CALIBRATION PROCEDURE

PXIe-5668

Up to 26.5 GHz PXI Vector Signal Analyzer

This document contains the verification procedures for the PXIe-5668. Refer to ni.com/calibration for more information about calibration solutions.

When not otherwise specified, the procedures in this document refer to both the PXIe-5668 14 GHz and the PXIe-5668 26.5 GHz Vector Signal Analyzer. In places where the procedures differ between the two products, the appropriate device settings are specified. Depending on the hardware option purchased, your device might not support all test frequencies noted in the procedures.

NI warrants the PXIe-5668 to meet its published specifications if the individual modules are calibrated and operating within specifications. Refer to *Letter of Conformance* at ni.com/manuals for more information about RF system calibration.

Contents

Software

Calibrating the PXIe-5668 requires you to install the following software on the calibration system:

- NI-RFSA 14.1 or later
- NI Spectral Measurements Toolkit 2.5 or later

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

The software supports programming the calibration procedures in the LabVIEW, C, and LabWindows™/CVI™ application development environments (ADEs). When you install the software, you need to install support only for the ADE that you intend to use.

Documentation

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

- *PXIe-5668 Vector Signal Analyzer Getting Started Guide*
- *NI RF Vector Signal Analyzers Help*
- *PXIe-5668 Specifications*

The latest versions of these documents are available at ni.com/manuals.

This calibration procedure calibrates the PXIe-5668 as a single system. To calibrate the PXIe-5653 or PXIe-5624 individually, refer to their calibration procedures, available at ni.com/manuals.

Test Equipment

Table 1 lists the equipment NI recommends for the performance verification procedures. If the recommended equipment is not available, select a substitute using the minimum requirements listed in the table.

Table 1. Recommended Equipment for PXIe-5668 Calibration

Equipment	Recommended Models	Where Used	Minimum Requirements
Power meter	Anritsu ML2438A	Verifying absolute amplitude accuracy	Display resolution: ≤ 0.01 dB Settling: ±0.1% Instrumentation accuracy: < ±0.5% Noise, zero set, and drift: ≤ ±0.5% full-scale (lowest range) Reference power uncertainty: ≤ ±1.2% Reference output VSWR: <1.12 : 1
Power sensor (x2)	Anritsu SC7413	Verifying absolute amplitude accuracy	Power range: -55 dBm to 20 dBm Frequency range: 100 kHz to 26.5 GHz Input VSWR: <150 MHz.....<1.17 : 1 150 MHz to <2 GHz .....<1.08 : 1 2 GHz to <12.4 GHz.....<1.16 : 1 12.4 GHz to <18 GHz.....<1.21 : 1 18 GHz to <26.5 GHz.....<1.29 : 1 Linearity: <18 GHz.....<1.8% <27 GHz.....<2.5% Refer to *Appendix B: Power Sensor Calibration Factor Uncertainty Requirements* for calibration factor uncertainty (2 σ) specifications.
Signal generator (RF source 1)	Anritsu MG3694C Options 1A, 2B, 4, and 28B	Verifying third-order intermodulation distortion, Verifying gain compression, Verifying second harmonic intercept	Frequency range: 10 MHz to 26.5 GHz Leveled power: -50 dBm to 14 dBm Power accuracy: ±1.0 dB Harmonics: >10 MHz to ≤100 MHz ..... <-40 dBc >100 MHz to ≤2.2 GHz ..... <-50 dBc >2.2 GHz to ≤16 GHz..... <-60 dBc Nonharmonic spurious: >10 MHz to ≤2.2 GHz ..... <-60 dBc >2.2 GHz to ≤16 GHz..... <-60 dBc Output VSWR: <2.0 : 1 **Note:** Do not use a signal generator with High Power option, since the Harmonic and Non-Harmonic spurious content would impact the measurements.

Table 1. Recommended Equipment for PXIe-5668 Calibration (Continued)

Equipment	Recommended Models	Where Used	Minimum Requirements
Signal generator (RF source 2)	Anritsu MG3694C Options 1A, 2B, 4, and 28B	Verifying absolute amplitude accuracy, Verifying image rejection, Verifying third-order intermodulation distortion, Verifying second harmonic intercept, Verifying gain compression	Frequency range: 10 MHz to 26.5 GHz Leveled power: -50 dBm to 9 dBm Power accuracy: ±1.0 dB Harmonics: >10 MHz to ≤100 MHz .....<-40 dBc >100 MHz to ≤2.2 GHz.....<-50 dBc >2.2 GHz to ≤16 GHz .....<-60 dBc Nonharmonic spurious: 10 MHz to ≤2.2 MHz ..... <-60 dBc >2.2 GHz to ≤16 GHz ..... <-60 dBc Output VSWR: <2.0 : 1 **Note:** Do not use a signal generator with High Power option, since the Harmonic and Non-Harmonic spurious content would impact the measurements.
50 Ω termination (x3)*	NI 778353-01	Verifying average noise level, Verifying non-input-related (residual) spurs	Frequency: 18 GHz **Note:** The termination load prevents input port leakage and does not contribute to measurement uncertainty.
PXI Express chassis	PXIe-1075 or PXIe-1085	All procedures	—
PXI Express controller	PXIe-8133 or PXIe-8135	All procedures	—
SMA-to-SMA cable, labeled U*	NI 152637A-01	—	—
SMA-to-SMA cable, labeled V*	NI 152638A-01	—	—
SMA-to-SMA cable, labeled W*	NI 152639A-01	—	—
SMA-to-SMA cable, labeled X*	NI 152640A-01	—	—
SMA-to-SMA cable, labeled Y*	NI 152641A-01	—	—

Table 1. Recommended Equipment for PXIe-5668 Calibration (Continued)

Equipment	Recommended Models	Where Used	Minimum Requirements
2.92 mm (m)-to-2.92 mm (m) cables (24 in.) (x3)	—	—	Frequency range: DC to 26.5 GHz Insertion loss: ≤10 dB at 26.5 GHz Impedance: 50 Ω VSWR: <2.0 : 1
2.92 mm (m)-to-2.92 mm (m) adapter	Anritsu K220B	—	Frequency range: DC to 26.5 GHz Impedance: 50 Ω VSWR: <1.12 : 1 Return loss: DC to 1.5 GHz .....≥35 dB 1.5 GHz to 6.0 GHz .....≥30 dB 6.0 GHz to 18.0 GHz .....≥20 dB
2.92 mm (f)-to-2.92 mm (f) adapter	Fairview Microwave SM4953	—	Frequency range: DC to 26.5 GHz Impedance: 50 Ω VSWR: <1.15 : 1
2.92 mm (m)-to-2.92 mm (f) 20 dB attenuator	Anritsu 41KC-20	—	Frequency range: DC to 26.5 GHz Attenuation: 20 dB (nominal) Power rating: 2 W average Impedance: 50 Ω VSWR: DC to 12 GHz .....≤1.1 : 1 12 GHz to 18 GHz .....≤1.15 : 1 18 GHz to 26.5 GHz .....≤1.2 : 1
Power splitter (two-resistor type)	Weinschel 1534	—	Frequency range: DC to 26.5 GHz Amplitude tracking: <0.3 dB Phase tracking: <2° Insertion loss: ≤8.0 dB (6 dB, nominal) Power rating: 1 W Impedance: 50 Ω VSWR: DC to 26.5 GHz .....≤1.4 : 1 Equivalent output VSWR: DC to 26.5 GHz .....≤1.35 : 1 Connectors: 2.92 mm (f)
Anti-distortion test fixture	NI 538381A-01	Verifying third-order intermodulation distortion, Verifying second harmonic intercept, Verifying gain compression	Refer to *Appendix A: Anti-Distortion Test Fixture* for specifications. **Note**: The anti-distortion test fixture requires an external +15 V/75 W supply and USB interface. Contact NI for programming details.

Table 1. Recommended Equipment for PXIe-5668 Calibration (Continued)

Equipment	Recommended Models	Where Used	Minimum Requirements
Frequency reference source	Symmetricom 8040C rubidium frequency standard	—	Frequency: 10 MHz Frequency accuracy: $\leq 1 \times 10^{-9}$
Torque wrench	—	—	Refer to *Test Conditions* for torque wrench specifications.
* Included in the PXIe-5668 cable accessory kit.			

Test Conditions

The following setup and environmental conditions are required to ensure the PXIe-5668 meets published specifications.

- Keep cabling as short as possible. Long cables and wires act as antennae, 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 the relative humidity between 10% and 90%, noncondensing.
- Allow a warm-up time of at least 30 minutes after the chassis is powered on and NI-RFSA is loaded and recognizes the PXIe-5668. The warm-up time ensures that the measurement circuitry of the PXIe-5668 is at a stable operating temperature.
- In each verification procedure, insert a delay between configuring all devices and acquiring the measurement. This delay may need to be adjusted depending on the instruments used but should always be at least 1,000 ms for the first iteration, 1,000 ms when the power level changes, and 100 ms for each other iteration.
- Perform self-calibration on the PXIe-5668.
- Use a torque wrench appropriate for the type of RF connector that you are using. NI recommends a 0.565 N · m (5 lb · in.) wrench for SMA connectors and an 0.90 N · m (8 lb · in.) wrench for 2.92 mm connectors.
- Connect the frequency reference source to the REF IN connector on the PXI Express chassis with a standard BNC (m)-to-BNC (m) cable. This connection replaces the connection from the PXIe-5653 REF OUT (10 MHz) connector to the PXI Express chassis REF IN connector, if present.
- Lock all test equipment to the REF OUT signal on the back of the PXI Express chassis. Refer to the *PXIe-5668 Timing Configurations* topic in the *NI RF Vector Signal Analyzers Help* for more information about configuring clocking sources.
- Ensure that the PXI/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, refer to the *Maintain Forced-Air Cooling Note to Users* document available at `ni.com/manuals`.

Initial Setup

Refer to the *PXIe-5668 RF Vector Signal Analyzer Getting Started Guide* for information about how to install the software and hardware and how to configure the device in Measurement & Automation Explorer (MAX).

Test System Characterization

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 tests.

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 and Calibrating the Power Sensor

1. Connect Channel A of the power meter to power sensor A.
2. Connect Channel B of the power meter to power sensor B.
3. Zero and calibrate the power sensors using the built-in functions in the power meter.

Characterizing Power Splitter Reference Output

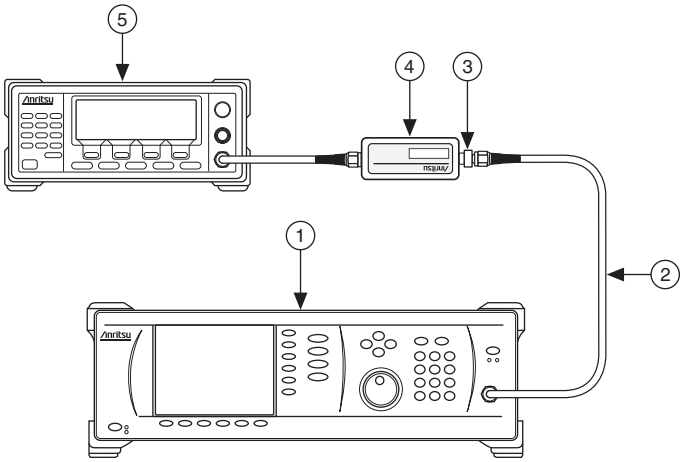
Designate either of the two outputs of the power splitter as the reference output. This output must be consistently used as the reference output throughout the characterization and verification procedures.

Characterizing RF Source Power (Direct)

Note Zero and calibrate the power sensor before starting this procedure. Refer to the *Zeroing and Calibrating the Power Sensor* section for more information.

1. Connect the RF source 2 output to the power sensor B input using the 2.92 mm (m)-to-2.92 mm (m) cable and 2.92 mm (f)-to-2.92 mm (f) adapter. The completed equipment setup is shown in Figure 1.

Figure 1. RF Source 2 Output Power Characterization Equipment Setup



1	RF Source 2	4	Power Sensor B
2	2.92 mm (m)-to-2.92 mm (m) Cable	5	Power Meter
3	2.92 mm (f)-to-2.92 mm (f) adapter		

2. Set the RF source 2 frequency to 10.0123 MHz.
3. Set the RF source 2 power to 0 dBm.
4. Measure the *Channel B Power* using the appropriate calibration factor for the power sensor frequency. Calculate the *RF Source Power Direct* using the following equation:

$$RF\ Source\ Power\ Direct = Channel\ B\ Power$$

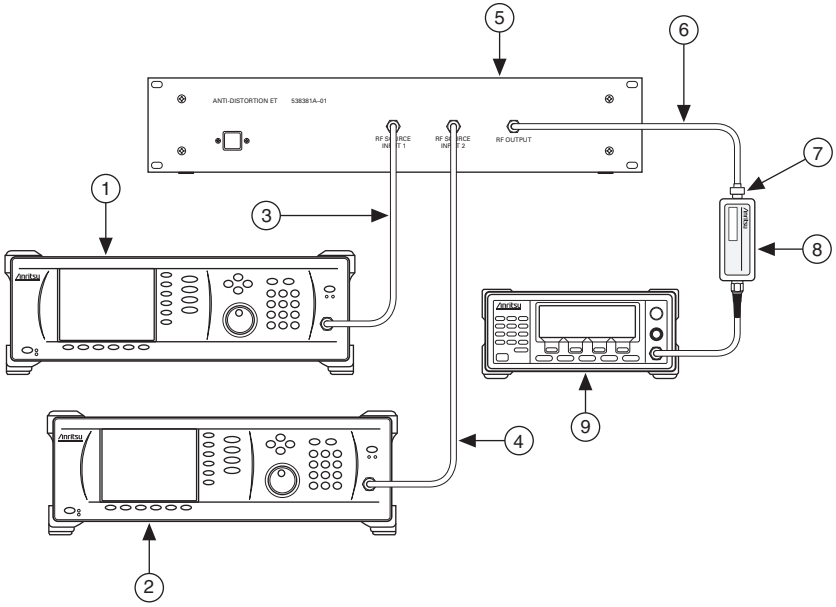
5. Repeat steps 2 to 4 for RF source 2 frequencies up to 26.5 GHz in 100 MHz increments.

