CALIBRATION PROCEDURE

NI PXIe-5665

3.6 GHz and 14 GHz RF Vector Signal Analyzer

This document contains the verification procedures for the National Instruments PXIe-5665 (NI 5665) RF vector signal analyzer (VSA). Refer to `ni.com/calibration` for more information about calibration solutions.

When not otherwise specified, the procedures in this document refer to both the NI 5665 3.6 GHz VSA and the NI 5665 14 GHz VSA products. In places where the procedures differ between the two products, the appropriate device settings are specified.

Note NI 5665 tuned frequencies greater than 3.6 GHz and procedures with the preselector enabled for frequencies greater than 3.6 GHz apply only to the NI 5665 14 GHz VSA.

NI warrants the NI 5665 to meet its published specifications if the individual modules are calibrated and operating within specifications. For more information on RF system calibration, visit `ni.com/manuals` and search for `Letter of Conformance`.

Contents

Software

Calibrating the NI 5665 requires you to install the following software on the calibration system:

- NI-RFSA 2.5 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:

- *NI 5665 RF Vector Signal Analyzer Getting Started Guide*
- *NI RF Vector Signal Analyzers Help*
- *NI PXIe-5665 Specifications*

The lastest versions of these documents are available on `ni.com/manuals`.

This calibration procedure calibrates the NI 5665 as a single system. To calibrate the NI PXIe-5653 or NI PXIe-5622 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 NI 5665 Calibration

Equipment	Recommended Models	Where Used	Minimum Requirements
Power Meter	Anritsu ML2438A	Frequency response, Absolute amplitude accuracy, LO output power	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: ≤±0.9% Reference Output VSWR: <1.04 : 1
Signal Generator (RF Source 1)	Anritsu MG3692C Options 2A, 3, 4, 15A, and 22	Third-order intermodulation distortion, Gain compression	Power Sensor Power Range: -55 dBm to 20 dBm Frequency Range: 10 MHz to 16 GHz Input VSWR: 10 MHz to 50 MHz .... <1.90 : 1 50 MHz to 2 GHz............... <1.12 : 1 2 GHz to 12.4 GHz............ <1.22 : 1 12.4 GHz to 16 GHz.......... <1.25 : 1 Linearity: -55 dBm to 20 dBm........... <1.8% Calibration Factor Uncertainty: 10 MHz to 50 MHz .... <1.9% 50 MHz to 500 MHz .... <1.5% 500 MHz to 7 GHz............ <1.5% 7 GHz to 12.4 GHz............ <1.9% 12.4 GHz to 16 GHz.......... <2.3%

Table 1. Recommended Equipment for NI 5665 Calibration

Equipment	Recommended Models	Where Used	Minimum Requirements
Signal Generator (RF Source 1)	Anritsu MG3692C Options 2A, 3, 4, 15A, and 22	Third-order intermodulation distortion, Gain compressio	Frequency Range: 8 MHz to 16 GHz Leveled Power: -115 dBm to 18 dBm Power Accuracy: ±1.5 dB Harmonics: 0.1 MHz to ≤10 MHz .... <-30 dBc >10 MHz to ≤100 MHz...... <-40 dBc >100 MHz to ≤2.2 GHz ..... <-50 dBc >2.2 GHz to ≤16 GHz .... <-30 dBc Nonharmonic Spurious: 0.1 MHz to ≤10 MHz .... <-30 dBc >10 MHz to ≤2.2 GHz .... <-60 dBc >2.2 GHz to ≤16 GHz........ <-60 dBc Output VSWR: <2.0 : 1
Signal Generator (RF Source 2)	Anritsu MG3692C Options 2A, 3, 4, 15A, and 22	Frequency response, Absolute amplitude accuracy, LO-related spurs, Image rejection, Third-order intermodulation distortion, Second harmonic intercept, Gain compression, LO output power	Frequency Range: 0.1 Hz to 16 GHz Leveled Power: -115 dBm to 18 dBm Power Accuracy: ±1.5 dB Harmonics: 0.1 MHz to ≤10 MHz .... <-30 dBc >10 MHz to ≤100 MHz...... <-40 dBc >100 MHz to ≤2.2 GHz ..... <-50 dBc >2.2 GHz to ≤16 GHz .... <-30 dBc Nonharmonic Spurious: 0.1 MHz to 10 MHz .... <-30 dBc 10 MHz to ≤2.2 MHz......... <-60 dBc >2.2 GHz to ≤16 GHz .... <-60 dBc Output VSWR: <2.0 : 1

Table 1. Recommended Equipment for NI 5665 Calibration

Equipment	Recommended Models	Where Used	Minimum Requirements
Spectrum Analyzer	Rohde & Schwarz FSUP26 Options B60 and B61	Frequency accuracy, Phase noise, LO-related spurs, LO output power	Frequency Range: 10 MHz to 18 GHz Noise Floor: <-152 dBm/Hz Phase noise measurement using cross-correlation Frequency counter marker feature Spectrum analysis capabilities
50 Ω Termination (three are included in the NI 5665 kit)	NI 778353-01	Average noise level, Non-input-related (residual) spurs	—
PXI Express Chassis	NI PXIe-1065 or NI PXIe-1075	—	—
PXI Express Controller	NI PXIe-8105 or NI PXIe-8133	—	—
Three SMA (m)-to-SMA (m) Semi-Rigid Cables[*]	NI 151611A-01	—	—
SMA (m)-to-SMA (m) Semi-Rigid Cable[*]	NI 151612A-01	—	—
SMA (m)-to-SMA (m) Semi-Flexible Cable[*]	NI 190412B-04	—	—

Table 1. Recommended Equipment for NI 5665 Calibration

Equipment	Recommended Models	Where Used	Minimum Requirements
SMA (m)-to-SMA (m) Flexible Cable*	NI 151890A-1R25	—	—
Three SMA (m)-to-SMA (m) Cables (36 in.)	MegaPhase G916-SISI-36	—	Frequency Range: DC to 18 GHz Insertion Loss: ≤2 dB at 18 GHz Impedance: 50 Ω VSWR: ≤1.35 : 1 at 18 GHz
3.5 mm (m)-to-3.5 mm (m) Adaptor	Huber+Suhner 32_PC35-50-0-2/199_NE	—	Frequency Range: DC to 18 GHz Impedance: 50 Ω 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
3.5 mm (f)-to-3.5 mm (f) Adaptor	Huber+Suhner 31_PC35-50-0-2/199_N	—	Frequency Range: DC to 18 GHz Impedance: 50 Ω 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

Table 1. Recommended Equipment for NI 5665 Calibration

Equipment	Recommended Models	Where Used	Minimum Requirements
SMA (m)-to-SMA (f) 10 dB Attenuator	Huber+Suhner 6610_SMA-50-1/199N	—	Frequency Range: DC to 18 GHz Attenuation: 10 dB (nominal) Power Rating: 2 W average Impedance: 50 Ω VSWR: DC to 4 GHz....................... ≤1.15 : 1 4 GHz to 8 GHz.................. ≤1.20 : 1 8 GHz to 12.4 GHz............ ≤1.25 : 1 12.4 GHz to 18 GHz........... ≤1.35 : 1
SMA (m)-to-SMA (f) 20 dB Attenuator	Huber+Suhner 6620_SMA-50-1/199N	—	Frequency Range: DC to 18 GHz Attenuation: 20 dB (nominal) Power Rating: 2 W average Impedance: 50 Ω VSWR: DC to 4 GHz....................... ≤1.15 : 1 4 GHz to 8 GHz.................. ≤1.20 : 1 8 GHz to 12.4 GHz............ ≤1.25 : 1 12.4 GHz to 18 GHz........... ≤1.35 : 1

Table 1. Recommended Equipment for NI 5665 Calibration

Equipment	Recommended Models	Where Used	Minimum Requirements
Power Splitter (Two-Resistor Type)	Aeroflex/Weinschel 1593	—	Frequency Range: DC to 18 GHz Amplitude Tracking: <0.25 dB Phase Tracking: <4° Insertion Loss: ≤8.5 dB (6 dB, nominal) Power Rating: 1 W Impedance: 50 Ω VSWR: DC to 18 GHz.................... ≤1.25 : 1 Equivalent Output VSWR: DC to 18 GHz.................... ≤1.25 : 1 Connectors: 3.5 mm (f)
Anti-Distortion Test Fixture	NI 166375A-01	Third-order intermodulation distortion, Second harmonic intercept, Gain compression	Refer to *Appendix A: Anti-Distortion Test Fixture* for specifications. Note: The Anti-Distortion Test Fixture requires an external +12 VDC suppply and USB interface. Contact NI for programming details.
Frequency Reference Source	Symmetricom 8040 Rubidium Frequency Standard	—	Frequency: 10 MHz Frequency Accuracy: $\pm 1 \times 10^{-9}$
Torque Wrench	—	—	Refer to *Test Conditions* for torque wrench specifications.
* Included in the NI PXIe-5665 cable accessory kit.			

Test Conditions

The following setup and environmental conditions are required to ensure the NI 5665 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.
- 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`.
- Allow a warm-up time of at least 30 minutes after NI-RFSA is loaded and recognizes the NI 5665. The warm-up time ensures that the measurement circuitry of the NI 5665 is at a stable operating temperature.
- 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 3.5 mm connectors.
- Connect the frequency reference source to the REF IN connector on the back of the PXI Express chassis with a standard BNC (m)-to-BNC (m) cable. This connection replaces the connection from the NI 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 *NI 5665 Timing Configurations* topic in the *NI RF Vector Signal Analyzers Help* for more information about configuring clocking sources.
- Perform self-calibration on the NI 5665.

System Options

The NI 5665 is available with options without certain features. The calibration procedure must be modified to handle the following options:

- No preamplifier: Skip steps in the verification procedures that call for the preamplifier to be enabled.
- 25 MHz instantaneous bandwidth: Verification procedures include any changes necessary to accommodate this option. There are no changes to the NI 5665 specifications for this digitizer option.

Initial Setup

Refer to the *NI 5665 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).

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 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.

Power Sensor Zero/Calibration

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.

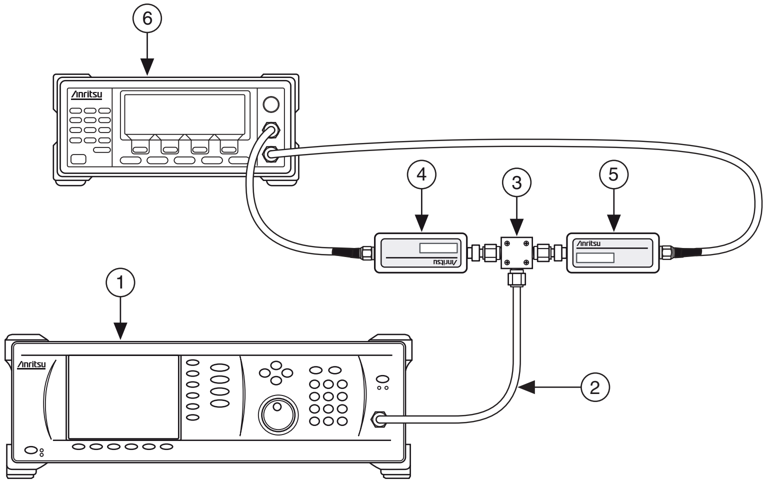
Power Splitter Reference Output

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.

Power Splitter Difference

1. Connect the RF Source 2 output to the Power Splitter input through the SMA (m)-to-SMA (m) cable.
2. Connect Power Sensor A to the reference output of the Power Splitter through the SMA (m)-to-SMA (m) cable.
3. Connect Power Sensor B to the other output of the Power Splitter through the SMA (m)-to-SMA (m) cable. The completed setup is shown in Figure 1.

Figure 1. Power Splitter Difference Characterization Equipment Setup



1	RF Source 2	3	Power Splitter	5	Power Sensor B
2	SMA (m)-to-SMA (m) cable	4	Power Sensor A	6	Power Meter

4. Set the RF Source 2 frequency to 4 GHz.
5. Set the RF Source 2 power to 0 dBm.
6. Measure the signal at 4 GHz with both power sensors.
7. Set the power sensors calibration factor for the measurement frequency at 4 GHz.
8. Calculate the *Power Splitter at 4 GHz Correction Factor* using the following formula:

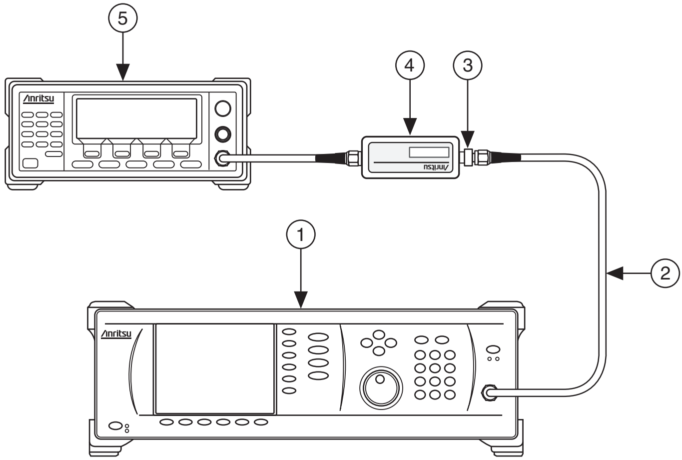
Power Splitter at 4 GHz Correction Factor = Corrected Power Sensor B Power - Corrected Power Sensor A Power

RF Source Power (Direct)

Note Zero and calibrate the Power Sensor using the procedure in the *RF Source Power (Direct)* section of this document prior to starting this procedure.

1. Connect the RF Source 2 output to the Power Sensor B input using the SMA (m)-to-SMA (m) cable and 3.5 mm (f)-to-3.5 mm (f) adaptor. The completed equipment setup is shown in Figure 2.

Figure 2. RF Source 2 Output Power Characterization Equipment Setup



1	RF Source 2	3	3.5 mm (f)-to-3.5 mm (f) Adaptor	5	Power Meter
2	SMA (m)-to-SMA (m) Cable	4	Power Sensor B		

2. Set the RF Source 2 frequency according to the first row in Table 2 or Table 3 as appropriate.

Table 2. NI 5665 3.6 GHz VSA RF Source 2 Characterization Frequencies

Start Frequency	Stop Frequency	Step Size
100.033325 MHz	2.000033325 GHz	100 MHz
2.099966675 GHz	3.599966675 GHz	100 MHz
9.325033325 GHz	11.225033325 GHz	100 MHz
11.324966675 GHz	12.824966675 GHz	100 MHz
1.325033325 GHz	3.225033325 GHz	100 MHz
3.324966675 GHz	4.824966675 GHz	100 MHz
74.966675 MHz	274.966675 MHz	100 MHz

Table 2. NI 5665 3.6 GHz VSA RF Source 2 Characterization Frequencies (Continued)

Start Frequency	Stop Frequency	Step Size
25.033325 MHz	1.625033325 GHz	100 MHz
1.724966675 GHz	3.224966675 GHz	100 MHz
3.3875 GHz	—	—
987.5 MHz	—	—

Table 3. NI 5665 14GHz VSA RF Source 2 Characterization Frequencies

Start Frequency	Stop Frequency	Step Size
100.033325 MHz	1.975033325 GHz	125 MHz
2.099966675 GHz	3.599966675 GHz	125 MHz
3.724966675 GHz	13.974966675 GHz	125 MHz
13.999966675 GHz	—	—
9.325033325 GHz	11.200033325 GHz	125 MHz
11.324966675 GHz	12.824966675 GHz	125 MHz
4.949966675 GHz	15.199966675 GHz	125 MHz
15.224966675 GHz	—	—
1.325033325 GHz	3.200033325 GHz	125 MHz
3.324966675 GHz	4.824966675 GHz	125 MHz
3.349966675 GHz	13.599966675 GHz	125 MHz
13.624966675 GHz	—	—
24.966675 MHz	274.966675 MHz	125 MHz
1.724966675 GHz	3.224966675 GHz	125 MHz
3.3875 GHz	—	—
987.5 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*

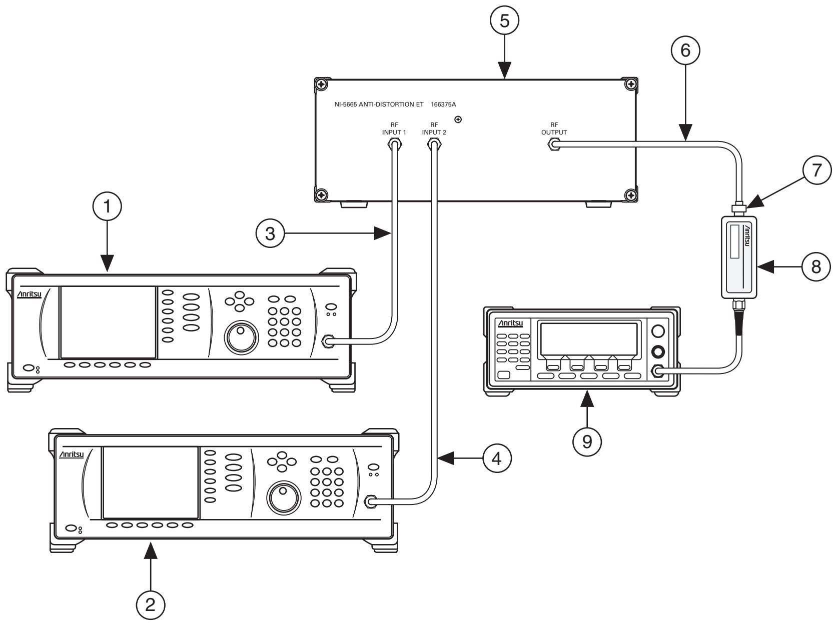
5. Repeat steps 2 to 4 for all remaining frequencies in Table 2 or Table 3.

