Amplitude Accuracy

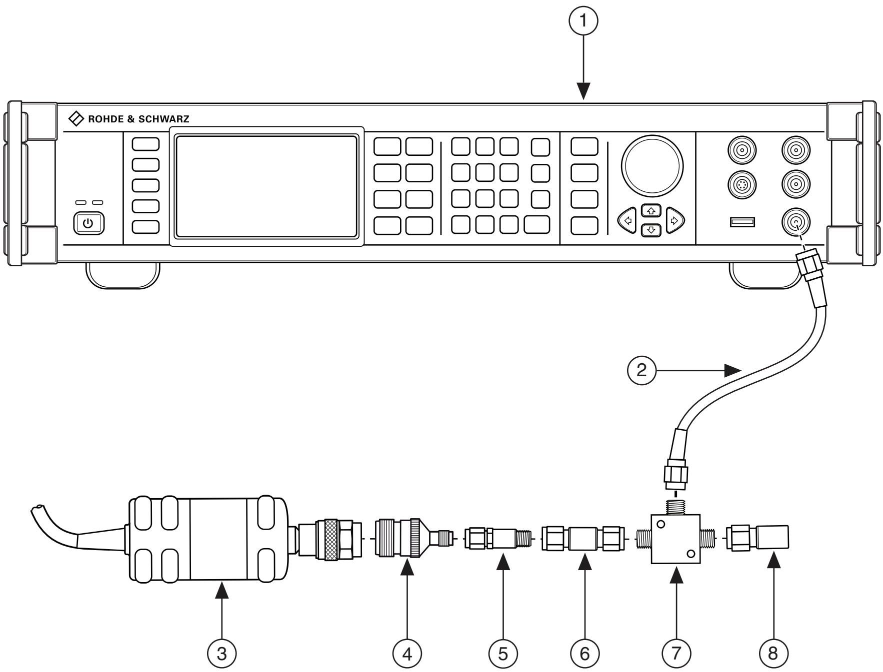
The verification and adjustment procedures use test points from 5 MHz to 2.005 GHz in 5 MHz steps for the splitter balance characterization. Frequencies in which harmonics alias on the fundamental frequency are excluded from the adjustment procedure. Be careful when applying splitter balance correction to measurements in the adjustment procedure. Ensure that you are applying the splitter balance for the correct frequency.

1. Connect the RF OUT connector of the signal generator to the input port of the power splitter using an SMA (m)-to-SMA (m) cable.
2. Connect the 50 Ω (m) terminator to one of the power splitter output ports. Refer to this port as splitter output 1.
3. Connect the other power splitter output to the SMA (f) connector of the 6 dB attenuator using a 3.5 mm (m)-to-3.5 mm (m) adapter. Refer to the combined power splitter output and 6 dB attenuator as splitter output 2.

4. Connect the power sensor to splitter output 2 using the SMA (f)-to-N (f) adapter.

   The following figure illustrates the hardware setup.

Figure 1. Connection Diagram for Measuring at Splitter Output 2



1	Signal Generator	5	6 dB Attenuator
2	SMA (m)-to-SMA (m) Cable	6	3.5 mm (m) to 3.5 mm (m) Adapter
3	Power Sensor	7	Power Splitter
4	SMA (f)-to-N (m) Adapter	8	50 Ω Terminator