Characterizing RF Source Power (with Lowpass Filter)

Note Zero and calibrate the power sensor according to the *Zeroing and Calibrating the Power Sensor* section before starting this procedure.

1. Connect the RF source 2 output to power sensor B through the anti-distortion test fixture. The completed equipment setup is shown in Figure 2.

Figure 2. RF Source Power (with Lowpass Filter) Characterization Equipment Setup



1	RF Source 1	6	2.92 mm (m)-to-2.92 mm (m) Cable
2	RF Source 2	7	2.92 mm (f)-to-2.92 mm (f) Adapter
3	2.92 mm (m)-to-2.92 mm (m) Cable	8	Power Sensor B
4	2.92 mm (m)-to-2.92 mm (m) Cable	9	Power Meter
5	Anti-Distortion Test Fixture		

2. Disable the RF source 1 output and the RF source 2 output.

3. Set the RF source 1 and RF source 2 frequency and power according to the first row in the following tables.

Table 2. RF Source 1 Settings

Start Frequency	Stop Frequency	Step Size	Power
10 MHz	100 MHz	10 MHz	-15 dBm
100 MHz	470 MHz	100 MHz	-15 dBm
470 MHz	471 MHz	1 MHz	-15 dBm
500 MHz	735 MHz	100 MHz	-15 dBm
735 MHz	736 MHz	1 MHz	-15 dBm
800 MHz	1.15 GHz	100 MHz	-15 dBm
1.15 GHz	1.151 GHz	1 MHz	-15 dBm
1.2 GHz	1.8 GHz	100 MHz	-15 dBm
1.8 GHz	1.801 GHz	1 MHz	-15 dBm
1.9 GHz	2.53 GHz	100 MHz	-15 dBm

Table 3. RF Source 2 Settings

Start Frequency	Stop Frequency	Step Size	Power
2.53 GHz	2.531 GHz	1 MHz	-15 dBm
2.6 GHz	3.55 GHz	100 MHz	-15 dBm
3.55 GHz	3.551 GHz	1 MHz	-15 dBm
3.6 GHz	4.985 GHz	100 MHz	-15 dBm
4.985 GHz	4.986 GHz	1 MHz	-15 dBm
5 GHz	7 GHz	100 MHz	-15 dBm
7 GHz	7.001 GHz	1 MHz	-15 dBm
7.2 GHz	14 GHz	100 MHz	-15 dBm

4. Configure the anti-distortion test fixture to use the appropriate Lowpass Filter Path, according to Table 4.

Table 4. Lowpass Filter Frequency Ranges

Lowpass Filter Path	Frequency Range	Appropriate RF Source
470 MHz	10 MHz to 470 MHz	Source 1
735 MHz	>470 MHz to 735 MHz	Source 1
1,150 MHz	>735 MHz to 1.150 GHz	Source 1
1,800 MHz	>1.150 GHz to 1.800 GHz	Source 1
2,530 MHz	>1.800 GHz to 2.530 GHz	Source 1
3,550 MHz	>2.530 GHz to 3.550 GHz	Source 2
4,985 MHz	>3.550 GHz to 4.985 GHz	Source 2
7,000 MHz	>4.985 GHz to 7.000 GHz	Source 2
14,000 MHz	>7.000 GHz to 14.000 GHz	Source 2

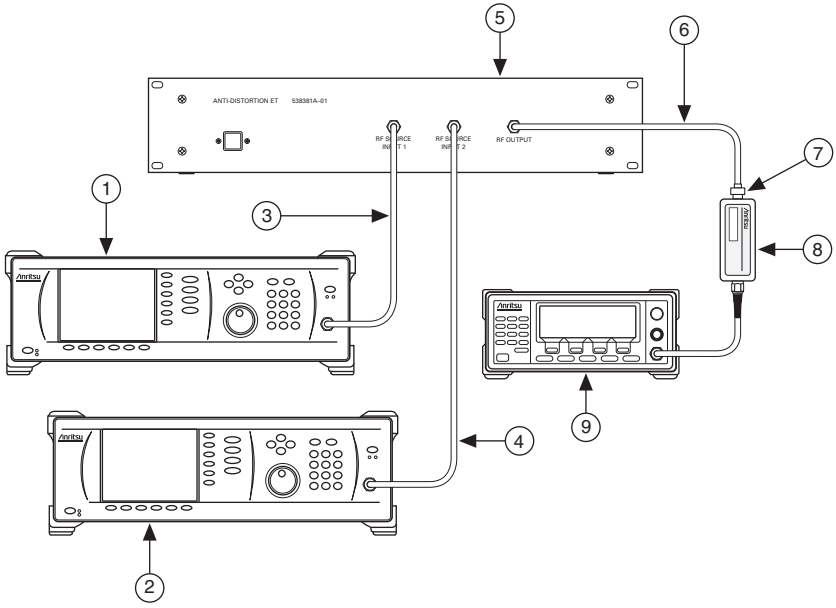
5. Enable the appropriate RF source output according to its frequency.
6. Measure the Channel B power using the appropriate calibration factor for the power sensor frequency. The power reading is the *RF Source Power LPF* for that frequency.
7. Repeat steps 3 to 6 for all the frequency and power values in Table 2 or Table 3, choosing the correct RF source for each frequency.

Characterizing RF Source Power (Combined) for Frequencies ≤ 700 MHz

Note Zero and calibrate the power sensor according to the *Zeroing and Calibrating the Power Sensor* section before starting this procedure.

1. Connect the RF source 1 and RF source 2 outputs to power sensor B through the anti-distortion test fixture. The completed equipment setup is shown in Figure 3.

Figure 3. RF Source Power (Combined) Characterization Equipment Setup (Frequencies ≤ 700 MHz)



1	RF Source 1	6	2.92 mm (m)-to-2.92 mm (m) Cable
2	RF Source 2	7	2.92 mm (f)-to-2.92 mm (f) Adapter
3	2.92 mm (m)-to-2.92 mm (m) Cable	8	Power Sensor B
4	2.92 mm (m)-to-2.92 mm (m) Cable	9	Power Meter
5	Anti-Distortion Test Fixture		

2. Set the anti-distortion test fixture to the ≤700 MHz combiner path.
3. Set the RF source 1 and RF source 2 frequency and power value according to the first row in Table 5.

Table 5. RF Source Power (Combined) Test Settings (Frequencies ≤ 700 MHz)

Start Frequency	Stop Frequency	Step Size	RF Source 1 Power	RF Source 2 Power
10 MHz	100 MHz	10 MHz	-15 dBm	-15 dBm
100 MHz	470 MHz	100 MHz	-15 dBm	-15 dBm
470 MHz	471 MHz	1 MHz	-15 dBm	-15 dBm
500 MHz	700 MHz	100 MHz	-15 dBm	-15 dBm

4. Disable the RF source 1 output, and enable the RF source 2 output.

Note When disabled, the RF source 1 output signal should be less than -60 dBm.

5. Measure and record the Channel B power using the appropriate sensor calibration factor for the RF source 2 frequency. Record this measurement as the *RF Source 2 Programmed Power* value for later in the *Verifying Third-Order Intermodulation Distortion* section.
6. Disable the RF source 2 output, and enable the RF source 1 output.

Note When disabled, the RF source 2 output signal should be less than -60 dBm.

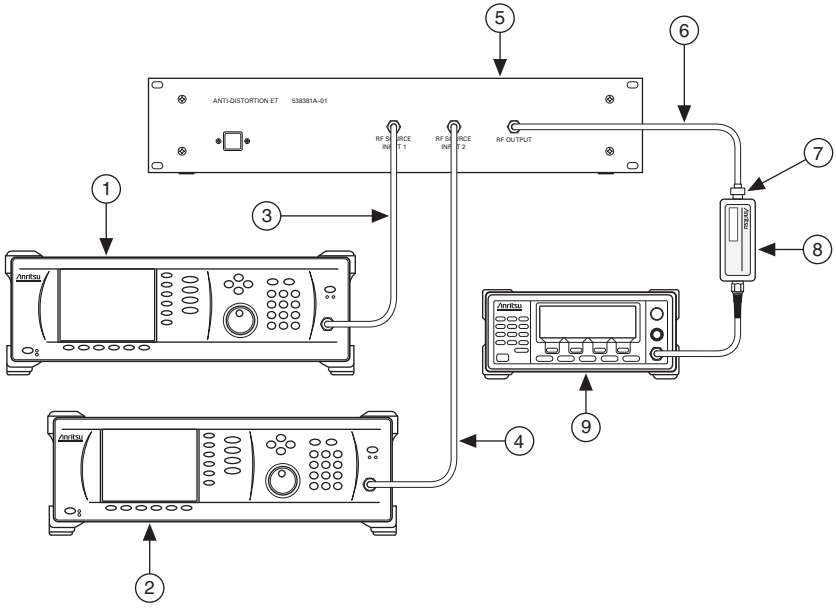
7. Measure the Channel B power using the appropriate sensor calibration factor for the RF source 1 frequency. Record this measurement as is the *RF Source 1 Programmed Power* value for later in the *Verifying Third-Order Intermodulation Distortion* section.
8. Repeat steps 3 to 7 for all remaining frequencies and power values in Table 5.

Characterizing RF Source Power (Combined) for Frequencies > 700 MHz

Note Zero and calibrate the power sensor according to the *Zeroing and Calibrating the Power Sensor* section before starting this procedure.

1. Connect the RF source 1 and RF source 2 outputs to power sensor B through the anti-distortion test fixture. The completed equipment setup is shown in Figure 4.

Figure 4. RF Source Power (Combined) Characterization Equipment Setup (Frequencies > 700 MHz)



1	RF Source 1	6	2.92 mm (m)-to-2.92 mm (m) Cable
2	RF Source 2	7	2.92 mm (f)-to-2.92 mm (f) Adapter
3	2.92 mm (m)-to-2.92 mm (m) Cable	8	Power Sensor B
4	2.92 mm (m)-to-2.92 mm (m) Cable	9	Power Meter
5	Anti-Distortion Test Fixture		

2. Set the anti-distortion test fixture to the >700 MHz combiner path.

3. Set the RF source 1 and RF source 2 frequency and power value according to the first row in Table 6.

Table 6. PXIe-5668 RF Source Power (Combined) Test Settings (Frequencies > 700 MHz)

Start Frequency	Stop Frequency	Step Size	RF Source 1 Power	RF Source 2 Power
700 MHz	735 MHz	35 MHz	-15 dBm	-15 dBm
735 MHz	735 MHz	1 MHz	-15 dBm	-15 dBm
800 MHz	1.15 GHz	100 MHz	-15 dBm	-15 dBm
1.15 GHz	1.151 GHz	1 MHz	-15 dBm	-15 dBm
1.2 GHz	1.8 GHz	100 MHz	-15 dBm	-15 dBm
1.8 GHz	1.801 GHz	1 MHz	-15 dBm	-15 dBm
1.9 GHz	2.53 GHz	100 MHz	-15 dBm	-15 dBm
2.53 GHz	2.531 GHz	1 MHz	-15 dBm	-15 dBm
2.6 GHz	3.55 GHz	100 MHz	-15 dBm	-15 dBm
3.55 GHz	3.551 GHz	1 MHz	-15 dBm	-15 dBm
3.6 GHz	4.985 GHz	100 MHz	-15 dBm	-15 dBm
5 GHz	7 GHz	100 MHz	-15 dBm	-15 dBm
7 GHz	7.001 GHz	1 MHz	-15 dBm	-15 dBm
7.2 GHz	14 GHz	100 MHz	-15 dBm	-15 dBm
14.1 GHz	27 GHz	100 MHz	-15 dBm	-15 dBm

4. Disable the RF source 1 output, and enable the RF source 2 output.

Note When disabled, the RF source 1 output signal should be less than -60 dBm.

5. Measure the Channel B power using the appropriate sensor calibration factor for the RF source 2 frequency. Record this measurement as the *RF Source 2 Programmed Power* value for later in the *Verifying Third-Order Intermodulation Distortion* section.

6. Disable the RF source 2 output, and enable the RF source 1 output.

Note When disabled, the RF source 2 output signal should be less than -60 dBm.

7. Measure the Channel B power using the appropriate sensor calibration factor for the RF source 1 frequency. Record this measurement as the *RF Source 1 Programmed Power* value for later in the *Verifying Third-Order Intermodulation Distortion* section.
8. Repeat steps 3 to 7 for all remaining frequencies listed in Table 6.

Characterizing RF Source Power (Through Splitter)

Note Before starting this procedure, zero and calibrate the power sensor and define the power splitter reference output using the procedures in the *Characterizing Power Splitter Reference Output* and *Characterizing RF Source Power (Direct)* sections of this document.

1. Connect the RF source 2 output to the power splitter input through the 2.92 mm (m)-to-2.92 mm (m) cable.
2. Connect a 50 Ω termination load to the power splitter reference output.
3. Connect the Channel B power sensor to the other output of the splitter.
4. Set the RF source 2 power to -10 dBm.
5. Set the RF source 2 frequency according to the first row in Table 7.

