SPECIFICATIONS

PXIe-5665

Vector Signal Analyzer with Digital Downconversion

These specifications apply to the PXIe-5665 3.6 GHz RF Vector Signal Analyzer (VSA) and the PXIe-5665 14 GHz VSA. Specifications for center frequencies greater than 3.6 GHz apply only to the PXIe-5665 14 GHz VSA and the PXIe-5605.

The PXIe-5665 3.6 GHz VSA comprises the following modules:

- PXIe-5603 RF Signal Downconverter
- PXIe-5622 IF Digitizer
- PXIe-5653 Analog Signal Generator

The PXIe-5665 14 GHz VSA comprises the following modules:

- PXIe-5605 RF Signal Downconverter
- PXIe-5622 IF Digitizer
- PXIe-5653 Analog Signal Generator

There is no physical device named "PXIe-5665."

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Definitions

Warranted specifications describe the performance of a model under stated operating conditions and are covered by the model warranty.

The following characteristic specifications describe values that are relevant to the use of the model under stated operating conditions but are not covered by the model warranty.

- *Typical* specifications describe the performance met by a majority of models.
- *Typical-95* specifications describe the performance met by 95% (≈2σ) of models with a 95% confidence.
- *Nominal* specifications describe an attribute that is based on design, conformance testing, or supplemental testing.

Specifications are *Warranted* unless otherwise noted.

Conditions

Warranted specifications are valid under the following conditions unless otherwise noted.

- Over ambient temperature range of 0 °C to 55 °C.
- 30 minutes warm-up time.
- Calibration cycle is maintained.
- Chassis fan speed is set to High. In addition, NI recommends using slot blockers and EMC filler panels in empty module slots to minimize temperature drift.
- The PXIe-5603/PXIe-5605, PXIe-5622, and PXIe-5653 are used as the downconverter, digitizer, and LO source, respectively.
- The PXIe-5653 onboard 100 MHz clock is used as the Reference Clock for the PXIe-5622.
- Modules are connected with NI cables as shown in the *PXIe-5665 Vector Signal Analyzer Getting Started Guide*.
- NI-RFSA instrument driver is used.
- Self-calibration is performed after instrument temperature is stable.

- PXIe-5603—The **Channel Coupling** property is set to DC Coupled for RF tuned frequencies less than 10 MHz and is set to AC Coupled for RF tuned frequencies greater than or equal to 10 MHz.
- PXIe-5605—The **Channel Coupling** property is set to DC Coupled for RF tuned frequencies less than 10 kHz and is set to AC Coupled for RF tuned frequencies greater than or equal to 10 kHz. For measurements at frequencies less than 10 kHz, remove the DC block accessory from the PXIe-5605 RF IN connector.

Frequency

Frequency range[1]	
PXIe-5665 3.6 GHz VSA	20 Hz to 3.6 GHz
PXIe-5665 14 GHz VSA	20 Hz to 14 GHz
Tuning resolution[2]	533 nHz

Bandwidth

Equalized Bandwidth

Table 1. PXIe-5665 Equalized Bandwidth

Frequency Range	RF Vector Signal Analyzer Bandwidth Configuration	Equalized Bandwidth
>10 MHz to 14 GHz	25 MHz (Standard)	25 MHz
	50 MHz (Optional)	50 MHz
Self-calibration performed using the NI-RFSA instrument driver with the preselector disabled. When using the preselector on the PXIe-5605, the signal is not equalized. Equalization is performed by digital filters in the digitizer. The IF through path is limited to either 50 MHz or 25 MHz depending on the digitizer option you purchased.		

[1] The PXIe-5665 maximum center frequency is 3.6 GHz when using the PXIe-5603 and 14 GHz when using the PXIe-5605.

[2] *Tuning resolution* refers to the digitial downconversion (DDC) tuning resolution.

Resolution Bandwidth

3 dB bandwidth	Fully adjustable, typical
Bandwidth range	
Standard	<1 Hz to 25 MHz, typical
Optional	<1 Hz to 50 MHz, typical
Selectivity, 60 dB : 3 dB Ratio	
Flat Top window	2.5, typical
7-term Blackman-Harris window	4.1, typical

Note These additional window types are supported: uniform, Hanning, Hamming, Blackman-Harris, Exact Blackman, Blackman, Flat Top, 4-term Blackman-Harris, and Low Side Lobe.

Frequency Reference

Internal Frequency Reference[3]

Frequency	10 MHz
Initial calibration accuracy	$\pm 50 \times 10^{-9}$ over a temperature range from 15 °C to 35 °C
Temperature stability	
15 °C to 35 °C	$\pm 10 \times 10^{-9}$ (maximum)
0 °C to 55 °C	$\pm 50 \times 10^{-9}$
Aging after 30 days of continuous operation	
Per day	$\pm 0.5 \times 10^{-9}$ (maximum)
Per year	$\pm 100 \times 10^{-9}$ (maximum)
Accuracy	*Initial Calibration Accuracy* ± *Aging* ± *Temperature Stability*

External Frequency Reference Input[5]

Frequency	5 MHz to 100 MHz in 1 MHz steps
Lock range	$\pm 0.2 \times 10^{-6}$
Peak-to-peak amplitude (Vpk-pk)	0.5 V to 2.0 V into 50 Ω (≥1 V recommended)
Peak-to-peak absolute maximum amplitude (Vpk-pk)	5 V

[3] The PXIe-5653 reference oscillator determines this specification.

Input impedance	50 Ω, nominal, AC coupled
Connector	SMA
REF OUT 10 MHz reference output[4]	
Accuracy	10 MHz * *Frequency Reference Accuracy*
Peak-to-peak amplitude (Vpk-pk)	
Maximum	2 V into 50 Ω
Typical	1.2 V into 50 Ω
Minimum	0.71 V into 50 Ω
Coupling	AC coupled
Connector	SMA
REF OUT 100 MHz reference output[5]	
Accuracy	100 MHz * *Frequency Reference Accuracy*
Peak-to-peak amplitude (Vpk-pk)	
Maximum	2 V into 50 Ω
Typical	1.0 V into 50 Ω
Minimum	0.71 V into 50 Ω
Coupling	AC coupled
Connector	SMA

Spectral Purity

Single Sideband (SSB) Phase Noise

Table 2. SSB Phase Noise (dBc/Hz, Typical)

Offset	Phase Noise (dBc/Hz)	
	23 °C ± 5 °C	0 °C to 55 °C
10 Hz	—	-87, nominal
100 Hz	-106	-105
1 kHz	-121	-119

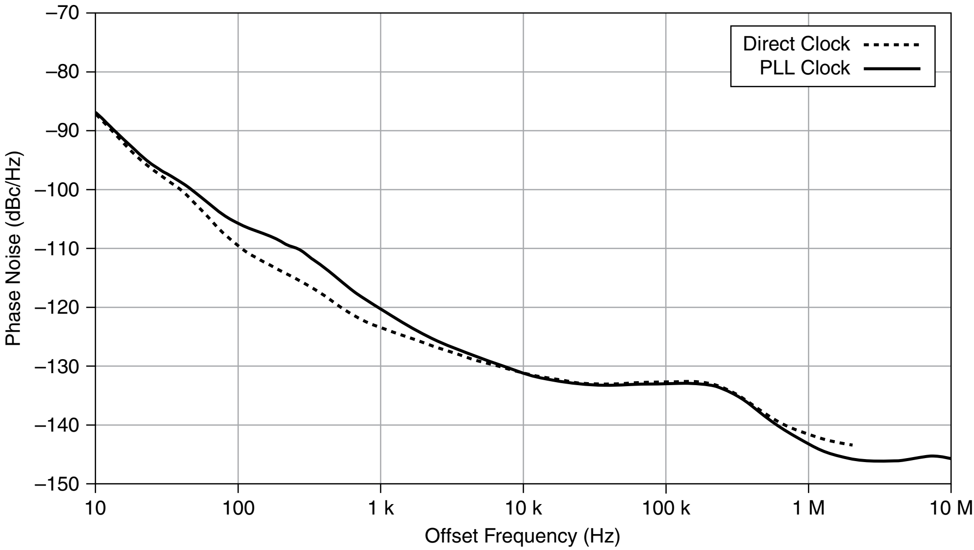
4 The PXIe-5653 10 MHz reference oscillator output determines this specification. System frequency accuracy error is equal to *Y* * (*f*/10 MHz), where *Y* is equal to the 10 MHz frequency error and *f* is equal to the frequency. For example, a frequency accuracy error at 20 MHz equals twice the 10 MHz frequency accuracy error.

5 The PXIe-5653 reference oscillator determines this specification.

Table 2. SSB Phase Noise (dBc/Hz, Typical) (Continued)

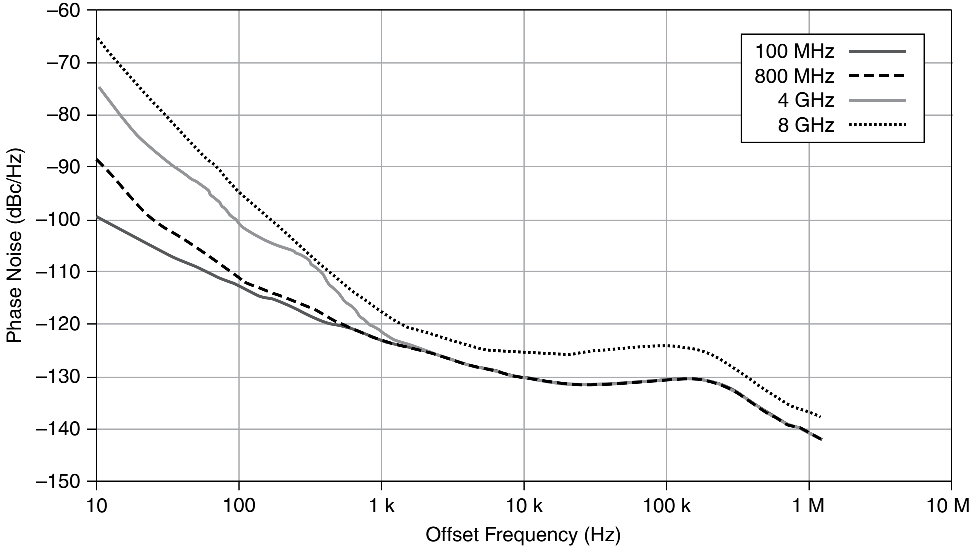
Offset	Phase Noise (dBc/Hz)	
	23 °C ± 5 °C	0 °C to 55 °C
10 kHz	-129	-128
100 kHz	-128	-127
1 MHz	-140	-140
Values are based on an RF center frequency of 800 MHz, PXIe-5653 internal frequency reference, PXIe-5622 digitizer directly clocked, no dither and the **LO YIG Main Coil Drive** property set to Normal. Refer to the following figures for typical performance at additional offsets and frequencies, and for typical phase noise with the preselector enabled.		

Figure 1. Nominal Phase Noise at 800 MHz Center Frequency [6]



[6] Measurement made with the IF through path. No dithering and spurs not shown. Broadband single side band noise floor typically -150 dBc/Hz at 10 MHz offset with 300 kHz IF filter selected.

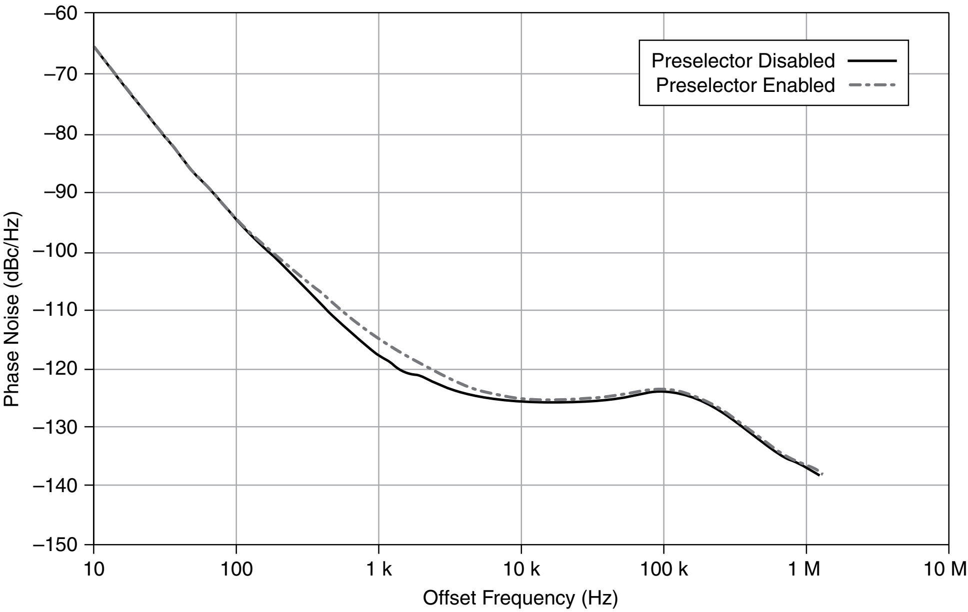
Figure 2. Nominal Phase Noise at 100 MHz, 800 MHz, 4 GHz, and 8 GHz[7, 8]