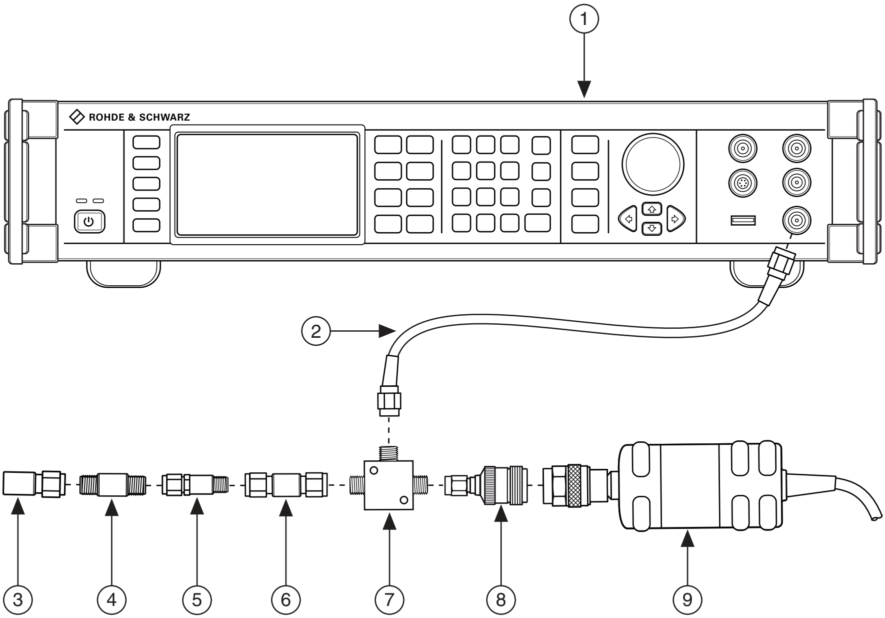
5. Configure the signal generator using the following settings:
   - Frequency: 5 MHz
   - Power level: 4 dBm
6. Configure the power sensor to correct for frequency using the power sensor frequency correction function.
7. Use the power sensor to measure the power at the frequency from step 6.
8. Repeat steps 5 through 7, by updating the signal generator frequency from 5 MHz to 2.005 GHz in 5 MHz steps.

   Record the resulting measurements as *splitter output 2 power*. Each frequency should have a corresponding value.
9. Disconnect the power sensor and 50 Ω terminator from the power splitter.
10. Connect the power sensor to splitter output 1 using an SMA (m)-to-N (f) adapter.

11. Connect the 50 Ω terminator to splitter output 2 using the 3.5 mm (f)-to-3.5 mm (f) adapter.

    The following figure illustrates the hardware setup.

Figure 2. Connection Diagram for Measuring at Splitter Output 1



1	Signal Generator	6	3.5 mm (m)-to-3.5 mm (m) Adapter
2	SMA (m)-to-SMA (m) Cable	7	Power Splitter
3	50 Ω Terminator	8	SMA (f)-to-N (m) Adapter
4	3.5 mm (f)-to-3.5 mm (f) Adapter	9	Power Sensor
5	6 dB Attenuator		

12. Configure the signal generator using the following settings:
    - Frequency: 5 MHz
    - Power level: 4 dBm
13. Configure the power sensor to correct for frequency using the power sensor frequency correction function.
14. Use the power sensor to measure the power.
15. Repeat steps 12 through 14 by updating the signal generator frequency from 5 MHz to 2.005 GHz in 5 MHz steps.

    Record the resulting measurements as *splitter output 1 power*. Each frequency should have a corresponding value.
16. Calculate the splitter balance for each frequency point using the following equation:

    $$\textit{splitter balance} = \textit{splitter output 2 power} - \textit{splitter output 1 power}$$
17. Disconnect the 50 Ω terminator and 3.5 mm (f)-to-3.5 mm (f) adapter from splitter output 2. The resulting fixture is used in *Verifying Absolute Amplitude Accuracy* and *Adjusting Absolute Amplitude Accuracy*.

Self-Calibrating the NI 5624R

Allow a 20 minute warm-up time before you begin self-calibration.

Note The warm-up time begins after the PXI Express chassis is powered on and the operating system completely loads.

The NI 5624R includes precise internal circuits and references used during self-calibration to adjust for any errors caused by short-term fluctuations in the environment. It is important that you perform a self-calibration function to validate the specifications listed in the next section.

You can perform the self-calibration through Measurement & Automation Explorer (MAX) or programmatically using LabVIEW.

Self-Calibrating Using MAX

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

1. Disconnect or disable any AC inputs to the digitizer.
2. Launch MAX.
3. Expand **My System»Devices and Interfaces»PXI System**.
4. Select the device that you want to calibrate.
5. Initiate self-calibration using one of the following methods:
   - Click **Self-Calibrate** in the upper right corner of MAX.
   - Right-click the name of the device in the MAX configuration tree and select **Self Calibrate** from the drop-down menu.

Self-calibration takes approximately 1 minute to complete.

Self-Calibrating Using LabVIEW

To initiate self-calibration using LabVIEW, complete the following steps:

1. Disconnect or disable any AC inputs to the digitizer.
2. Use the Self-Calibrate VI located at **FPGA Interface»Software Designed Instruments» IF Digitizer»Calibration** to initiate self-calibration.