Table 7. RF Source 2 Frequencies

Start Frequency	Stop Frequency	Step Size
100 MHz	3.5 GHz	200 MHz
3.6 GHz	26.5 GHz	100 MHz

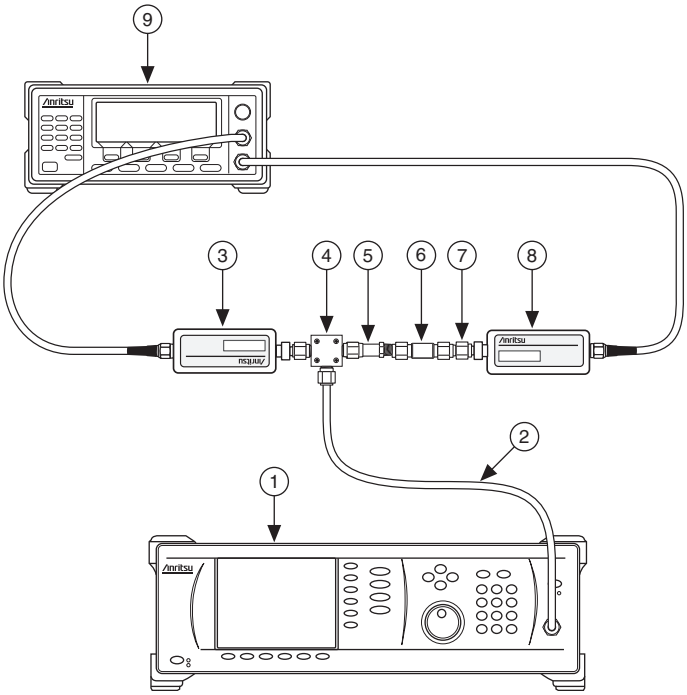
6. Measure the *Channel B Power* using the appropriate calibration factor for the RF source 2 frequency. Adjust the RF source 2 power until this measured power is within ±0.1 dB of -10 dBm.
7. Store the RF source 2 set power as the *RF Source Power through Splitter*.
8. Repeat steps 5 to 7 for all remaining frequencies in Table 7.

Characterizing RF Source Power (with Splitter and Attenuator)

Note Before starting this procedure, zero and calibrate the power sensor and define the power splitter reference output using the procedures in the *Characterizing Power Splitter Reference Output* and *Characterizing RF Source Power (Direct)* sections of this document.

1. Connect the RF source 2 output to the power splitter input through the 2.92 mm (m)-to-2.92 mm (m) cable.
2. Connect power sensor A to the power splitter reference output.
3. Connect power sensor B to the other output of the power splitter through the 2.92 mm (m)-to-2.92 mm (m) adapter, the 2.92 mm (f)-to-2.92 mm (f) adapter, and the 20 dB attenuator. The completed equipment setup is shown in Figure 5.

Figure 5. RF Source Power (with Splitter and Attenuator) Characterization Equipment Setup



1	RF Source 2	6	2.92 mm (m)-to-2.92 mm (m) Adapter
2	2.92 (m)-to-2.92 (m) Cable	7	2.92 mm (f)-to-2.92 mm (f) Adapter
3	Power Sensor A	8	Power Sensor B
4	Power Splitter	9	Power Meter
5	20 dB Attenuator		

4. Set the RF source 2 power to 0 dBm.
5. Set the RF source 2 frequency according to the first row in Table 8.

Table 8. RF Source 2 Frequencies

Start Frequency	Stop Frequency	Step Size
10 MHz	100 MHz	10 MHz
200 MHz	600 MHz	100 MHz
612.5 MHz	613.5 MHz	1 MHz
700 MHz	3.6 GHz	100 MHz
3.8 GHz	26.6 GHz	200 MHz

6. Measure the *Channel A Power* and the *Channel B Power* using each sensor and the appropriate calibration factor for the RF Source 2 frequency.
7. Calculate the *DUT to Power Meter through Attenuator Path Loss* and *RF Source to DUT through Attenuator Path Loss* for that frequency using the following formulas:

$$\textit{DUT to Power Meter through Attenuator Path Loss} = \textit{Channel A Power} - \textit{Channel B Power}$$

$$\textit{RF Source to DUT through Attenuator Path Loss} = -\textit{Channel B Power}$$

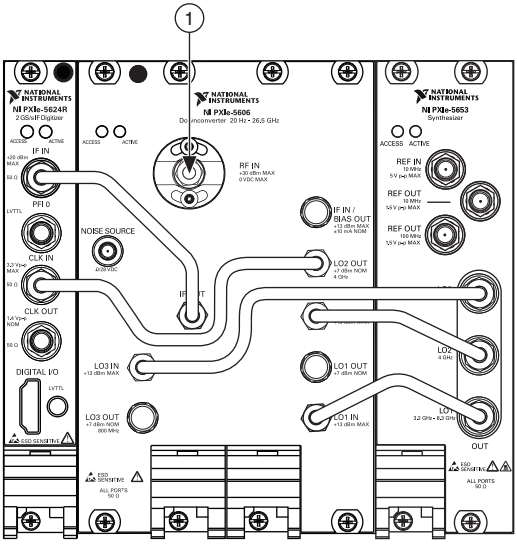
8. Repeat steps 5 to 7 for all remaining frequencies in Table 8.

Self-Calibrating the PXIe-5668

Note No signal connections are needed for self-calibration.

1. Connect a 50 Ω termination to the PXIe-5668 RF IN connector, as shown in the following figure.

Figure 6. Self-Calibration Equipment Setup



1 50 Ω Termination

2. Create a new session for the PXIe-5668.
3. Configure the niRFSA Self Cal API to run all self calibration steps.
4. Commit the PXIe-5668 settings to hardware.
5. Close the PXIe-5668 session.

As-Found and As-Left Limits

The as-found limits are the published specifications for the PXIe-5668. NI uses these limits to determine whether the PXIe-5668 meets the device specifications when it is received for calibration.

The as-left limits are equal to the published NI specifications for the PXIe-5668, less guard bands for manufacturing test measurement uncertainty, temperature drift, and drift over time. NI uses these limits to determine whether the PXIe-5668 meets the device specifications over its calibration interval.

Verification

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

In the event of a failure during the verification of the PXIe-5668, perform a calibration of the individual modules. Refer to the *Adjustment* section for more information. Return the PXIe-5606 module to NI for calibration and adjustment, if needed.

Verifying Reference Accuracy

The PXIe-5668 reference accuracy specification is derived from the PXIe-5653 reference accuracy. For more information about PXIe-5653 calibration values, refer to the *PXIe-5653 Calibration Procedure* available at `ni.com/manuals`.

Verifying Phase Noise

The phase noise for the PXIe-5668 system is determined by the phase noise of the PXIe-5653 module. To verify the PXIe-5653 phase noise specification, you must use the phase noise verification test for the PXIe-5653. For more information about calibration and verification of the PXIe-5653, refer to the *PXIe-5653 Calibration Procedure,* available at `ni.com/manuals`.

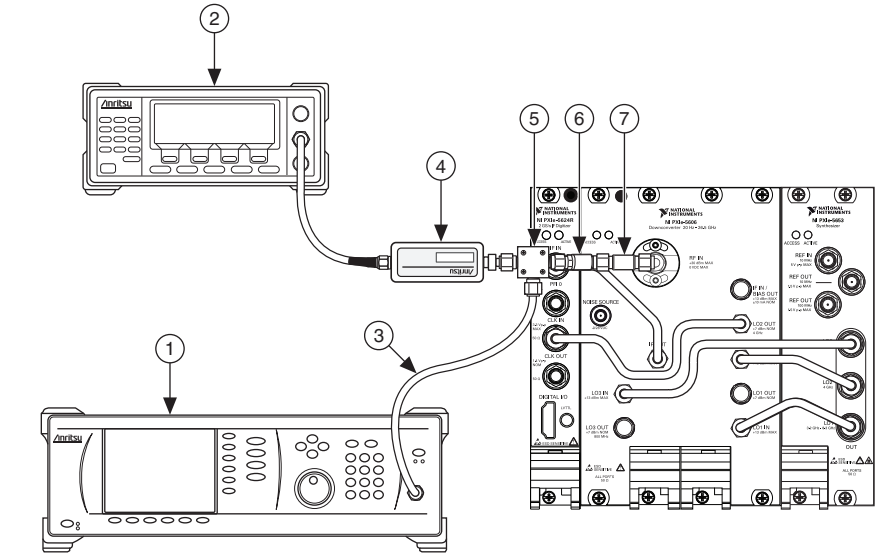
Verifying Absolute Amplitude Accuracy

Note Before starting this procedure, zero and calibrate the power sensor according to the *Zeroing and Calibrating the Power Sensor* section.

Note This section requires the characterizations *DUT to Power Meter through Attenuator Path Loss* and *RF Source to DUT through Attenuator Path Loss*.

1. Connect the RF source 2 to the power splitter input using the 2.92 mm (m)-to-2.92 mm (m) cable.
2. Connect the power splitter reference output to power sensor A.
3. Connect the other power splitter output to the PXIe-5668 RF IN connector using the 2.92 mm (m)-to-2.92 mm (m) adapter and 20 dB attenuator. The completed equipment setup is shown in Figure 7.

Figure 7. Absolute Amplitude Accuracy Verification (Frequencies > 10 MHz) Equipment Setup



1	RF Source 2	5	Power Splitter
2	Power Meter	6	20 dB Attenuator
3	2.92 mm (m)-to-2.92 mm (m) Cable	7	2.92 mm (m)-to-2.92 mm (m) Adapter
4	Power Sensor A		

4. Create a new session for the PXIe-5668.
5. Configure the PXIe-5668 according to the following fixed property settings. These settings remain unchanged during the test.
   - Acquisition Type: Spectrum

- Averaging Mode: RMS averaging
- Number of Averages: 20
- Digital IF Equalization Enabled: TRUE
- Digitizer Dither Enabled: Enabled
- Ref Clock Source: PXI_Clk
- Channel Coupling: AC coupled
- Span: 100 kHz
- Resolution Bandwidth: 1 kHz

6. Configure the PXIe-5668 according to the following variable property settings:
   - Preamp Enabled: Disabled
   - Device Instantaneous Bandwidth: 300 kHz for frequency < 100 MHz, 100 MHz for frequency ≥ 100 MHz
   - Preselector enabled: Disabled
7. Set the PXIe-5668 reference level using the following values:
   - Start power: -50 dBm
   - Stop power: -10 dBm (-30 dBm with preamplifier enabled)
8. Set the PXIe-5668 center frequency and the RF source 2 frequency according to the first row in Table 9.

Table 9. Absolute Amplitude Accuracy Verification (Frequencies > 10 MHz) Test Frequencies

Start Frequency	Stop Frequency	Step Size
10 MHz*	100.0 MHz	30 MHz
200 MHz	600.0 MHz	200 MHz
612.5 MHz	613.5 MHz	1 MHz
800 MHz	3.6 GHz	400 MHz
4 GHz	26.5 GHz	500 MHz

* The 10 MHz to 100 MHz frequency range applies only to the 300 kHz device instantaneous bandwidth values.

9. Set the RF source 2 amplitude for that RF source 2 frequency using the following equation:

$$\textit{RF Source 2 Amplitude} = \textit{PXIe-5668 Reference Level} + \textit{RF Source to DUT through Attenuator Path Loss}$$

10. Commit the PXIe-5668 settings to hardware.
11. Take a reading of the RF source 2 amplitude using power sensor A. This measurement is the *Measured Average Power* value.

12. Calculate the *Corrected Input Power* using the following formula:

Corrected Input Power = Measured Average Power - DUT to Power Meter through Attenuator Path Loss

Note The *RF source to DUT through Attenuator Path* and *DUT to Power Meter through Attenuator Path Loss* values were measured in the *Characterizing RF Source Power (with Splitter and Attenuator)* equipment characterization procedure. Use the values that correspond to the frequency range you are testing.

13. Read the PXIe-5668 power spectrum. The *PXIe-5668 Power* is the peak value of that spectrum.
14. Calculate the *Absolute Amplitude Accuracy* at each RF frequency using the following formula:

Absolute Amplitude Accuracy = PXIe-5668 *Power - Corrected Input Power*

15. Repeat steps 8 to 14 for all remaining frequencies in Table 9.
16. Repeat steps 7 to 15 for all remaining PXIe-5668 power levels.
17. Compare the *Absolute Amplitude Accuracy* to the verification test limits in Table 10.

Table 10. Absolute Amplitude Accuracy Verification Test Limits (Preamplifier Disabled, Preselector Disabled)

Frequency	As-Found Limit	As-Left Limit*
612.5 MHz	±0.57 dB	±0.35 dB
10 MHz to 100 MHz	±0.66 dB	±0.43 dB
>100 MHz to 300 MHz	±0.68 dB	±0.45 dB
>300 MHz to 1.7 GHz	±0.72 dB	±0.50 dB
>1.7 GHz to 2.8 GHz	±0.73 dB	±0.50 dB
>2.8 GHz to 3.6 GHz	±0.73 dB	±0.50 dB
>3.6 GHz to 8.5 GHz	±0.82 dB	±0.59 dB
>8.5 GHz to 14 GHz	±0.91 dB	±0.67 dB
>14 GHz to 17 GHz	±0.94 dB	±0.69 dB
>17 GHz to 20 GHz	±1.19 dB	±0.91 dB
>20 GHz to 26.5 GHz	±1.50 dB	±1.20 dB

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

18. Configure the PXIe-5668 according to the following variable property settings:

- Preamp Enabled: Enabled
- Device Instantaneous Bandwidth: 300 kHz

19. Repeat steps 8 to 14 for all frequencies ≤ 3.6 GHz in Table 9.
20. Compare the *Absolute Amplitude Accuracy* to the verification test limits in Table 11.

Table 11. Absolute Amplitude Accuracy Verification Test Limits (Preamplifier Enabled)

Frequency	As-Found Limit	As-Left Limit*
612.5 MHz	±0.96 dB	±0.74 dB
10 MHz to 100 MHz	±1.16 dB	±0.53 dB
>100 MHz to 300 MHz	±1.08 dB	±0.63 dB
>300 MHz to 1.7 GHz	±1.00 dB	±0.78 dB
>1.7 GHz to 2.8 GHz	±1.15 dB	±0.93 dB
>2.8 GHz to 3.6 GHz	±1.16 dB	±0.93 dB

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

21. Configure the PXIe-5668 according to the following variable property settings:
    - Preamp Enabled: Disabled
    - Device Instantaneous Bandwidth: 300 kHz
    - Preselector Enabled: Enabled
22. Repeat steps 8 to 14 for all frequencies > 3.6 GHz in Table 9.
23. Repeat steps 7 to 15 for all remaining PXIe-5668 reference power levels.
24. Compare the *Absolute Amplitude Accuracy* to the verification test limits in Table 12.