RF Source Power (with Lowpass Filter)

Note Zero and calibrate the Power Sensor according to the *RF Source Power (Direct)* section of this document prior to 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 3.

Figure 3. RF Source Power (with Lowpass Filter) Characterization Equipment Setup



1	RF Source 1	6	SMA (m)-to-SMA (m) Cable
2	RF Source 2	7	3.5 mm (f)-to-3.5 mm (f) Adaptor
3	SMA (m)-to-SMA (m) Cable	8	Power Sensor B
4	SMA (m)-to-SMA (m) Cable	9	Power Meter
5	Anti-Distortion Test Fixture		

2. Disable the RF Source 1 output.

3. Set the RF Source 2 frequency and power according to the first row in Table 4.

Table 4. RF Source 2 Settings

Start Frequency	Stop Frequency	Step Size	Power (dBm)
300 MHz	1.8 GHz	10 MHz	0
1.9 GHz	7.0 GHz	100 MHz	0
300.0333125 MHz	1790.0333125 MHz	10 MHz	-30
1.8 GHz	—	—	-30

4. Configure the Anti-Distortion Test Fixture to use the appropriate Lowpass Filter Path according to Table 5.

Table 5. Lowpass Filter Frequency Ranges

Lowpass Filter Path	Frequency Range
470 MHz	1 to 470 MHz
735 MHz	>470 to 735 MHz
1150 MHz	>735 MHz to 1.150 GHz
1800 MHz	>1.150 GHz to 1.800 GHz

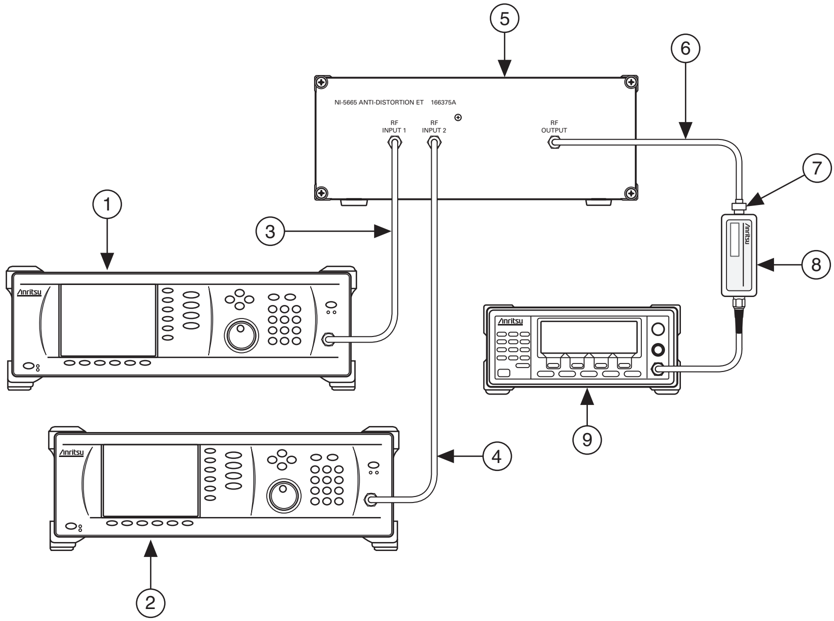
5. Enable the RF Source 2 output.
6. Measure the Channel B power using the appropriate calibration factor for the Power Sensor frequency. Adjust the RF Source 2 power until this measured power is within ±0.1 dB of the value listed in Table 4. The final RF Source 2 power setting is the *RF Source Power LPF* for that frequency.
7. Repeat steps 3 to 6 for all the frequencies and powers in step 3.

RF Source Power (Combined) for Frequencies ≤700 MHz

Note Zero and calibrate the Power Sensor using the procedures in the *RF Source Power (Direct)* section of this document prior to 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	SMA (m)-to-SMA (m) Cable
2	RF Source 2	7	3.5 mm (f)-to-3.5 mm (f) Adaptor
3	SMA (m)-to-SMA (m) Cable	8	Power Sensor B
4	SMA (m)-to-SMA (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 frequencies and power values according to the first row in Table 6.

Table 6. RF Source Power (Combined) Test Settings (Frequencies ≤700 MHz)

Start Frequency (MHz)	Stop Frequency (MHz)	Step Size (MHz)	RF Source 1		RF Source 2	
			Frequency Offset	Power (dBm)	Frequency Offset	Power (dBm)
12.05	92.05	10	+350 kHz	-10	-350 kHz	-10
100	700	100	+350 kHz	-10	-350 kHz	-10
12.05	92.05	10	+350 kHz	-30	-350 kHz	-30
100	700	100	+350 kHz	-30	-350 kHz	-30
10	100	10	+1 MHz	+9.1	0 Hz	-24
10	100	10	+1 MHz	-16	0 Hz	-54
200	700	100	+1 MHz	+9.1	0 Hz	-24
200	700	100	+1 MHz	-13	0 Hz	-54
10	100	10	+1 MHz	+8	0 Hz	-24
200	700	100	+1 MHz	+8	0 Hz	-24
10	100	10	+1 MHz	-18	0 Hz	-54
200	700	100	+1 MHz	-15	0 Hz	-54

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.
6. Repeat step 5, adjusting the RF Source 2 power until the Channel B reading is within ±0.1 dB of the power listed in Table 6. The RF Source 2 power is the *RF Source 2 Programmed Power.*
7. 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.

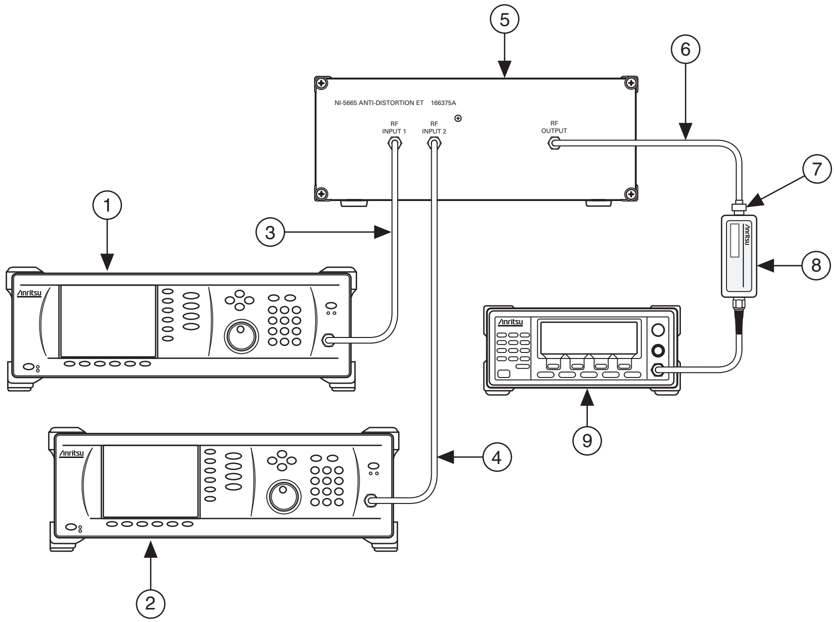
8. Measure the Channel B power using the appropriate sensor calibration factor for the RF Source 1 frequency.
9. Repeat step 8, adjusting the RF Source 1 power until the Channel B power is within ±0.1 dB of the power listed in Table 6. The RF Source 1 power is the *RF Source 1 Programmed Power.*
10. Repeat steps 3 to 9 for all remaining frequencies in Table 6.

RF Source Power (Combined) for Frequencies >700 MHz

Note Zero and calibrate the Power Sensor using the procedures in the *RF Source Power (Direct)* section of this document prior to 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 5.

Figure 5. RF Source Power (Combined) Characterization Equipment Setup (Frequencies > 700 MHz)



1	RF Source 1	6	SMA (m)-to-SMA (m) cable
2	RF Source 2	7	3.5 mm (f)-to-3.5 mm (f) Adaptor
3	SMA (m)-to-SMA (m) cable	8	Power Sensor B
4	SMA (m)-to-SMA (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 frequencies and power values according to the first row in Table 7.

Table 7. NI 5665 RF Source Power (Combined) Test Settings (Frequencies >700 MHz)

Start Frequency	Stop Frequency	Step Size (MHz)	RF Source 1		RF Source 2	
			Frequency Offset	**Power (dBm)**	**Frequency Offset**	**Power (dBm)**
800 MHz	3.500 GHz	100	+350 kHz	-10	-350 kHz	-10
3598.95 MHz	—	—	+350 kHz	-10	-350 kHz	-10
3.6 GHz	13.8 GHz	200	+350 kHz	-10	-350 kHz	-10
13.99895 GHz	—	—	+350 kHz	-10	-350 kHz	-10
800 MHz	3.500 GHz	100	+350 kHz	-30	-350 kHz	-30
3598.95 MHz	—	—	+350 kHz	-30	-350 kHz	-30
3.6 GHz	—	—	+350 kHz	-30	-350 kHz	-30
800 MHz	1.700 GHz	100	+1 MHz	+9.1	0 Hz	-24
800 MHz	1.700 GHz	100	+1 MHz	+8	0 Hz	-24
800 MHz	1.700 GHz	100	+1 MHz	-13	0 Hz	-54
800 MHz	1.700 GHz	100	+1 MHz	-15	0 Hz	-54
1.800 GHz	14.000 GHz	100	+1 MHz	+7.1	0 Hz	-24
1.800 GHz	14.000 GHz	100	+1 MHz	+6	0 Hz	-24
1.800 GHz	3.600 GHz	100	+1 MHz	-16	0 Hz	-54
1.800 GHz	3.600 GHz	100	+1 MHz	-18	0 Hz	-54

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.
6. Repeat step 5, adjusting the RF Source 2 power until the Channel B reading is within ±0.1 dB of the power in Table 7. The RF Source 2 power is the *RF Source 2 Programmed Power*.
7. 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.

8. Measure the Channel B power using the appropriate sensor calibration factor for the RF Source 1 frequency.
9. Repeat step 8, adjusting the RF Source 1 power until the Channel B power is within ±0.1 dB of the power in Table 7. The RF Source 1 power is the *RF Source 1 Programmed Power*.
10. Repeat steps 3 to 9 for all remaining frequencies listed in Table 7.

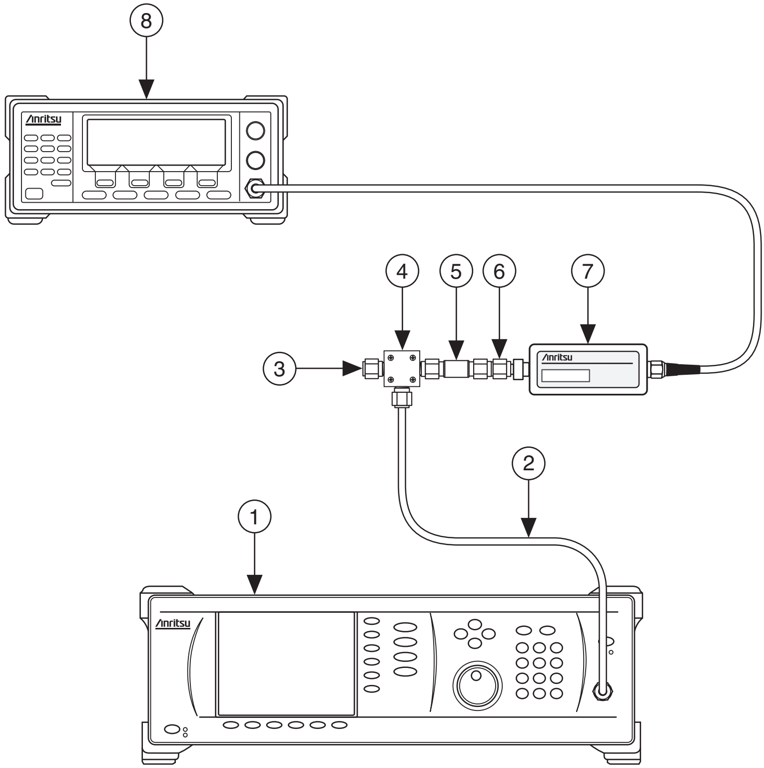
RF Source Power (Through Splitter)

Note Zero and calibrate the Power Sensor and define the Power Splitter reference output using the procedures in the *Power Splitter Reference Output* and *RF Source Power (Direct)* sections of this document prior to starting this procedure.

1. Connect the RF Source 2 output to the Power Splitter input through the SMA (m)-to-SMA (m) cable.
2. Connect a 50 Ω termination load to the reference output of the Power Splitter.

3. Connect Power Sensor B to the other output of the Power Splitter through the 3.5 mm (m)-to-3.5 mm (m) adaptors and the 3.5 mm (f)-to-3.5 mm (f) adaptor. The completed equipment setup is shown in Figure 6.

Figure 6. RF Source Power (Through Splitter) Characterization Equipment Setup



1	RF Source 2	5	3.5 mm (m)-to-3.5 mm (m) Adaptor
2	SMA (m)-to-SMA (m) Cable	6	3.5 mm (f)-to-3.5 mm (f) Adaptor
3	50 Ω Termination Load	7	Power Sensor B
4	Power Splitter	8	Power Meter

4. Set the RF Source 2 power to -10 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
100 MHz	3.5 GHz	200 MHz
3.6 GHz	—	—
3.7 GHz	14 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 8.

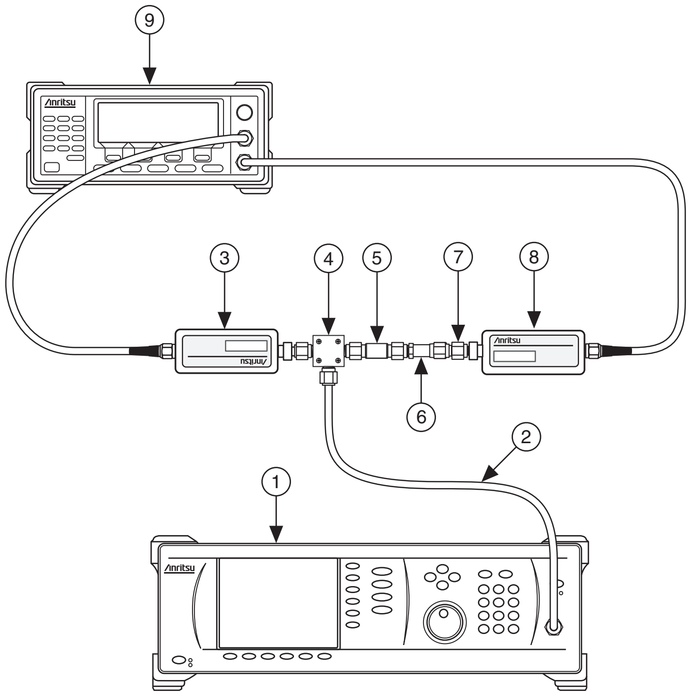
RF Source Power (with Splitter and Attenuator)

Note Zero and calibrate the Power Sensor and define the Power Splitter reference output using the procedures in the *Power Splitter Reference Output* and *RF Source Power (Direct)* sections of this document prior to starting this procedure.

1. Connect the RF Source 2 output to the Power Splitter input through the SMA (m)-to-SMA (m) cable.
2. Connect Power Sensor A to the reference output of the Power Splitter.

3. Connect Power Sensor B to the other output of the Power Splitter through the 3.5 mm (m)-to-3.5 mm (m) adaptor, the 3.5 mm (f)-to-3.5 mm (f) adaptor and the 20 dB attenuator. The completed equipment setup is shown in Figure 7.