Self calibration takes approximately 1 minute to complete.

As-Found and As-Left Limits

The as-found limits are the published specifications for the NI 5624R. NI uses these limits to determine whether the NI 5624R meets the device specifications when it is received for calibration.

The as-left limits are equal to the published NI specifications for the NI 5624R, less guard bands for the measurement uncertainty, temperature drift, and drift over time. NI uses these limits to ensure that the NI 5624R meets the published specifications over its calibration interval.

Verification

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

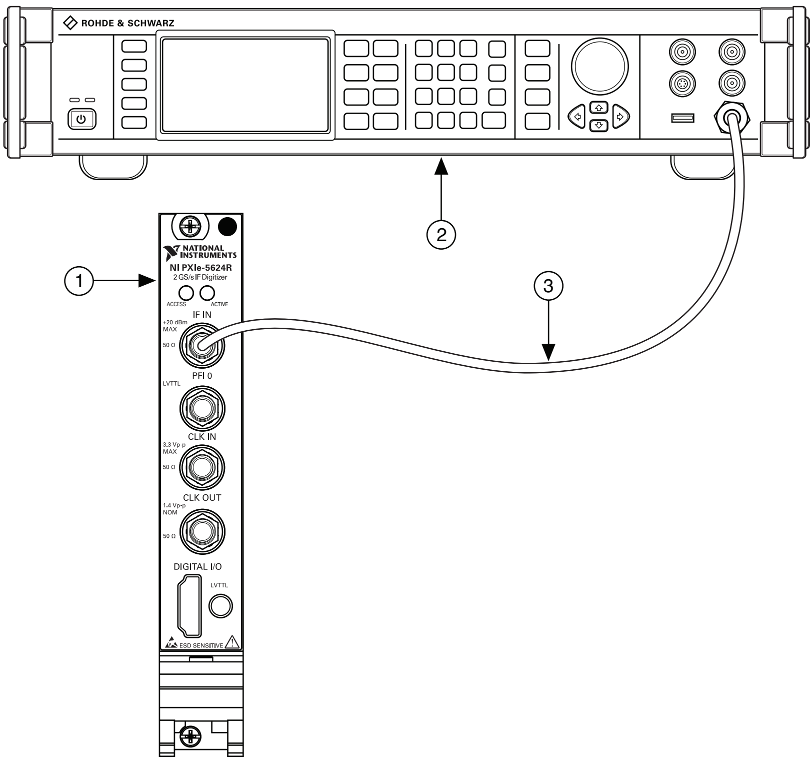
Verifying Internal Frequency Reference

This procedure verifies the frequency accuracy of the NI 5624R onboard frequency reference using a signal generator. Use digitizer mode of the NI 5624R. Use `Interactive IF Acquisition Without DSP (Host).vi` in the Multirecord Acquisition sample project as a starting point.

1. Connect the signal generator RF OUT front panel connector to the NI 5624R IF IN front panel connector using an SMA (m)-to-SMA (m) cable.

   The following figure illustrates the hardware setup.

Figure 3. Internal Frequency Reference Verification Cabling Diagram



1	NI 5624R	2	Signal Generator	3	SMA (m)-to-SMA (m) Cable

2. Configure the signal generator using the following settings:
   - Frequency: 11 MHz
   - Power level: 0 dBm
3. Configure the NI 5624R to acquire and measure the signal generated in step 2, using the following settings:
   - Digitizer mode
   - Dither: Off
   - Samples: 1×10^6
   - Reference Clock source: Onboard
4. Measure the frequency of the peak acquired tone using `Extract Single Tone Information.vi`.
5. Calculate the deviation using the following equation:

$$\Delta f = \left|\frac{f_{measured} - 11MHz}{11MHz}\right|$$

6. Compare the value determined in step 5 to the verification test limits in the following table.

Table 2. Internal Frequency Reference Verification Limits

As-Found Limit	*initial accuracy* + *aging* + *temperature stability*
As-Left Limit	*initial accuracy*

where

$initial\ accuracy = \pm 200 \times 10^{-9}$

$aging = \dfrac{\pm 0.5x10^{-6}}{year} \times number\ of\ years\ since\ last\ adjustment$

$temperature\ stability = \pm 2 \times 10^{-6}$

Note You can find *number of years since last adjustment* programmatically using NI LabVIEW Instrument Design Libraries for IF Digitizers.