Table 12. Absolute Amplitude Accuracy Verification Test Limits (Preamplifier Disabled, Preselector Enabled)

Frequency	As-Found Limit	As-Left Limit*
>3.6 GHz to 8.5 GHz	±1.60 dB	±1.37 dB
>8.5 GHz to 14 GHz	±1.51 dB	±1.28 dB
>14 GHz to 17 GHz	±1.60 dB	±1.36 dB
>17 GHz to 20 GHz	±2.11 dB	±1.81 dB
>20 GHz to 26.5 GHz	±2.31 dB	±2.01 dB

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

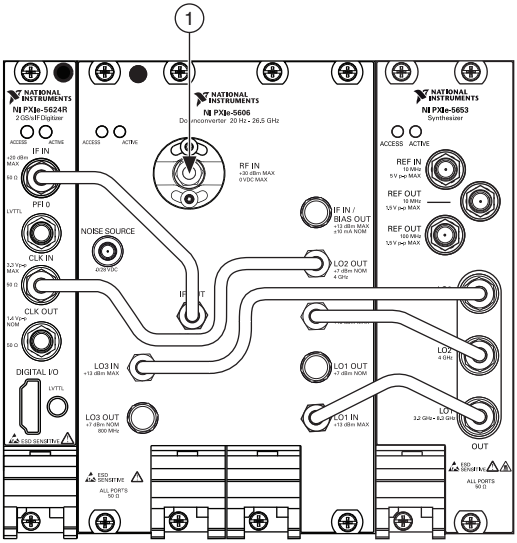
25. Close the PXIe-5668 session.

If the frequency response and absolute amplitude accuracy verification procedures determines that the PXIe-5668 is outside its limits, refer to *NI Services* for information about support resources or service requests.

Verifying Average Noise Level

1. Connect a 50 Ω termination to the PXIe-5668 RF IN connector. The completed equipment setup is shown in Figure 8.

Figure 8. Average Noise Level Verification Equipment Setup



1 50 Ω Termination

2. Create a new session for the PXIe-5668.
3. Configure the PXIe-5668 according to the following property settings:
   - Acquisition Type: Spectrum
   - Averaging Mode: Log Averaging
   - Channel Coupling: AC coupled
   - Digital IF Equalization Enabled: TRUE
   - Digitizer Dither Enabled: Enabled
   - Number of Averages: 20
   - Ref Clock Source: PXI_Clk
   - Power Spectrum Units: Volts squared
   - Preamp Enabled: Disabled

- Resolution Bandwidth Type: ENBW
- Reference Level: -50 dBm
- Resolution Bandwidth: 1 kHz
- Device Instantaneous Bandwidth: 300 kHz
- Span: 100 kHz
- RF Attenuation: 0 dB
- FFT Window Type: Flat Top
- Preselector Enabled: Disabled

4. Set the PXIe-5668 center frequency according to Table 13.

Table 13. Average Noise Level Verification Test Frequencies

Start Frequency	Stop Frequency	Step Size
10 MHz	90 MHz	20 MHz
100 MHz	200 MHz	100 MHz
600 MHz	14 GHz or 26.5 GHz*	500 MHz
* Your stop frequency depends on the hardware option purchased.		

5. Commit the PXIe-5668 settings to hardware.
6. Read the power spectrum from the PXIe-5668. Convert the power spectrum to a power spectral density (dBm/Hz) value.
7. Remove five points from around the center of the power spectral density from step 6.
8. Convert the power spectral density with the points removed to watts/Hz, and use the mean to convert the result back to dBm/Hz. This value is the *PXIe-5668 Average Noise (dBm/Hz)*.
9. Repeat steps 4 to 8 for all remaining frequencies in Table 13.
10. Repeat steps 4 to 9 for each of the following IF filter bandwidths:
    - 5 MHz
    - 100 MHz
    - 320 MHz (not available on the PXIe-5668 with 80 MHz bandwidth)
11. Repeat steps 4 to 10 for frequencies ≤ 3.6 GHz with the PXIe-5668 preamplifier enabled.

Note When the 320 MHz filter is selected, the maximum bandwidth is 3.41 GHz.

12. Repeat steps 4 to 10 for frequencies greater than 3.6 GHz with the PXIe-5668 preselector enabled and preamplifier disabled.

Note The 320 MHz filter bandwidth is not available when the preselector is enabled.

Note The PXIe-5668 preselector has a maximum instantaneous bandwidth of 50 MHz.

13. Compare the *PXIe-5668 Average Noise (dBm/Hz)* to the verification test limits in Table 14, Table 15, or Table 16 as appropriate.

Table 14. Average Noise Verification Test Limits (Preamplifier Disabled, Preselector Disabled)

Frequency	As-Found Limit	As-Left Limit*
200 kHz to 10 MHz	-151.0 dBm/Hz	-152.0 dBm/Hz
>10 MHz to 100 MHz	-154.0 dBm/Hz	-154.5 dBm/Hz
>100 MHz to 300 MHz	-155.0 dBm/Hz	-155.5 dBm/Hz
>300 MHz to 1.7 GHz	-154.0 dBm/Hz	-154.5 dBm/Hz
>1.7 GHz to 2.8 GHz	-151.0 dBm/Hz	-151.5 dBm/Hz
>2.8 GHz to 3.6 GHz	-149.0 dBm/Hz	-149.5 dBm/Hz
>3.6 GHz to 5 GHz	-153.0 dBm/Hz	-153.3 dBm/Hz
>5 GHz to 14 GHz	-153.0 dBm/Hz	-153.5 dBm/Hz
>14 GHz to 17 GHz	-147.0 dBm/Hz	-147.4 dBm/Hz
>17 GHz to 24 GHz	-150.0 dBm/Hz	-150.4 dBm/Hz
>24 GHz to 26.5 GHz	-148.0 dBm/Hz	-148.5 dBm/Hz

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

Table 15. Average Noise Verification Test Limits (Preamplifier Enabled)

Frequency	As-Found Limit	As-Left Limit*
>10 MHz to 30 MHz	-164.0 dBm/Hz	-164.5 dBm/Hz
>30 MHz to 100 MHz	-165.0 dBm/Hz	-165.5 dBm/Hz
>100 MHz to 300 MHz	-167.0 dBm/Hz	-167.5 dBm/Hz
>300 MHz to 1.7 GHz	-165.0 dBm/Hz	-165.5 dBm/Hz
>1.7 GHz to 2.8 GHz	-164.0 dBm/Hz	-164.5 dBm/Hz
>2.8 GHz to 3.6 GHz	-163.0 dBm/Hz	-163.5 dBm/Hz

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

Table 16. Average Noise Verification Test Limits
(Preamplifier Disabled, Preselector Enabled)

Frequency	As-Found Limit	As-Left Limit*
>3.6 GHz to 5 GHz	-149.0 dBm/Hz	-149.5 dBm/Hz
>5 GHz to 14 GHz	-149.0 dBm/Hz	-149.5 dBm/Hz
>14 GHz to 17 GHz	-143.0 dBm/Hz	-144.0 dBm/Hz
>17 GHz to 22 GHz	-146.0 dBm/Hz	-146.6 dBm/Hz
>22 GHz to 24 GHz	-145.0 dBm/Hz	-146.0 dBm/Hz
>24 GHz to 26.5 GHz	-143.0 dBm/Hz	-144.0 dBm/Hz

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

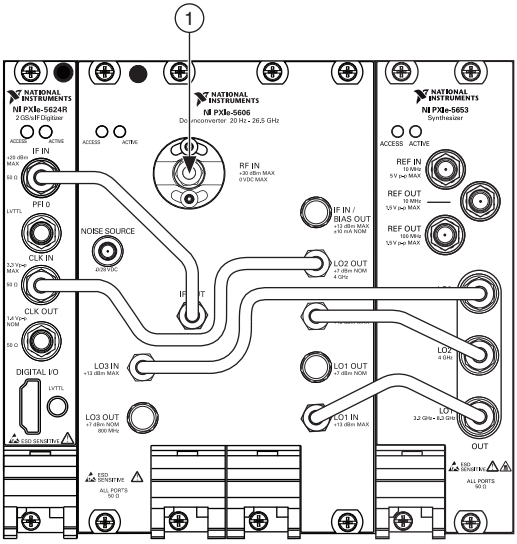
14. Close the PXIe-5668 session.

If the average noise level verification procedure determines that the PXIe-5668 is outside its limits, refer to *NI Services* for information about support resources or service requests.

Verifying Non-Input-Related Spurs (Residual Spurs)

1. Connect a 50 Ω termination to the PXIe-5668 RF IN connector. The completed equipment setup is shown in Figure 9.

Figure 9. Non-Input-Related Spurs Verification Equipment Setup



1 50 Ω Termination

2. Create a new session for the PXIe-5668.
3. Configure the PXIe-5668 according to the following property settings:
   - Acquisition Type: Spectrum
   - Averaging Mode: RMS averaging
   - Number of Averages: 5
   - Ref Clock Source: PXI_Clk
   - Ref Clock Rate: 10 MHz
   - Channel Coupling: AC coupled
   - Preamp Enabled: Disabled
   - Span: 100 MHz (80 MHz for the PXIe-5668 with 80 MHz bandwidth, 5 MHz for the 5 MHz IF filter path)
   - Device Instantaneous Bandwidth: 100 MHz (80 MHz for the PXIe-5668 with 80 MHz bandwidth, 5 MHz for the 5 MHz IF filter path)
   - Resolution Bandwidth: 500 Hz for frequency ≤ 3.6 GHz, 2 kHz for frequency > 3.6 GHz
   - RF Attenuation: 0 dB

- Reference Level: -60 dBm
- FFT Window Type: Flat Top
- Preselector Enabled: Disabled

4. Set the PXIe-5668 center frequency using the following values:
   - Start Frequency: 100 MHz
   - **(PXIe-5668 26.5GHz VSA)** Stop Frequency: 26.5 GHz
   - Step Size: 5 MHz for 5 MHz path, 100 MHz for 100 MHz IF filter path
5. Commit the PXIe-5668 settings to hardware.
6. Read the power spectrum from the PXIe-5668.
7. Measure the highest power in the spectrum returned from the PXIe-5668. This value is the *PXIe-5668 Non-Input-Related Spurious Level*.
8. Repeat steps 4 to 7 for all frequencies and filter paths in step 4.
9. Compare the *PXIe-5668 Non-Input-Related Spurious Level* to the verification test limits in Table 17 and Table 18.

Table 17. Non-Input-Related Spurs Verification Test Limits, 5 MHz Instantaneous Bandwidth Path

Center Frequency	As-Found Limit	As-Left Limit*
100 MHz to <3.6 GHz	-110 dBm	-110.5 dBm
>3.6 GHz to 11 GHz		
>11 GHz to 26.5 GHz	-97 dBm	-97.5 dBm
* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.		

Table 18. Non-Input-Related Spurs Verification Test Limits, 100 MHz Instantaneous Bandwidth Path

Center Frequency	As-Found Limit	As-Left Limit*
100 MHz to <3.6 GHz	-99 dBm	-99.5 dBm
>3.6 GHz to 11 GHz	-102 dBm	-102.5 dBm
>11 GHz to 24 GHz	-92 dBm	-92.5 dBm
>24 GHz to 26.5 GHz	-91 dBm	-91.5 dBm
* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.		

10. Close the PXIe-5668 session.

If the non-input-related spurs (residual spurs) verification procedure determines that the PXIe-5668 is outside its limits, refer to *NI Services* for information about support resources or service requests.

Verifying Image Rejection

This procedure verifies the following image responses of the PXIe-5668:

For test frequencies < 3.6 GHz:

$$IF1\ Image = Test\ Frequency + 9.225\ \text{GHz}$$

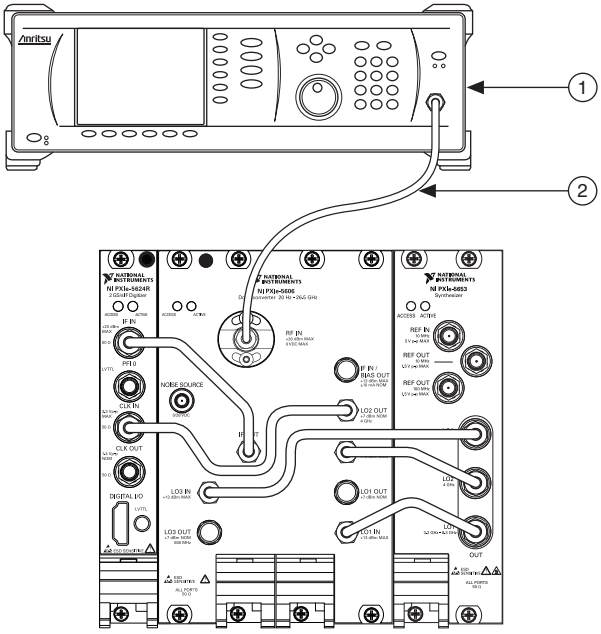
For test frequencies > 3.6 GHz:

$$IF1\ Image = Test\ Frequency + 1.225\ \text{GHz}$$

where *Test Frequency* is the PXIe-5668 center frequency.

1. Connect RF source 2 to the PXIe-5668 RF IN using the 2.92 mm (m)-to-2.92 mm (m) cable. The completed equipment setup is shown in Figure 10.