Figure 7. RF Source Power (with Splitter and Attenuator) Characterization Equipment Setup



1	RF Source 2	6	20 dB Attenuator
2	SMA (m)-to-SMA (m) Cable	7	3.5 mm (f)-to-3.5 mm (f) Adaptor
3	Power Sensor A	8	Power Sensor B
4	Power Splitter	9	Power Meter
5	3.5 mm (m)-to-3.5 mm (m) Adaptor		

4. Set the RF Source 2 power to 0 dBm.

5. Set the RF Source 2 frequency according to the first row in Table 9.

Table 9. 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	—	—
700 MHz	3.6 GHz	100 MHz
3.8 GHz	14 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 via Attenuator Path Loss* for that frequency using the following formulas:

DUT to Power Meter through Attenuator Path Loss =
Channel A Power - *Channel B Power*

RF Source to DUT via Attenuator Path Loss = -*Channel B Power*

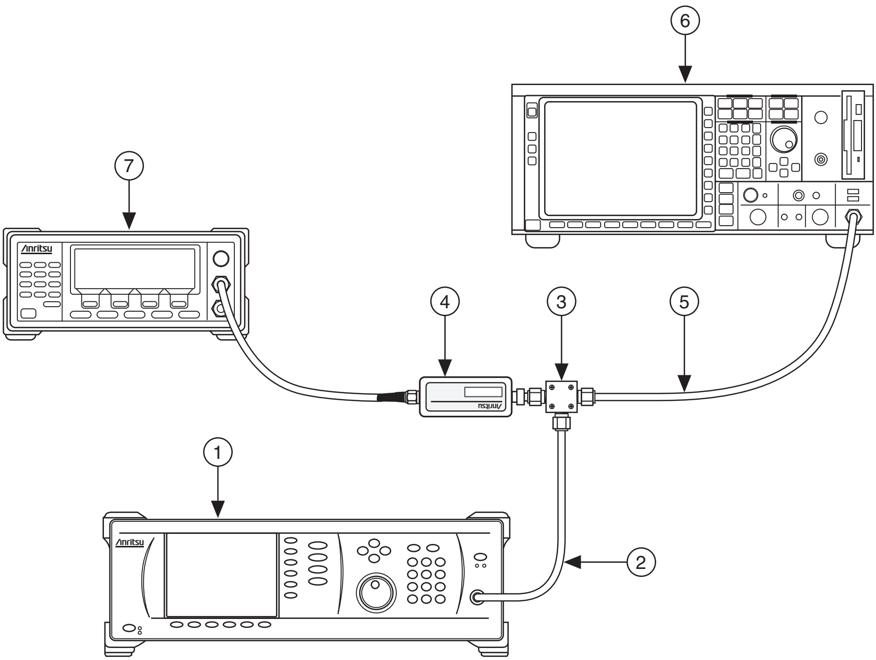
8. Repeat steps 5 to 7 for all remaining frequencies in Table 9.

Spectrum Analyzer Response

1. Connect the RF Source 2 output to the Power Splitter input through the SMA (m)-to-SMA (m) cable.
2. Connect Power Sensor A to the Power Splitter reference output through the SMA (m)-to-SMA (m) cable.

3. Connect the Spectrum Analyzer to the other Power Splitter output through the SMA (m)-to-SMA (m) cable. The completed equipment setup is shown in Figure 8.

Figure 8. Spectrum Analyzer Response Characterization Equipment Setup



1	RF Source 2	4	Power Sensor A	7	Power Meter
2	SMA (m)-to-SMA (m) cable	5	SMA (m)-to-SMA (m) cable		
3	Power Splitter	6	Spectrum Analyzer		

4. Set the RF Source 2 power to 0 dBm.
5. Set the RF Source 2 frequency to 4 GHz.
6. Configure the Spectrum Analyzer according to the following settings:
   - Resolution Bandwidth: 1 kHz
   - Center Frequency: 4 GHz
   - Frequency Span: 0 Hz
   - Reference Level: 0 dBm
7. Measure the Power Sensor A power.
8. Correct the Power Sensor A measured power for the measurement frequency of 4 GHz.
9. Correct the Power Sensor A measured power for the *Power Splitter at 4 GHz Correction Factor* from the *Power Splitter Difference* equipment characterization section of this document using the following equation:

Corrected Power Sensor Power = *Power Sensor A reading* + *Power Splitter at 4 GHz Correction Factor*

10. Measure the Spectrum Analyzer peak power.
11. Calculate the S*pectrum Analyzer Correction Factor* using the following formula:

Spectrum Analyzer Correction Factor =
Corrected Power Sensor Power - Spectrum Analyzer Power

As-Found and As-Left Limits

The as-found limits are the published specifications for the NI 5665. NI uses these limits to determine whether the NI 5665 meets the device specifications when it is received for calibration.

The as-left limits are equal to the published NI specifications for the NI 5665, less guard bands for manufacturing test measurement uncertainty, temperature drift, and drift over time. NI uses these limits to determine whether the NI 5665 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 NI 5665, perform a calibration of the individual modules. Return the NI PXIe-5603 or NI PXIe-5605 module to NI for calibration and adjustment, if needed.

Verifying Reference Accuracy

The NI 5665 reference accuracy specification is derived from the NI 5653 reference accuracy. For more information about NI PXIe-5653 calibration values, refer to the *NI PXIe-5653 Calibration Procedure* available at `ni.com/manuals`.

Verifying Phase Noise

The phase noise for the NI 5665 system is determined by the phase noise of the NI 5653 module. To verify the NI 5653 phase noise specification, you must use the phase noise verification test for the NI 5653. For more information about calibration and verification of the NI 5653, refer to the *NI PXIe-5653 Calibration Procedure,* available at `ni.com/manuals`.

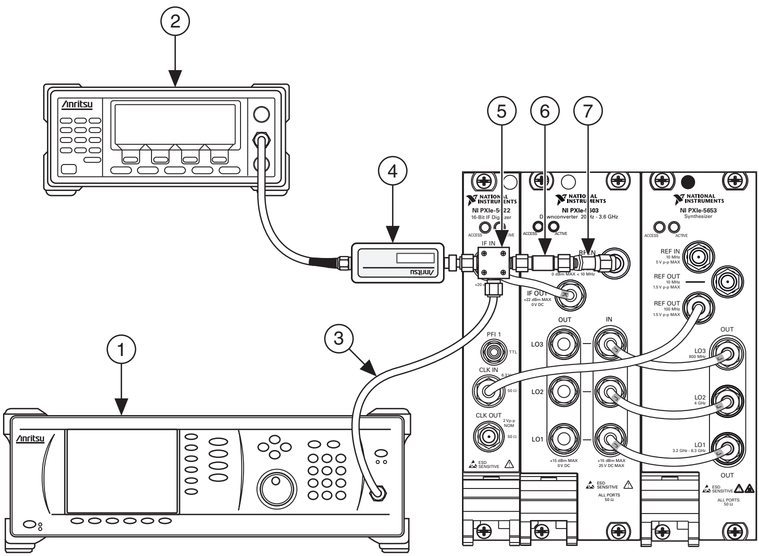
Verifying Frequency Response and Absolute Amplitude Accuracy

Verifying Frequency Response and Absolute Amplitude Accuracy for Frequencies > 10 MHz

Note Zero and calibrate the Power Sensor according to the *RF Source Power (Direct)* section of this document prior to starting this procedure.

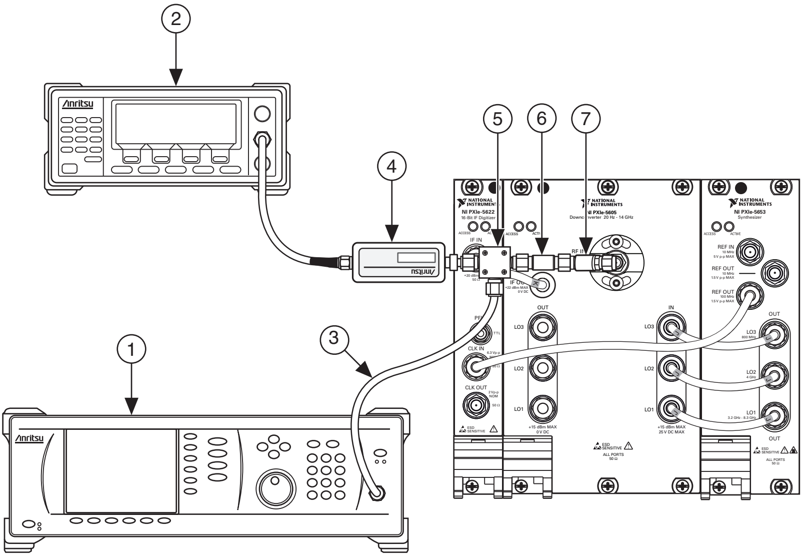
1. Connect the RF Source 2 to the Power Splitter input using the SMA (m)-to-SMA (m) cable.
2. Connect the Power Splitter reference output to Power Sensor A.
3. Connect the other Power Splitter output to the NI 5665 RF IN connector using the 3.5 mm (m)-to-3.5 mm (m) adaptor and 20 dB attenuator. The completed equipment setup is shown in Figure 9 and Figure 10.

Figure 9. NI 5665 3.6 GHz VSA Frequency Response and Absolute Amplitude Accuracy Verification (Frequencies > 10 MHz) Equipment Setup



1	RF Source 2	5	Power Splitter
2	Power Meter	6	3.5 mm (m)-to-3.5 mm (m) Adaptor
3	SMA (m)-to-SMA (m) cable	7	20 dB Attenuator
4	Power Sensor A		

Figure 10. NI 5665 14 GHz VSA Frequency Response and Absolute Amplitude Accuracy Verification (Frequencies > 10 MHz) Equipment Setup



1	RF Source 2	5	Power Splitter
2	Power Meter	6	3.5 mm (m)-to-3.5 mm (m) Adaptor
3	SMA (m)-to-SMA (m) cable	7	20 dB Attenuator
4	Power Sensor A		

4. Create a new session for the NI 5665.
5. Configure the NI 5665 according to the following fixed property settings. These settings remain unchanged during the test.
   - 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
   - Span: 100 kHz
   - Resolution Bandwidth: 10 kHz
6. Configure the NI 5665 according to the following variable property settings:
   - Preamp Enabled: Disabled
   - Device Instantaneous Bandwidth: 300 kHz
   - **(NI 5665 14 GHz VSA)** Preselector Enabled: Disabled

7. Set the NI 5665 reference level using the following values:
   - Start Power: -50 dBm
   - Stop Power: -10 dBm
8. Set the NI 5665 center frequency and the RF Source 2 frequency according to the first row in Table 10.

Table 10. Frequency Response and Absolute Amplitude Accuracy Verification (Frequencies > 10 MHz) Test Frequencies

Start Frequency	Stop Frequency	Step Size
10 MHz[*]	100 MHz	30 MHz
200 MHz	600 MHz	200 MHz
612.5 MHz	—	—
800 MHz	3.6 GHz	400 MHz
4 GHz	14 GHz	500 MHz

[*] The 10 MHz to 100 MHz frequency range applied only to the 300 kHz device instantaneous bandwidth value.

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

$$\textit{RF Source 2 Amplitude} = \textit{NI 5665 Reference Level} + \textit{RF Source to DUT via Attenuator Path Loss}$$

10. Commit the NI 5665 settings to hardware.
11. Take five readings of the RF Source 2 amplitude using Power Sensor A. Calculate the average power.
12. Repeat step 11 until any two readings measured differ no more than 0.02 dB and no two averages differ by more than 0.005 dB. This average is the *Measured Average Power*.

Note More than 30 averages total indicate a test failure that you must diagnose.

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

$$\textit{Corrected Input Power} = \textit{Measured Average Power} - \textit{DUT to Power Meter through Attenuator Path Loss}$$

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

14. Read the NI 5665 power spectrum. The *NI 5665 Power* is the peak value of that spectrum.

15. Calculate the *Absolute Amplitude Accuracy* at each RF frequency using the following formula:

    Absolute Amplitude Accuracy = NI 5665 Power - Corrected Input Power

16. Repeat steps 8 to 15 for all remaining frequencies in Table 10.
17. Calculate the *Frequency Response* at each RF frequency using the following formula:

    Frequency Response = Absolute Amplitude Accuracy -
    Absolute Amplitude Accuracy at 612.5 MHz

Note Calculate *Frequency Response* only for NI 5665 center frequencies less than or equal to 3.6 GHz.

18. Repeat steps 9 to 17 for all reference levels listed in step 7.
19. Repeat steps 8 to 18 for an instantaneous bandwidth of 50 MHz (25 MHz for the NI 5665 with 25 MHz bandwidth).
20. Repeat steps 8 to 19 with the NI 5665 preamplifier enabled.
21. **(NI 5665 14 GHz VSA)** Repeat steps 8 to 19 for test frequencies greater than 3.6 GHz with the NI 5665 preselector enabled and preamplifier disabled.

Note The NI 5665 preselector has a maximum instantaneous bandwidth of 47 MHz. When using the preselector, for steps that call for a 50 MHz instantaneous bandwidth, use a 47 MHz instantaneous bandwidth instead.

22. Compare the *Frequency Response* to the verification test limits in Table 11 or Table 12 as appropriate.

Table 11. Frequency Response Verification Test Limits (Preamplifier Disabled)

<table>
<tr><th>Frequency</th><th>Device</th><th>As-Found Limit</th><th>As-Left Limit*</th></tr>
<tr><td>10 MHz to 100 MHz</td><td rowspan="2">NI 5665</td><td>±0.60 dB</td><td>±0.35 dB</td></tr>
<tr><td>>100 MHz to 1.7 GHz</td><td>±0.35 dB</td><td>±0.25 dB</td></tr>
<tr><td rowspan="2">>1.7 GHz to 2.8 GHz</td><td>NI 5665
3.6 GHz VSA</td><td>±0.40 dB</td><td rowspan="2">±0.30 dB</td></tr>
<tr><td>NI 5665
14 GHz VSA</td><td>±0.42 dB</td></tr>
<tr><td rowspan="2">>2.8 GHz to 3.6 GHz</td><td>NI 5665
3.6 GHz VSA</td><td>±0.45 dB</td><td rowspan="2">±0.35 dB</td></tr>
<tr><td>NI 5665
14 GHz VSA</td><td>±0.62 dB</td></tr>
<tr><td colspan="4">* Refer to the As-Found and As-Left Limits section of this document for more information about as-left limits.</td></tr>
</table>

Table 12. Frequency Response Verification Test Limits (Preamplifier Enabled)

<table>
<tr><th>Frequency</th><th>Device</th><th>As-Found Limit</th><th>As-Left Limit*</th></tr>
<tr><td>10 MHz to 100 MHz</td><td rowspan="2">NI 5665</td><td>±0.75 dB</td><td>±0.50 dB</td></tr>
<tr><td>>100 MHz to 2.8 GHz</td><td>±0.45 dB</td><td>±0.30 dB</td></tr>
<tr><td rowspan="2">>2.8 GHz to 3.6 GHz</td><td>NI 5665
3.6 GHz VSA</td><td>±0.45 dB</td><td>±0.30 dB</td></tr>
<tr><td>NI 5665
14 GHz VSA</td><td>±0.50 dB</td><td>±0.45 dB</td></tr>
<tr><td colspan="4">* Refer to the As-Found and As-Left Limits section of this document for more information about as-left limits.</td></tr>
</table>

23. Compare the *Absolute Amplitude Accuracy* to the verification test limits in Table 13, Table 14, or Table 15 as appropriate.