Verifying Absolute Amplitude Accuracy

This procedure verifies the absolute amplitude accuracy of the NI 5624R input channel. Accuracy is specified using the calibration IP on the default 400 MHz acquisition FPGA image provided in the Multirecord Acquisition sample project. The `Interactive Spectrum Acquisition (Host).vi` provides a starting point for this procedure. The calibration IP equalizes the frequency response and corrects for losses. Because a digital downconverter (DDC) is used, multiple center frequencies are chosen in order to cover the entire specified bandwidth. The response across 400 MHz of bandwidth for each center frequency is measured.

This procedure requires the test setup and data collected in the *Characterizing Power Splitter Balance* section. Characterize the power splitter balance before running this procedure.

Zero the power sensor as described in the *Zeroing the Power Sensor* section prior to starting this procedure.

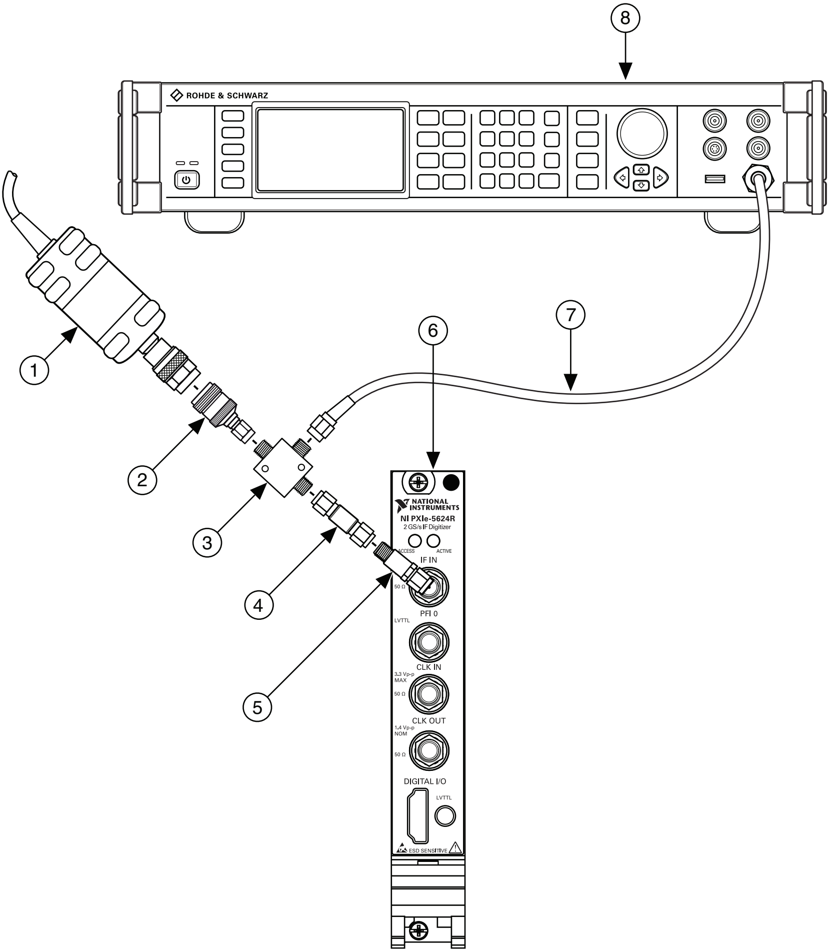
1. Connect the signal generator RF OUT front panel connector to the input terminal of the power splitter using an SMA (m)-to-SMA (m) cable.
2. Connect splitter output 1 directly to the power sensor input connector using the SMA (m)-to-N(f) adapter.
3. Connect splitter output 2 to the SMA (f) end of the 6 dB attenuator using a 3.5 mm (m)-to-3.5 mm (m) adapter.

Note The power splitter configuration must match the configuration used in the *Characterizing Power Splitter Balance* procedure.

4. Connect the 6 dB attenuator SMA (m) connector directly to the NI 5624R IF IN front panel connector.

   The following figure illustrates the complete hardware setup.