7 Frequencies greater than 3.6 GHz apply only to the PXIe-5665 14 GHz VSA.

8 Direct clocking, no dithering, and spurs not shown.

Figure 3. PXIe-5665 14 GHz VSA Nominal Phase Noise at 8 GHz[8]

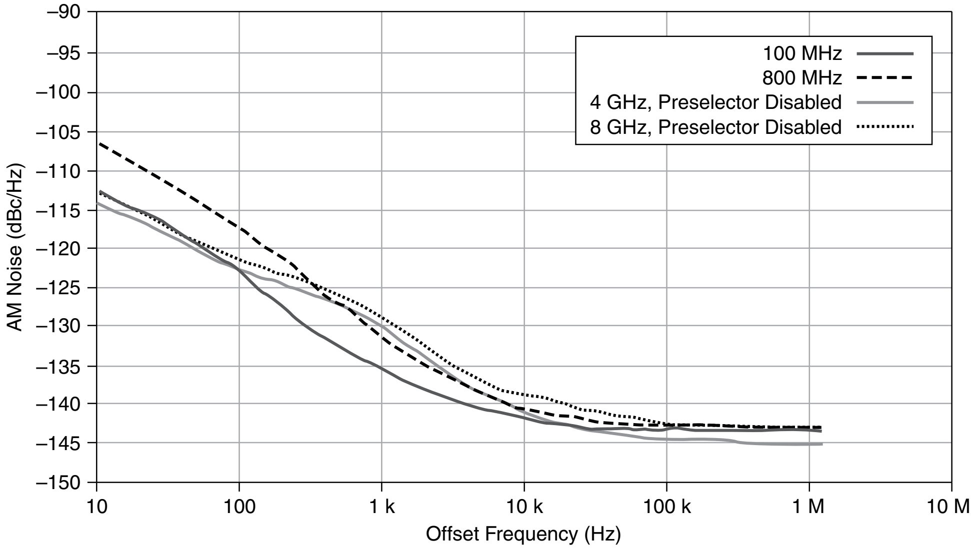


Residual FM (RMS) at 800 MHz

10 Hz to 10 kHz	<0.5 Hz, typical

AM Noise

Figure 4. Nominal AM Noise for Carrier Frequencies of 100 MHz, 800 MHz, 4 GHz, and 8 GHz (Nominal, Spurs Not Shown)[9]



Amplitude

Amplitude Range

Amplitude range	*Average Noise Level* to +30 dBm, nominal[10]
RF input attenuation	
PXIe-5665 3.6 GHz VSA	
Mechanical	0 dB to 30 dB in 10 dB steps, nominal
Electronic	0 dB to 40 dB in 1 dB steps, nominal

9 Frequencies greater than 3.6 GHz apply only to the PXIe-5665 14 GHz VSA.

10 Refer to the *Maximum Safe Continuous RF Power* section for the lower amplitude range limit under specific conditions.

PXIe-5665 14 GHz VSA	
Mechanical	0 dB to 75 dB in 5 dB steps (20 Hz to 14 GHz, nominal)
Electronic	0 dB to 30 dB in 1 dB steps (20 Hz to 3.6 GHz, nominal)

Average Noise Level

Table 3. PXIe-5665 Average Noise Level, Preamplifier Disabled and Preselector Disabled

Center Frequency	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBm/Hz)	Typical (dBm/Hz)	Specification (dBm/Hz)	Typical (dBm/Hz)
20 Hz to 10 kHz	—	—	—	-70
>10 kHz to 10 MHz	—	—	—	-100
>10 MHz to 100 MHz	-149	-152	-149	-151
>100 MHz to 300 MHz	-152	-157	-151	-154
>300 MHz to 1.7 GHz	-151	-154	-151	-153
>1.7 GHz to 2.8 GHz	-149	-152	-149	-151
>2.8 GHz to 3.6 GHz	-148	-151	-148	-150
>3.6 GHz to 7.5 GHz	-148	-151	-147	-150
>7.5 GHz to 8.5 GHz	-146	-151	-145	-150
>8.5 GHz to 12 GHz	-147	-151	-146	-150

Table 3. PXIe-5665 Average Noise Level, Preamplifier Disabled and Preselector Disabled (Continued)

Center Frequency	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBm/Hz)	Typical (dBm/Hz)	Specification (dBm/Hz)	Typical (dBm/Hz)
>12 GHz to 14 GHz	-145	-147	-144	-146
Values are based on input-terminated, 0 dB RF attenuation for center frequency ≥10 MHz, 20 dB RF attenuation for center frequency <10 MHz, IF through path for center frequency ≥100 MHz, 300 kHz IF filter for center frequency <100 MHz, ≤-50 dBm reference level, and >10 averages. RMS average noise level is normalized to a 1 Hz noise bandwidth. When the average noise level is measured as the displayed average noise level (DANL) associated with spectrum analyzers, there is a net 2.5 dB improvement caused by averaging log and other measurement biases in spectrum analyzer DANL. For example, the equivalent DANL at 2 GHz is -151.5 dBm/Hz.				

Table 4. PXIe-5665 Average Noise Level, Preamplifier Present and Enabled

Center Frequency	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBm/Hz)	Typical (dBm/Hz)	Specification (dBm/Hz)	Typical (dBm/Hz)
10 MHz to 100 MHz	-161	-163	-159	-161
>100 MHz to 300 MHz	-162	-167	-161	-166
>300 MHz to 1.7 GHz	-162	-165	-162	-164
>1.7 GHz to 2.8 GHz	-161	-164	-161	-163

Table 4. PXIe-5665 Average Noise Level, Preamplifier Present and Enabled (Continued)

Center Frequency	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBm/Hz)	Typical (dBm/Hz)	Specification (dBm/Hz)	Typical (dBm/Hz)
>2.8 GHz to 3.6 GHz	-160	-163	-160	-163
Values are based on input-terminated, 0 dB RF attenuation for center frequency ≥10 MHz, IF through path for center frequency ≥100 MHz, 300 kHz IF filter for center frequency <100 MHz, ≤-50 dBm reference level, and >10 averages. RMS average noise level normalized to a 1 Hz noise bandwidth. When the average noise level is measured as the DANL associated with spectrum analyzers, there is a net 2.5 dB improvement due to averaging of log and other measurement biases in spectrum analyzer DANL. For example, the equivalent DANL at 2 GHz is -163.5 dBm/Hz.				

Table 5. PXIe-5665 Average Noise Level, Preselector (YIG-Tuned Filter) Present and Enabled

Center Frequency	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBm/Hz)	Typical (dBm/Hz)	Specification (dBm/Hz)	Typical (dBm/Hz)
>3.6 GHz to 7.5 GHz	-144	-147	-142	-146
>7.5 GHz to 8.5 GHz	-140	-145	-140	-144
>8.5 GHz to 12 GHz	-141	-145	-140	-144
>12 GHz to 14 GHz	-140	-142	-139	-141
Values are based on input-terminated, 0 dB RF attenuation, IF through path, ≤-50 dBm reference level, and >10 averages. RMS average noise level normalized to a 1 Hz noise bandwidth. When the average noise level is measured as the DANL associated with spectrum analyzers, there is a net 2.5 dB improvement due to averaging of log and other measurement biases in spectrum analyzer DANL. For example, the equivalent DANL at 8 GHz is -142.5 dBm/Hz.				

Amplitude Accuracy

Frequency Response

Table 6. PXIe-5665 3.6 GHz VSA Frequency Response, Preamplifier Disabled and Preselector Disabled

Center Frequency	23 °C ± 5 °C			0 °C to 55 °C	
	Specification (dB)	2σ (dB)	Typical (dB)	Specifications (dB)	Typical (dB)
10 MHz to 100 MHz	±0.60	±0.30	±0.20	±0.80	±0.40
>100 MHz to 1.7 GHz	±0.35	±0.15	±0.10	±0.80	±0.40
>1.7 GHz to 2.8 GHz	±0.40	±0.20	±0.20	±0.80	±0.40
>2.8 GHz to 3.6 GHz	±0.45	±0.20	±0.20	±1.30	±0.80
Frequency response is measured relative to the 612.5 MHz calibration tone frequency. Values are based on an IF through path for center frequency ≥100 MHz, 300 kHz IF filter for center frequency <100 MHz, signal-to-noise ratio >20 dB, and using the automatic calibration correction of the NI-RFSA instrument driver within ±5 °C of the temperature at the last calibration. RF attenuation is 20 dB for frequencies <10 MHz and is 10 dB for frequencies >10 MHz.					

Table 7. PXIe-5665 14 GHz VSA Frequency Response, Preamplifier Disabled and Preselector Disabled

Center Frequency	23 °C ± 5 °C			0 °C to 55 °C	
	Specification (dB)	2σ (dB)	Typical (dB)	Specification (dB)	Typical (dB)
10 MHz to 100 MHz	±0.60	±0.30	±0.20	±0.80	±0.40
>100 MHz to 1.7 GHz	±0.35	±0.20	±0.15	±0.80	±0.40

Table 7. PXIe-5665 14 GHz VSA Frequency Response, Preamplifier Disabled and Preselector Disabled (Continued)

Center Frequency	23 °C ± 5 °C			0 °C to 55 °C	
	Specification (dB)	2σ (dB)	Typical (dB)	Specification (dB)	Typical (dB)
>1.7 GHz to 2.8 GHz	±0.42	±0.31	±0.25	±1.20	±0.70
>2.8 GHz to 3.6 GHz	±0.62	±0.41	±0.30	±1.20	±0.70
Frequency response is measured relative to the 612.5 MHz calibration tone frequency. Values are based on an IF through path for center frequency ≥100 MHz, 300 kHz IF filter for center frequency <100 MHz, signal-to-noise ratio >20 dB, and using the automatic calibration correction of the NI-RFSA instrument driver within ±5 °C of the temperature at the last calibration. RF attenuation is 20 dB for frequencies <10 MHz and is 10 dB for frequencies >10 MHz.					

Table 8. PXIe-5665 Frequency Response, Preamplifier Present and Enabled

Center Frequency	Device	23 °C ± 5 °C			0 °C to 55 °C	
		Specification (dB)	2σ (dB)	Typical (dB)	Specification (dB)	Typical (dB)
10 MHz to 100 MHz	PXIe-5665	±0.75	±0.50	±0.30	±1.0	±0.6
>100 MHz to 2.8 GHz	PXIe-5665	±0.45	±0.40	±0.25	±1.0	±0.6

Table 8. PXIe-5665 Frequency Response, Preamplifier Present and Enabled (Continued)

Center Frequency	Device	23 °C ± 5 °C			0 °C to 55 °C	
		Specification (dB)	2σ (dB)	Typical (dB)	Specification (dB)	Typical (dB)
>2.8 GHz to 3.6 GHz	PXIe-5665 3.6 GHz VSA	±0.45	±0.40	±0.25	±1.5	±0.8
	PXIe-5665 14 GHz VSA	±0.50	±0.40	±0.30	±1.5	±0.8
Frequency response is measured relative to the 612.5 MHz calibration tone frequency. Values are based on an IF through path for center frequency ≥100 MHz, 300 kHz IF filter for center frequency <100 MHz, signal-to-noise ratio >20 dB, and using automatic calibration correction of the NI-RFSA instrument driver within ±5 °C of the temperature at the last calibration. RF attenuation is 20 dB for frequencies <10 MHz and is 10 dB for frequencies >10 MHz.						

Absolute Amplitude Accuracy

Table 9. PXIe-5665 3.6 GHz VSA Absolute Amplitude Accuracy, Preamplifier Disabled and Preselector Disabled

Center Frequency	23 °C ± 5 °C			0 °C to 55 °C	
	Specification (dB)	2σ (dB)	Typical (dB)	Specification (dB)	Typical (dB)
612.5 MHz	±0.35	—	±0.10	±0.50	±0.35
>20 Hz to 1 MHz[11]	—	—	±1.20	—	±1.20
>1 MHz to 10 MHz[11]	—	—	±1.00	—	±1.00
>10 MHz to 100 MHz	±0.35 + *Frequency Response*	±0.15	±0.10	±1.15	±0.40

[11] For frequency ranges from 20 Hz to 10 MHz, the reference level is -10 dBm to -30 dBm. DC coupling causes an additional uncertainty of 0.2 dB for frequencies less than 10 kHz.

Table 9. PXIe-5665 3.6 GHz VSA Absolute Amplitude Accuracy, Preamplifier Disabled and Preselector Disabled (Continued)

Center Frequency	23 °C ± 5 °C			0 °C to 55 °C	
	Specification (dB)	2σ (dB)	Typical (dB)	Specification (dB)	Typical (dB)
>100 MHz to 1.7 GHz	±0.35 + *Frequency Response*	±0.15	±0.10	±1.15	±0.40
>1.7 GHz to 2.8 GHz	±0.35 + *Frequency Response*	±0.20	±0.15	±1.15	±0.40
>2.8 GHz to 3.6 GHz	±0.35 + *Frequency Response*	±0.20	±0.15	±1.60	±0.80

Values are based on -10 dBm to -50 dBm reference level, IF through path for center frequency ≥100 MHz, 300 kHz IF filter for center frequency <100 MHz, and using automatic calibration correction of the NI-RFSA instrument driver within ±5 °C of the temperature at the last calibration. RF attenuation is 20 dB for frequencies <10 MHz and is 10 dB for frequencies >10 MHz.