Table 13. Absolute Amplitude Accuracy Verification Test Limits (Preamplifier Disabled, NI 5665 14 GHz VSA Preselector Disabled)

Frequency	Device	As-Found Limit	As-Left Limit*
612.5 MHz	NI 5665 3.6 GHz VSA	±0.35 dB	±0.25 dB
	NI 5665 14 GHz VSA	±0.46 dB	±0.38 dB
10 MHz to 100 MHz	NI 5665 3.6 GHz VSA	±0.95 dB	±0.60 dB
	NI 5665 14 GHz VSA	±1.06 dB	±0.73 dB
>100 MHz to 1.7 GHz	NI 5665 3.6 GHz VSA	±0.70 dB	±0.50 dB
	NI 5665 14 GHz VSA	±0.81 dB	±0.63 dB
>1.7 GHz to 2.8 GHz	NI 5665 3.6 GHz VSA	±0.75 dB	±0.55 dB
	NI 5665 14 GHz VSA	±0.88 dB	±0.68 dB
>2.8 GHz to 3.6 GHz	NI 5665 3.6 GHz VSA	±0.80 dB	±0.60 dB
	NI 5665 14 GHz VSA	±1.08 dB	±0.73 dB
>3.6 GHz to 7.5 GHz	NI 5665 14 GHz VSA	±0.70 dB	±0.50 dB
>7.5 GHz to 8.5 GHz		±0.80 dB	±0.50 dB
>8.5 GHz to 14 GHz		±1.25 dB	±0.75 dB

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

Table 14. Absolute Amplitude Accuracy Verification Test Limits (Preamplifier Enabled)

Frequency	Device	As-Found Limit	As-Left Limit*
612.5 MHz	NI 5665 3.6 GHz VSA	±0.35 dB	±0.30 dB
	NI 5665 14 GHz VSA	±0.70 dB	±0.60 dB
10 MHz to 100 MHz	NI 5665 3.6 GHz VSA	±1.10 dB	±0.80 dB
	NI 5665 14 GHz VSA	±1.45 dB	
>100 MHz to 2.8 GHz	NI 5665 3.6 GHz VSA	±0.80 dB	±0.60 dB
	NI 5665 14 GHz VSA	±1.15 dB	
>2.8 GHz to 3.6 GHz	NI 5665 3.6 GHz VSA	±0.80 dB	±0.60 dB
	NI 5665 14 GHz VSA	±1.20 dB	±0.75 dB

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

Table 15. NI 5665 14 GHz VSA Absolute Amplitude Accuracy Verification Test Limits (Preamplifier Disabled, NI 5665 14 GHz VSA Preselector Enabled)

Frequency	As-Found Limit (dB)	As-Left Limit*
>3.6 GHz to 7.5 GHz	±4.0 dB	±1.5 dB
>7.5 GHz to 8.5 GHz	±4.0 dB	±1.5 dB
>8.5 GHz to 14 GHz	±4.0 dB	±1.5 dB

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

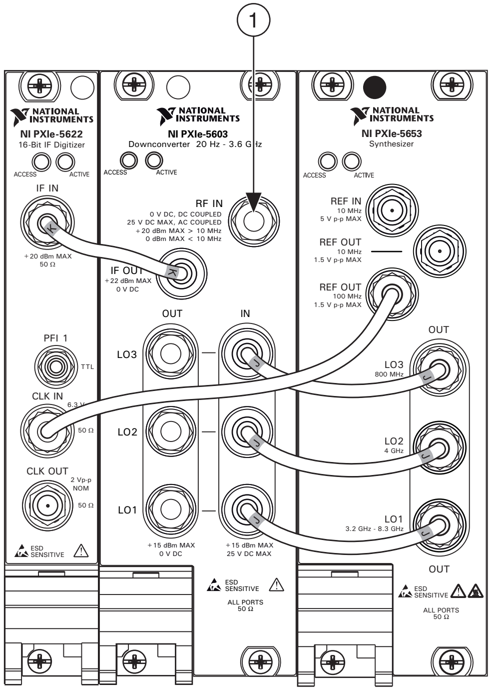
24. Close the NI 5665 session.

If the frequency response and absolute amplitude accuracy verification procedures determines that the NI 5665 is outside its limits, refer to *Worldwide Support and Services* for information about support resources or service requests.

Verifying Average Noise Level

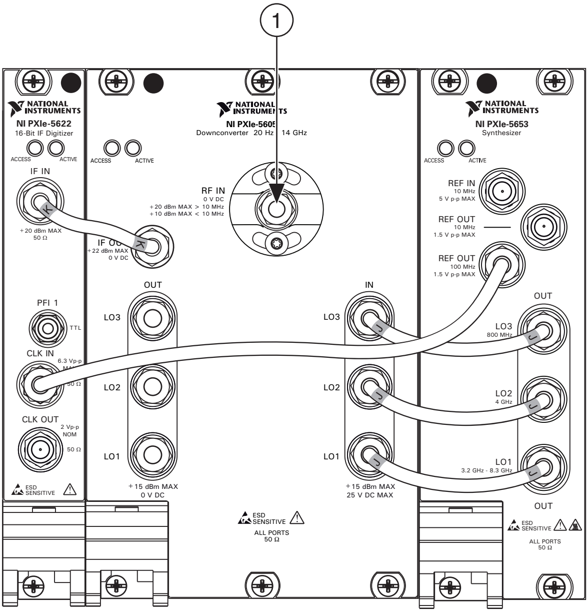
1. Connect a 50 Ω termination to the NI 5665 RF IN connector. The completed equipment setup is shown in Figure 11 and Figure 12.

Figure 11. NI 5665 3.6 GHz VSA Average Noise Level Verification Equipment Setup



1 50 Ω termination

Figure 12. NI 5665 14 GHz VSA Average Noise Level Verification Equipment Setup



1 50 Ω termination

2. Create a new session for the NI 5665.
3. Configure the NI 5665 according to the following property settings:
   - Acquisition Type: Spectrum
   - Averaging Mode: RMS Averages
   - 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: 300 Hz
   - RF Attenuation: 0 dB
   - FFT Window Type: Blackman-Harris
   - **(NI 5665 14 GHz VSA)** Preselector Enabled: Disabled

4. Set the NI 5665 center frequency according to Table 16.

Table 16. Average Noise Level Verification Test Frequencies

Start Frequency	Stop Frequency	Step Size
10 MHz	90 MHz	20 MHz
100 MHz	3.6 GHz	500 MHz
4 GHz	14 GHz	500 MHz

5. Set the NI 5665 channel coupling, RF attenuation, device instantaneous bandwidth, span, resolution bandwidth, sampling ratio, and number of averages according to Table 17.

Table 17. NI 5665 Settings for Average Noise Level Verification

Test Frequency	Device Instantaneous Bandwidth	Span (Hz)	OSP Sampling Ratio
10 MHz to <100 MHz	300 kHz	100 kHz	32
100 MHz to ≤3.6 GHz	300 kHz	100 kHz	32
	50 MHz*	5 MHz	1
3.8 GHz to 14 GHz	50 MHz*	5 MHz	1

* Set the NI 5665 Device Instantaneous Bandwidth to 25 MHz for the NI 5665 with 25 MHz bandwidth.

6. Commit the NI 5665 settings to hardware.
7. Read the power spectrum from the NI 5665. Convert the power spectrum to a power spectral density (dBm/Hz) value.
8. Remove five points from around the center of the power spectral density from step 7.
9. Convert the power spectral density with the points removed to watts/Hz, take the mean, and then convert the result back to dBm/Hz. This value is the *NI 5665 Average Noise (dBm/Hz)*.
10. Repeat steps 4 to 9 for all frequencies in Table 16.
11. Repeat steps 4 to 10 for frequencies less than or equal to 3.6 GHz with the NI 5665 preamplifier enabled.
12. **(NI 5665 14 GHz VSA)** Repeat steps 4 to 10 for frequencies greater than 3.6 GHz with the NI 5665 preselector enabled and preamplifier disabled.

Note The NI 5665 preselector has a maximum instantaneous bandwidth of 47 MHz. When using the preselector, for steps that call for a 50 MHz instantaneous bandwidth, use a 47 MHz instantaneous bandwidth instead.

13. Compare the *NI 5665 Average Noise (dBm/Hz)* to the verification test limits in Table 18, Table 19 or Table 20 as appropriate.

Table 18. Average Noise Verification Test Limits (Preamplifier Disabled, NI 5665 14 GHz VSA Preselector Disabled)

Frequency	As-Found Limit (dBm/Hz)	As-Left Limit[*] (dBm/Hz)
>10 MHz to 100 MHz	-149	-151
>100 MHz to 300 MHz	-152	-154
>300 MHz to 1.7 GHz	-151	-153
>1.7 GHz to 2.8 GHz	-149	-151
>2.8 GHz to 3.6 GHz	-148	-150
>3.6 GHz to 7.5 GHz[†]	-148	-150
>7.5 GHz to 8.5 GHz[†]	-146	-147
>8.5 GHz to 12 GHz[†]	-147	-148
>12 GHz to 14 GHz[†]	-145	-146

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

[†] Frequencies > 3.6 GHz apply only to the NI 5665 14 GHz VSA.

Table 19. Average Noise Verification Test Limits (Preamplifier Enabled)

Frequency	As-Found Limit (dBm/Hz)	As-Left Limit[*] (dBm/Hz)
>10 MHz to 100 MHz	-161	-163
>100 MHz to 300 MHz	-162	-165
>300 MHz to 1.7 GHz	-162	-164
>1.7 GHz to 2.8 GHz	-161	-163
>2.8 GHz to 3.6 GHz	-160	-163

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

Table 20. Average Noise Verification Test Limits (Preamplifier Disabled, NI 5665 14 GHz VSA Preselector Enabled)

Frequency	As-Found Limit (dBm/Hz)	As-Left Limit* (dBm/Hz)
>3.6 GHz to 7.5 GHz	-144	-145
>7.5 GHz to 8.5 GHz	-140	-141
>8.5 GHz to 12 GHz	-141	-142
>12 GHz to 14 GHz	-140	-141

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

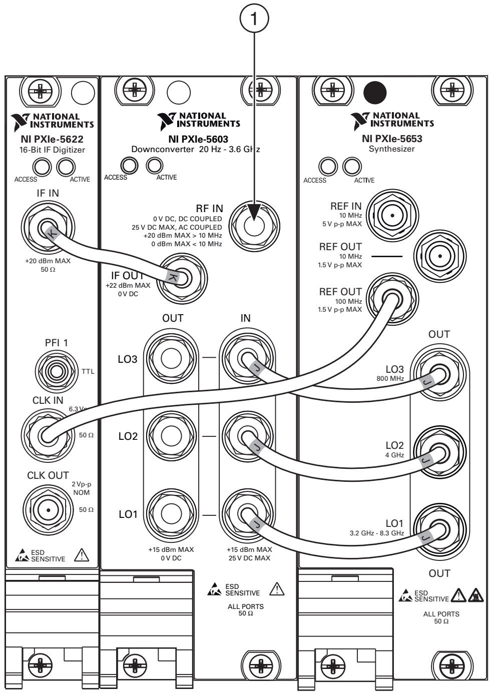
14. Close the NI 5665 session.

If the average noise level verification procedure determines that the NI 5665 is outside its limits, refer to *Worldwide Support and Services* for information about support resources or service requests.

Verifying Non-Input-Related Spurs (Residual Spurs)

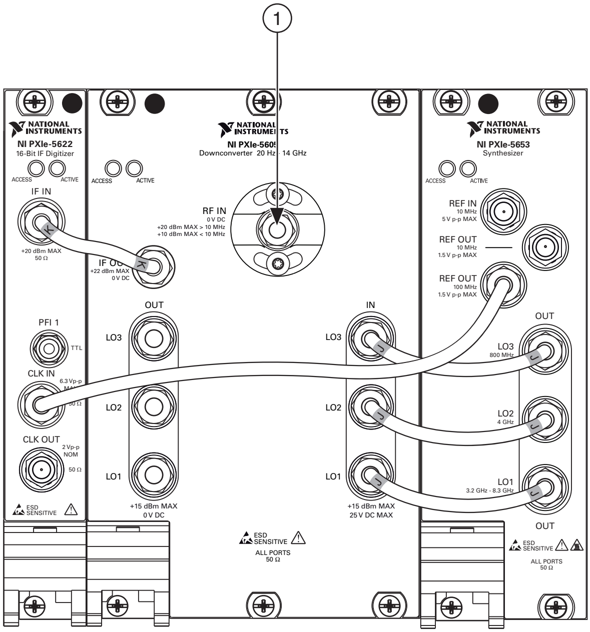
1. Connect a 50 Ω termination to the NI 5665 RF IN connector. The completed equipment setup is shown in Figure 13 and Figure 14.

Figure 13. NI 5665 3.6 GHz VSA Non-Input-Related Spurs Verification Equipment Setup



1	50 Ω Termination

Figure 14. NI 5665 14 GHz VSA Non-Input-Related Spurs Verification Equipment Setup



1 50 Ω Termination

2. Create a new session for the NI 5665.
3. Configure the NI 5665 according to the following property settings:
   - Acquisition Type: Spectrum
   - Averaging Mode: RMS Averaging
   - Number of Averages: 4
   - Ref Clock Source: PXI_Clk
   - Ref Clock Rate: 10 MHz
   - Channel Coupling: AC Coupled
   - Preamp Enabled: Disabled
   - Span: 50 MHz (25 MHz for the NI 5665 with 25 MHz bandwidth)
   - Device Instantaneous Bandwidth: 50 MHz (25 MHz for the NI 5665 with 25 MHz bandwidth)
   - Resolution Bandwidth: 2 kHz
   - RF Attenuation: 0 dB
   - Reference Level: -60 dBm
   - FFT Window Type: Flat Top
   - **(NI 5665 14 GHz VSA)** Preselector Enabled: Disabled

4. Set the NI 5665 center frequency using the following values:
   - Start Frequency: 100 MHz
   - Stop Frequency:
     – **(NI 5665 3.6 GHz VSA)** 3.6 GHz
     – **(NI 5665 14 GHz VSA)** 14 GHz
   - Step Size: 9.997331 MHz
5. Commit the NI 5665 settings to hardware.
6. Read the power spectrum from the NI 5665.
7. Measure the highest power in the spectrum returned from the NI 5665. This value is the *NI 5665 Non-Input-Related Spurious Level*.
8. Repeat steps 4 to 7 for all frequencies in step 4.
9. Compare the *NI 5665 Non-Input-Related Spurious Level* to the verification test limits in Table 21.

Table 21. Non-Input-Related Spurs Verification Test Limits

Center Frequency	As-Found Limit	As-Left Limit*
100 MHz to <1.650 GHz	-95 dBm	-96 dBm
1.650 GHz to 1.750 GHz	-85 dBm	-88 dBm
>1.750 GHz to 3.6 GHz	-95 dBm	-96 dBm
>3.6 GHz to 7.5 GHz†	-92 dBm	-94 dBm
>7.5 GHz to 8.5 GHz†	-90 dBm	-92 dBm
>8.5 GHz to 14 GHz†	-90 dBm	-92 dBm

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

† Center frequencies > 3.6 GHz apply only to the NI 5665 14 GHz VSA.

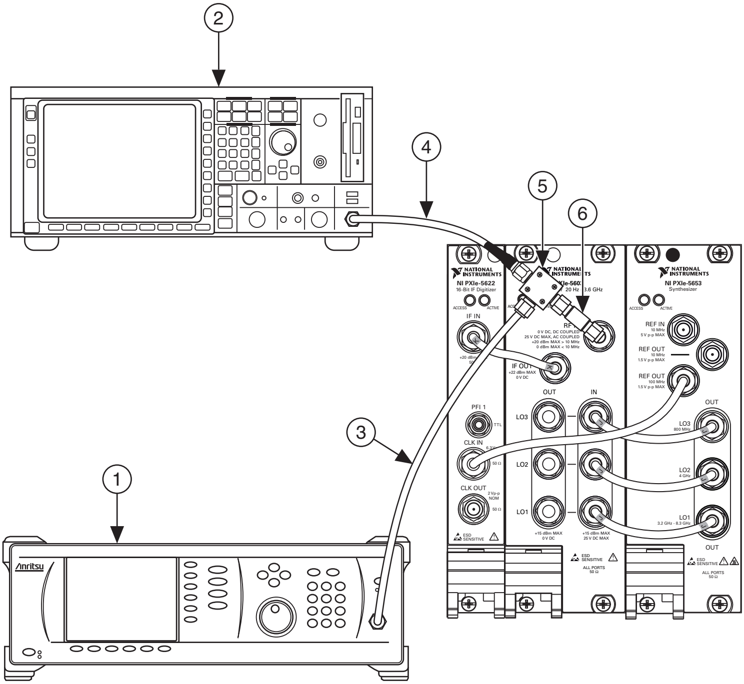
10. Close the NI 5665 session.

If the non-input-related spurs (residual spurs) verification procedure determines that the NI 5665 is outside its limits, refer to *Worldwide Support and Services* for information about support resources or service requests.

Verifying LO-Related Spurs (Sideband Spurs)

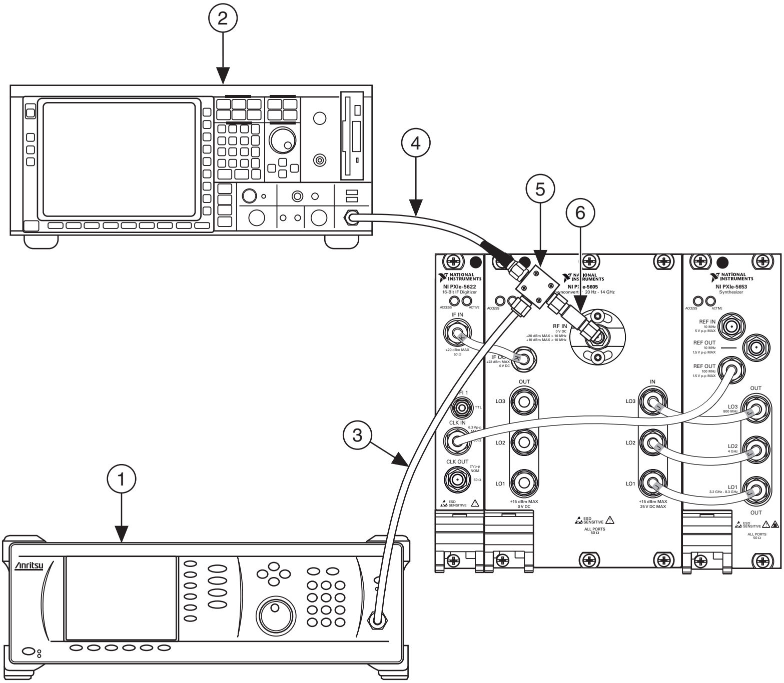
1. Connect RF Source 2 to the Power Splitter input through the SMA (m)-to-SMA (m) cable.
2. Connect the Power Splitter reference output to the Spectrum Analyzer through the SMA (m)-to-SMA (m) cable.
3. Connect the other Power Splitter output to the NI 5665 RF IN connector using the 3.5 mm (m)-to-3.5 mm (m) adaptor. The completed equipment setup is shown in Figure 15 and Figure 16.