Figure 10. Image Rejection Verification Equipment Setup



1	RF Source 2	2	SMA (m)-to-SMA (m) Cable

2. Create a new session for the PXIe-5668.
3. Configure the RF source 2 using the following values:

- Mode: Single frequency
- Power level: 0 dBm

4. Configure the PXIe-5668 according to following property settings:
   - Acquisition Type: Spectrum
   - Averaging Mode: RMS averaging
   - Number of Averages: 10
   - Ref Clock Source: PXI_Clk
   - Channel Coupling: AC coupled
   - Preamp Enabled: Disabled
   - Span: 20 kHz
   - Resolution Bandwidth: 100 Hz
   - Device Instantaneous Bandwidth: 50 MHz
   - RF Attenuation: 10 dB
   - Reference Level: 0 dBm
   - Preselector Enabled: Enabled
5. Set the PXIe-5668 center frequency according to Table 19 as appropriate.

Table 19. Image Rejection Verification Test Frequencies

Start Frequency	Stop Frequency	Step Size
100.033325 MHz	2.000033325 GHz	400 MHz
2.399966675 GHz	26.499966675 GHz	400 MHz

6. Commit the PXIe-5668 settings to hardware.
7. For each test frequency from Table 19, calculate PXIe-5668 image frequencies using the following formulas:

   For test frequencies < 3.6 GHz:

   $$IF1\ Image = Test\ Frequency + 9.225\ \text{GHz}$$

   For test frequencies > 3.6 GHz:

   $$IF1\ Image = Test\ Frequency + 1.225\ \text{GHz}$$

   where *Test Frequency* is the PXIe-5668 center frequency.
8. Set the RF source 2 to each frequency from step 7 and the PXIe-5668 center frequency from step 5 with a *Power Setting* of 0 dB. First set the test frequencies, then the image frequencies. The *RF Source Power Direct* for this frequency is used in step 11.

Note *RF Source Power Direct* value was measured in the *Characterizing RF Source Power (Direct)* equipment characterization procedure.

9. Wait for 200 ms to allow the PXIe-5668 and RF source 2 amplitudes to settle.

Note Settling times are a characteristic of the RF source device. Refer to the *Test Equipment* section of this document for a list of NI-recommended source devices and device specifications. If you use an RF source device with different device specifications, your settling times may differ from those listed in this procedure.

10. Acquire the spectrum and determine the peak power for each frequency. The peak power value is the *Measured Level*.
11. For each *Measured Level,* calculate the *Response Correction* using the following equation:

Response Correction = Measured Level + RF Source Power Direct

12. Calculate the *Image Rejection* at each of the image frequencies using the following equation:

Image Rejection = Response Correction (at test frequency) - Response Correction (at each image frequency)

13. Repeat steps 5 to 12 for all center frequencies in Table 19.
14. Compare the *Image Rejection* results to the verification test limits in Table 20.

Table 20. Image Rejection Verification Test Limits

Center Frequency	As-Found Limit	As-Left Limit*
100 MHz to 3.6 GHz	-98 dBc	-100 dBc
>3.6 GHz to 14 GHz	-81 dBc	-83 dBc
>14 GHz to 26.5 GHz	-74 dBc	-76 dBc

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

15. Close the PXIe-5668 session.

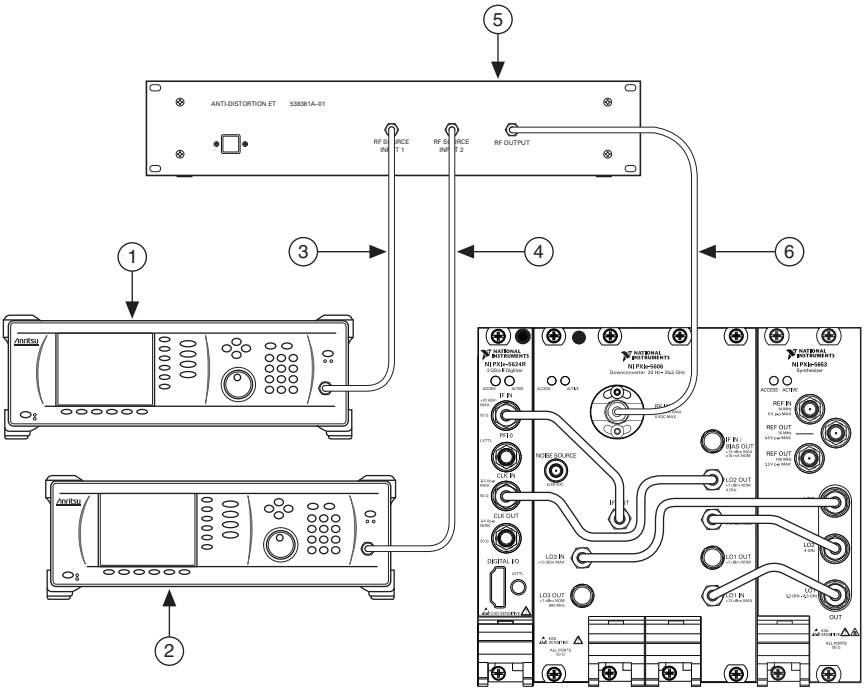
If the image rejection verification procedure determines that the PXIe-5668 is outside its limits, refer to *NI Services* for information about support resources or service requests.

Verifying Third-Order Intermodulation Distortion

Frequencies ≤ 700 MHz

1. Connect RF source 1 and RF source 2 to the PXIe-5668 RF IN connector through the anti-distortion test fixture as shown in Figure 11.

Figure 11. Third-Order Intermodulation Verification (Frequencies ≤ 700 MHz) Equipment Setup



1	RF Source 1	4	2.92 mm (m)-to-2.92 mm (m) Cable
2	RF Source 2	5	Anti-Distortion Test Fixture
3	2.92 mm (m)-to-2.92 mm (m) Cable	6	2.92 mm (m)-to-2.92 mm (m) Cable

2. Create a new session for the PXIe-5668.
3. Configure the PXIe-5668 according to the following property settings:
   - Acquisition Type: Spectrum
   - Averaging Mode: RMS averaging
   - Number of Averages: 10
   - Digital IF Equalization Enabled: TRUE
   - Digitizer Dither Enabled: Enabled
   - Ref Clock Source: PXI_Clk

- Channel Coupling: AC Coupled
- RF Attenuation: 0 dB
- IF Filter Bandwidth: 300 kHz
- Resolution Bandwidth: 350 Hz
- Span: 10 kHz

4. Configure the anti-distortion test fixture to use the ≤700 MHz combiner path.
5. Disable the RF source 1 and RF source 2 outputs.

Note When disabled, the RF source 1 and RF source 2 output signals should be less than -60 dBm.

6. Set the RF source 1 power to the *RF Source 1 Programmed Power*[1] corresponding to one of the following values:
   - Preamplifier disabled: -10 dBm
   - Preamplifier enabled: -30 dBm
7. Set the RF source 2 power to the *RF Source 2 Programmed Power*[2] corresponding to one of the following values:
   - Preamplifier disabled: -10 dBm
   - Preamplifier enabled: -30 dBm
8. Configure the PXIe-5668 reference level to one of the following values:
   - Preamplifier disabled: -10 dBm
   - Preamplifier enabled: -30 dBm
9. For each test frequency in Table 21, calculate the following four frequencies:
   - *IMD Low Frequency* = *Test Frequency* - 1.05 MHz
   - *P1 Frequency* = *Test Frequency* + 350 kHz
   - *P2 Frequency* = *Test Frequency* - 350 kHz
   - *IMD High Frequency* = *Test Frequency* + 1.05 MHz

   where *IMD* is the intermodulation distortion.

Table 21. TOI (Frequencies ≤ 700 MHz) Verification Test Frequencies

Start Frequency	Stop Frequency	Step Size
12.05 MHz	92.05 MHz	40 MHz
100 MHz	700 MHz	300 MHz

10. Set the RF source 1 frequency to *P1 Frequency*.

[1] The *RF Source 1 Programmed Power* value was measured in the *RF Source Power (Combined) for Frequencies ≤ 700 MHz* equipment characterization procedure.

[2] The *RF Source 2 Programmed Power* value was measured in the *RF Source Power (Combined) for Frequencies ≤ 700 MHz* equipment characterization procedure.

11. Set the RF source 2 frequency to *P2 Frequency*.
12. Set the PXIe-5668 center frequency to *IMD Low Frequency*.
13. Commit the PXIe-5668 settings to hardware.
14. Enable the RF source 1 and the RF source 2 outputs.
15. Wait 250 ms before making the first measurement and wait 100 ms before making subsequent measurements to allow the PXIe-5668, RF Source 1, and RF Source 2 amplitudes to settle.

Note Settling times are a characteristic of the RF source device. Refer to the *Test Equipment* section of this document for a list of NI-recommended source devices and device specifications. If you use an RF source device with different device specifications, your settling times may differ from those listed in this procedure.

16. Measure the power spectrum with the PXIe-5668.
17. Find the highest peak within the measurement bandwidth. This value is the *IMD Low Power*.
18. Repeat steps 12 to 17 for the PXIe-5668 center frequencies of *P1 Frequency*, *P2 Frequency*, and *IMD High Frequency*. The values from step 17 are *IMD Low Power*, *P1 Power*, *P2 Power*, and *IMD High Power,* respectively.
19. Calculate the upper and lower third-order intercept (TOI) points using the following equations:

$$TOI\ Upper = P1\ Power + (P2\ Power - IMD\ High\ Power)/2$$

$$TOI\ Lower = P2\ Power + (P1\ Power - IMD\ Low\ Power)/2$$

The smaller of the *TOI Lower* and *TOI Upper* values is the *TOI Minimum*.

20. Repeat steps 9 to 19 for all test frequencies in Table 21.
21. Repeat steps 6 to 20 with the PXIe-5668 preamplifier enabled.

22. Compare the *TOI Minimum* to the verification test limits in Table 22 or Table 23 as appropriate.

Table 22. TOI (Frequencies ≤ 700 MHz) Verification Test Limits (Preamplifier Disabled)

Center Frequency	As-Found Limit	As-Left Limit*
10 MHz to 100 MHz	+16.0 dBm	+16.4 dBm
>100 MHz to 700 MHz	+21.0 dBm	+21.3 dBm
* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.		

Table 23. TOI (Frequencies ≤ 700 MHz) Verification Test Limits (Preamplifier Enabled)

Center Frequency	As-Found Limit	As-Left Limit*
10 MHz to 500 MHz	-16.0 dBm	-15.4 dBm
>500 MHz to 700 MHz	-14.0 dBm	-13.3 dBm
* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.		

23. Disable the RF source 1 output and the RF source 2 output.

Note When disabled, the RF source 1 and RF source 2 output signals should be less than -60 dBm.

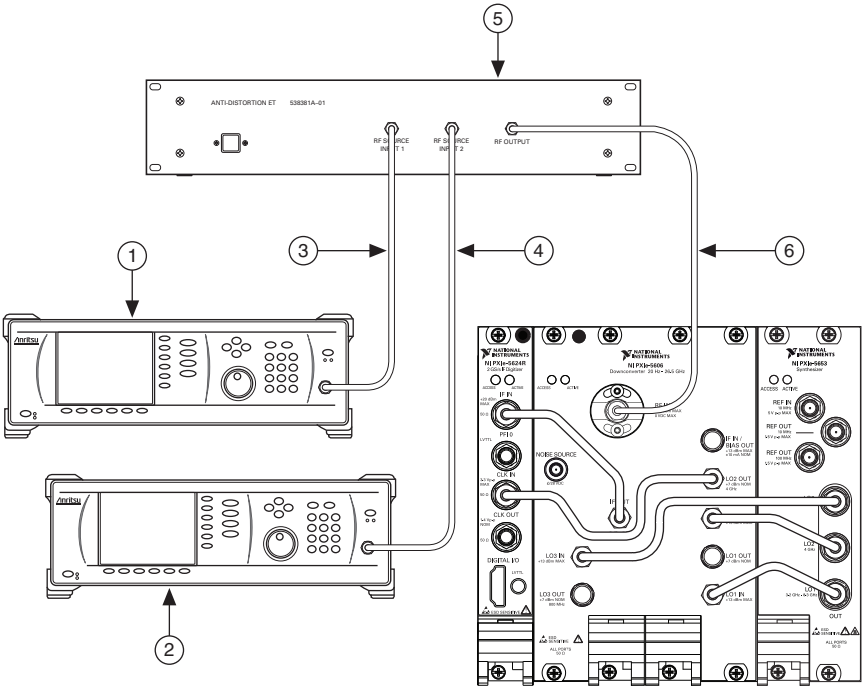
24. Close the PXIe-5668 session.

If the third-order intermodulation distortion for frequencies ≤ 700 MHz verification procedure determines that the PXIe-5668 is outside its limits, refer to *NI Services* for information about support resources or service requests.

Frequencies > 700 MHz

1. Connect RF source 1 and RF source 2 to the PXIe-5668 RF IN connector through the anti-distortion test fixture as shown in Figure 12.

Figure 12. Third-Order Intermodulation (Frequencies > 700 MHz) Verification Equipment Setup



1	RF Source 1	4	2.92 mm (m)-to-2.92 mm (m) Cable
2	RF Source 2	5	Anti-Distortion Test Fixture
3	2.92 mm (m)-to-2.92 mm (m) Cable	6	2.92 mm (m)-to-2.92 mm (m) Cable

2. Create a new session for the PXIe-5668.
3. Configure the PXIe-5668 according to the following property settings:
   - Acquisition Type: Spectrum
   - Averaging Mode: RMS averaging
   - Number of Averages: 10
   - Digital IF Equalization Enabled: TRUE
   - Ref Clock Source: PXI_Clk
   - Channel Coupling: AC Coupled
   - RF Attenuation: 0 dB
   - Device Instantaneous Bandwidth: 300 kHz

- Resolution Bandwidth: 350 Hz
- Span: 10 kHz
- Preselector Enabled: Disabled

4. Configure the anti-distortion test fixture to use the >700 MHz combiner path.
5. Disable the RF source 1 and RF source 2 outputs.