The absolute amplitude accuracy is measured at the center frequency. The absolute amplitude accuracy measurements are made after the hardware has settled. The high band to low band signal path transitions can take up to 200 ms for hardware to settle to within 0.1 dB of the final amplitude.

Table 10. PXIe-5665 14 GHz VSA Absolute Amplitude Accuracy, Preamplifier Disabled and Preselector Disabled

Center Frequency	23 °C ± 5 °C			0 °C to 55 °C	
	Specification (dB)	2σ (dB)	Typical (dB)	Specification (dB)	Typical (dB)
612.5 MHz	±0.46	—	±0.28	±0.75	±0.40
>20 Hz to 1 MHz [12]	—	—	±1.20	—	±1.20

[12] For frequency ranges from 20 Hz to 10 MHz, the reference level is -10 dBm to -30 dBm. DC coupling causes an additional uncertainty of 0.2 dB for frequencies less than 10 kHz.

Table 10. PXIe-5665 14 GHz VSA Absolute Amplitude Accuracy, Preamplifier Disabled and Preselector Disabled (Continued)

Center Frequency	23 °C ± 5 °C			0 °C to 55 °C	
	Specification (dB)	2σ (dB)	Typical (dB)	Specification (dB)	Typical (dB)
>1 MHz to 10 MHz [12]	—	—	±1.00	—	±1.00
>10 MHz to 100 MHz	±0.46 + *Frequency Response*	±0.38	±0.25	±1.25	±0.70
>100 MHz to 1.7 GHz	±0.46 + *Frequency Response*	±0.32	±0.25	±1.20	±0.70
>1.7 GHz to 2.8 GHz	±0.46 + *Frequency Response*	±0.38	±0.28	±1.50	±0.80
>2.8 GHz to 3.6 GHz	±0.46 + *Frequency Response*	±0.48	±0.30	±1.60	±0.80
>3.6 GHz to 7.5 GHz	±0.70	±0.48	±0.30	±1.60	±0.80
>7.5 GHz to 8.5 GHz	±0.80	±0.48	±0.30	±1.60	±0.80
>8.5 GHZ to 14 GHz	±1.25	±0.90	±0.60	±2.00	±1.10

Values are based on -10 dBm to -50 dBm reference level, IF through path for center frequency ≥100 MHz, 300 kHz IF filter for center frequency <100 MHz, and using automatic calibration correction of the NI-RFSA instrument driver within ±5 °C of the temperature at the last calibration. RF attenuation is 20 dB for frequencies <10 MHz and is 10 dB for frequencies >10 MHz.

The absolute amplitude accuracy is measured at the center frequency. The absolute amplitude accuracy measurements are made after the hardware has settled. The high band to low band signal path transitions can take up to 200 ms for hardware to settle to within 0.1 dB of the final amplitude.

Table 11. PXIe-5665 3.6 GHz VSA Absolute Amplitude Accuracy, Preamplifier Present and Enabled

Center Frequency	23 °C ± 5 °C			0 °C to 55 °C	
	Specification (dB)	2σ (dB)	Typical (dB)	Specification (dB)	Typical (dB)
612.5 MHz	±0.35	—	±0.25	±0.80	±0.50
>10 MHz to 100 MHz	±0.35 + *Frequency Response*	±0.40	±0.20	±1.20	±0.60
>100 MHz to 2.8 GHz	±0.35 + *Frequency Response*	±0.40	±0.20	±1.20	±0.60
>2.8 GHz to 3.6 GHz	±0.35 + *Frequency Response*	±0.40	±0.20	±1.70	±0.80

Values are based on -10 dBm to -50 dBm reference level, IF through path for center frequency ≥100 MHz, 300 kHz IF filter for center frequency <100 MHz, and using automatic calibration correction of the NI-RFSA instrument driver within ±5 °C of the temperature at the last calibration. RF attenuation is 20 dB for frequencies <10 MHz and is 10 dB for frequencies >10 MHz.

The absolute amplitude accuracy is measured at the center frequency. The absolute amplitude accuracy measurements are made after the hardware has settled. The high band to low band signal path transitions can take up to 200 ms for hardware to settle to within 0.1 dB of the final amplitude.

Table 12. PXIe-5665 14 GHz VSA Absolute Amplitude Accuracy, Preamplifier Present and Enabled

Center Frequency	23 °C ± 5 °C			0 °C to 55 °C	
	Specification (dB)	2σ (dB)	Typical (dB)	Specification (dB)	Typical (dB)
612.5 MHz	±0.70	—	±0.25	±1.10	±0.50
>10 MHz to 100 MHz	±0.70 + *Frequency Response*	±0.75	±0.60	±1.70	±0.60

Table 12. PXIe-5665 14 GHz VSA Absolute Amplitude Accuracy, Preamplifier Present and Enabled (Continued)

Center Frequency	23 °C ± 5 °C			0 °C to 55 °C	
	Specification (dB)	2σ (dB)	Typical (dB)	Specification (dB)	Typical (dB)
>100 MHz to 300 MHz	±0.70 + *Frequency Response*	±0.75	±0.60	±1.50	±0.60
>300 MHz to 2.8 GHz	±0.70 + *Frequency Response*	±0.75	±0.60	±1.75	±0.70
>2.8 GHz to 3.6 GHz	±0.70 + *Frequency Response*	±0.75	±0.60	±1.90	±0.80

Values are based on -10 dBm to -50 dBm reference level, IF through path for center frequency ≥100 MHz, 300 kHz IF filter for center frequency <100 MHz, and using automatic calibration correction of the NI-RFSA instrument driver within ±5 °C of the temperature at the last calibration. RF attenuation is 20 dB for frequencies <10 MHz and is 10 dB for frequencies >10 MHz.

The absolute amplitude accuracy is measured at the center frequency. The absolute amplitude accuracy measurements are made after the hardware has settled. The high band to low band signal path transitions can take up to 200 ms for hardware to settle to within 0.1 dB of the final amplitude.

Table 13. PXIe-5665 14 GHz VSA Absolute Amplitude Accuracy, Preselector (YIG-Tuned Filter) Present and Enabled

Center Frequency	23 °C ± 5 °C			0 °C to 55 °C	
	Specification (dB)	2σ (dB)	Typical (dB)	Specification (dB)	Typical (dB)
>3.6 GHz to 7.5 GHz	±4.00	±3.00	±2.50	±5.00	±4.00
>7.5 GHz to 14 GHz	±4.00	±2.50	±2.25	±5.00	±4.00

Values are based on -10 dBm to -50 dBm reference level, 10 dB RF attenuation, and using the automatic calibration correction of the NI-RFSA instrument driver within ±5 °C of a self-calibration.

The absolute amplitude accuracy is measured at the center frequency. The absolute amplitude accuracy measurements are made after the hardware has settled. The high band to low band signal path transitions can take up to 200 ms for hardware to settle to within 0.1 dB of the final amplitude.

Linearity

Table 14. Linearity (Display Scale Fidelity), Typical

Response Relative to Full Scale (dB)	Linearity (dB)
-20 to 0	±0.10
-30 to <-20	±0.13
-35 to <-30	±0.20

Spurious Responses

Non-Input-Related (Residual) Spurs[13]

Table 15. PXIe-5665 Non-Input-Related (Residual) Spurs, Preselector Disabled (23 °C ± 5 °C)

Frequency	Specification (dBm)	Typical (dBm)
100 MHz to 3.6 GHz	-95	-100
>3.6 GHz to 7.5 GHz	-92	-100
>7.5 GHz to 8.5 GHz	-90	-98
>8.5 GHz to 14 GHz	-90	-98

LO-Related Spurious Responses

LO-related sideband spurs, 10 kHz to 10 MHz offset from center frequency (23 °C ± 5 °C)

Specification	-73 dBc
Typical	-78 dBc

Note The LO-related sideband spurs that appear in observed signals are caused by LO signals mixing and other internal spurious signals in the downconverter. These spurious signals exclude the image frequency-related spurs and intermediate frequency divided by two because they are specified separately. Values are based on -10 dBm input level, -10 dBm reference level, IF through path, and preamplifier disabled.

[13] Non-input-related spurs (residual spurs) are the responses observed when no input signal is present. The non-input-related spur values are based on ambient temperature of 23 °C ± 5 °C, RF input terminated, 0 dB RF attenuation, and -60 dBm reference level. For the PXIe-5665 14 GHz VSA from 1.65 GHz to 1.75 GHz, the warranted non-input-related spur specification is -85 dBm.

Higher-Order RF Responses[14]

Table 16. PXIe-5665 Higher-Order RF Responses (23 °C ± 5 °C, Typical)

Center Frequency	Higher-Order RF Responses (dBc)
100 MHz to 3.6 GHz	-80
>3.6 GHz to 14 GHz	-80
The higher-order RF responses are measured greater than 10 MHz offset from the carrier signal at a mixer level of -40 dBm. The preselector is enabled for center frequencies greater than 3.6 GHz.	

Image Rejection

Table 17. PXIe-5665 Image Rejection (23 °C ± 5 °C)

Center Frequency	Specification (dBc)	Typical (dBc)
100 MHz to 2.2 GHz	-80	-89
>2.2 GHz to 3.6 GHz	-77	-87
>3.6 GHz to 14 GHz	-80	-85
Values are based on 0 dBm input signal, 10 dB RF attenuation, 0 dBm reference level, and preamplifier disabled. The preselector is enabled for center frequencies greater than 3.6 GHz. Specification includes images from all conversion stages.		

IF Rejection[15]

Table 18. PXIe-5665 3.6 GHz VSA IF Rejection (23 °C ± 5 °C, Typical)

Center Frequency	IF1 (dBc)	IF2 (dBc)	IF3 (dBc)
100 MHz to 3.6 GHz	-59	-70	-92
IF rejection is the suppression of an input signal at the IF frequency when the RF signal analyzer is tuned elsewhere. Values are based on 0 dBm input signal, 10 dB RF attenuation, 0 dBm reference level, IF through path, and preamplifier disabled.			

14 Higher-order RF responses are responses resulting from RF second-order and higher-order harmonic-related spurs.

15 Refer to the *PXIe-5603/5605 RF Signal Downconverter Specifications* section for the IF1, IF2, and IF3 frequency definitions.

Table 19. PXIe-5665 14 GHz VSA IF Rejection (23 °C ± 5 °C, Typical)

Center Frequency	IF1 (dBc)	IF2 (dBc)	IF3 (dBc)
100 MHz to 3.6 GHz	-59	-92	-92
>3.6 GHz to 14 GHz	-87	-92	—
IF rejection is the suppression of an input signal at the IF frequency when the RF signal analyzer is tuned elsewhere. Values are based on 0 dBm input signal, 10 dB RF attenuation, 0 dBm reference level, IF through path, and preamplifier disabled. For center frequencies greater than 3.6 GHz, the preselector is enabled.			

Digital Downconverter Spur

PXIe-5622 maximum numerical controlled oscillator spur — -100 dBFS, typical[16]

Linearity

Third-Order Intermodulation Distortion

Table 20. PXIe-5665 Input Third-Order Intercept Point (IP_3), Preamplifier Disabled

Center Frequency	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBm)	Typical (dBm)	Specification (dBm)	Typical (dBm)
10 MHz to ≤100 MHz	+16	+19	+17	+18
>100 MHz to 700 MHz	+19	+22	+18	+21
>700 MHz to 3.6 GHz	+20	+24	+19	+22
>3.6 GHz to 8.5 GHz	+20	+24	+19	+24

[16] The digital downconversion can be optionally bypassed.

Table 20. PXIe-5665 Input Third-Order Intercept Point (IP_3), Preamplifier Disabled (Continued)

Center Frequency	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBm)	Typical (dBm)	Specification (dBm)	Typical (dBm)
>8.5 GHz to 14 GHz	+20	+24	+19	+22
Values are based on two -10 dBm input tones (-10 dBm equivalent mixer level) at 700 kHz apart, 0 dB RF attenuation, preamplifier disabled, -10 dB reference level, and the 300 kHz IF filter. Specifications for frequencies greater than 3.6 GHz apply when the preselector is enabled or disabled. Mixer level is equivalent to input signal level minus RF attenuation.				

Table 21. PXIe-5665 Input Third-Order Intercept Point (IP_3), Preamplifier Present and Enabled

Center Frequency	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBm)	Nominal (dBm)	Specification (dBm)	Nominal (dBm)
10 MHz to ≤100 MHz	-3.0	+1.0	-4.0	+0.0
>100 MHz to 700 MHz	+2.0	+2.5	+1.0	+2.0
>700 MHz to 3.6 GHz	+2.5	+3.5	+1.0	+2.0
Values are based on two -30 dBm tones (-30 dBm equivalent mixer level) spaced at 700 kHz apart, 0 dB RF attenuation, preamplifier disabled, -30 dBm reference level, and the 300 kHz filter. Mixer level is equivalent to input signal level minus RF attenuation plus preamplifier gain.				