Figure 15. NI 5665 3.6 GHz VSA LO-Related Spurs Verification Equipment Setup



1	RF Source 2	4	SMA (m)-to-SMA (m) cable
2	Spectrum Analyzer	5	Power Splitter
3	SMA (m)-to-SMA (m) cable	6	3.5 mm (m)-to-3.5 mm (m) Adaptor

Figure 16. NI 5665 14 GHz VSA LO-Related Spurs Verification Equipment Setup



1	RF Source 2	4	SMA (m)-to-SMA (m) cable
2	Spectrum Analyzer	5	Power Splitter
3	SMA (m)-to-SMA (m) cable	6	3.5 mm (m)-to-3.5 mm (m) Adaptor

4. Create a new session for the NI 5665.
5. Configure the NI 5665 according to the following fixed property settings. These settings remain unchanged during the test.
   - Acquisition Type: Spectrum
   - Averaging Mode: RMS Averaging
   - Number of Averages: 10
   - Ref Clock Source: PXI_Clk
   - Ref Clock Rate: 10 MHz
   - Preamp Enabled: Disabled
   - Reference Level: -10 dBm
   - FFT Window Type: Flat Top
   - Resolution Bandwidth Type: Bin Width
   - Channel Coupling: AC Coupled
   - Device Instantaneous Bandwidth: 50 MHz (25 MHz for the NI 5665 with the 25 MHz bandwidth)

- **(NI 5665 14 GHz VSA)** Preselector Enabled: Disabled

6. Set the RF Source 2 mode to Single Frequency.
7. Connect the Frequency Reference Source to the Spectrum Analyzer reference frequency input.
8. Set the Spectrum Analyzer reference source to External.

Note If the RF source you use for this test has consistent, known offset spurs, these spurs can be characterized independently of the LO-related spurs. You can ignore these offset frequencies to save time during testing.

9. Set the NI 5665 center frequency according to the first row in either Table 22 or Table 23.

Table 22. NI 5665 3.6 GHz VSA Test Frequencies

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

Table 23. NI 5665 14 GHz VSA Test Frequencies

Start Frequency	Stop Frequency	Step Size
100 MHz	13.9 GHz	200 MHz
14 GHz	—	—

10. Configure the RF Source 2 according to the following settings:
    - Center frequency: NI 5665 center frequency
    - Output power: *RF Source Power through Splitter* for that frequency
11. Set the Spectrum Analyzer center frequency to the RF Source 2 frequency.
12. Set the NI 5665 span and resolution bandwidth according to the first row in Table 24.

Table 24. LO-Related Spurs Verification Bandwidth and Span Settings

NI 5665 Span	NI 5665 RBW	NI 5665 Notch BW (Number of Bins at Stated RBW)	Spectrum Analyzer Span	Spectrum Analyzer RBW	Spectrum Analyzer Averages
200 kHz	10 Hz	20 kHz (1999)	600 Hz	50 Hz	6
2 MHz	40 Hz	200 kHz (4999)	300 Hz	50 Hz	3
20 MHz	60 Hz	2 MHz (33333)	300 Hz	50 Hz	3

13. Set the Spectrum Analyzer span, resolution bandwidth, and number of averages according to the values in Table 24.

14. Commit the NI 5665 settings to hardware.
15. Wait 250 ms before making the first measurement and wait 100 ms before making a subsequent measurements to allow the NI 5665 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 RF Source 2 spectrum with the Spectrum Analyzer.
17. Perform a peak search on the spectrum from step 16. The value of the peak is the *Spectrum Analyzer Tone Power*. This value is used in step 19(c).
18. Measure the spectrum on the NI 5665 and complete the following steps:
    a. Find the peak value of the spectrum.
    b. Confirm that the peak value is between -16 dBm and -4 dBm. The peak value is the *NI 5665 Tone Power*. This value is used in step 18(d).
    c. Notch filter the spectrum by replacing the appropriate number of bins from the center of the spectrum according to Table 24 with bins of -130 dB in value. The resulting spectrum is the *Notched Spectrum*.
    d. Calculate the *Notched Spectrum Response* using the following equation:

Notched Spectrum Response (dB) = *Notched Spectrum* (dBm) - *NI 5665 Tone Power* (dBm)

    e. Create a list of target spurs from the *Notched Spectrum Response* (dB) that have a level greater than -90 dB.
    f. If any two spurs are within ±500 Hz of each other, retain only the spur with the greater power magnitude. This reduced list is used in step 19(a).

Note The RF Source 2 indicated for use in this procedure exhibits spurious responses that have a frequency spread of 500 Hz. Any target spur found within ±500 Hz of an RF Source 2 spurious response is considered to be from the RF Source 2 because of this frequency spread.

19. Eliminate any RF Source 2 spurious responses from the list of target spurs by completing the following steps:
    a. Tune the Spectrum Analyzer to the frequency of each target spur in the reduced list from step 18(f).
    b. Measure the spectrum and perform a peak search on the measured spectrum. This value is the *Spectrum Analyzer Peak Value*.
    c. Convert the *Spectrum Analyzer Peak Value* units to dB using the following equation:

Spectrum Analyzer Peak (dB) = *Spectrum Analyzer Peak Value* (dBm) - *Spectrum Analyzer Tone Power*

d. If the value of the *Spectrum Analyzer Peak (dB)* is 5 dB or more below the spur level in the reduced list from step 18(f), retain the spur level, otherwise discard the value.

20. Compare the spur values from the sorted list in step 19(d) to the verification test limits in Table 25.

Table 25. LO-Related Spurious Responses (Sideband Spurs) Verification Test Limits

Center Frequency	As-Found Limit	As-Left Limit[*]
100 MHz to 3.6 GHz	-73 dBc	-75 dBc
3.6 GHz to 14 GHz[†]	-73 dBc	-75 dBc

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

[†] Center frequencies > 3.6 GHz apply only to the NI 5665 14 GHz VSA.

21. Repeat steps 11 to 19 for all spans in Table 24.
22. Repeat steps 9 to 20 for all center frequencies in Table 22.
23. **(NI 5665 14 GHz VSA)** Repeat steps 9 to 20 for center frequencies from 3.8 GHz to 14 GHz in 200 MHz steps with the NI 5665 preselector enabled.

Note The NI 5665 preselector has a maximum instantaneous bandwidth of 47 MHz. When using the preselector, for steps that call for a 50 MHz instantaneous bandwidth, use a 47 MHz instantaneous bandwidth instead.

24. Close the NI 5665 session.

If the LO-related spurs (sideband spurs) verification procedure determines that the NI 5665 is outside its limits, refer to *Worldwide Support and Services* for information about support resources or service requests.

Verifying Image Rejection

This procedure verifies the following image responses of the NI 5665:

For test frequencies < 3.6 GHz:

- *IF1 Image* = *Test Frequency* + 9.225 GHz
- *IF2 Image* = 3.3875 GHz
- *IF3 Image* = 987.5 MHz
- *IF2 Image at RF* = *Test Frequency* + 1.225 GHz
- *IF3 Image at RF* = |*Test Frequency* - 375 MHz | (Evaluated only for images greater than 10 MHz)

For test frequencies > 3.6 GHz,

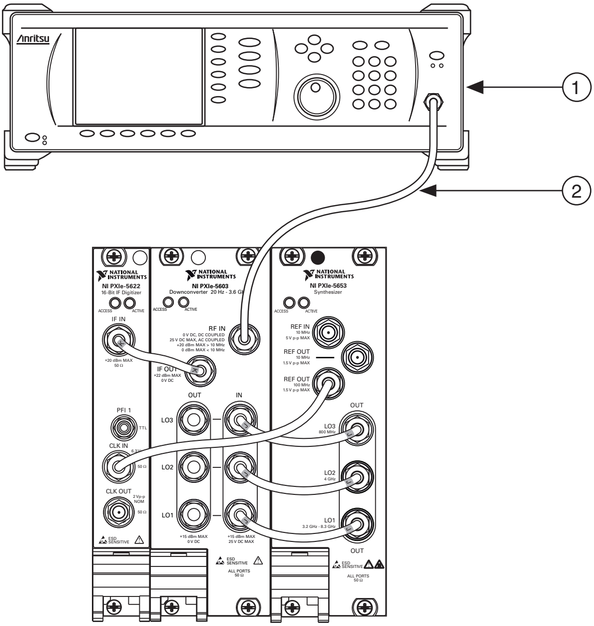
- *IF1 Image* = *Test Frequency* + 1.225 GHz
- *IF2 Image* = 987.5 GHz

- *IF2 Image at RF = Test Frequency* - 375 MHz

where *Test Frequency* is the NI 5665 center frequency.

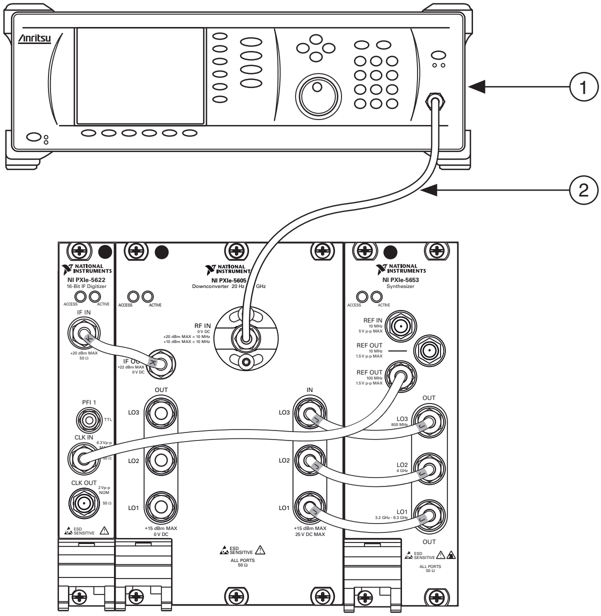
1. Connect RF Source 2 to the NI 5665 RF IN using the SMA (m)-to-SMA (m) cable. The completed equipment setup is shown in Figure 17 and Figure 18.

Figure 17. NI 5665 3.6 GHz VSA Image Rejection Verification Equipment Setup



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

Figure 18. NI 5665 14 GHz VSA Image Rejection Verification Equipment Setup



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

2. Create a new session for the NI 5665.
3. Configure the RF Source 2 using the following values:
   - Mode: Single Frequency
   - Power Level: 0 dBm
4. Configure the NI 5665 according to following property settings:
   - Acquisition Type: Spectrum
   - Averaging Mode: RMS Averaging
   - Number of Averages: 20
   - Ref Clock Source: PXI_Clk
   - Channel Coupling: AC Coupled
   - Preamp Enabled: Disabled
   - Span: 20 kHz
   - Resolution Bandwidth: 100 Hz
   - Device Instantaneous Bandwidth: 47 MHz (25 MHz for the NI 5665 with 25 MHz bandwidth)
   - RF Attenuation: 10 dB
   - Reference Level: 0 dBm
   - **(NI 5665 14 GHz VSA)** Preselector Enabled: Enabled

5. Set the NI 5665 center frequency according to Table 26 or Table 27 as appropriate.

Table 26. NI 5665 3.6 GHz VSA Image Rejection Verification Test Frequencies

Start Frequency	Stop Frequency	Step Size
100.033325 MHz	2.000033325 GHz	400 MHz
2.399966675 GHz	3.599966675 GHz	400 MHz

Table 27. NI 5665 14 GHz VSA Image Rejection Verification Test Frequencies

Start Frequency	Stop Frequency	Step Size
100.033325 MHz	2.000033325 GHz	400 MHz
2.399966675 GHz	13.999966675 GHz	400 MHz

6. Commit the NI 5665 settings to hardware.
7. For each test frequency from Table 26 or Table 27, calculate NI 5665 image frequencies using the following formulas:

   For test frequencies < 3.6 GHz,

   - *IF1 Image* = *Test Frequency* + 9.225 GHz
   - *IF2 Image* = 3.3875 GHz
   - *IF3 Image* = 987.5 MHz
   - *IF2 Image at RF* = *Test Frequency* + 1.225 GHz
   - *IF3 Image at RF* = | *Test Frequency* - 375 MHz | (Evaluated only for images greater than 10 MHz)

   For test frequencies > 3.6 GHz,

   - *IF1 Image* = *Test Frequency* + 1.225 GHz
   - *IF2 Image* = 987.5 MHz
   - *IF2 Image at RF* = *Test Frequency* - 375 MHz

   where *Test Frequency* is the NI 5665 center frequency.
8. For each of the frequencies (image frequencies and test frequencies) in the list from step 7 and the NI 5665 center frequency from step 5, set the RF Source 2 to the frequency with a *Power Setting* of 0 dB. The *RF Source Power Direct* for this frequency is used in step 11.

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

9. Wait for 200 ms to allow the NI 5665 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 26 or Table 27.
14. Compare the *Image Rejection* results to the verification test limits in Table 28.

Table 28. Image Rejection Verification Test Limits

Center Frequency	As-Found Limit	As-Left Limit*
100 MHz to 2.2 GHz	-80 dBc	-83 dBc
>2.2 GHz to 3.6 GHz	-77 dBc	-80 dBc
>3.6 GHz to 14 GHz†	-80 dBc	-82 dBc

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

† Center frequencies > 3.6 GHz apply only to the NI 5665 14 GHz VSA.

15. Close the NI 5665 session.

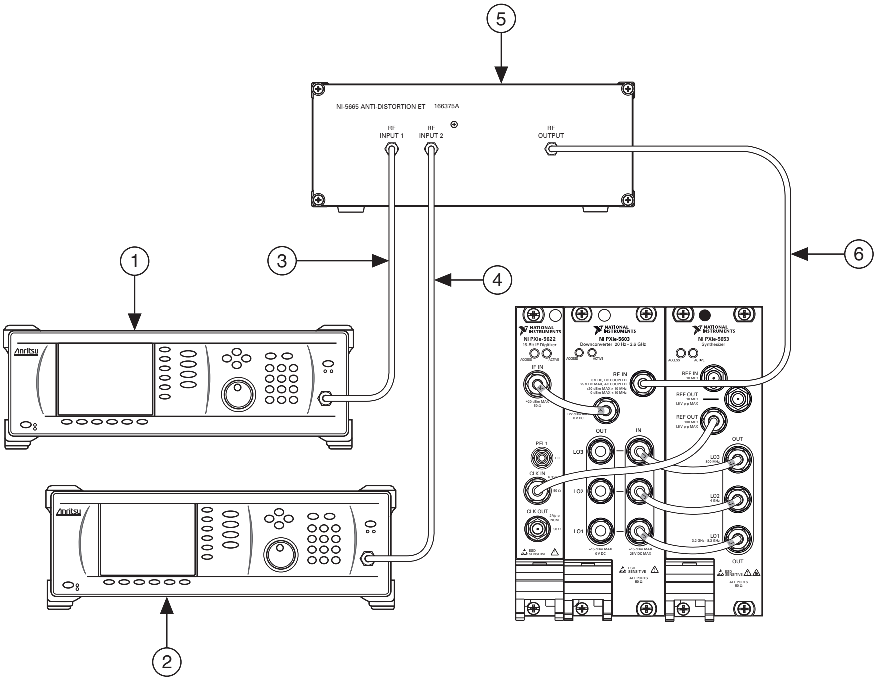
If the image rejection verification procedure determines that the NI 5665 is outside its limits, refer to *Worldwide Support and Services* for information about support resources or service requests.