Note When disabled, the RF source 1 and RF source 2 output signals should be less than -60 dBm.

6. Set the RF source 1 power to the *RF Source 1 Programmed Power*[1] corresponding to one of the following values:
   - Preamplifier disabled: -10 dBm
   - Preamplifier enabled: -30 dBm
7. Set the RF source 2 power to the *RF Source 2 Programmed Power*[2] corresponding to one of the following values:
   - Preamplifier disabled: -10 dBm
   - Preamplifier enabled: -30 dBm
8. Configure the PXIe-5668 reference level to one of the following values:
   - Preamplifier disabled: -10 dBm
   - Preamplifier enabled: -30 dBm
9. For each test frequency in Table 24, calculate the following four frequencies:
   - *IMD Low Frequency* = *Test Frequency* - 1.05 MHz
   - *P1 Frequency* = *Test Frequency* + 350 kHz
   - *P2 Frequency* = *Test Frequency* - 350 kHz
   - *IMD High Frequency* = *Test Frequency* + 1.05 MHz

Table 24. TOI (Frequencies > 700 MHz) Verification Test Frequencies

Preamp Enabled	Start Frequency	Stop Frequency	Step Size
Enabled	800 MHz	3.59 GHz	500 MHz
Disabled	800 MHz	3.59 GHz	500 MHz
	3.61 GHz	26.5 GHz	500 MHz

10. Set the RF source 1 frequency to *P1 Frequency*.
11. Set the RF source 2 frequency to *P2 Frequency*.
12. Set the PXIe-5668 center frequency to *IMD Low Frequency*.

[1] *The RF Source 1 Programmed Power* value was measured in the *Characterizing RF Source Power (Combined) for Frequencies > 700 MHz* equipment characterization procedure.

[2] The *RF Source 2 Programmed Power* value was measured in the *Characterizing RF Source Power (Combined) for Frequencies > 700 MHz* equipment characterization procedure.

13. Commit the PXIe-5668 settings to hardware.
14. Enable the RF source 1 and RF source 2 outputs.
15. Wait 250 ms before making the first measurement and wait 100 ms before making subsequent measurements to allow the PXIe-5668, RF Source 1, and RF Source 1 amplitudes to settle.

Note Settling times are a characteristic of the RF source device. Refer to the *Test Equipment* section of this document for a list of NI-recommended source devices and device specifications. If you use an RF source device with different device specifications, your settling times may differ from those listed in this procedure.

16. Measure the power spectrum with the PXIe-5668.
17. Find the highest peak within the measurement bandwidth. This value is the *IMD Low Power*.
18. Repeat steps 12 to 17 for the PXIe-5668 center frequencies of *P1 Frequency*, *P2 Frequency*, and *IMD High Frequency*. The values from step 17 are *IMD Low Power*, *P1 Power*, *P2 Power*, and *IMD High Power,* respectively.
19. Calculate the upper and lower TOI points using the following equations:

$$TOI\ Upper = P1\ Power + (P2\ Power - IMD\ High\ Power)/2$$

$$TOI\ Lower = P2\ Power + (P1\ Power - IMD\ Low\ Power)/2$$

The smaller value of the *TOI Lower* and *TOI Upper* is the *TOI Minimum*.

20. Repeat steps 9 to 19 for all test frequencies in Table 24.
21. Repeat steps 6 to 20 with the PXIe-5668 preselector enabled for frequencies greater than 3.6 GHz.
22. Compare the *TOI Minimum* to the verification test limits in Table 25, Table 26, or Table 27 as appropriate.

Table 25. TOI (Frequencies > 700 MHz) Verification Test Limits (Preamplifier Disabled, Preselector Disabled)

Center Frequency	As-Found Limit	As-Left Limit*
>700 MHz to 1 GHz	+21.00 dBm	+21.70 dBm
>1 GHz to 2.8 GHz	+23.00 dBm	+23.70 dBm
>2.8 GHz to 3.6 GHz	+25.00 dBm	+25.70 dBm
>3.6 GHz to 5.0 GHz	+6.00 dBm	+6.70 dBm
>5.0 GHz to 7.5 GHz	+10.30 dBm	+11.00 dBm

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

Table 26. TOI (Frequencies > 700 MHz) Verification Test Limits (Preamplifier Disabled, Preselector Enabled)

Center Frequency	As-Found Limit	As-Left Limit*
>3.6 GHz to 5.0 GHz	11.00 dBm	11.70 dBm
>5.0 GHz to 7.5 GHz	11.00 dBm	12.50 dBm
>7.5 GHz to 14 GHz	15.50 dBm	16.50 dBm
>14 GHz to 17 GHz	14.00 dBm	15.00 dBm
>17 GHz to 26.5 GHz	17.00 dBm	18.00 dBm

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

Table 27. TOI (Frequencies > 700 MHz) Verification Test Limits (Preamplifier Enabled)

Center Frequency	As-Found Limit	As-Left Limit*
>700 MHz to 2 GHz	-14.0 dBm	-13.3 dBm
>2 GHz to 3 GHz	-12.0 dBm	-11.3 dBm
>3 GHz to 3.6 GHz	-9.0 dBm	-8.3 dBm

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

23. Disable the RF source 1 output and the RF source 2 output.

Note When disabled, the RF source 1 and RF source 2 output signals should be less than -60 dBm.

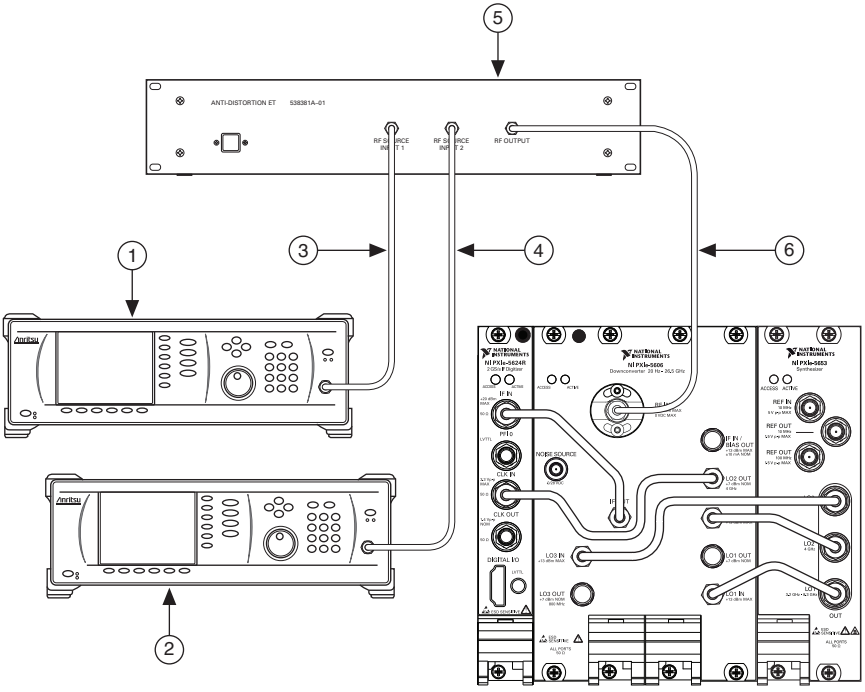
24. Close the PXIe-5668 session.

If the third-order intermodulation distortion for frequencies > 700 MHz verification procedure determines that the PXIe-5668 is outside its limits, refer to *NI Services* for information about support resources or service requests.

Verifying Second Harmonic Intercept (SHI)

1. Connect RF source 1 and RF source 2 to the PXIe-5668 RF IN connector through the anti-distortion test fixture as shown in Figure 13.

Figure 13. SHI Verification Equipment Setup



1	RF Source 1	4	2.92 mm (m)-to-2.92 mm (m) Cable
2	RF Source 2	5	Anti-Distortion Test Fixture
3	2.92 mm (m)-to-2.92 mm (m) Cable	6	2.92 mm (m)-to-2.92 mm (m) Cable

2. Create a new session for the PXIe-5668.
3. Configure the PXIe-5668 according to the following property settings:
   - Acquisition Type: Spectrum
   - Digital IF Equalization Enabled: TRUE
   - Digitizer Dither Enabled: Enabled
   - Ref Clock Source: PXI_Clk
   - Channel Coupling: AC coupled
   - Span: 150 kHz
   - Device Instantaneous Bandwidth: 300 kHz
   - IF Power Level: -1 dBm
   - Resolution Bandwidth: 350 Hz

- RF Attenuation: 0 dB
- Power Spectrum Units: Volts squared
- Preselector Enabled: Disabled

4. Disable the RF source 1 output and the RF source 2 output.

Note When disabled, the RF source 1 and RF source 2 output signals should be less than -60 dBm.

5. Disable the PXIe-5668 preamplifier.
6. Set the PXIe-5668 reference level to one of the following values:
   - Preamplifier disabled: -10 dBm
   - Preamplifier enabled: -30 dBm
7. Set the RF source 2 frequency and the PXIe-5668 center frequency to the values shown in the first row of Table 28.

Table 28. RF Source 2 SHI Verification Test Frequencies

Start Frequency	Stop Frequency	Step Size
2.54 GHz	3.50 GHz	500 MHz
3.80 GHz	13.25 GHz	500 MHz

8. Set the RF source 1 frequency and the PXIe-5668 center frequency to 305 MHz.

Table 29. RF Source 1 SHI Verification Test Frequencies

Start Frequency	Stop Frequency	Step Size
100 MHz	300 MHz	100 MHz
500 MHz	700 MHz	200 MHz
800 MHz	1.80 GHz	500 MHz
1.8 GHz	2.53 GHz	500 MHz

9. Configure the anti-distortion test fixture to use the appropriate Lowpass Filter Path as shown in Table 30.

Table 30. Lowpass Filter Specifications

Lowpass Filter Path	Frequency Range
470 MHz	1 MHz to 470 MHz
735 MHz	>470 MHz to 735 MHz
1,150 MHz	>735 MHz to 1.150 GHz

Table 30. Lowpass Filter Specifications (Continued)

Lowpass Filter Path	Frequency Range
1,800 MHz	>1.150 GHz to 1.800 GHz
2,530 MHz	>1.800 GHz to 2.530 GHz
3,550 MHz	>2.530 GHz to 3.550 GHz
4,985 MHz	>3.550 GHz to 4.985 GHz
7,000 MHz	>4.985 GHz to 7.000 GHz
14,000 MHz	>7.00 GHz to 14.00 GHz

10. Commit the PXIe-5668 settings to hardware.
11. Set both RF source power levels to the *RF Source Power LPF*[1] to one of the following values for the RF source frequency:
    - Preamplifier disabled: -10 dBm
    - Preamplifier enabled: -30 dBm
12. Enable the appropriate RF source depending on the RF frequency tested. Refer to the *Characterizing RF Source Power (with Lowpass Filter)* procedure, Table 2, and Table 3 for more information about appropriate RF source frequencies.
13. Wait 500 ms after enabling an RF source before making the first measurement and wait 100 ms before making subsequent measurements to allow the PXIe-5668 and RF Source amplitudes to settle.

Note Settling times are a characteristic of the RF source device. Refer to the *Test Equipment* section of this document for a list of NI-recommended source devices and device specifications. If you use an RF source device with different device specifications, your settling times may differ from those listed in this procedure.

14. Measure the power spectrum with the PXIe-5668.
15. Calculate the SHI using the following equation:

$$SHI = 2\,(Fundamental\ Power) - Harmonic\ Power - RF\ Attenuation$$

16. Repeat steps 6 to 15 for test frequencies between 305 MHz and 3.8 MHz listed in Table 28 and Table 29.
17. Repeat steps 6 to 16 for test frequencies between 700 MHz and 13.25 GHz with the PXIe-5668 signal conditioning highpass filter enabled or preselector enabled.
18. Compare the *SHI* to the verification test limits in Table 31 or Table 33 as appropriate.
19. Repeat steps 6 to 16 for test frequencies up to 1.8 GHz listed in Table 29 with the preamplifier enabled.

[1] *The RF Source Power LPF* value was measured in the *Characterizing RF Source Power (with Lowpass Filter)* equipment characterization procedure.

20. Compare the measured values to the limits in Table 32.

Table 31. SHI Verification Test Limits (Preamplifier Disabled, Signal Conditioning Highpass Filter Enabled*, Preselector Enabled†)

Device	Source Frequency	As-Found Limit	As-Left Limit‡
All	>700 MHz to 1.0 GHz	+70.00 dBm	+72.00 dBm
	>1.0 GHz to 1.8 GHz	+71.00 dBm	+73.00 dBm
	>1.8 GHz to 7.0 GHz	+62.00 dBm	+63.80 dBm
PXIe-5668 26.5 GHz VSA	>7.0 GHz to 8.5 GHz	+58.00 dBm	+58.85 dBm
	>8.5 GHz to 11.0 GHz	+58.00 dBm	+60.00 dBm
	>11.0 GHz to 13.25 GHz	+58.00 dBm	+60.00 dBm

* The 1.35 GHz highpass filter is enabled for frequencies between 1.35 GHz and 2.2 GHz. The 2.2 GHz highpass filter is enabled for frequencies between 2.2 GHz and 3.6 GHz.

† Preselector enabled only for frequencies > 3.6 GHz.