Second Harmonic Distortion (Input SHI)

Table 22. PXIe-5665 Input SHI, Preamplifier Disabled and Preselector Enabled

Source Frequency	Device	23 °C ± 5 °C		0 °C to 55 °C	
		Specification (dBm)	Typical (dBm)	Specification (dBm)	Typical (dBm)
50 MHz to 300 MHz	PXIe-5665	—	+52	—	+50
>300 MHz to 700 MHz	PXIe-5665	+42	+53	+41	+50
>700 MHz to 1.80 GHz	PXIe-5665 3.6 GHz VSA	+50	+53	+45	+50
	PXIe-5665 14 GHz VSA	+44	+51	+40	+45
>1.80 GHz to 7.0 GHz	PXIe-5665	+54	+62	+52	+62
Values are based on a -10 dBm mixer level and 300 kHz IF filter. Mixer level is equivalent to input signal level minus RF attenuation. For center frequencies greater than 3.6 GHz, the preselector is enabled.					

Table 23. PXIe-5665 Input SHI, Preamplifier Present and Enabled

Center Frequency	Device	23 °C ± 5 °C			0 °C to 55 °C		
		Specification (dBm)	Nominal (dBm)	Typical (dBm)	Specification (dBm)	Nominal (dBm)	Typical (dBm)
50 MHz to <300 MHz	PXIe-5665	—	+17	—	—	+17	—
300 MHz to 1.8 GHz	PXIe-5665 3.6 GHz VSA	+15	—	+17	+12	—	+17
	PXIe-5665 14 GHz VSA	+20	—	+30	+20	—	+30
Values are based on a -40 dBm mixer level and 300 kHz IF filter. Mixer level is equivalent to input signal level minus RF attenuation plus preamplifier gain.							

Table 24. PXIe-5665 Input SHI, Preselector (YIG-Tuned Filter) Disabled

Source Frequency	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBm)	Typical (dBm)	Specification (dBm)	Typical (dBm)
1.8 GHz to 4.25 GHz	+28	+45	+25	+40
>4.25 GHz to 7.0 GHz	+18	+30	+15	+30
Values are based on a -10 dBm mixer level and 300 kHz IF filter. Mixer level is equivalent to input signal level minus RF attenuation.				

Gain Compression[17]

Table 25. PXIe-5665 1 dB Gain Compression Level, Preamplifier Disabled and Preselector Disabled

Center Frequency	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBm)	Typical (dBm)	Specification (dBm)	Typical (dBm)
10 MHz to 100 MHz	+8.0	+9.5	+6.0	+8.0
>100 MHz to 1.7 GHz	+8.0	+9.5	+6.0	+8.0
>1.7 GHz to 3.6 GHz	+6.0	+8.0	+5.0	+7.0
>3.6 GHz to 14 GHz	+6.0	+8.0	+5.0	+7.0
Values are based on a two-tone technique, tone separation at >900 kHz, 0 dB RF attenuation, 0 dBm reference level, and 300 kHz IF filter.				

Table 26. PXIe-5665 1 dB Gain Compression Level, Preamplifier Present and Enabled

Center Frequency	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBm)	Typical (dBm)	Specification (dBm)	Typical (dBm)
10 MHz to 100 MHz	-18	-12	-18	−12
>100 MHz to 1.7 GHz	-15	-11	-15	-11
>1.7 GHz to 3.6 GHz	-18	-11	-18	-11
Values are based on a two-tone technique, tone separation at >900 kHz, 0 dB RF attenuation, -30 dBm reference level, and 300 kHz IF filter.				

[17] Compression of an in-band signal by an out-of-band interfering signal, referenced to the RF input.

Table 27. PXIe-5665 1 dB Gain Compression Level, Preselector (YIG-Tuned Filter) Present and Enabled

Center Frequency	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBm)	Typical (dBm)	Specification (dBm)	Typical (dBm)
>3.6 GHz to 7.5 GHz	+6	+8	+5	+7
>7.5 GHz to 8.5 GHz	+6	+8	+5	+7
>8.5 GHz to 14 GHz	+6	+8	+5	+7
Values are based on a two-tone technique, tone separation at >900 kHz, 0 dB RF attenuation, -30 dBm reference level, and 300 kHz IF filter.				

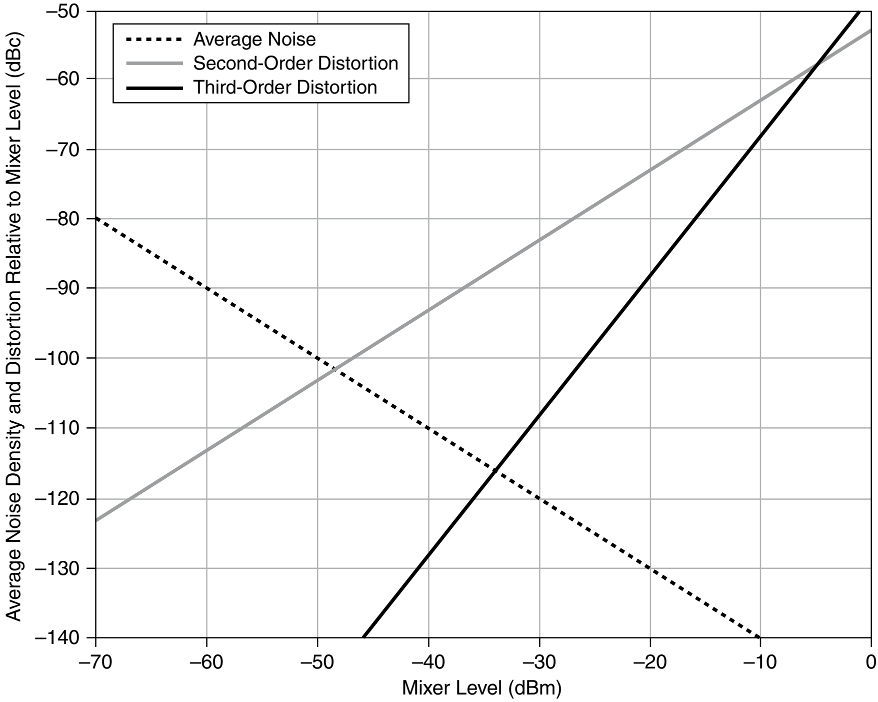
Clipping (ADC Overrange)[18]

Single tone, relative to the reference level 10 dB (nominal)

[18] The IF power offset defaults to 0 dB.

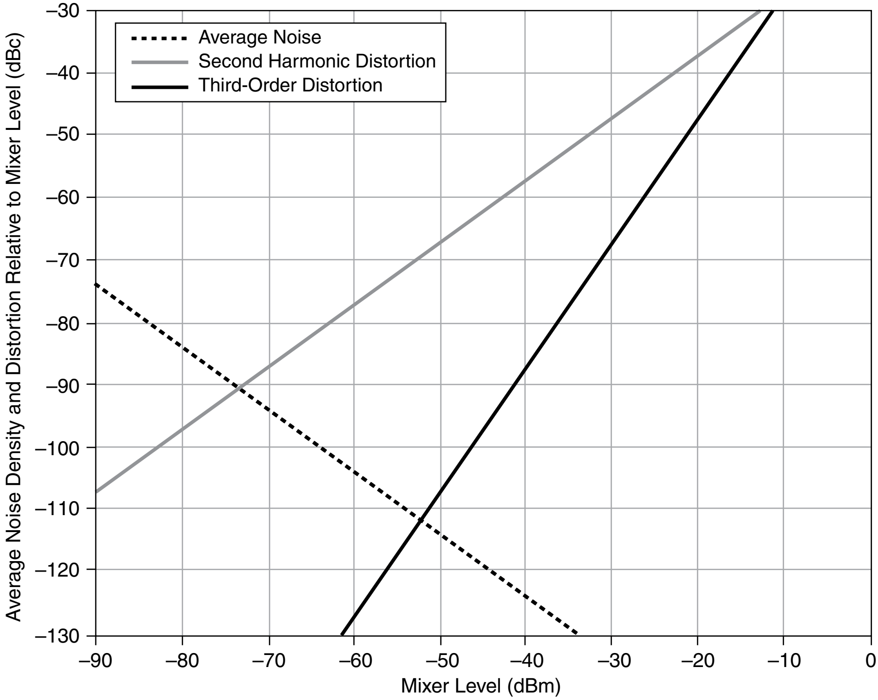
Dynamic Range

Figure 5. PXIe-5603/PXIe-5605 RF Downconverter Dynamic Range, Preamplifier Disabled (Nominal)



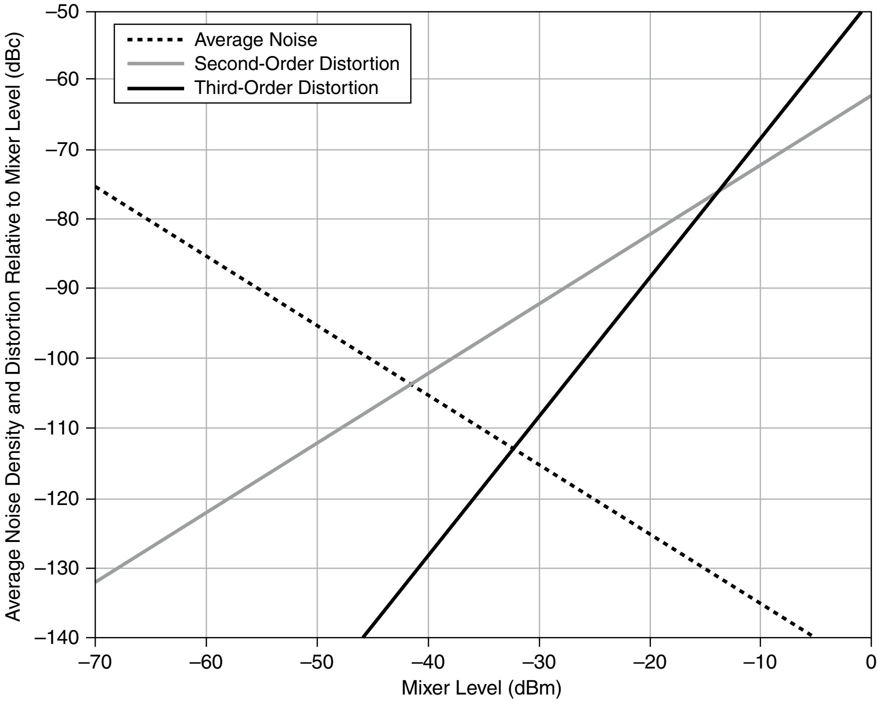
Note Values plotted are based on frequencies >700 MHz to ≤3.6 GHz with the preamplifier disabled and an ambient temperature of 23 °C ± 5 °C. RMS average noise level is normalized to a 1 Hz noise bandwidth while using NI-RFSA in I/Q acquisition mode. Third-order distortion is based on two tones with >700 kHz spacing, and using the 300 kHz IF filter. The *Second-Order Distortion* and *Third-Order Distortion* lines, shown below the *Average Noise* line, are extrapolations. The dynamic range plot shows nominal performance with settings that are optimized for noise performance. If you use the manual RF attenuation settings, IP_3 performance can improve with minimal degradation in noise floor, thus increasing the effective spurious free dynamic range in the power per tone signal range of -10 dB to 0 dB below the reference level.

Figure 6. PXIe-5603/PXIe-5605 Downconverter Nominal Dynamic Range, Preamplifier Present and Enabled (Nominal)



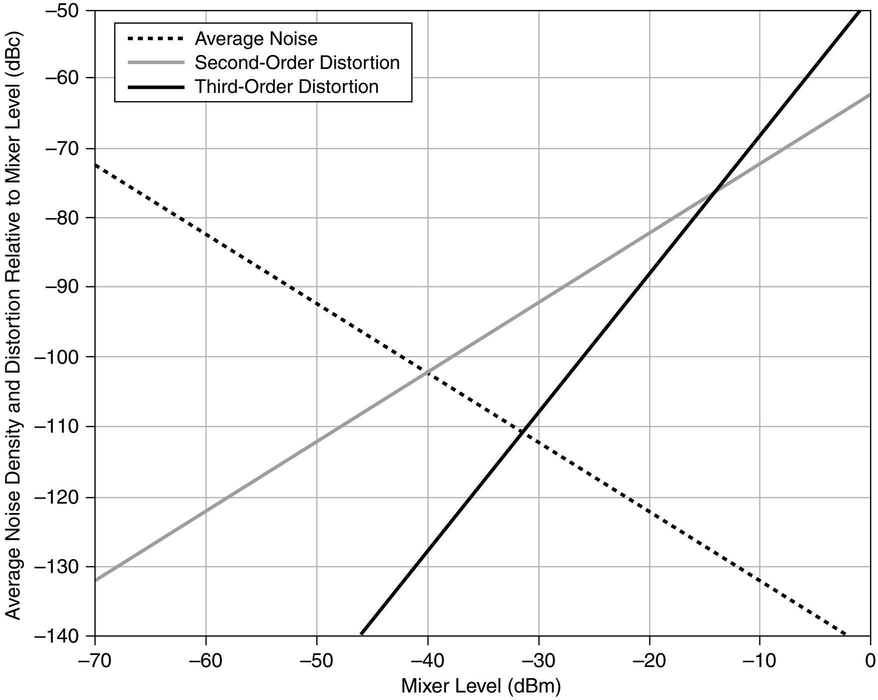
Note Values plotted are based on frequencies >700 MHz to ≤3.6 GHz with the preamplifier enabled and an ambient temperature of 23 °C ± 5 °C. RMS average noise level is normalized to a 1 Hz noise bandwidth while using NI-RFSA in I/Q acquisition mode. The dynamic range plot shows nominal performance with settings that are optimized for noise performance. If you use the manual RF attenuation settings, IP_3 performance can improve with minimal degradation in noise floor, thus increasing the effective spurious free dynamic range in the power per tone signal range of -10 dB to 0 dB below the reference level.