Figure 4. Absolute Amplitude Accuracy Verification Cabling Diagram



1	Power Sensor	5	6 dB Attenuator
2	SMA (m)-to-N (f) Adapter	6	NI 5624R
3	Power Splitter	7	SMA (m)-to-SMA (m) Cable
4	3.5 mm (m)-to-3.5 mm (m) Adapter	8	Signal Generator

5. Configure the NI 5624R with the following settings:
   - DDC mode
   - Center frequency: The first frequency listed in the *NI 5624R Center Frequency (MHz)* column in Table 3.
   - I/Q rate: 500 MHz
   - Dither: On (High)
6. Configure the signal generator with the following settings:
   - Frequency: The first frequency listed in the *Generator Start Frequency (MHz)* column in Table 3
   - Power level: 4 dBm

Table 3. Configured Center Frequencies

NI 5624R Center Frequency (MHz)	Generator Start Frequency (MHz)	Generator Stop Frequency (MHz)	Step Size (MHz)
225	25	425	5
500	300	700	5
800	600	995	5
1200	1005	1400	5
1500	1300	1700	5
1800	1600	1975	5

7. Configure the power sensor to correct for the current frequency of the signal generator using the power sensor frequency correction function.
8. Use the power sensor to measure the power. Record the result as *measured input power*.

Note Power sensor readings are in dBm, not watts.

9. Calculate the *corrected input power* using the following equation:

$$\textit{corrected input power} = \textit{measured input power} + \textit{splitter balance}$$

Tip Find the splitter balance by using the appropriate data points from the *Characterizing Power Splitter Balance* section.

10. Perform an acquisition and measure the tone present at the frequency generated by the signal generator.
11. Calculate the *absolute amplitude accuracy* using the following equation:

$$\textit{absolute amplitude accuracy} = \textit{NI 5624R input power} - \textit{corrected input power}$$

12. Repeat steps 6 through 11, increasing the generator frequency by the value in the *Step Size* column, until you reach the value in the *Generator Stop Frequency (MHz)* column.
13. Repeat steps 5 through 12 for the remaining frequencies in the *NI 5624R Center Frequency (MHz)* column in Table 3.
14. Compare the *absolute amplitude accuracy* values measured to the verification test limits in the following table.

Table 4. Absolute Amplitude Accuracy Verification Limits

Frequency	As-Found Limit (dB)	As-Left Limit (dB)
25 MHz to 1 GHz	±0.25	±0.10
1 GHz to 1.975 GHz	±0.30	±0.15

Updating Calibration Date and Time

This procedure updates the date and time of the last NI 5624R calibration in the NI 5624R flash memory.

Successfully complete all required verifications or successfully complete reverification following adjustment prior to updating the calibration date and time on the NI 5624R.

Complete the following steps to update the NI 5624R calibration date and time.

1. Call `niIFDig Group A ExternalCal v1 Host.lvclass:Initialize External Calibration.vi`. The default password is `NI`.
2. Call `niIFDig ExternalCal v1 Host.lvclass:Write Ext Cal Date.vi`. Wire in the current date and time.
3. Call `niIFDig External Cal v1 Host.lvclass:Close External Calibration.vi`. Set the **write calibration to hardware?** input to TRUE to store the results.

Adjustment

This section describes the steps needed to adjust the NI 5624R to meet published specifications.