‡ Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

Table 32. SHI Verification Test Limits (Preamplifier Enabled)

Source Frequency	As-Found Limit	As-Left Limit*
50 MHz to 100 MHz	-7 dBm	-5 dBm
>100 MHz to 300 MHz	-6 dBm	-4 dBm
>300 MHz to 1.0 GHz	-5 dBm	-3 dBm
>1.0 GHz to 1.8 GHz	-2 dBm	0 dBm

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

Table 33. SHI Verification Test Limits (Preselector Disabled and Signal Conditioning Highpass Filter Disabled)

Source Frequency	As-Found Limit	As-Left Limit*
>300 MHz to 1.0 GHz	+63.00 dBm	+65.00 dBm
>1.0 GHz to 1.8 GHz	+49.00 dBm	+51.00 dBm
>1.8 GHz to 4 GHz	+25.20 dBm	+27.00 dBm

21. Disable the RF source 1 output and the RF source 2 output.

Note When disabled, the RF source 2 output signal should be less than -60 dBm.

22. Close the PXIe-5668 session.

If the second harmonic intercept verification procedure determines that the PXIe-5668 is outside its limits, refer to *NI Services* for information about support resources or service requests.

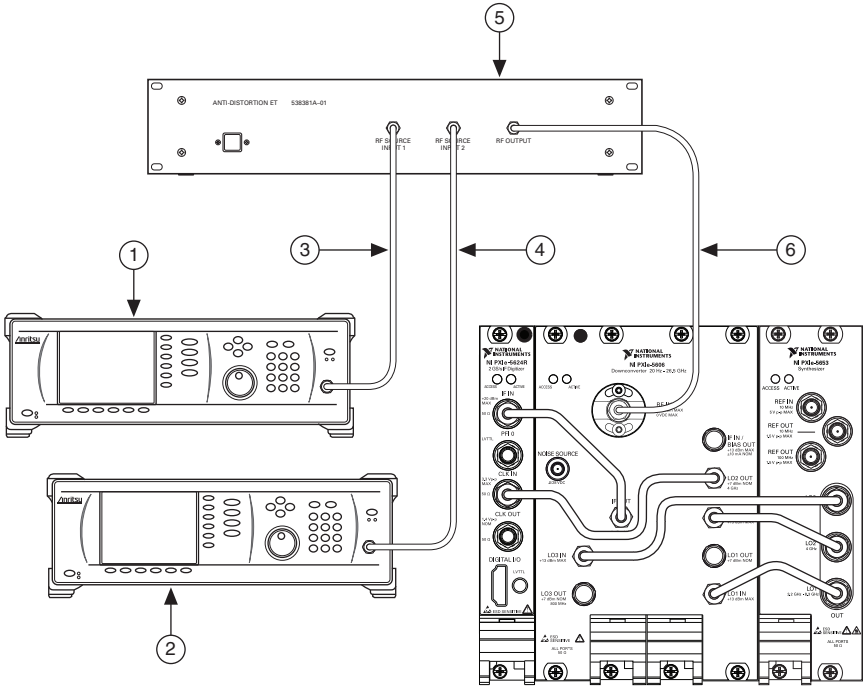
Verifying Gain Compression

Note The power level you apply differs depending on whether you are verifying the as-found or as-left limit.

Frequencies ≤ 700 MHz

1. Connect RF source 1 and RF source 2 to the PXIe-5668 RF IN connector through the anti-distortion test fixture. The completed equipment setup is shown in Figure 14.

Figure 14. Gain Compression Verification (Frequencies ≤ 700 MHz) Equipment Setup



1	RF Source 1	4	2.92 mm (m)-to-2.92 mm (m) Cable
2	RF Source 2	5	Anti-Distortion Test Fixture
3	2.92 mm (m)-to-2.92 mm (m) Cable	6	2.92 mm (m)-to-2.92 mm (m) Cable

2. Create a new session for the PXIe-5668.
3. Configure the PXIe-5668 according to the following property settings:
   - Acquisition Type: Spectrum
   - Averaging Mode: RMS averaging
   - Number of Averages: 10
   - Ref Clock Source: PXI_Clk
   - Channel Coupling: AC coupled
   - Span: 150 kHz
   - Device Instantaneous Bandwidth: 300 kHz
   - Resolution Bandwidth: 1 kHz

- RF Attenuation: 0 dB
- FFT Window Type: Flat Top

4. Configure the anti-distortion test fixture to use the ≤700 MHz combiner path.
5. Disable the RF source 1 and RF source 2 outputs.

Note When disabled, the RF source 1 and RF source 2 output signals should be less than -60 dBm.

6. Disable the PXIe-5668 preamplifier.
7. Set the RF source 1 frequency according to Table 34.
8. Set the RF source 2 frequency 450 kHz above the RF source 1 frequency.
9. Set the PXIe-5668 center frequency according to the first row in Table 34.

Table 34. Gain Compression Verification Test Frequencies (Frequencies ≤ 700 MHz)

Start Frequency	Stop Frequency	Step Size
10 MHz	90 MHz	40 MHz
100 MHz	700 MHz	200 MHz

10. Set the RF source 2 power to the *RF Source 2 Programmed Power* in Table 35 or Table 36 as appropriate.
11. Set the RF source 1 power to the *RF Source 1 Programmed Power* in Table 35 or Table 36 as appropriate.
12. Set the PXIe-5668 reference level according to Table 35 or Table 36 as appropriate.

Table 35. Gain Compression Verification Test Settings (Preamplifier Disabled)

Setting	Frequency Range	Limit	Value
RF Source 2 Programmed Power	10 MHz to 100 MHz	As-Found	-1.0 dBm
		As-Left*	+1.0 dBm
	>100 MHz to 700 MHz	As-Found	+4.0 dBm
		As-Left*	+5.0 dBm
RF Source 1 Programmed Power	10 MHz to 700 MHz	Both	-35 dBm
PXIe-5668 Reference Level	10 MHz to 700 MHz	Both	0 dBm

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

Table 36. Gain Compression Test Settings (Preamplifier Enabled)

Setting	Frequency Range	Limit	Value
RF Source 2 Programmed Power	11 MHz to 100 MHz	As-Found	-30 dBm
		As-Left*	-28 dBm
	>100 MHz to 700 MHz	As-Found	-27 dBm
		As-Left*	-26 dBm
RF Source 1 Programmed Power	10 MHz to 700 MHz	Both	-55 dBm
PXIe-5668 Reference Level	10 MHz to 700 MHz	Both	-30 dBm

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

13. Commit the PXIe-5668 settings to hardware.
14. Enable the RF source 1 output and wait 250 ms or wait 100 ms if the output is already enabled. The wait time allows the PXIe-5668 and RF Source 1 amplitudes to settle.

Note Settling times are a characteristic of the RF source device. Refer to the *Test Equipment* section of this document for a list of NI-recommended source devices and device specifications. If you use an RF source device with different device specifications, your settling times may differ from those listed in this procedure.

15. Read the power spectrum from the PXIe-5668.
16. Depending on your equipment configuration, using the spectrum returned from the PXIe-5668, measure the power at the center frequency and record this value as the *Small Tone First Measurement* (RF Source 2 output disabled) or as the *Small Tone Second Measurement* (RF source 2 output enabled).
17. Repeat steps 7 to 16 for all test frequencies in Table 34.
18. Repeat steps 7 to 17 with the PXIe-5668 preamplifier enabled.
19. Enable the RF source 2 output.
20. Repeat steps 6 to 18 with the RF source 2 output enabled.
21. Calculate the PXIe-5668 *Gain Compression* using the following equation:

Gain Compression = Small Tone First Measurement - Small Tone Second Measurement

22. Compare the *Gain Compression* to the verification test limits in Table 37 or Table 38 as appropriate.

Table 37. Gain Compression Verification Test Limits (Frequencies ≤ 700 MHz, Preamplifier Disabled)

Frequency	Limit	Compression	Applied Power
10 MHz to 100 MHz	As-Found	≤1 dB	-1 dBm
	As-Left*		+1 dBm
>100 MHz to 700 MHz	As-Found	≤1 dB	+4 dBm
	As-Left*		+5 dBm

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

The device specification calls for ≤1 dB gain compression for a minimum applied power. The applied power includes the measurement uncertainty to guarantee the required minimum applied power.

Table 38. Gain Compression Verification Test Limits (Frequencies ≤ 700 MHz, Preamplifier Enabled)

Frequency (MHz)	Limit	Compression	Applied Power
10 MHz to 100 MHz	As-Found	≤1 dB	-30 dBm
	As-Left*		-28 dBm
>100 MHz to 700 MHz	As-Found	≤1 dB	-27 dBm
	As-Left*		-26 dBm

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

The device specification calls ≤1 dB gain compression for a minimum applied power. The applied power includes the measurement uncertainty to guarantee the required minimum applied power.

23. Disable the RF source 1 output and the RF source 2 output.

Note When disabled, the RF source 1 and RF source 2 output signals should be less than -60 dBm.

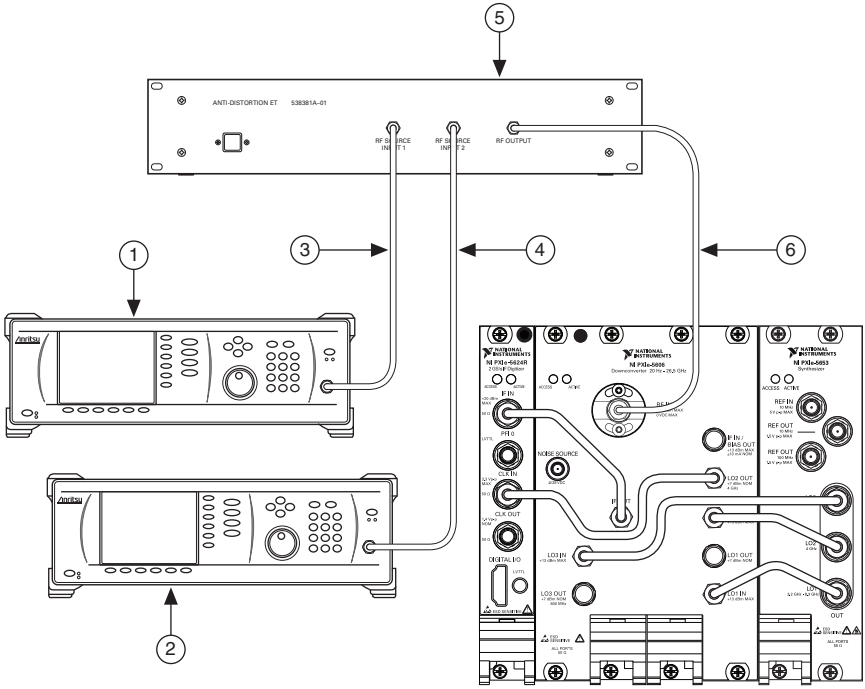
24. Close the PXIe-5668 session.

If the gain compression for frequencies ≤ 700 MHz verification procedure determines that the PXIe-5668 is outside its limits, refer to *NI Services* for information about support resources or service requests.

Frequencies > 700 MHz

1. Connect RF source 1 and RF source 2 to the PXIe-5668 RF IN connector through the anti-distortion test fixture as shown in Figure 15.

Figure 15. Gain Compression Verification (Frequencies > 700 MHz) Equipment Setup



1	RF Source 1	4	2.92 mm (m)-to-2.92 mm (m) Cable
2	RF Source 2	5	Anti-Distortion Test Fixture
3	2.92 mm (m)-to-2.92 mm (m) Cable	6	2.92 mm (m)-to-2.92 mm (m) Cable

2. Create a new session for the PXIe-5668.
3. Configure the PXIe-5668 according to the following property settings:
   - Acquisition Type: Spectrum
   - Averaging Mode: No averaging
   - Ref Clock Source: PXI_Clk
   - Channel Coupling: AC Coupled
   - Span: 150 kHz
   - Device Instantaneous Bandwidth: 300 kHz
   - Resolution Bandwidth: 1 kHz
   - RF Attenuation: 0 dB
   - FFT Window Type: Flat Top

4. Configure the anti-distortion test fixture to use the >700 MHz combiner path.
5. Disable the RF source 1 and RF source 2 outputs.

Note When disabled, the RF source 1 and RF source 2 output signals should be less than -60 dBm.

6. Disable the PXIe-5668 preamplifier.
7. Disable the PXIe-5668 preselector.
8. Set the RF source 1 frequency according to the first row in Table 39 as appropriate.

Table 39. PXIe-5668 26.5 GHz Gain Compression Test Frequencies (Frequencies >700 MHz)

Start Frequency	Stop Frequency	Step Size
800 MHz	3.3 GHz	500 MHz
3.6 GHz	3.6 GHz	—
3.8 GHz	26.3 GHz	500 MHz
26.5 GHz	26.5 GHz	—

9. Set the RF source 2 frequency 450 kHz above the RF source 2 frequency.
10. Set the PXIe-5668 center frequency according to the values listed in Table 39.

11. Set the RF source 2 power to the *RF Source 2 Programmed Power* in Table 40, Table 41, or Table 42 as appropriate.
12. Set the RF source 1 power to the *RF Source 1 Programmed Power* in Table 40, Table 41, or Table 42 as appropriate.
13. Set the PXIe-5668 reference level according to Table 40, Table 41, or Table 42 as appropriate.