Figure 7. PXIe-5605 Downconverter Nominal Dynamic Range for Frequencies 3.6 GHz to 7.5 GHz, Preselector Present and Enabled (Nominal)



Note Values plotted are based on frequencies >3.6 GHz to ≤7.5 GHz with the preselector enabled and an ambient temperature of 23 °C ± 5 °C. RMS average noise level is normalized to a 1 Hz noise bandwidth while using NI-RFSA in I/Q acquisition mode. The dynamic range plot shows nominal performance with settings that are optimized for noise performance. If you use the manual RF attenuation settings, IP_3 performance can improve with minimal degradation in noise floor, thus increasing the effective spurious free dynamic range in the power per tone signal range of -10 dB to 0 dB below the reference level.

Figure 8. PXIe-5605 Downconverter Nominal Dynamic Range for Frequencies 7.5 GHz to 14 GHz, Preselector Present and Enabled (Nominal)



Note Values plotted are based on frequencies >7.5 GHz to ≤14 GHz with the preselector enabled and an ambient temperature of 23 °C ± 5 °C. RMS average noise level is normalized to a 1 Hz noise bandwidth while using NI-RFSA in I/Q acquisition mode. The dynamic range plot shows nominal performance with settings that are optimized for noise performance. If you use the manual RF attenuation settings, IP_3 performance can improve with minimal degradation in noise floor, thus increasing the effective spurious free dynamic range in the power per tone signal range of -10 dB to 0 dB below the reference level.

Modulation

IF Amplitude Response

Table 28. Typical PXIe-5665 IF Amplitude Response (23 °C ± 5 °C)

IF Passband	Preamplifier Disabled Center Frequency ≤ 3.6 GHz (dB)	Preamplifier Present and Enabled Center Frequency ≤ 3.6 GHz (dB)	Preselector Disabled Center Frequency > 3.6 GHz (dB)
≤5 MHz	±0.15	±0.20	±0.10
≤10 MHz	±0.25	±0.30	±0.20
≤25 MHz	±0.35	±0.40	±0.45
≤40 MHz	±0.40	±0.45	±0.70
≤50 MHz	±0.40	±0.45	±0.80
IF passband response is relative to IF center frequency. The specification applies when RF center frequency is ≥100 MHz, 0 dB RF attenuation, IF through path, IF equalization is enabled, and self-calibration is performed. The standard 25 MHz bandwidth option for the PXIe-5665 provides IF bandwidth up to 25 MHz.			

IF Phase Linearity (Deviation from Linear Phase)

Table 29. Typical PXIe-5665 Deviation from Linear Phase (Degrees, 23 °C)

IF Passband	Preamplifier Disabled[19] Center Frequency <3.6 GHz	Preamplifier Present and Enabled[20] Center Frequency <3.6 GHz	Preselector Disabled Center Frequency >3.6 GHz
≤5 MHz	±0.1	±0.2	±0.1
≤10 MHz	±0.3	±0.4	±0.3
≤25 MHz	±1.4	±1.6	±1.0
≤40 MHz	±2.1	±1.8	±1.4

[19] When the preamplifier is disabled, the reference levels vary from +20 dBm to -30 dBm.
[20] When the preamplifier is enabled, the reference levels vary from -20 dBm to -50 dBm.

Table 29. Typical PXIe-5665 Deviation from Linear Phase (Degrees, 23 °C) (Continued)

IF Passband	Preamplifier Disabled[19] Center Frequency <3.6 GHz	Preamplifier Present and Enabled[20] Center Frequency <3.6 GHz	Preselector Disabled Center Frequency >3.6 GHz
≤50 MHz	±2.9	±2.5	±2.1
IF passband response is relative to IF center frequency. The specification applies when RF center frequency is ≥100 MHz, 0 dB RF attenuation, IF through path, IF equalization is enabled, and self-calibration is performed. The standard 25 MHz bandwidth option for the PXIe-5665 provides IF bandwidth up to 25 MHz.			

Error Vector Magnitude (EVM) and Modulation Error Ratio (MER)

Data length in the following two tables is a 1,250 symbol pseudorandom bit sequence (PRBS) at a -30 dBm power level. These results were obtained using the independent onboard clocks for the vector signal analyzer and do not include software equalization using the Modulation Toolkit. Results are the composite effect of both the PXIe-5665 and the PXIe-5673E RF vector signal generator.

Table 30. 825 MHz Carrier Frequency (Nominal)

QAM Order	Symbol Rate (kS/s)	α_{RRC}	EVM (% RMS)	MER (dB)
4	160	0.25	0.23	53.5
	800	0.21	0.29	52.3
	4,090	0.22	0.41	49.2
16	17,600	0.25	0.52	45.1
	32,000	0.25	0.74	43.0
64	5,360	0.15	0.31	48.0
	6,952	0.15	0.36	46.9
	40,990	0.22	0.79	40.2
256	6,952	0.15	0.33	46.8

[19] When the preamplifier is disabled, the reference levels vary from +20 dBm to -30 dBm.
[20] When the preamplifier is enabled, the reference levels vary from -20 dBm to -50 dBm.

Table 31. 3.4 GHz Carrier Frequency (Nominal)

QAM Order	Symbol Rate (kS/s)	α_{RRC}	EVM (% RMS)	MER (dB)
4	160	0.25	0.57	45.2
	800	0.25	0.53	48.6
	4,090	0.22	0.63	45.1
16	17,600	0.25	0.70	42.1
	32,000	0.25	1.98	39.9
64	5,360	0.15	0.46	44.4
	6,952	0.15	0.51	44.1
	40,990	0.22	1.06	38.2
256	6,952	0.15	0.45	44.0

Table 32. 5.8 GHz Carrier Frequency (Nominal)

QAM Order	Symbol Rate (kS/s)	α_{RRC}	EVM (% RMS)	MER (dB)
4	160	0.25	0.72	44.0
	800	0.25	0.62	44.3
	4,090	0.22	0.63	44.2
16	17,600	0.25	0.67	41.2
	32,000	0.25	0.86	39.8
64	5,360	0.15	0.47	43.7
	6,952	0.15	0.50	42.9
	40,990	0.22	0.98	39.4
256	6,952	0.15	0.44	43.5

Measurement Speed

Measurement duration is made up of tuning time plus analysis time. The tuning benchmark includes programming time, frequency settling time, and amplitude settling time. Programming time partially overlaps frequency settling time and amplitude settling time. Measurement duration is dependent on the specific measurement settings used.

Amplitude Settling Time[21]

Table 33. PXIe-5665 Amplitude Settling Time (Nominal)

Center Frequency	Device	Mechanical Attenuator Stationary	Mechanical Attenuator State Changed
>100 MHz to ≤3.6 GHz	PXIe-5665 3.6 GHz VSA	25 µs	5 ms
	PXIe-5665 14 GHz VSA		40 ms
>3.6 GHz to ≤14 GHz	PXIe-5665 14 GHz VSA	25 µs	40 ms

Tuning Time

Table 34. PXIe-5665 Tuning Time (Nominal)[22]

Step Size	Fast Configuration[23] (ms)	Normal Configuration[24] (ms)
50 MHz	1.8	5.6
75 MHz	1.9	7.7
250 MHz	2.3	9.3
1.0 GHz	6.6	15.0
3.5 GHz	14.5	19.6

21 Amplitude settling is within 0.1 dB.

22 Tuning times refer to tuning with a single band, for example, tuning within 0 Hz to 3.6 GHz or within 3.6 GHz to 7.5 GHz. The tuning times for tuning within the 7.5 GHz to 14 GHz band are lower than if the frequency spans multiple frequency bands. If your application uses the PXIe-5665 14 GHz VSA device with the preselector enabled, add the preselector tuning times to the tuning times listed in this table.

23 Fast Configuration refers to setting the **LO YIG Main Coil Drive** property to Fast at an accuracy of 1.0×10^{-6} of final frequency.

24 Normal Configuration refers to setting the **LO YIG Main Coil Drive** property to Normal at an accuracy of 0.1×10^{-6} of final frequency.

RF Configuration List Mode Tuning Time

Table 35. PXIe-5665 RF Configuration List Mode Tuning Time (Nominal)

Step Size	Tuning Time[25]	
	Fast Configuration[26] (ms)	Normal Configuration[27] (ms)
50 MHz	1.2	7.1
75 MHz	1.5	8.1
250 MHz	1.9	11.1
1.0 GHz	10.1	15.1
3.5 GHz	17.1	20.1

The maximum tuning time for an arbitrary frequency jump depends on the locking time and the settling time for the LO. You can calculate the LO frequency for a given RF frequency using the following equation:

$$f_{LO} = \begin{cases} f_{RF} + (4800\text{ MHz} - f_{IF}) \ldots 20\text{ Hz} \leq f_{RF} \leq 3.6\text{ GHz} \\ f_{RF} + (800\text{ MHz} - f_{IF}) \ldots 3.6\text{ GHz} < f_{RF} \leq 7.5\text{ GHz} \\ \dfrac{f_{RF} + (800\text{ MHz} - f_{IF})}{2} \ldots 7.5\text{ GHz} < f_{RF} \leq 14\text{ GHz} \end{cases}$$

where

f_{LO} represents the *LO frequency*

f_{RF} represents the *RF center frequency*

f_{If} represents the *IF path center frequency*

25 Tuning times refer to tuning with a single band, for example, tuning within 0 Hz to 3.6 GHz or within 3.6 GHz to 7.5 GHz. The tuning times for tuning within the 7.5 GHz to 14 GHz band are lower than if the frequency spans multiple frequency bands. If your application uses the PXIe-5665 14 GHz VSA device with the preselector enabled, add the preselector tuning times to the tuning times listed in this table.

26 Fast Configuration refers to setting the **LO YIG Main Coil Drive** property to Fast at an accuracy of 1.0×10^{-6} of final frequency.

27 Normal Configuration refers to setting the **LO YIG Main Coil Drive** property to Normal at an accuracy of 0.1×10^{-6} of final frequency.

Table 36. PXIe-5665 IF Path Center Frequency

Instantaneous Bandwidth[28]	IF Path Center Frequency
≤300 kHz	199.0 MHz
>300 kHz and <5 MHz	190.0 MHz
>5 MHz	187.5 MHz

You can calculate the tuning time for an arbitrary frequency jump using the following equations:

$$Tuning\ Time_{Normal\ Mode} = Frequency\ Settling\ Time_{\Delta LOFrequency}(\text{ms}) + 0.6\ \text{ms}$$
$$Tuning\ Time_{List\ Mode} = Frequency\ Settling\ Time_{\Delta LOFrequency}(\text{ms}) + 0.1\ \text{ms}$$

where $\Delta LOFrequency$ is the LO frequency step size.

Note If your application uses the PXIe-5665 14 GHz VSA device with the preselector enabled, add the preselector tuning time to the values you calculate using these equations.

Note Refer to the *PXIe-5653 LO Specifications* section of this document for LO tuning times.

Preselector Tuning Time

Table 37. PXIe-5665 14 GHz VSA Preselector Tuning Time (Nominal)

Center Frequency Step Size	Preselector Tuning Time[29] (ms)
≤100 MHz	2.1
500 MHz	3.4
1.0 GHz	5.1
2.0 GHz	8.4
3.0 GHz	11.6
3.5 GHz	13.3

28 The instantaneous bandwidth of the device is the value of the **Device Instantaneous Bandwidth** property.

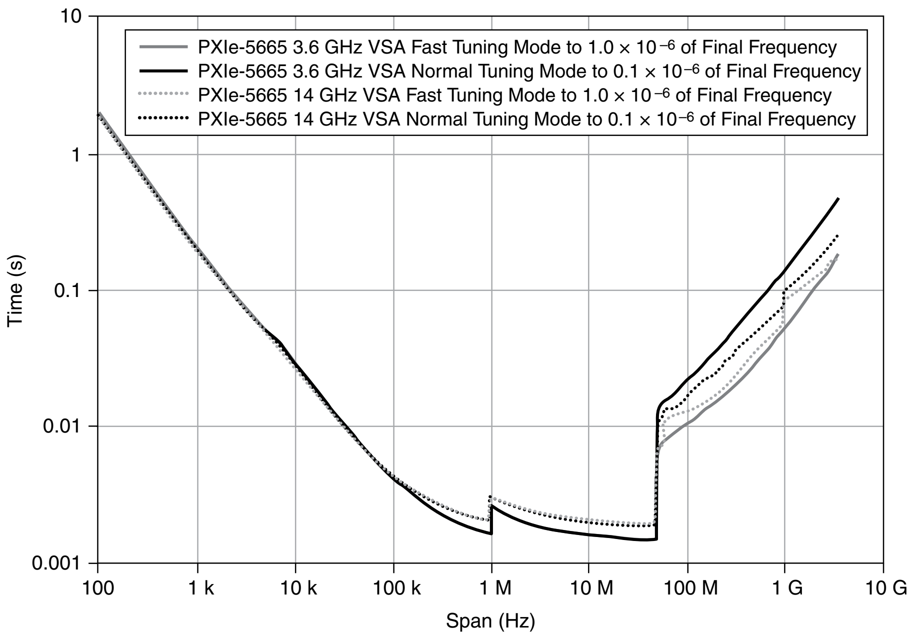
29 Tuning time refers to the time required to tune the preselector upwards in frequency. The time required to tune downwards in frequency can be 13 ms to 27 ms for RF center frequencies from 3.6 GHz to 7.5 GHz and can be 26 ms to 48 ms for RF center frequencies from 7.5 GHz to 14 GHz.