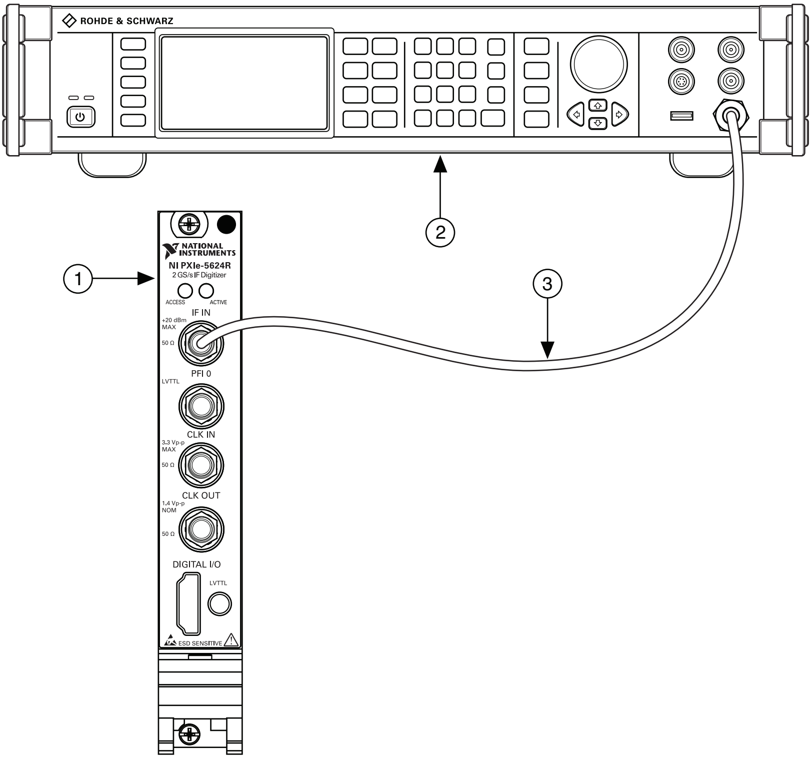
Adjusting Internal Frequency Reference

This procedure adjusts the internal frequency reference.

1. Connect the signal generator RF OUT front panel connector to the NI 5624R IF IN front panel connector using an SMA (m)-to-SMA (m) cable.

   The following figure illustrates the hardware setup.

Figure 5. Internal Frequency Reference Adjustment Cabling Diagram



1	NI 5624R	2	Signal Generator	3	SMA (m)-to-SMA (m) Cable

2. Configure the signal generator using the following settings.
   - Frequency: 11 MHz
   - Power level: 5 dBm
3. Call `niIFDig Group A ExternalCal v1 Host.lvclass:Initialize External Calibration.vi`. The default password is `NI`.

4. Call `niIFDig ExternalCal v1 Host.lvclass:Clock FrequencyCal.vi`. Wire the frequency of the signal generator to the **actual frequency (Hz)** input.
5. Call `niIFDig ExternalCal v1 Host.lvclass:Close External Calibration.vi`. Set the **write calibration to hardware?** input to TRUE to store the results to the NI 5624R flash memory.

Adjusting Absolute Amplitude Accuracy

This procedure measures the response of the IF IN signal path of the NI 5624R.

This procedure requires the test setup and data collected in the *Characterizing Power Splitter Balance* section. Characterize the power splitter balance before running this procedure.

Make sure to use the power splitter balance characterization data for the correct frequency, as the following frequencies are excluded from the adjustment procedure due to harmonics aliasing back on to the fundamental and disrupting the measurement:

- 200 MHz
- 250 MHz
- 400 MHz
- 500 MHz
- 600 MHz
- 750 MHz
- 800 MHz
- 1.2 GHz
- 1.5 GHz
- 1.6 GHz

Zero the power sensor as described in the *Zeroing the Power Sensor* section prior to starting this procedure.

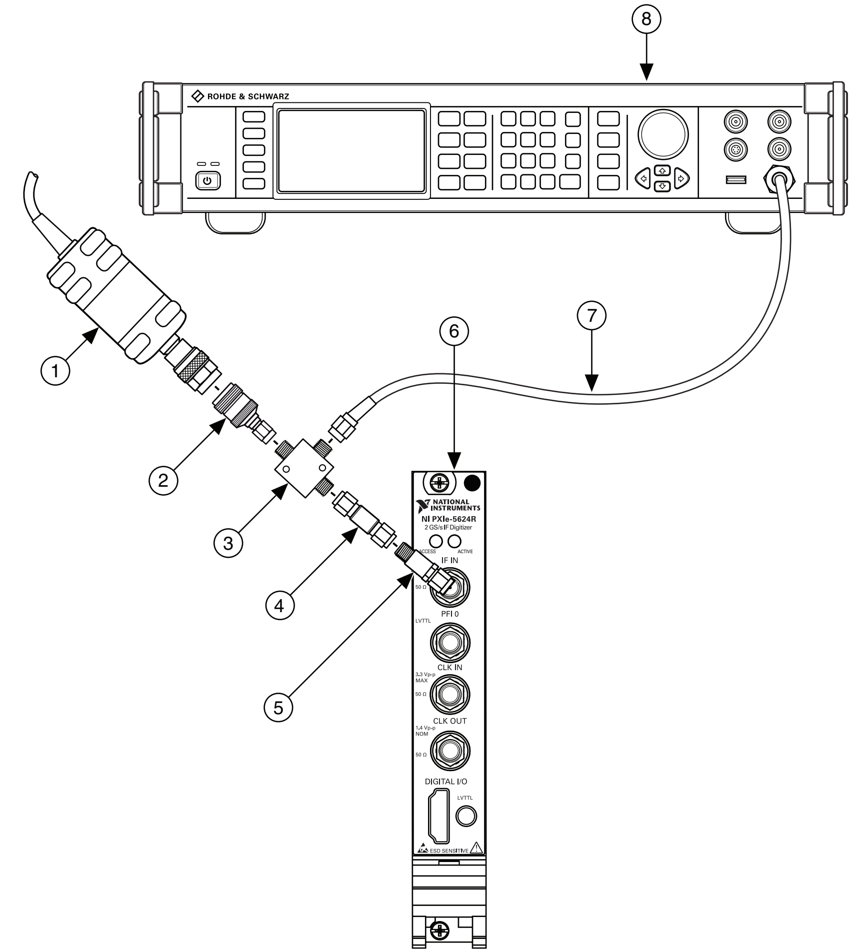
1. Connect the signal generator RF OUT front panel connector to the input terminal of the power splitter using an SMA (m)-to-SMA (m) cable.
2. Connect splitter output 1 directly to the power sensor input connector using an SMA (m)-to-N (f) adapter.
3. Connect the splitter output 2 to the SMA (f) end of the 6 dB attenuator using a 3.5 mm (m)-to-3.5 mm (m) adapter.