Verifying Third-Order Intermodulation Distortion

Frequencies ≤700 MHz

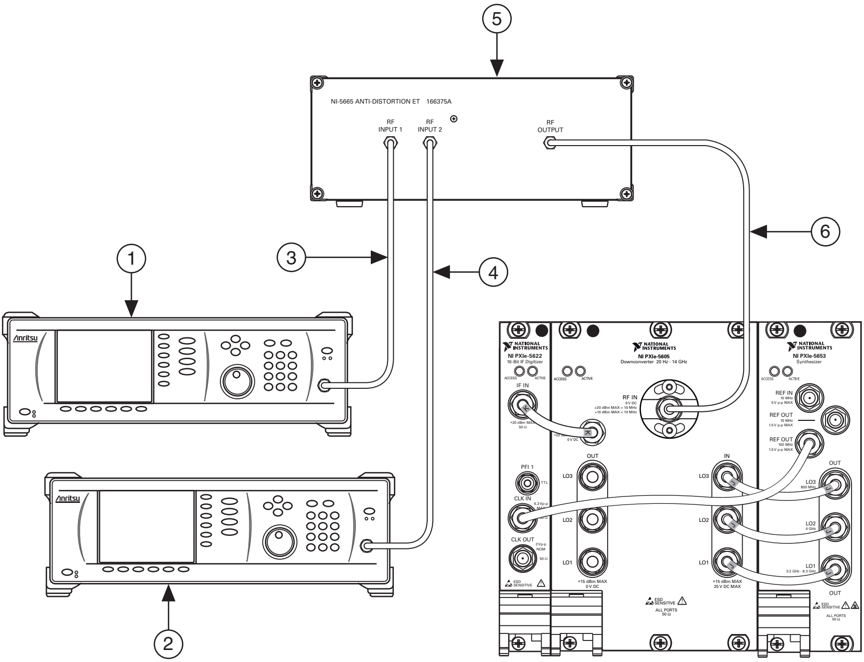
1. Connect RF Source 1 and RF Source 2 to the NI 5665 RF IN connector through the Anti-Distortion Test Fixture as shown in Figure 19 and Figure 20.

Figure 19. NI 5665 3.6 GHz VSA Third-Order Intermodulation Verification (Frequencies ≤ 700 MHz) Equipment Setup



1	RF Source 1	4	SMA (m)-to-SMA (m) cable
2	RF Source 2	5	Anti-Distortion Test Fixture
3	SMA (m)-to-SMA (m) cable	6	SMA (m)-to-SMA (m) cable

Figure 20. NI 5665 14 GHz VSA Third-Order Intermodulation Verification (Frequencies ≤ 700 MHz) Equipment Setup



1	RF Source 1	4	SMA (m)-to-SMA (m) cable
2	RF Source 2	5	Anti-Distortion Test Fixture
3	SMA (m)-to-SMA (m) cable	6	SMA (m)-to-SMA (m) cable

2. Create a new session for the NI 5665.
3. Configure the NI 5665 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
   - Device Instantaneous Bandwidth: 300 kHz
   - IF Output Power Level: 0 dB
   - Resolution Bandwidth: 750 Hz
   - Span: 150 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 NI 5665 reference level to one of the following values:
   - Preamplifier Disabled: -10 dBm
   - Preamplifier Enabled: -30 dBm
9. For each test frequency from Table 29, 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 29. 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*.
11. Set the RF Source 2 frequency to *P2 Frequency*.
12. Set the NI 5665 Center Frequency to *IMD Low Frequency*.
13. Commit the NI 5665 settings to hardware.
14. Enable the RF Source 1 and the RF Source 2 outputs.
15. Wait 2.5 s before making the first measurement and wait 100 ms before making subsequent measurements to allow the NI 5665, RF Source 1, and RF Source 2 amplitudes to settle.

[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.

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 NI 5665.
17. Find the highest peak within the measurement bandwidth. This value is the *IMD Low Power*.
18. Repeat steps 11 to 16 for the NI 5665 center frequencies of *P1 Frequency*, *P2 Frequency*, and *IMD High Frequency*. The values from step 16 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:

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

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

20. The smaller of the *TOI Lower* and *TOI Upper* values is the *TOI Minimum*.
21. Repeat steps 8 to 19 for all test frequencies in Table 29.
22. Repeat steps 5 to 20 with the NI 5665 preamplifier enabled.
23. Compare the *TOI Minimum* to the verification test limits in Table 30 or Table 31 as appropriate.

Table 30. TOI (Frequencies ≤ 700 MHz) Verification Test Limits (Preamplifier Disabled)

Center Frequency	As-Found Limit	As-Left Limit*
10 MHz to <100 MHz	+16 dBm	+17 dBm
100 MHz to 700 MHz	+19 dBm	+20 dBm

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

Table 31. TOI (Frequencies ≤ 700 MHz) Verification Test Limits (Preamplifier Enabled)

Center Frequency	As-Found Limit	As-Left Limit*
10 MHz to <100 MHz	-3 dBm	-2 dBm
100 MHz to 700 MHz	+2 dBm	+3 dBm

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

24. Disable the output of the RF Source 1 and RF Source 2.

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

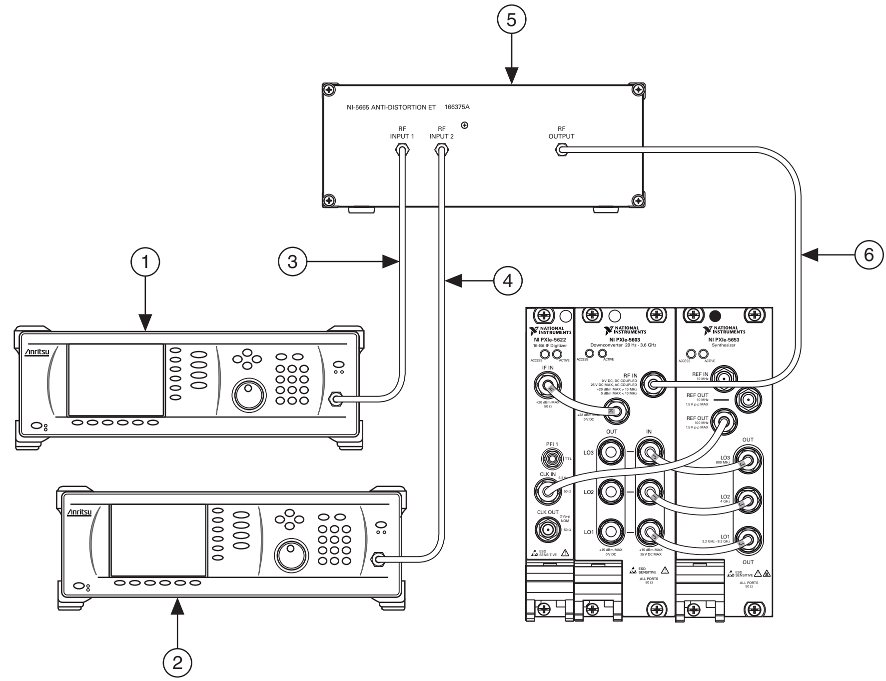
25. Close the NI 5665 session.

If the third-order intermodulation distortion for frequencies ≤ 700 MHz verification procedure determines that the NI 5665 is outside its limits, refer to *Worldwide Support and Services* for information about support resources or service requests.

Frequencies > 700 MHz

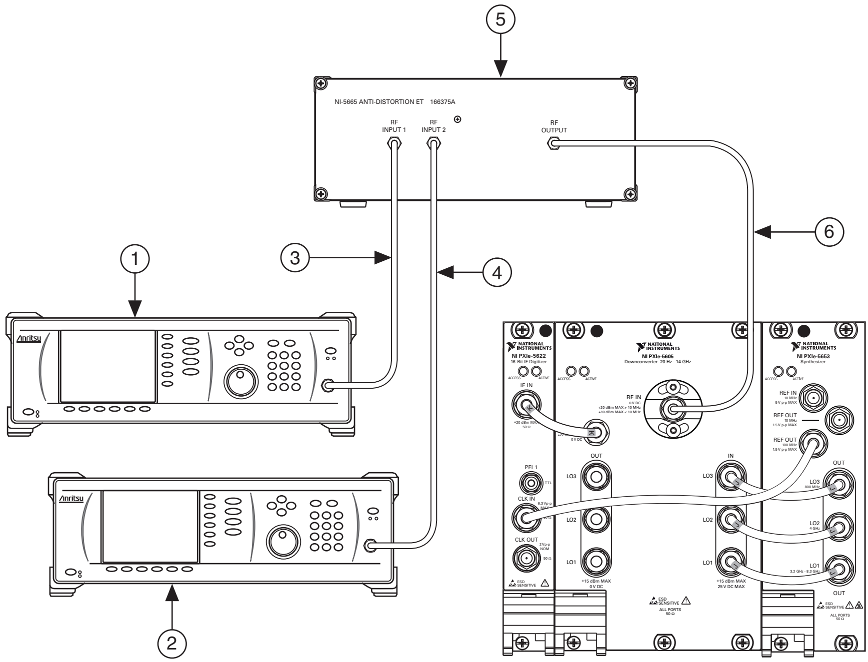
1. Connect RF Source 1 and RF Source 2 to the NI 5665 RF IN connector through the Anti-Distortion Test Fixture as shown in Figure 21 and Figure 22.

Figure 21. NI 5665 3.6 GHz VSA Third-Order Intermodulation (Frequencies > 700 MHz) Verification Equipment Setup



1	RF Source 1	4	SMA (m)-to-SMA (m) cable
2	RF Source 2	5	Anti-Distortion Test Fixture
3	SMA (m)-to-SMA (m) cable	6	SMA (m)-to-SMA (m) cable

Figure 22. NI 5665 14 GHz VSA Third-Order Intermodulation (Frequencies >700 MHz) Verification Equipment Setup



1	RF Source 1	4	SMA (m)-to-SMA (m) cable
2	RF Source 2	5	Anti-Distortion Test Fixture
3	SMA (m)-to-SMA (m) cable	6	SMA (m)-to-SMA (m) cable

2. Create a new session for the NI 5665.
3. Configure the NI 5665 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
   - IF Output Power Level: 0 dB
   - Resolution Bandwidth: 750 Hz
   - Span: 150 kHz
   - **(NI 5665 14 GHz VSA)** 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 NI 5665 Reference Level to one the following values:
   - Preamplifier Disabled: -10 dBm
   - Preamplifier Enabled: -30 dBm
9. For each test frequency from Table 32 or Table 33, 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 32. NI 5665 3.6 GHz VSA TOI (Frequencies > 700 MHz) Verification Test Frequencies

Start Frequency	Stop Frequency	Step Size
800 MHz	3.3 GHz	500 MHz
3.59895 GHz	—	—

[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.

Table 33. NI 5665 14 GHz VSA TOI (Frequencies > 700 MHz) Verification Test Frequencies

Preamp Enabled	Start Frequency	Stop Frequency	Step Size
Enabled	800 MHz	3.3 GHz	500 MHz
Disabled	800 MHz	3.3 GHz	500 MHz
	3.6 GHz	13.6 GHz	500 MHz
	13.99895 GHz	—	—

10. Set the RF Source 1 frequency to *P1 Frequency*.
11. Set the RF Source 2 frequency to *P2 Frequency*.
12. Set the NI 5665 center frequency to *IMD Low Frequency*.
13. Commit the NI 5665 settings to hardware.
14. Enable the RF Source 1 and RF Source 2 outputs.
15. Wait 2.5 s before making the first measurement and wait 100 ms before making subsequent measurements to allow the NI 5665, 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 NI 5665.
17. Find the highest peak within the measurement bandwidth. This value is the *IMD Low Power*.
18. Repeat steps 11 to step 16 for the NI 5665 center frequencies of *P1 Frequency*, *P2 Frequency*, and *IMD High Frequency*. The values from step 16 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 8 to 18 for all test frequencies in Table 32.
21. Repeat steps 5 to 19 with the NI 5665 preamplifier enabled for frequencies greater than or equal to 3.6 GHz.

22. Compare the *TOI Minimum* to the verification test limits in Table 34 or Table 35 as appropriate.

Table 34. TOI (Frequencies > 700 MHz) Verification Test Limits (Preamplifier Disabled, NI 5665 14 GHz VSA Preselector Disabled)

Center Frequency	As-Found Limit	As-Left Limit*
>700 MHz to 3.6 GHz	+20 dBm	+21 dBm
>3.6 GHz to 14 GHz†	+20 dBm	+21 dBm

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

† Center frequencies > 3.6 GHz apply only to the NI 5665 14 GHz VSA.

Table 35. TOI (Frequencies > 700 MHz) Verification Test Limits (Preamplifier Enabled)

Center Frequency	As-Found Limit	As-Left Limit*
>700 MHz to 3.6 GHz	+2.5 dBm	+3.5 dBm

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

23. Disable the output of the RF Source 1 and RF Source 2.

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

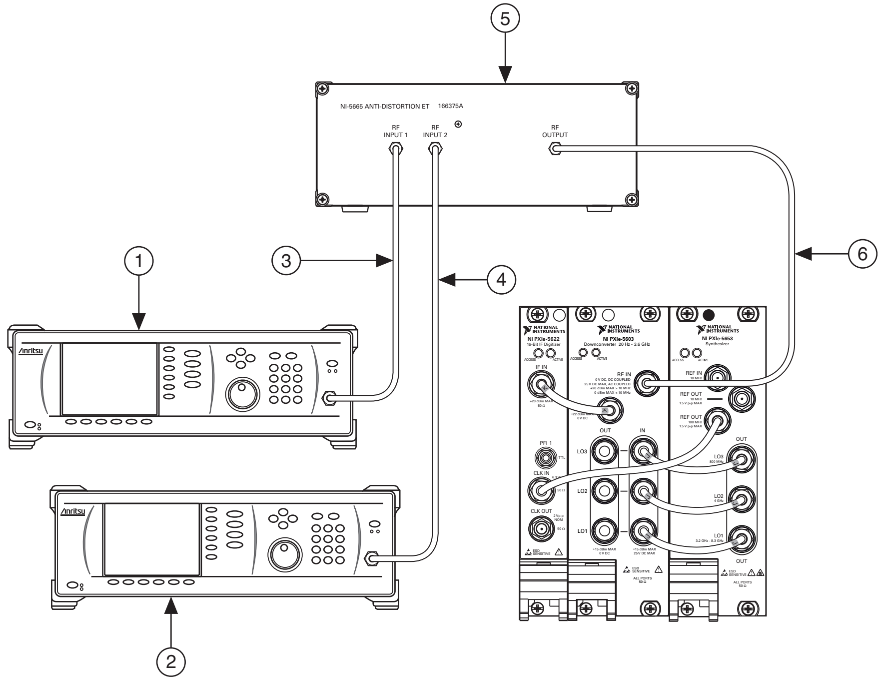
24. Close the NI 5665 session.

If the third-order intermodulation distortion for frequencies > 700 MHz verification procedure determines that the NI 5665 is outside its limits, refer to *Worldwide Support and Services* for information about support resources or service requests.

Verifying Second Harmonic Intercept

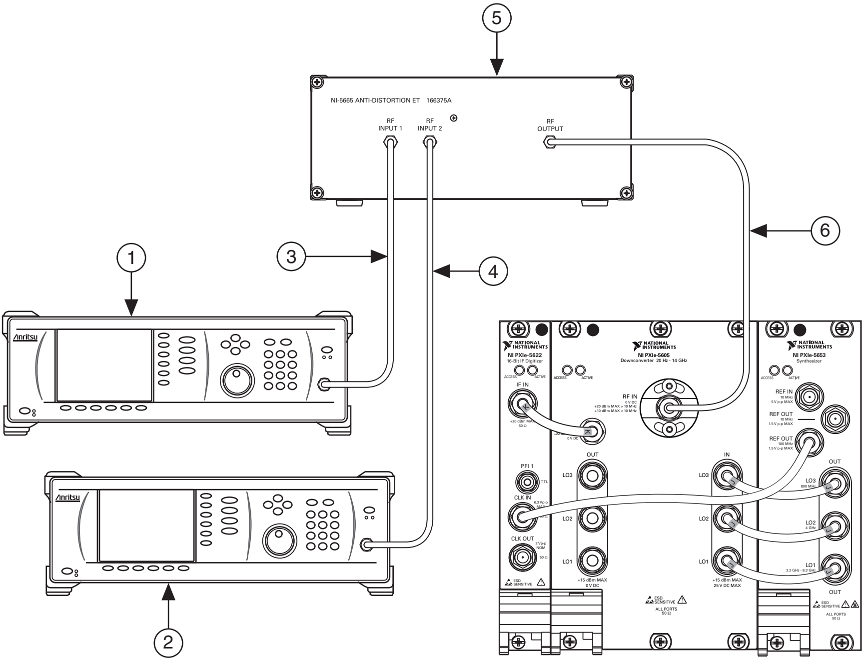
1. Connect RF Source 1 and RF Source 2 to the NI 5665 RF IN connector through the Anti-Distortion Test Fixture as shown in Figure 23 and Figure 24.

Figure 23. NI 5665 3.6 GHz VSA SHI Verification Equipment Setup



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

Figure 24. NI 5665 14 GHz VSA SHI Verification Equipment Setup



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

2. Create a new session for the NI 5665.
3. Configure the NI 5665 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
   - Resolution Bandwidth: 750 Hz
   - RF Attenuation: 10 dB
   - Power Spectrum Units: Volts Squared
   - **(NI 5665 14 GHz VSA)** Preselector Enabled: Disabled
4. Configure the Anti-Distortion Test Fixture to use the 470 MHz Lowpass Filter 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 NI 5665 preamplifier.
7. Set the NI 5665 reference level to one of the following values:
   - Preamplifier Disabled: 0 dBm
   - Preamplifier Enabled: -30 dBm
8. Set the RF Source 2 frequency and the NI 5665 center frequency to the values shown in the first row of Table 36.