Table 37. PXIe-5665 14 GHz VSA Preselector Tuning Time (Nominal) (Continued)

Center Frequency Step Size	Preselector Tuning Time[29] (ms)
4.0 GHz	15.0
6.0 GHz	21.5

Analysis Time Versus Span[30]

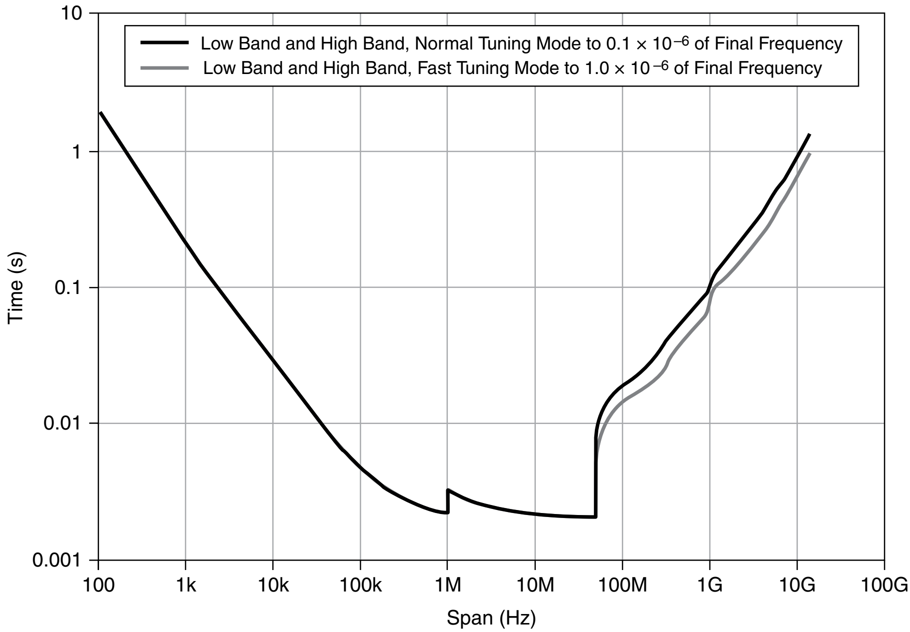
Figure 9. PXIe-5665 Analysis Time for Center Frequencies <3.6 GHz (Nominal)



29 Tuning time refers to the time required to tune the preselector upwards in frequency. The time required to tune downwards in frequency can be 13 ms to 27 ms for RF center frequencies from 3.6 GHz to 7.5 GHz and can be 26 ms to 48 ms for RF center frequencies from 7.5 GHz to 14 GHz.

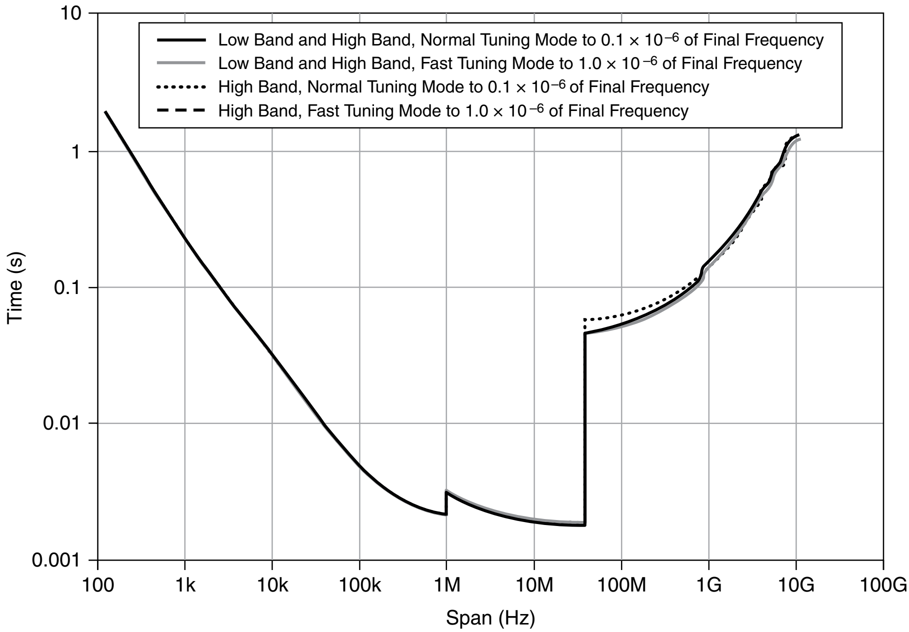
30 Analysis time versus span was measured with a tuned frequency >10 MHz. For spans <1 MHz, 190 frequency points were measured; for spans >1 MHz, 1,000 frequency points were measured. Analysis time includes acquisition, FFT analysis, and data transfer time. For spans >50 MHz, analysis time also includes tuning time. Tuning Mode indicates the **LO YIG Main Coil Drive** property was set to Fast or Normal.

Figure 10. PXIe-5665 14 GHz VSA Analysis Time[31], Preselector Disabled (Nominal)



[31] *Low band* refers to RF center frequencies less than 3.6 GHz. *High band* refers to RF center frequencies from 3.6 GHz to 14 GHz.

Figure 11. PXIe-5665 14 GHz VSA Analysis Time[32], Preselector Enabled (Nominal)



Data Streaming[33]

Maximum continuous transfer rate	300 MB/s (nominal)

Input and Output Characteristics

RF IN Front Panel Connector (PXIe-5603/PXIe-5605)

Connector	SMA female
Impedance	50 Ω (nominal)
Coupling	AC and DC

[32] *Low band* refers to RF center frequencies less than 3.6 GHz. *High band* refers to RF center frequencies from 3.6 GHz to 14 GHz.

[33] Refer to the *PXIe-5622 Specifications* for more information about data streaming. The data streaming specification was measured using the PXIe-1065 chassis and the PXIe-8130 controller. Performance is system-dependent.

Maximum safe DC input voltage	
AC coupled[34]	±25 VDC
DC coupled[35]	±0 VDC

Maximum Safe Continuous RF Power

Table 38. PXIe-5603 Maximum Safe Continuous RF Power

Mechanical Attenuation	Level
≥10 dB	+30 dBm
0 dB	+20 dBm

Table 39. PXIe-5605 Maximum Safe Continuous RF Power

Mechanical Attenuation	Level	
	<10 MHz	≥10 MHz
≥10 dB	+25 dBm	+30 dBm
0 dB	+10 dBm	+20 dBm

Voltage Standing Wave Ratio (VSWR) of RF Input

Table 40. PXIe-5603 VSWR (Nominal)

Attenuation[36]	Center Frequency	VSWR
≥10 dB	>100 MHz to ≤3.6 GHz	≤1.4:1
0 dB	>100 MHz to ≤3.6 GHz	≤2.0:1

34 DC voltages less than ±25 VDC at the RF IN connector of the PXIe-5603 are safe for the downconverter. However, high transient currents from low-impedance DC step voltages at the RF IN connector can cause damage to the downconverter. NI is not liable for damage caused by improper signal connections.

35 Ensure that the DC voltage at the RF IN connector of the PXIe-5605 is limited to ±2 V even with the DC block attached to the RF IN connector. With the DC block removed, the maximum safe DC input voltage for the RF IN connector is 0 V.

36 Attenuation available in 1 dB steps.

Table 41. PXIe-5605 VSWR (Nominal)

Attenuation[37]	Center Frequency	VSWR
≥10 dB	>100 MHz to ≤14 GHz	≤1.3:1
0 dB	>100 MHz to ≤14 GHz	≤3.3:1

IF OUT Front Panel Connector (PXIe-5603/PXIe-5605)

Connector	SMA female
Impedance	50 Ω (nominal)
Return loss	15 dB (nominal)
Maximum IF output level[38]	+22 dBm
Output voltage	0 VDC

LO IN and LO OUT Front Panel Connectors (PXIe-5603/PXIe-5605)

Connector	SMA female
Impedance	50 Ω (nominal)
Coupling	AC
LO IN maximum safe power level	+15 dBm
LO IN maximum safe voltage	
PXIe-5603	25 VDC
PXIe-5605	0 VDC
LO OUT maximum safe power level	+15 dBm
LO OUT maximum safe voltage	0 VDC
LO frequency	
LO1	4.6 GHz to 8.3 GHz
LO2	4.0 GHz
LO3	800 MHz

[37] Attenuation available in 1 dB steps for frequencies less than 3.6 GHz. Attenuation is available in 5 dB steps from 20 Hz to 14 GHz.

[38] IF output may exhibit high-level transients of +24 dBm (nominal) during tuning of the PXIe-5665.

LO output level	
LO1	+7 dBm to +8 dBm, typical, varies with frequency
LO2	+9 dBm to +10 dBm, typical
LO3	+9 dBm to +10 dBm, typical

LO Output (PXIe-5653)

Table 42. LO Output Level

LO	Minimum	Nominal	Maximum
LO1 (from 3.2 GHz to 8.2 GHz)	*Nominal Value* - 2.5 dB	Varies by frequency according to the following equation: $10.5 - 3\left(\frac{Frequency(GHz) - 3.2GHz}{5.0GHz}\right)(dBm)$	*Nominal Value* + 2.5 dB
LO1 (at 8.3 GHz)	+4 dBm	+6.5 dBm	+9 dBm
LO2	+6.5 dBm	+9 dBm	+13 dBm
LO3	+7 dBm	+9 dBm	+13 dBm

Power Requirements

Table 43. PXIe-5665 Power Requirements (Voltages ±5%)

Module	From +3.3 VDC	From +12 VDC
PXIe-5603	1.70 A (5.61 W)	1.80 A (21.60 W)
PXIe-5605	1.20 A (3.96 W)	3.40 A (40.80 W)
PXIe-5622	1.75 A (5.78 W)	2.25 A (27.00 W)
PXIe-5653	1.10 A (3.63 W)	4.00 A (48.00 W)

Calibration

Interval	2 years

PXIe-5653 LO Specifications

LO frequency

LO1	3.2 GHz to 8.3 GHz (nominal)
LO2	4.0 GHz (nominal)
LO3	800 MHz (nominal)

Single Sideband (SSB) Phase Noise (LO1)

LO1 (5.4125 GHz)

Table 44. Phase Noise (dBc/Hz), PXIe-5665 Center Frequency = 800 MHz

Offset	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBc/Hz)	Typical (dBc/Hz)	Nominal (dBc/Hz)	Typical (dBc/Hz)
10 Hz	—	—	<-73[39]	—
100 Hz	<-89	<-94	—	<-89
1 kHz	<-118	<-122	—	<-119
10 kHz	<-128	<-131	—	<-130
100 kHz	<-125	<-128	—	<-127
1 MHz	<-141	<-144	—	<-143
5 MHz	<-155	<-157	—	<-155
LO YIG Main Coil Drive property set to Normal.				

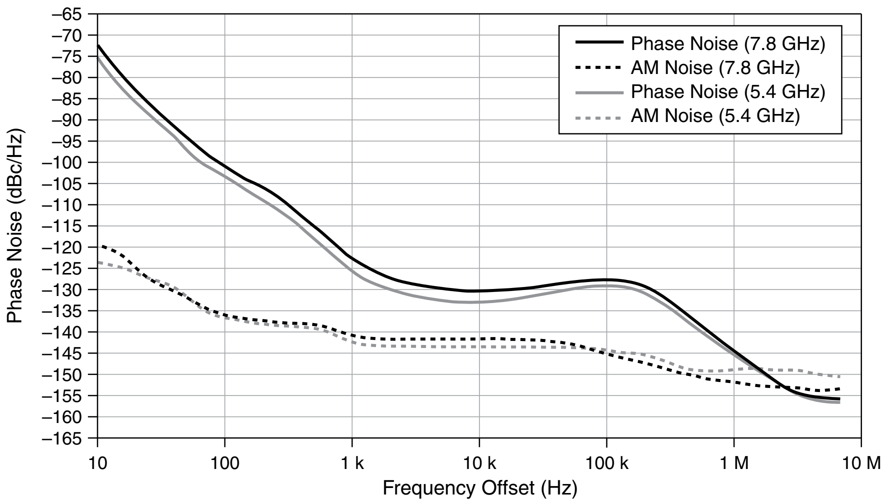
[39] When used in a VSA system, the nominal specification for the VSA improves significantly from this value because the VSA uses all the LOs instead of a single LO. The phase noise of other LOs is correlated to the phase noise on LO1 at low offsets, which improves performance of the VSA system.