Note The power splitter configuration must match the configuration used in the *Characterizing Power Splitter Balance* procedure.

4. Connect the 6 dB attenuator SMA (m) connector directly to the NI 5624R IF IN front panel connector.

   The following figure illustrates the hardware setup.

Figure 6. Absolute Amplitude Accuracy Adjustment Cabling Diagram



1	Power Sensor	5	6 dB Attenuator
2	SMA (m)-to-N (f) Adapter	6	NI 5624R
3	Power Splitter	7	SMA (m)-to-SMA (m) Cable
4	3.5 mm (m)-to-3.5 mm (m) Adapter	8	Signal Generator

5. Ensure that the NI 5624R and the signal generator share a common reference. The following steps assume you have connected the signal generator reference frequency REF OUT to the NI 5624R REF IN connector.

6. Call `niIFDig Group A ExternalCal v1 Host.lvclass:Initialize External Calibration.vi`.

7. Call `niIFDig ExternalCal v1 Host.lvclass:Amplitude Cal Initialize.vi`. Wire **External 10 MHz Reference Clock** to the **reference clock source** input.
8. Call `niIFDig ExternalCal v1 Host.lvclass:Amplitude Cal Configure.vi`.
9. Configure the signal generator using the following settings:
   - Frequency: value of the **frequency to generate (Hz)** output from `niIFDig External Cal v1 Host.lvclass:Amplitude Cal Configure.vi`
   - Power level: value of the **power to generate (dBm)** output from `niIFDig External Cal v1 Host.lvclass:Amplitude Cal Configure.vi` plus 12 dB
   - Reference Clock source: Internal
10. Configure the power sensor to correct for the **frequency to generate (Hz)** output from `niIFDig External Cal v1 Host.lvclass:Amplitude Cal Configure.vi` using the power sensor frequency correction function.
11. Measure the power of the signal present at splitter output 1 of the power splitter using the power sensor. Record this value as the *measured input power*.
12. Calculate the *corrected input power* using the following equation:

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

> **Tip** Find the *splitter balance* by choosing the correct data point from the *Characterizing Power Splitter Balance* section. Remember that certain frequencies are not measured due to harmonics aliasing back on the fundamental.

13. Call `niIFDig ExternalCal v1 Host.lvclass Amplitude Cal Adjust.vi`. Wire the *corrected input power* calculated in step 12 to the **actual power (dBm)** input. Wire the **frequency** output from `niIFDig External Cal v1 Host.lvclass: Amplitude Cal Configure.vi` to the **actual frequency (Hz)** input.
14. Repeat steps 8 through 13 until the **amplitude calibration complete** output of `niIFDig ExternalCal v1 Host.lvclass:Amplitude Cal Adjust.vi` returns a value of TRUE.
15. Call `niIFDig ExternalCal v1 Host.lvclass:Close External Calibration.vi`. Set the **write calibration to hardware?** input to TRUE to store the results to the NI 5624R flash memory.

Reverification

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

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

Worldwide Support and Services

The National Instruments 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 National Instruments product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

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