Table 36. SHI Verification Test Frequencies

Start Frequency	Stop Frequency	Step Size
300 MHz	700 MHz	200 MHz
800 MHz	1.8 GHz	500 MHz
2 GHz	3.5 GHz	500 MHz
3.8 GHz	6.8 GHz	500 MHz
7 GHz	—	—

9. Configure the Anti-Distortion Test Fixture to use the appropriate Lowpass Filter Path as shown in Table 37.

Table 37. Lowpass Filter Specifications

Lowpass Filter Path	Frequency Range
470 MHz	1 MHz to 470 MHz
735 MHz	>470 MHz to 735 MHz
1150 MHz	>735 MHz to 1.150 GHz
1800 MHz	>1.150 GHz to 1.800 GHz
2530 MHz	>1.800 GHz to 2.530 GHz
3550 MHz	>2.530 GHz to 3.550 GHz
4985 MHz	>3.550 GHz to 4.985 GHz
7000 MHz	>4.985 GHz to 7.000 GHz

10. Commit the NI 5665 settings to hardware.

11. Set the RF Source 2 power to the *RF Source Power LPF* to one of the following values for the RF Source 2 frequency:
    - Preamplifier Disabled: 0 dBm
    - Preamplifier Enabled: -30 dBm
12. Enable the RF Source 2 output.
13. Wait 500 ms before making the first measurement and wait 100 ms before making subsequent measurements to allow the NI 5665 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.

14. Measure the power spectrum with the NI 5665.
15. Find the highest peak within the measurement bandwidth. This value is the *Peak Power.*
16. Calculate the *noise measurement bandwidth* (BW) and the *noise center frequency* (CF) using the following equations:

$$Noise\ Measurements\ BW = \frac{\text{Span}}{2} - \frac{10\ kHz}{2}$$

$$Noise\ CF = Center\ Frequency + \frac{\text{Span}}{4} + \frac{10\ kHz}{4}$$

17. Calculate the *Power in Band* for the spectrum from step 13 using the *Noise Measurement BW* and *Noise CF* values from step 16.

Note *Power in Band* is a built-in function in the NI Spectral Measurements Toolkit.

18. Calculate the *Average Noise Power* using the following equation:

$$Average\ Noise\ Power = Power\ in\ Band - 10\log_{10}\left(\frac{Noise\ Measurement\ BW}{Resolution\ Bandwidth}\right)$$

19. Record either *Peak Power* (from step 14) or *Average Noise Power* (from step 17). According to the frequency tuned to with the NI 5665, record whichever value is greater as the *Fundamental Power* or the *Harmonic Power.*
20. Repeat steps 7 to 19 for the second harmonic, which is twice the test frequency.
21. Calculate the SHI using the following equation:

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

22. Repeat steps 7 to 20 for all test frequencies listed in step 8.
23. **(NI 5665 14 GHz VSA)** Repeat steps 6 to 21 for test frequencies between 3.8 GHz and 7 GHz with the NI 5665 preselector enabled.

24. Repeat steps 6 to 22 for the frequencies in Table 38 with the NI 5665 preamplifier enabled.

Table 38. SHI Verification Test Frequencies

Start Frequency	Stop Frequency	Step Size
300.0333125 MHz	1.3000333125 GHz	200 MHz
1800 MHz	—	—

25. Compare the *SHI* to the verification test limits in Table 39, Table 40, or Table 41 as appropriate.

Table 39. SHI Verification Test Limits (Preamplifier Disabled, NI 5665 14 GHz VSA Preselector Enabled)

Source Frequency	Device	As-Found Limit	As-Left Limit*
300 MHz to < 700 MHz	NI 5665	+42 dBm	+43 dBm
700 MHz to 1.8 GHz	NI 5665 3.6 GHz VSA	+50 dBm	+51 dBm
	NI 5665 14 GHz VSA	+44 dBm	+45 dBm
>1.8 GHz to 3.75 GHz†	NI 5665 14 GHz VSA	+54 dBm	+56 dBm
>3.75 GHz to 4.25 GHz†		+54 dBm	+56 dBm
>4.25 GHz to 7 GHz†		+54 dBm	+56 dBm

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

† Source frequencies > 1.8 GHz apply only to the NI 5665 14 GHz VSA.

Table 40. SHI Verification Test Limits (Preamplifier Enabled)

Source Frequency	Device	As-Found Limit	As-Left Limit*
300 MHz to 1.8 GHz	NI 5665 3.6 GHz VSA	+15 dBm	+18 dBm
	NI 5665 14 GHz VSA	+20 dBm	+25 dBm

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

Table 41. SHI Verification Test Limits (NI 5665 14 GHz VSA Preselector Disabled)

Frequency	As-Found Limit	As-Left Limit*
>1.80 GHz to 4.25 GHz	+28 dBm	+30 dBm
>4.25 GHz to 7.00 GHz	+18 dBm	+20 dBm

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

26. Disable the output of RF Source 2.

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

27. Close the NI 5665 session.

If the second harmonic intercept verification procedure determines that the NI 5665 is outside its limits, refer to *Worldwide Support and Services* for information about support resources or service requests.

Verifying Gain Compression

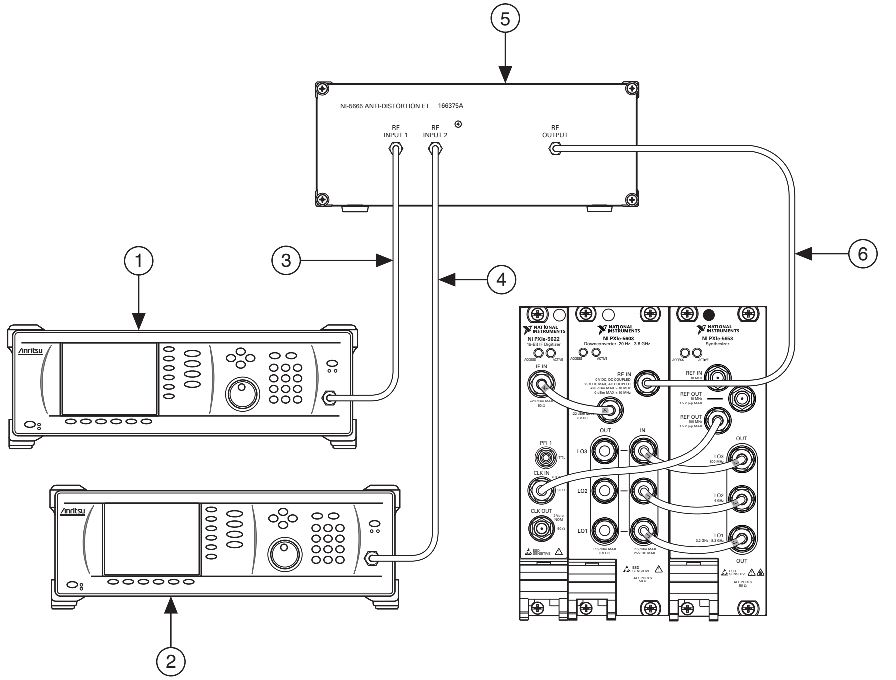
This procedure verifies that < 1 dB of gain compression occurs when the specified power level is applied at the RF IN connector of the NI 5665.

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

Frequencies ≤ 700 MHz

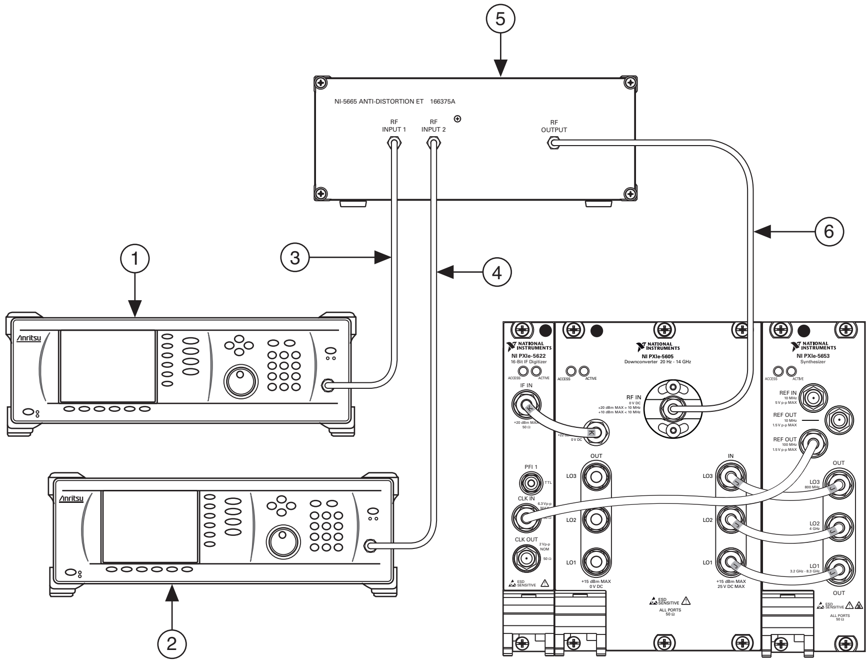
1. Connect RF Source 1 and RF Source 2 to the NI 5665 RF IN connector through the Anti-Distortion Test Fixture, as shown in Figure 25 and Figure 26.

Figure 25. NI 5665 3.6 GHz VSA Gain Compression Verification (Frequencies ≤ 700 MHz) Equipment Setup



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

Figure 26. NI 5665 14 GHz VSA Gain Compression Verification (Frequencies ≤ 700 MHz) Equipment Setup



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

2. Create a new session for the NI 5665.
3. Configure the NI 5665 according to the following property settings:
    - Acquisition Type: Spectrum
    - Averaging Mode: No Averaging
    - Ref Clock Source: PXI_Clk
    - Channel Coupling: AC Coupled
    - Span: 100 kHz
    - Device Instantaneous Bandwidth: 300 kHz
    - Resolution Bandwidth: 500 Hz
    - 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 NI 5665 preamplifier.
7. Set the RF Source 2 frequency according to Table 42.
8. Set the RF Source 1 frequency 1 MHz above the RF Source 2 frequency.
9. Set the NI 5665 center frequency according to the first row in Table 42.

Table 42. 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* for the power from Table 43 or Table 44 as appropriate.
11. Set the RF Source 1 power to the *RF Source 1 Programmed Power* for the power from Table 43 or Table 44 as appropriate.
12. Set the NI 5665 reference level according to Table 43 or Table 44 as appropriate.

Table 43. Gain Compression Verification Test Settings (Preamplifier Disabled)

<table>
<tr><th>Setting</th><th>Frequency Range</th><th>Limit</th><th>Value</th></tr>
<tr><td rowspan="2">RF Source 1 Programmed Power</td><td rowspan="2">11 MHz to 701 MHz</td><td>As-Found</td><td>+8.0 dBm</td></tr>
<tr><td>As-Left*</td><td>+9.1 dBm</td></tr>
<tr><td>RF Source 2 Programmed Power</td><td>10 MHz to 700 MHz</td><td>Both</td><td>-24 dBm</td></tr>
<tr><td>NI 5665 Reference Level</td><td>10 MHz to 700 MHz</td><td>Both</td><td>0 dBm</td></tr>
<tr><td colspan="4">* Refer to the As-Found and As-Left Limits section of this document for more information about as-left limits.</td></tr>
</table>

Table 44. Gain Compression Test Settings (Preamplifier Enabled)

Setting	Frequency Range	Limit	Value
RF Source 1 Programmed Power	11 MHz to 101 MHz	As-Found	-18 dBm
		As-Left*	-16 dBm
	>101 MHz to 701 MHz	As-Found	-15 dBm
		As-Left*	-13 dBm
RF Source 2 Programmed Power	10 MHz to 700 MHz	Both	-54 dBm
NI 5665 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 NI 5665 settings to hardware.
14. Enable the RF Source 2 output and wait 250 ms, or wait 100 ms if the output is already enabled, to allow the NI 5665 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.

15. Read the power spectrum from the NI 5665.
16. Depending on your equipment configuration, using the spectrum returned from the NI 5665, measure the power at the center frequency and record this value as the *Small Tone First Measurement* (RF Source 1 output disabled) or as the *Small Tone Second Measurement* (RF Source 1 output enabled).
17. Repeat steps 7 to 16 for all Test Frequencies in Table 42.
18. Repeat steps 7 to 17 with the NI 5665 preamplifier enabled.
19. Enable the RF Source 1 output.
20. Repeat steps 6 to 18 with the RF Source 1 output enabled.
21. Calculate the NI 5665 *Gain Compression* using the following equation:

$$\textit{Gain Compression} = \textit{Small Tone First Measurement} - \textit{Small Tone Second Measurement}$$

22. Compare the *Gain Compression* to the verification test limits in Table 45 or Table 46 as appropriate.

Table 45. Gain Compression Verification Test Limits (Frequencies ≤ 700 MHz, Preamplifier Disabled)

Frequency	Limit	Compression	Applied Power
10 MHz to 700 MHz	As-Found	1 dB	+8 dBm
	As-Left*	1 dB	+9.1 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 less than or equal to 1 dB gain compression for a minimum applied power. The applied power includes the measurement uncertainty to guarantee the required minimum applied power.

Table 46. Gain Compression Verification Test Limits (Frequencies ≤ 700 MHz, Preamplifier Enabled)

Frequency	Limit	Compression	Applied Power
10 MHz to 100 MHz	As-Found	1 dB	-18 dBm
	As-Left*	1 dB	-16 dBm
>100 MHz to 700 MHz	As-Found	1 dB	-15 dBm
	As-Left*	1 dB	-13 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 less than or equal to 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 output of RF Source 1 and RF Source 2.

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

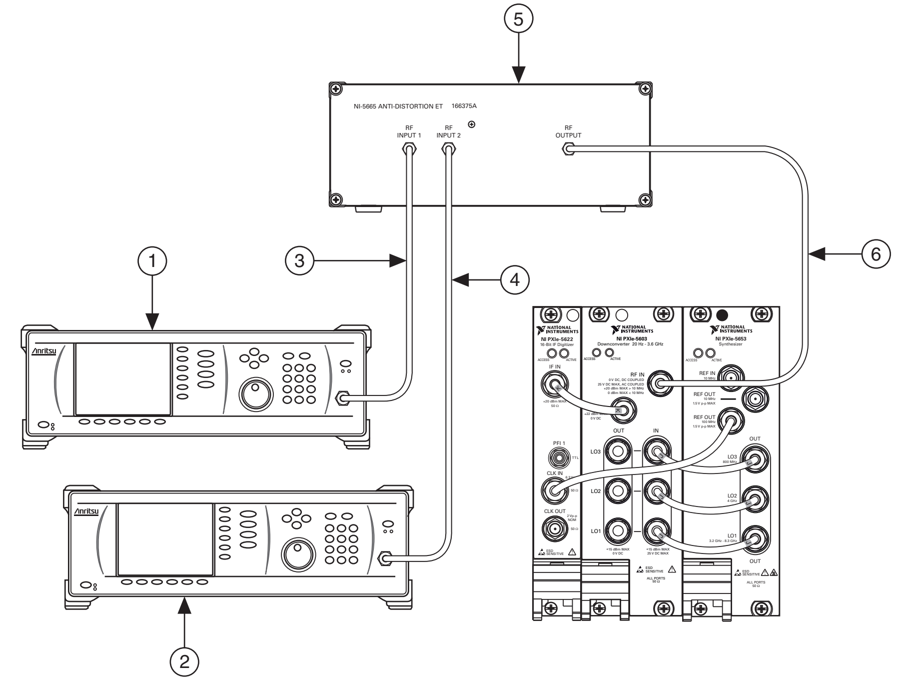
24. Close the NI 5665 session.

If the gain compression for frequencies ≤ 700 MHz verification procedure determines that the NI 5665 is outside its limits, refer to *Worldwide Support and Services* for information about support resources or service requests.