LO1 (7.8125 GHz)

Table 45. Phase Noise (dBc/Hz), PXIe-5665 Center Frequency =3.2 GHz

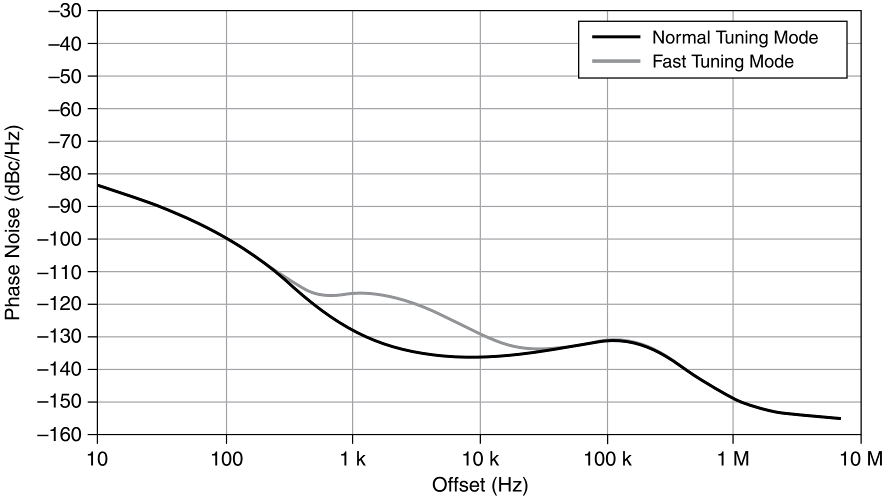
Offset	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBc/Hz)	Typical (dBc/Hz)	Nominal[39] (dBc/Hz)	Typical (dBc/Hz)
10 Hz	—	—	<-70	—
100 Hz	<-86	<-92	—	<-86
1 kHz	<-115	<-119	—	<-116
10 kHz	<-127	<-130	—	<-129
100 kHz	<-125	<-128	—	<-127
1 MHz	<-141	<-144	—	<-143
5 MHz	<-155	<-157	—	<-155
LO YIG Main Coil Drive property set to Normal.				

Figure 12. LO1 Phase and Amplitude Noise (AM, Nominal)[40]



[40] LO1 Noise Sidebands: LO1 = 5.4125 GHz, 7.8125 GHz. Plots of measured LO1 performance (Phase Noise and AM Noise) shown without spurs.

Figure 13. LO1 Phase Noise Measured Performance Comparison, Normal Tuning Versus Fast Tuning Speed[41]



Single Sideband (SSB) Phase Noise (LO2)

LO2 (4 GHz)

Table 46. Noise Density, PXIe-5665 Center Frequencies >3.6 GHz

Offset	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBc/Hz)	Typical (dBc/Hz)	Nominal[42] (dBc/Hz)	Typical (dBc/Hz)
10 Hz	—	—	<-76	—
100 Hz	<-92	<-97	—	<-92
1 kHz	<-121	<-125	—	<-122
10 kHz	<-134	<-137	—	<-135
100 kHz	<-134	<-137	—	<-135

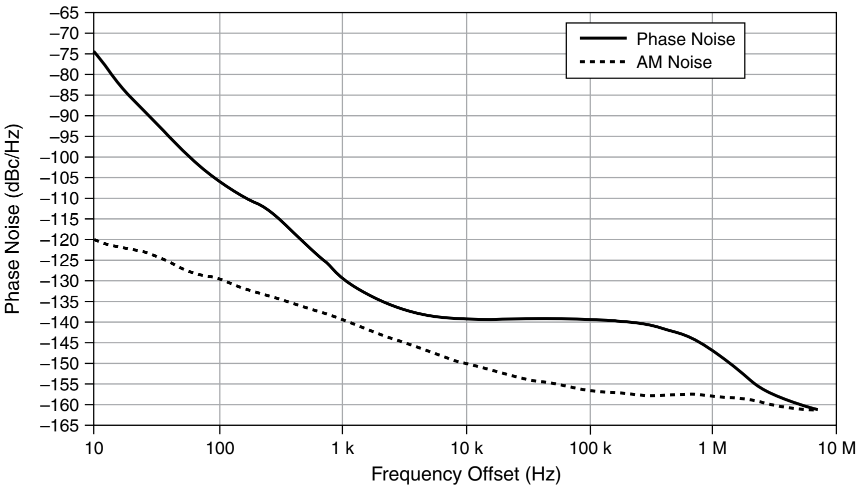
[41] LO1 frequency is 5 GHz. Representative of nominal performance difference across the entire frequency range of LO1 (shown without spurs). Tuning Mode refers to the setting of the **LO YIG Main Coil Drive** property to Fast or Normal.

[42] When used in a vector signal analyzer (VSA) system, the nominal specification for the VSA improves significantly from this value because the VSA uses all the LOs instead of a single LO. The phase noise of other LOs is correlated to the phase noise on LO1 at low offsets, which results in improved performance of the VSA system.

Table 46. Noise Density, PXIe-5665 Center Frequencies >3.6 GHz (Continued)

Offset	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBc/Hz)	Typical (dBc/Hz)	Nominal[42] (dBc/Hz)	Typical (dBc/Hz)
1 MHz	<-143	<-146	—	<-145
5 MHz	<-155	<-157	—	<-155

Figure 14. LO2 Phase and Amplitude Noise (Nominal) [43]



42 When used in a vector signal analyzer (VSA) system, the nominal specification for the VSA improves significantly from this value because the VSA uses all the LOs instead of a single LO. The phase noise of other LOs is correlated to the phase noise on LO1 at low offsets, which results in improved performance of the VSA system.

43 LO2 = 4.0 GHz. Plots of measured LO2 performance (Phase Noise and AM Noise) shown without spurs.

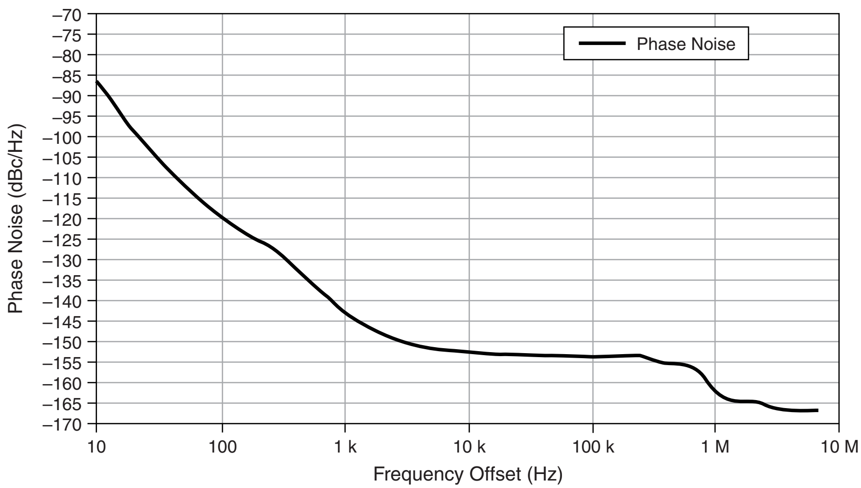
Single Sideband (SSB) Phase Noise (LO3)

LO3 (800 MHz)

Table 47. Noise Density, PXIe-5665 Center Frequencies >3.6 GHz

Offset	23 °C ± 5 °C		0 °C to 55 °C	
	Specification (dBc/Hz)	Typical (dBc/Hz)	Nominal[44] (dBc/Hz)	Typical (dBc/Hz)
10 Hz	—	—	<-90	—
100 Hz	<-104	-111	—	<-106
1 kHz	<-135	-139	—	<-134
10 kHz	<-148	-152	—	<-149
100 kHz	<-149	-153	—	<-150
1 MHz	<-158	-160	—	<-156
5 MHz	<-160	-163	—	<-159

Figure 15. LO3 Phase Noise[45]



44 When used in a VSA system, the nominal specification for the VSA improves significantly from this value because the VSA uses all the LOs instead of a single LO. The phase noise of other LOs is correlated to the phase noise on LO1 at low offsets, which improves performance of the VSA system.

45 LO3 = 800 MHz. *Phase Noise* plot of measured LO3 performance shown without spurs.

PXIe-5653 Frequency Lock Time[46]

Table 48. PXIe-5653 Maximum Lock Time (0 °C to 55 °C)

Frequency Step Size	Fast Tuning Mode[47] (ms)	Normal Tuning Mode[48] (ms)
≤25 MHz	0.85	3
≤50 MHz	1.10	6
≤75 MHz	1.35	7
≤80 MHz	1.35	7
≤90 MHz	1.35	7
≤100 MHz	1.35	7
≤250 MHz	1.80	10
≤500 MHz	6	12
≤1.0 GHz	10	14
≤2.0 GHz	13	17
≤3.0 GHz	15	18
≤5.1 GHz	17	20

[46] PXIe-5653 Frequency Tuning Time consists of *Lock Time* + *Settling Time to Required Accuracy*. For example, in Fast Configuration mode, a 50 MHz step requires 1.1 ms (the frequency lock time) + 0.75 (the frequency settling time), or 1.85 ms to lock and settle to 0.1 ppm accuracy.

[47] Fast Tuning Mode refers to setting the **LO YIG Main Coil Drive** property to Fast at an accuracy of 1.0×10^{-6} of the final frequency.

[48] Normal Tuning Mode refers to setting the **LO YIG Main Coil Drive** property to Normal at an accuracy of 1.0×10^{-6} of the final frequency.

PXIe-5653 Frequency Settling Time[49]

Table 49. PXIe-5665 Maximum Settling Time (0 °C to 55 °C)

Settling Accuracy (Relative to Final Frequency)	Fast Tuning Mode[50] (ms)	Normal Tuning Mode[51] (ms)
1.0×10^{-6}	0.00	0.00
0.1×10^{-6}	0.75	1.00
0.01×10^{-6}	1.60	6.00
0.001×10^{-6}	5.00	20.0

PXIe-5603/5605 RF Signal Downconverter Specifications

Instantaneous Bandwidth

IF passband bandwidth	
IF through path (≥80 MHz)	6 dB, typical
IF through path (≥50 MHz)	3 dB, typical
≥5 MHz[52]	3 dB, typical
≥300 kHz	3 dB, typical
RF preselector[53] passband bandwidth	
Preselector enabled (≥47 MHz)	6 dB, typical

49 PXIe-5653 Frequency Tuning Time consists of *Lock Time + Settling Time to Required Accuracy*. For example, in Fast Configuration mode, a 50 MHz step requires 1.1 ms (the frequency lock time) + 0.75 (the frequency settling time), or 1.85 ms to lock and settle to 0.1 ppm accuracy.

50 Fast Tuning Mode refers to setting the **LO YIG Main Coil Drive** property to Fast at an accuracy of 1.0×10^{-6} of the final frequency.

51 Normal Tuning Mode refers to setting the **LO YIG Main Coil Drive** property to Normal at an accuracy of 1.0×10^{-6} of the final frequency.

52 The 5 MHz filter is available only for the PXIe-5605.

53 The RF preselector is available only for the PXIe-5605. Preselector ripple may affect the bandwidth at some frequencies. The typical preselector bandwidth includes the effects of passband ripple and modes.

IF Frequencies

Table 50. Nominal PXIe-5665 Downconverter IF Frequencies

RF Center Frequency	IF Signal Path	IF1	IF2	IF3
20 Hz to 3.6 GHz	Through	4.6125 GHz	612.5 MHz	187.5 MHz
	5 MHz	4.6100 GHz	610.0 MHz	190.0 MHz
	300 kHz	4.6010 GHz	601.0 MHz	199.0 MHz
>3.6 GHz	Through	612.5 MHz	187.5 MHz	—
	5 MHz	610.0 MHz	190.0 MHz	—
	300 kHz	601.0 MHz	199.0 MHz	—

Amplitude Range

The PXIe-5603/PXIe-5605 amplitude range is the same as the amplitude range specified for the PXIe-5665.

Average Noise Level

Preamplifier Disabled

Table 51. PXIe-5665 Downconverter Average Noise Level, Preamplifier Disabled (Typical)

Center Frequency	23 ± 5 °C (dBm/Hz)	0 to 55 °C (dBm/Hz)
20 Hz to 10 kHz	—	-70
>10 kHz to 10 MHz	—	-100
>10 MHz to 100 MHz	-152	-151
>100 MHz to 300 MHz	-157	-154
>300 MHz to 1.7 GHz	-154	-153
>1.7 GHz to 2.8 GHz	-152	-151
>2.8 GHz to 12 GHz	-151	-150

Table 51. PXIe-5665 Downconverter Average Noise Level, Preamplifier Disabled (Typical) (Continued)

Center Frequency	23 ± 5 °C (dBm/Hz)	0 to 55 °C (dBm/Hz)
>12 GHz to 14 GHz	-147	-146
Values based on input terminated, no input signal, 0 dB RF attenuation for center frequency ≥10 MHz, 20 dB RF attenuation for center frequency <10 MHz, IF through path for center frequency ≥100 MHz, 300 kHz IF filter for center frequency <100 MHz, ≤-50 dBm reference level, IF through path, and >10 averages. RMS average noise level normalized to a 1 Hz noise bandwidth. When the average noise level is measured as DANL, there is a 2.5 dB improvement; for example, the equivalent DANL measured at 2 GHz is -154.5 dBm/Hz.		