Table 40. Gain Compression Verification Test Settings (Preamplifier Disabled, Preselector Disabled)

Device	Setting	Frequency Range	Limit	Value
PXIe-5668 14 GHz VSA	RF Source 2 Programmed Power	800 MHz to 1.8 GHz	As-Found	+4 dBm
			As-Left*	+5 dBm
		>1.8 GHz to 3.6 GHz	As-Found	+4 dBm
			As-Left*	+5 dBm
		>3.6 GHz to 14.0 GHz	As-Found	+3 dBm
			As-Left*	+4 dBm
	RF Source 1 Programmed Power	800 MHz to 14.0 GHz	Both	-35 dBm
	PXIe-5668 Reference Level	800 MHz to 14.0 GHz	Both	0 dBm

Table 40. Gain Compression Verification Test Settings (Preamplifier Disabled, Preselector Disabled) (Continued)

Device	Setting	Frequency Range	Limit	Value
PXIe-5668 26.5 GHz VSA	RF Source 2 Programmed Power	800 MHz to 1.8 GHz	As-Found	+4 dBm
			As-Left*	+5 dBm
		>1.8 GHz to 3.6 GHz	As-Found	+4 dBm
			As-Left*	+5 dBm
		>3.6 GHz to 20.0 GHz	As-Found	+3 dBm
			As-Left*	+4 dBm
		>20.0 GHz to 24.0 GHz	As-Found	+6 dBm
			As-Left*	+7 dBm
		>24.0 GHz to 26.5 GHz	As-Found	+8 dBm
			As-Left*	+9 dBm
	RF Source 1 Programmed Power	800 MHz to 26.5 GHz	Both	-35 dBm
	PXIe-5668 Reference Level	800 MHz to 26.5 GHz	Both	0 dBm

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

Table 41. Gain Compression Verification Test Settings (Preamplifier Disabled, Preselector Enabled)

Device	Setting	Frequency Range	Limit	Value
PXIe-5668 14 GHz VSA	RF Source 2 Programmed Power	>3.6 GHz to 7.5 GHz	As-Found	+6 dBm
			As-Left*	+7 dBm
		>7.5 GHz to 11.0 GHz	As-Found	+7 dBm
			As-Left*	+8 dBm
		>11.0 GHz to 14.0 GHz	As-Found	+8 dBm
			As-Left*	+9 dBm
	RF Source 1 Programmed Power	>3.6 GHz to 14 GHz	Both	0 dBm
	PXIe-5668 Reference Level	>3.6 GHz to 14 GHz	Both	0 dBm

Table 41. Gain Compression Verification Test Settings (Preamplifier Disabled, Preselector Enabled) (Continued)

Device	Setting	Frequency Range	Limit	Value
PXIe-5668 26.5 GHz VSA	RF Source 2 Programmed Power	>3.6 GHz to 7.5 GHz	As-Found	+6 dBm
			As-Left*	+7 dBm
		>7.5 GHz to 11.0 GHz	As-Found	+7 dBm
			As-Left*	+8 dBm
		>11.0 GHz to 14.0 GHz	As-Found	+8 dBm
			As-Left*	+9 dBm
		>14.0 GHz to 20.0 GHz	As-Found	+9 dBm
			As-Left*	+10 dBm
		>20.0 GHz to 26.5 GHz	As-Found	+9 dBm
			As-Left*	+10 dBm
	RF Source 1 Programmed Power	>3.6 GHz to 26.5 GHz	Both	0 dBm
	PXIe-5668 Reference Level	>3.6 GHz to 26.5 GHz	Both	0 dBm

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

Table 42. Gain Compression Verification Test Settings (Preamplifier Enabled, Preselector Disabled)

Device	Setting	Frequency Range	Limit	Value
PXIe-5668 14 GHz VSA	RF Source 2 Programmed Power	800 MHz to 2.0 GHz	As-Found	-27 dBm
			As-Left*	-26 dBm
		>2.0 GHz to 3.0 GHz	As-Found	-26 dBm
			As-Left*	-25 dBm
		>3.0 GHz to 3.6 GHz	As-Found	-24 dBm
			As-Left*	-23 dBm
	RF Source 1 Programmed Power	800 MHz to 3.6 GHz	Both	-55 dBm
	PXIe-5668 Reference Level	800 MHz to 3.6 GHz	Both	-30 dBm
PXIe-5668 26.5 GHz VSA	RF Source 2 Programmed Power	800 MHz to 2.0 GHz	As-Found	-27 dBm
			As-Left*	-26 dBm
		>2.0 GHz to 3.0 GHz	As-Found	-26 dBm
			As-Left*	-25 dBm
		>3.0 GHz to 3.6 GHz	As-Found	-24 dBm
			As-Left*	-23 dBm
	RF Source 1 Programmed Power	800 MHz to 3.6 GHz	Both	-55 dBm
	PXIe-5668 Reference Level	800 MHz to 3.6 GHz	Both	-30 dBm

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

14. Commit the PXIe-5668 settings to hardware.
15. Enable the RF source 1 output and wait 250 ms or wait 100 ms if the output is already enabled. The wait time allows the PXIe-5668 and RF Source 1 amplitudes to settle.

Note Settling times are a characteristic of the RF source device. Refer to the *Test Equipment* section of this document for a list of NI-recommended source devices and device specifications. If you use an RF source device with different device specifications, your settling times may differ from those listed in this procedure.

16. Read the power spectrum from the PXIe-5668.
17. Depending on your equipment configuration, using the spectrum returned from the PXIe-5668, measure the power at the center frequency and record this value as the *Small Tone First Measurement* (RF Source 2 output disabled) or as the *Small Tone Second Measurement* (RF source 2 output enabled).
18. Repeat steps 8 to 17 for all test frequencies in Table 39.
19. Repeat steps 8 to 18 for frequencies greater than 3.6 GHz with the PXIe-5668 preselector enabled.
20. Repeat steps 7 to 18 with the PXIe-5668 preamplifier enabled for frequencies less than 3.6 GHz.
21. Enable the RF source 2 output.
22. Repeat steps 6 to 20 with the RF source 2 output enabled.
23. Calculate the PXIe-5668 *Gain Compression* using the following equation:

Gain Compression = Small Tone First Measurement - Small Tone Second Measurement

24. Compare the *Gain Compression* to the verification test limits in Table 43, Table 44, or Table 45 as appropriate.

Table 43. Gain Compression Verification Test Limits (>700 MHz, Preamplifier Disabled, Preselector Disabled)

Frequency	Limit	Compression	Applied Power
>700 MHz to 1.8 GHz	As-Found	≤1 dB	+4 dBm
	As-Left*		+5 dBm
>1.8 GHz to 3.6 GHz	As-Found	≤1 dB	+4 dBm
	As-Left*		+5 dBm
>3.6 GHz to 20.0 GHz	As-Found	≤1 dB	+3 dBm
	As-Left*		+4 dBm

Table 43. Gain Compression Verification Test Limits (>700 MHz, Preamplifier Disabled, Preselector Disabled) (Continued)

Frequency	Limit	Compression	Applied Power
>20.0 GHz to 24.0 GHz	As-Found	≤1	+6
	As-Left*		+7
>24.0 GHz to 26.5 GHz	As-Found	≤1	+8
	As-Left*		+9

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

The device specification calls ≤ 1 dB gain compression for a minimum applied power. The applied power includes the measurement uncertainty to guarantee the required minimum applied power.

Table 44. Gain Compression Verification Test Limits (>700 MHz, Preamplifier Disabled, Preselector Enabled)

Frequency	Limit	Compression	Applied Power
>3.6 GHz to 7.5 GHz	As-Found	≤1 dB	+6 dBm
	As-Left*		+7 dBm
>7.5 GHz to 11.0 GHz	As-Found	≤1 dB	+7 dBm
	As-Left*		+8 dBm
>11.0 GHz to 14.0 GHz	As-Found	≤1 dB	+8 dBm
	As-Left*		+9 dBm
>14.0 GHz to 20.0 GHz	As-Found	≤1 dB	+9 dBm
	As-Left*		+10 dBm
>20.0 GHz to 26.5 GHz	As-Found	≤1 dB	+9 dBm
	As-Left*		+10 dBm

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

The device specification calls ≤ 1 dB gain compression for a minimum applied power. The applied power includes the measurement uncertainty to guarantee the required minimum applied power.

Table 45. Gain Compression Verification Test Limits (>700 MHz, Preamplifier Enabled)

Frequency	Limit	Compression	Applied Power
>700 MHz to 2.0 GHz	As-Found	≤1 dB	-27 dBm
	As-Left*		-26 dBm
>2.0 GHz to 3.0 GHz	As-Found	≤1 dB	-26 dBm
	As-Left*		-25 dBm
>3.0 GHz to 3.6 GHz	As-Found	≤1 dB	-24 dBm
	As-Left*		-23 dBm

* Refer to the *As-Found and As-Left Limits* section of this document for more information about as-left limits.

The device specification calls ≤ 1 dB gain compression for a minimum applied power. The applied power includes the measurement uncertainty to guarantee the required minimum applied power.

25. Disable the RF source 1 output and the RF source 2 output.

Note When disabled, the RF source 1 and RF source 2 output signals should be less than -60 dBm.

26. Close the PXIe-5668 session.

If the gain compression for frequencies >700 MHz verification procedure determines that the PXIe-5668 is outside its limits, refer to *NI Services* for information about support resources or service requests.

Adjustment

This section describes how to adjust the PXIe-5668 modules to meet published specifications.

NI warrants the PXIe-5668 to meet its published specifications if the individual modules are calibrated and operating within specifications. Refer to the Letter of Conformance at `ni.com/manuals` for more information about RF system calibration.

The PXIe-5668 is a vector signal analyzer composite module composed of the three following PXI modules.

- PXIe-5653
- PXIe-5606
- PXIe-5624

If you encounter a failure while verifying the PXIe-5668, adjust each of the modules. The adjustment procedure for the PXIe-5668 is composed of the adjustment procedures for the three

modules. Adjust the modules in the following order. You can read the *NI 5624R Calibration Procedure* and *PXIe-5653 Calibration Procedure* on ni.com/manuals.

1. Adjust the PXIe-5624 IF digitizer module according to the *Adjustmen*t section of the *NI 5624R Calibration Procedure*.
2. Adjust the PXIe-5653 RF synthesizer module according to the *Adjustment* section of the *PXIe-5653 Calibration Procedure*.

Reverification

Repeat the *Verification* section to determine the as-left status of the PXIe-5668. If the PXIe-5668 verification passes, then you do not need to adjust the PXIe-5606 module. If the PXIe-5668 verification fails, then you need to adjust the PXIe-5606 module. The PXIe-5606 module cannot be adjusted in the field, so you need to return it to NI for calibration and adjustment. Refer to *NI Services* for information about support resources or service requests.

Revision History

Revision	Section	Changes
374568A-01 December 2014	—	This is the initial release version of the *PXIe-5668 Calibration Procedure*.
374568E-01 August 2020	Verifying Absolute Accuracy	Updated steps to make it more clear and less redundant.
	Adjustment	Added section.
	Reverification	Added section.
	Appendix B: Power Sensor Calibration Factor Uncertainty	Updated Table 49.

Revision	Section	Changes
374568F-01 March 2021	Verifying Average Noise Level	Updated test limits in Table 14, Table 15, and Table 16.
	Verifying Third-Order Intermodulation Distortion	Updated stop frequency values in Table 24 and test limits in Table 25 and Table 26.
	Verifying Second Harmonic Intercept (SHI)	Added rows to Table 29 and Table 32. Updated source frequencies and test limits in Table 33. Added 14 GHz PXIe-5668 to Table 41.

Appendix A: Anti-Distortion Test Fixture

Note The anti-distortion test fixture specifications are for the entire fixture and include the performance of all components internal to the fixture.

Table 46. Lowpass Filter Passband Paths

Filter Path	Start	Stop	Insertion Loss (Maximum)	VSWR* (Maximum)
470 MHz	10 MHz	≤470 MHz	2.5 dB	1.75
735 MHz	>470 MHz	≤735 MHz	2.5 dB	1.75
1,150 MHz	>735 MHz	≤1,150 MHz	2.5 dB	1.75
1,800 MHz	>1,150 MHz	≤1,800 MHz	2.5 dB	1.75
2,530 MHz	>1,800 MHz	≤2,530 MHz	2.5 dB	1.75
3,550 MHz	>2,530 MHz	≤3,550 MHz	2.5 dB	1.75
4,985 MHz	>3,550 MHz	≤4,985 MHz	2.5 dB	1.75
7,000 MHz	>4,985 MHz	≤7,000 MHz	2.5 dB	1.75
14,000 MHz	>7,000 MHz	<14,000 MHz	2.5 dB	1.75

* Input or output ports.

Table 47. Lowpass Filter Stopband Paths

Filter Path	Start	Stop	Rejection*
470 MHz	600 MHz	≤940 MHz	50
735 MHz	>940 MHz	≤1,470 MHz	50
1,150 MHz	>1,470 MHz	≤2,300 MHz	50
1,800 MHz	>2,300 MHz	≤3,600 MHz	50
2,530 MHz	>3,600 MHz	≤5,060 MHz	70
3,550 MHz	>5,060 MHz	≤7,100 MHz	70
4,985 MHz	>7,100 MHz	≤9,970 MHz	70

Table 47. Lowpass Filter Stopband Paths (Continued)

Filter Path	Start	Stop	Rejection*
7,000 MHz	>9,970 MHz	≤14,000 MHz	70
14,000 MHz	>14,000 MHz	<26,500 MHz	70

* Rejection equals *Fundamental Power - Second Harmonic Power*

Table 48. Combiner Paths

Combiner	Path	Start	Stop	Total Loss* (Maximum)	Isolation† (Minimum)	VSWR‡ (Maximum)
1	1	10 MHz	≤700 MHz	5 dB	20 dB	1.75
	2			15 dB		
2	1	>700 MHz	≤26.5 MHz	8 dB	20 dB	1.75
	2			18 dB		

* *Total Loss* includes the splitter loss at either input or output ports. The unused input port is terminated in 50 Ω.

† *Isolation* is the loss between input ports. The output port is terminated in 50 Ω.

‡ *VSWR* includes any port. All other ports are terminated in 50 Ω.

Appendix B: Power Sensor Calibration Factor Uncertainty Requirements

Table 49. Power Sensor Calibration Factor Uncertainty Requirements (2 σ)

Frequency	Calibration Factor Uncertainty
10 MHz to 100 MHz	≤0.85%
>100 MHz to 2000 MHz	≤1.0%
>2 GHz to 8 GHz	≤1.2%
>8 GHz to 10 GHz	≤1.4%
>10 GHz to 12 GHz	≤1.5%
>12 GHz to 27.0 GHz	≤1.9%

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