Frequencies > 700 MHz

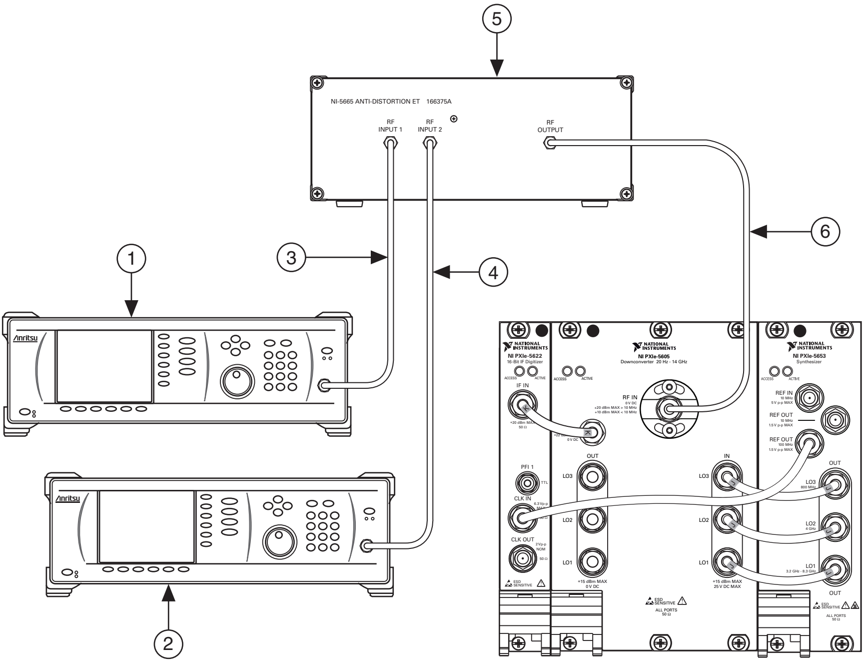
1. Connect RF Source 1 and RF Source 2 to the NI 5665 RF IN connector through the Anti-Distortion Test Fixture, as shown in Figure 27 and Figure 28.

Figure 27. NI 5665 3.6 GHz VSA Gain Compression Verification (Frequencies > 700 MHz) Equipment Setup



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

Figure 28. NI 5665 14 GHz VSA Gain Compression Verification (Frequencies > 700 MHz) Equipment Setup



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

2. Create a new session for the NI 5665.
3. Configure the NI 5665 according to the following property settings:
   - Acquisition Type: Spectrum
   - Averaging Mode: No Averaging
   - Ref Clock Source: PXI_Clk
   - Channel Coupling: AC Coupled
   - Span: 100 kHz
   - Device Instantaneous Bandwidth: 300 kHz
   - Resolution Bandwidth: 500 Hz
   - 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 NI 5665 preamplifier.
7. **(NI 5665 14 GHz VSA)** Disable the NI 5665 preselector.
8. Set the RF Source 2 frequency according to the first row in Table 47 or Table 48 as appropriate.

Table 47. NI 5665 3.6 GHz Gain Compression Test Frequencies (Frequencies > 700 MHz)

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

Table 48. NI 5665 14 GHz Gain Compression Test Frequencies (Frequencies > 700 MHz)

Start Frequency	Stop Frequency	Step Size
800 MHz	3.3 GHz	500 MHz
3.6 GHz	—	—
3.8 GHz	13.8 GHz	500 MHz
14 GHz	—	—

9. Set the RF Source 1 frequency 1 MHz above the RF Source 2 frequency.
10. Set the NI 5665 center frequency according to the values listed in step 8.
11. Set the RF Source 2 power to the *RF Source 2 Programmed Power* from Table 49 or Table 50 as appropriate.
12. Set the RF Source 1 power to the *RF Source 1 Programmed Power* from Table 49 or Table 50 as appropriate.
13. Set the NI 5665 reference level according to Table 49 or Table 50 as appropriate.

Table 49. Gain Compression Verification Test Settings (Preamplifier Disabled)

Device	Setting	Frequency Range	Limit	Value (dBm)
NI 5665 3.6 GHz VSA	RF Source 1 Programmed Power	801 MHz to 1.701 GHz	As-Found	+8.0
			As-Left*	+9.1
		>1.701 GHz to 3.601 GHz	As-Found	+6.0
			As-Left*	+7.1
	RF Source 2 Programmed Power	800 MHz to 3.600 GHz	Both	-24
	NI 5665 Reference Level	800 MHz to 3.600 GHz	Both	0
NI 5665 14 GHz VSA	RF Source 1 Programmed Power	801 MHz to 1.701 GHz	As-Found	+8.0
			As-Left*	+9.1
		>1.701 GHz to 14.001 GHz	As-Found	+6.0
			As-Left*	+7.1
	RF Source 2 Programmed Power	800 MHz to 14.00 GHz	Both	-24
	NI 5665 Reference Level	800 MHz to 14.00 GHz	Both	0

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

Table 50. Gain Compression Verification Test Settings (Preamplifier Enabled)

Device	Setting	Frequency Range	Limit	Value (dBm)
NI 5665 3.6 GHz VSA	RF Source 1 Programmed Power	801 MHz to 1.701 GHz	As-Found	-15
			As-Left*	-13
		>1.701 GHz to 3.601 GHz	As-Found	-18
			As-Left*	-16
	RF Source 2 Programmed Power	800 MHz to 3.600 GHz	Both	-54
	NI 5665 Reference Level	800 MHz to 3.600 GHz	Both	-30
NI 5665 14 GHz VSA	RF Source 1 Programmed Power	801 MHz to 1.701 GHz	As-Found	-15
			As-Left*	-13
		>1.701 GHz to 14.001 GHz	As-Found	-18
			As-Left*	-16
	RF Source 2 Programmed Power	800 MHz to 14.00 GHz	Both	-54
	NI 5665 Reference Level	800 MHz to 14.00 GHz	Both	-30

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

14. Commit the NI 5665 settings to hardware.
15. Enable the RF Source 2 output and wait 250 ms, or wait 100 ms if the output is already enabled, to allow the NI 5665 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. Read the power spectrum from the NI 5665.

17. Depending on your equipment configuration, using the spectrum returned from the NI 5665, measure the power at the center frequency and record this value as the *Small Tone First Measurement* (RF Source 1 output disabled) or as the *Small Tone Second Measurement* (RF Source 1 output enabled).
18. Repeat steps 8 to 17 for all test frequencies in step 8.
19. **(NI 5665 14 GHz VSA)** Repeat steps 8 through 18 for frequencies greater than 3.6 GHz with the NI 5665 preselector enabled.
20. Repeat steps 7 to 18 with the NI 5665 preamplifier enabled for frequencies less than 3.6 GHz.
21. Enable the RF Source 1 output.
22. Repeat steps 6 to 20 with the RF Source 1 output enabled.
23. Calculate the NI 5665 *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 51 or Table 52.

Table 51. Gain Compression Verification Test Limits (> 700 MHz, Preamplifier Disabled)

Frequency	Limit	Compression	Applied Power
>700 MHz to 1.70 GHz	As-Found	1 dB	+8.0 dBm
	As-Left*	1 dB	+9.1 dBm
>1.70 GHz to 3.6 GHz	As-Found	1 dB	+6.0 dBm
	As-Left*	1 dB	+7.1 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 less than or equal to 1 dB gain compression for a minimum applied power. The applied power includes the measurement uncertainty to guarantee the required minimum applied power.

Table 52. Gain Compression Verification Test Limits (> 700 MHz, Preamplifier Enabled)

Frequency	Limit	Compression	Applied Power
>700 MHz to 1.70 GHz	As-Found	1 dB	-15 dBm
	As-Left*	1 dB	-13 dBm
>1.70 GHz to 3.6 GHz	As-Found	1 dB	-18 dBm
	As-Left*	1 dB	-16 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 less than or equal to 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 output of RF Source 1 and RF Source 2.

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

26. Close the NI 5665 session.

If the gain compression for frequencies >700 MHz verification procedure determines that the NI 5665 is outside its limits, refer to *Worldwide Support and Services* for information about support resources or service requests.

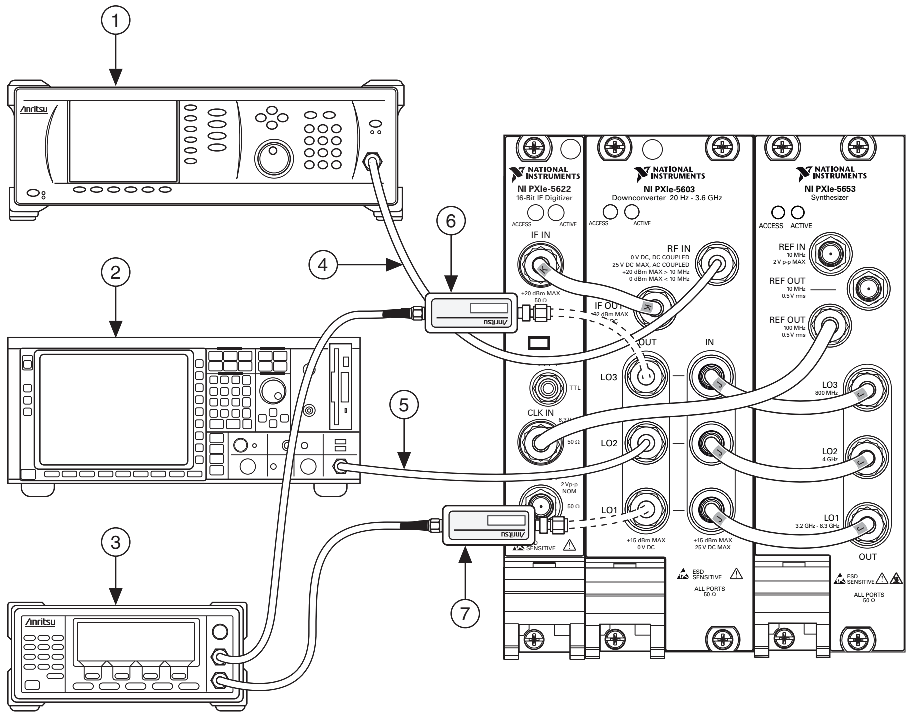
Verifying LO Output Power

Note Zero and calibrate the Power Sensor according to the *RF Source Power (Direct)* section of this document prior to starting this procedure.

1. Connect the RF Source 2 output to the NI 5605 RF IN connector using the SMA (m)-to-SMA (m) cable.
2. Connect Power Sensor A to the NI 5605 LO3 OUT connector using the SMA (m)-to-SMA (m) cable.
3. Connect the Spectrum Analyzer to the NI 5605 LO2 OUT connector.

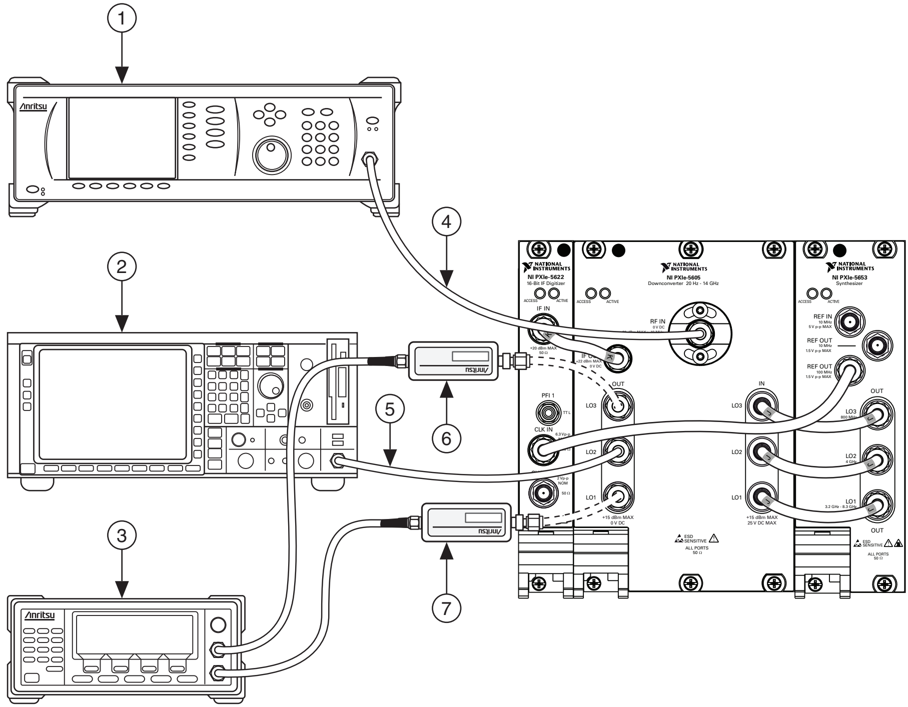
4. Connect Power Sensor B to the NI 5605 LO1 OUT connector. The completed setup is shown in Figure 29 and Figure 30.

Figure 29. NI 5665 3.6 GHz VSA LO Output Power Verification Equipment Setup



1	RF Source 2	4	SMA (m)-to-SMA (m) Cable	7	Power Sensor B
2	Spectrum Analyzer	5	SMA (m)-to-SMA (m) Cable		
3	Power Meter	6	Power Sensor A		

Figure 30. NI 5665 14 GHz VSA LO Output Power Verification Equipment Setup



1	RF Source 2	4	SMA (m)-to-SMA (m) Cable	7	Power Sensor B
2	Spectrum Analyzer	5	SMA (m)-to-SMA (m) Cable		
3	Power Meter	6	Power Sensor A		

5. Configure the Spectrum Analyzer according to the following settings:
   - Resolution Bandwidth: 1 kHz
   - Span: 0 Hz
   - Reference Level: +20 dBm
   - Center Frequency: 4 GHz
6. Configure the RF Source 2 according to the following settings:
   - Power: -20 dBm
   - Frequency: 1 GHz

Note The RF Source 2 settings do not affect this test. It is programmed to a known state for convenience only.

7. Create a new session for the NI 5665.

8. Configure the NI 5665 according to the following property setting:
   - LO Export Enabled: True
9. Initiate the NI 5665.
10. Close the NI 5665 session.
11. Create a new session for the NI 5653.
12. Configure the NI 5653 according to the following property settings:
    - Ref Clock Source: PXI -Clk
    - Frequency: 4.05625 GHz
13. Read the Power Meter Channel B power and correct for the NI 5653 frequency.
14. Repeat step 13 and record the frequency where the minimum measured power occurs for the following NI 5653 frequencies:
    - Minimum Frequency: 4.05625 GHz
    - Maximum Frequency: 8.2125 GHz
    - Frequency Step: 50 MHz
15. Tune the NI 5653 to the frequency found in step 14.
16. Measure the LO1 power with Power Meter Channel B. Correct the reading for the LO1 frequency.
17. Measure the LO2 power with the Spectrum Analyzer. Correct the reading for the 4 GHz LO2 frequency using the following equation:

    LO2 Power = *Spectrum Analyzer reading* + *Spectrum Analyzer Correction Factor*[1]

18. Measure the LO3 power with Power Meter Channel A. Correct the reading for the LO3 frequency of 800 MHz.
19. Compare the readings from steps 16 to 18 to the following verification test limits in Table 53.

Table 53. LO Output Power Verification Test Limits

LO	Minimum Power	Maximum Power
LO1	+7 dBm	+8 dBm
LO2	+9 dBm	+10 dBm
LO3	+9 dBm	+10 dBm

20. Close the NI 5653 session.

If the LO output power verification procedure determines that the NI 5665 is outside its limits, refer to *Worldwide Support and Services* for information about support resources or service requests.

[1] The *Spectrum Analyzer Correction Factor* value was calculated in the *Spectrum Analyzer Response* equipment characterization procedure.

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 54. Lowpass Filter Passband Paths

Filter Path	Start	Stop	Insertion Loss (dB, max.)	VSWR* (max.)
470 MHz	10 MHz	≤470 MHz	2.5	1.75
735 MHz	>470 MHz	≤735 MHz	2.5	1.75
1150 MHz	>735 MHz	≤1150 MHz	2.5	1.75
1800 MHz	>1150 MHz	≤1800 MHz	2.5	1.75
2530 MHz	>1800 MHz	≤2530 MHz	2.5	1.75
3550 MHz	>2530 MHz	≤3550 MHz	2.5	1.75
4985 MHz	>3550 MHz	≤4985 MHz	2.5	1.75
7000 MHz	>4985 MHz	≤7000 MHz	2.5	1.75

* Input or output ports.

Table 55. Lowpass Filter Stopband Paths

Filter Path	Start	Stop	Rejection*
470 MHz	600 MHz	≤940 MHz	50
735 MHz	>940 MHz	≤1470 MHz	50
1150 MHz	>1470 MHz	≤2300 MHz	50
1800 MHz	>2300 MHz	≤3600 MHz	50
2530 MHz	>3600 MHz	≤5060 MHz	70
3550 MHz	>5060 MHz	≤7100 MHz	70
4985 MHz	>7100 MHz	≤9970 MHz	70
7000 MHz	>9970 MHz	≤14000 MHz	70

* Rejection equals *Fundamental Power* - *Second Harmonic Power*

Table 56. Combiner Paths

Combiner	Path	Start	Stop	Total Loss[*] (dB, max.)	Isolation[†] (dB, min.)	VSWR[‡] (max.)
1	1	10 MHz	≤700 MHz	5	20	1.75
	2			15		
2	1	>700 MHz	≤14 GHz	8	20	1.75
	2			18		

[*] *Total Loss* includes the splitter loss at either input or ouput 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.

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