Preamplifier Present and Enabled

Table 52. PXIe-5665 Downconverter Average Noise Level, Preamplifier Present and Enabled (Typical)

Center Frequency	23 °C ± 5 °C (dBm/Hz)	0 °C to 55 °C (dBm/Hz)
10 MHz to 100 MHz	-163	-161
>100 MHz to 300 MHz	-167	-166
>300 MHz to 1.7 GHz	-165	-164
>1.7 GHz to 2.8 GHz	-164	-163
>2.8 GHz to 3.6 GHz	-163	-163
Values based on input terminated, no input signal, 0 dB RF attenuation, IF through path for center frequency ≥ 100 MHz, 300 kHz IF filter for center frequency <100 MHz, ≤−50 dBm reference level, IF through path, and >10 averages. RMS average noise level measured in a 1 Hz noise bandwidth using NI-RFSA I/Q acquisition mode. When the average noise level is measured as DANL, there is a 2.5 dB improvement; for example, the equivalent DANL measured at 2 GHz is -166.5 dBm/Hz.		

Preselector (YIG-Tuned Filter) Present and Enabled

Table 53. PXIe-5665 Downconverter Average Noise Level, Preselector (YIG-Tuned Filter) Present and Enabled (Typical)

Center Frequency	23 °C ± 5 °C (dBm/Hz)	0 °C to 55 °C (dBm/Hz)
>3.6 GHz to 7.5 GHz	-147	-146
>7.5 GHz to 8.5 GHz	-145	-144
>8.5 GHz to 12 GHz	-145	-144

Table 53. PXIe-5665 Downconverter Average Noise Level, Preselector (YIG-Tuned Filter) Present and Enabled (Typical) (Continued)

Center Frequency	23 °C ± 5 °C (dBm/Hz)	0 °C to 55 °C (dBm/Hz)
>12 GHz to 14 GHz	-142	-141
Values based on input terminated, 0 dB RF attenuation, IF through path, ≤−50 dBm reference level, IF through path, and >10 averages. RMS average noise level normalized to a 1 Hz noise bandwidth. When the average noise level is measured as the DANL associated with spectrum analyzers, there is a 2.5 dB improvement caused by the averaging of log and other measurement biases in spectrum analyzer DANL. For example, the equivalent DANL at 8 GHz is -147.5 dBm/Hz.		

Downconverter Gain Accuracy

The PXIe-5603/PXIe-5605 gain accuracy after use of the internal self-calibration factor is the same as the amplitude accuracy specification. The receiver that is used with the PXIe-5603/PXIe-5605 downconverter should have resolution and temperature stability equal to or better than that of the PXIe-5622 digitizer.

Downconverter Conversion Gain

Figure 16. PXIe-5603 Typical Maximum Conversion Gain (Center Frequency <3.6 GHz)

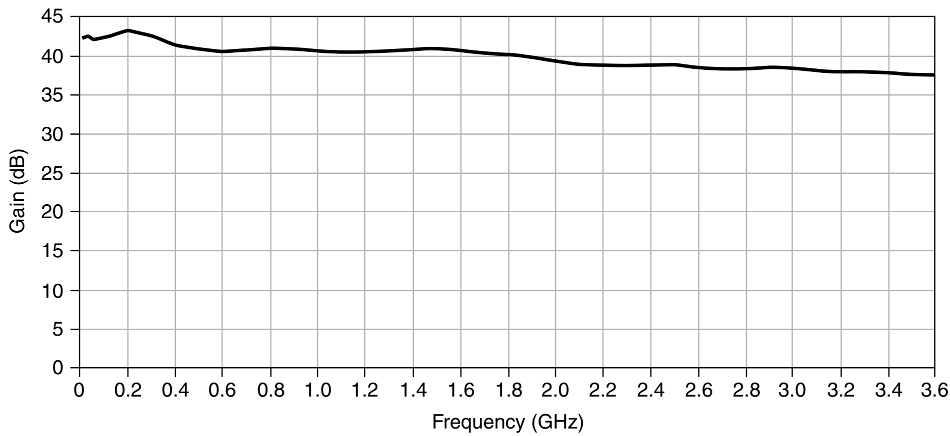


Figure 17. PXIe-5605 Typical Low Band Conversion Gain (Center Frequency <3.6 GHz)

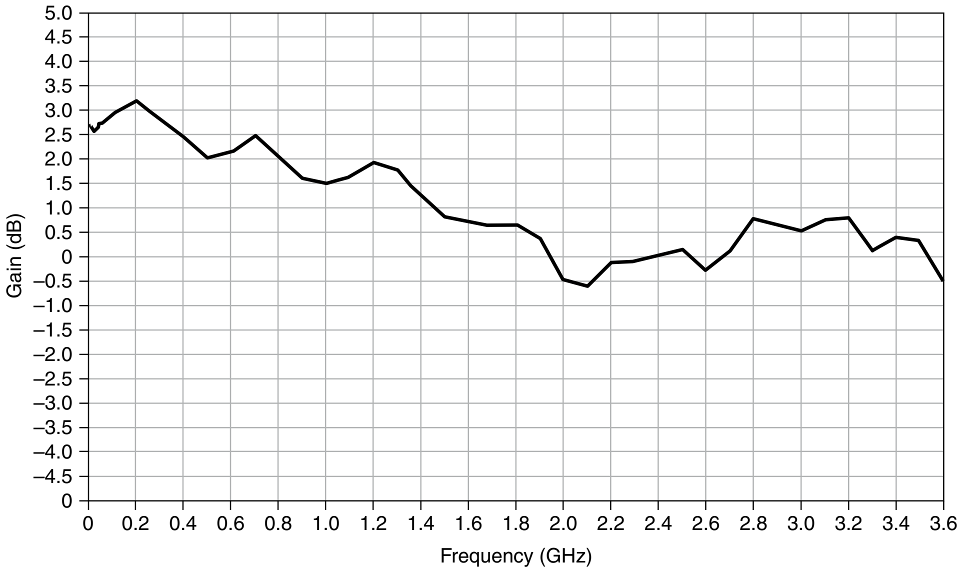
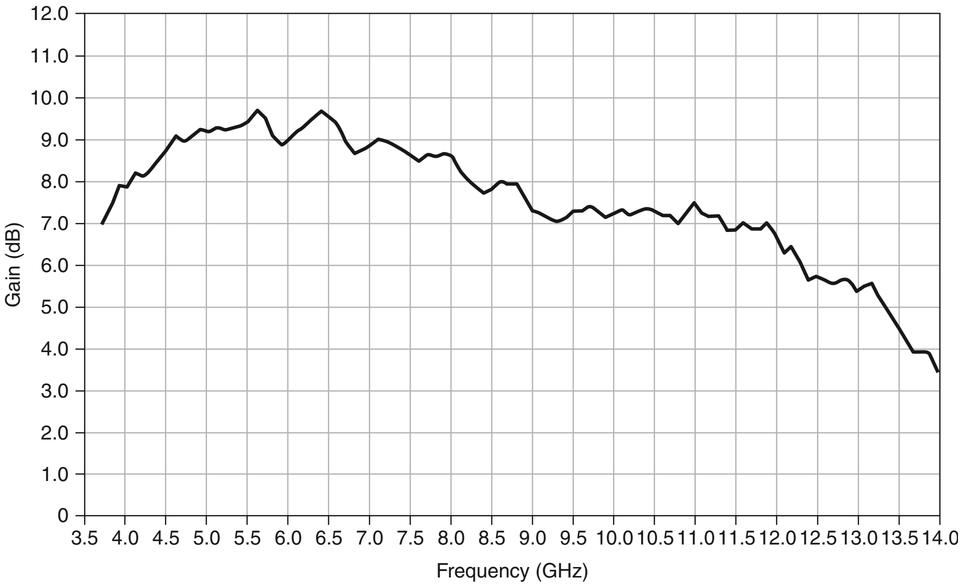


Figure 18. PXIe-5605 Typical High Band Conversion Gain (Center Frequency >3.6 GHz)



Spurious Response Level

The PXIe-5603/PXIe-5605 spurious response level is the same as or better than the PXIe-5665 spurious responses specification when the PXIe-5653 is used as the LO and the Digitizer is used as the digitizer.

Image and IF Rejection

Table 54. PXIe-5665 Image Rejection (23 °C ± 5 °C)

Center Frequency	Image Rejection (dBc)
100 MHz to 2.2 GHz	-89
>2.2 GHz to 3.6 GHz	-87
>3.6 GHz to 14 GHz	-85
Values are based on 0 dBm input signal, 10 dB RF attenuation, 0 dBm reference level, and preamplifier disabled. For center frequencies greater than 3.6 GHz, the preselector is enabled. Specification includes images from all conversions stages.	

The PXIe-5603/PXIe-5605 IF rejection are the same as those specified for the PXIe-5665.

Linearity and Dynamic Range Specifications

The PXIe-5603/PXIe-5605 linearity (TOI, SHI, two tone compression) and dynamic range specifications are the same as or better than the PXIe-5665 linearity and dynamic range specifications.

Measurement Configuration Speed

The PXIe-5603/PXIe-5605 measurement configuration speed specification is the same as or better than the PXIe-5665 measurement speed specification when the PXIe-5653 is used as the LO.

PXIe-5622 IF Digitizer Module Specifications[54]

IF IN

Connector	SMA female
Impedance	50 Ω
Return loss	15 dB (nominal)

PFI 1	
Direction	Bidirectional
Connector	SMB
Impedance (as input)	150 kΩ
CLK IN	
Connector	SMA female
Impedance	50 Ω
Input amplitude, sine wave	0.63 Vpk-pk to 2.8 Vpk-pk (0 dBm to +13 dBm)
Input amplitude, square wave	0.25 Vpk-pk to 2.8 Vpk-pk
Maximum input overload	6.3 Vpk-pk (+20 dBm)
CLK OUT	
Connector	SMA
Output impedance	50 Ω
Output amplitude, 50 Ω load	> +10 dBm
Output amplitude, 1 kΩ load	>2 Vpk-pk

Physical Characteristics

PXIe-5603	3U, Two Slot, PXI Express module 21.6 cm × 4.0 cm × 13.0 cm (8.5 in. × 1.6 in. × 5.1 in.)
PXIe-5605	3U, Four Slot, PXI Express module 21.6 cm × 8.2 cm × 13.0 cm (8.5 in. × 3.2 in. × 5.1 in.)
PXIe-5622	3U, One Slot, PXI Express module 21.6 cm × 2.0 cm × 13.0 cm (8.5 in. × 0.8 in. × 5.1 in.)
PXIe-5653	3U, Two Slot, PXI Express module 21.6 cm × 4.0 cm × 13.0 cm (8.5 in. × 1.6 in. × 5.1 in.)
Weight	
PXIe-5603	907 g (32.0 oz)
PXIe-5605	1,882 g (66.4 oz)

[54] Refer to the *PXIe-5622 Specifications* for detailed information about the digitizer module.

PXIe-5622	376 g (13.3 oz)
PXIe-5653	1,076 g (37.8 oz)
Combined Unit	
PXIe-5665 3.6 GHz VSA	2,359 g (83.1 oz)
PXIe-5665 14 GHz VSA	3,334 g (117.5 oz)

Caution Clean the hardware with a soft, nonmetallic brush. Make sure that the hardware is completely dry and free from contaminants before returning it to service.

Environment

Maximum altitude	2,000 m (800 mbar) (at 25 °C ambient temperature)
Pollution Degree	2

Indoor use only.

Operating Environment

Ambient temperature range	0 °C to 55 °C (Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2. Meets MIL PRF-28800F Class 3 low temperature limit and MIL PRF-28800F Class 2 high temperature limit.)
Relative humidity range	10% to 90%, noncondensing (Tested in accordance with IEC 60068-2-56.)

Storage Environment

Ambient temperature range	-41 °C to +71 °C (Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2. Meets MIL PRF-28800F Class 3 limits.)
Relative humidity range	5% to 95%, noncondensing (Tested in accordance with IEC 60068-2-56.)

Shock and Vibration

Operating shock	30 g peak, half-sine, 11 ms pulse (Tested in accordance with IEC 60068-2-27. Meets MIL-PRF-28800F Class 2 limits.)

Random vibration

Operating	5 Hz to 500 Hz, 0.3 g_{rms} (Tested in accordance with IEC 60068-2-64.)
Nonoperating	5 Hz to 500 Hz, 2.4 g_{rms} (Tested in accordance with IEC 60068-2-64. Test profile exceeds the requirements of MIL-PRF-28800F, Class 3.)

Compliance and Certifications

Safety

This product is designed to meet the requirements of the following electrical equipment safety standards for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA C22.2 No. 61010-1

Note For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Electromagnetic Compatibility

This product meets the requirements of the following EMC standards for electrical equipment for measurement, control, and laboratory use:

- EN 61326-1 (IEC 61326-1): Class A emissions; Basic immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- EN 55022 (CISPR 22): Class A emissions
- EN 55024 (CISPR 24): Immunity
- AS/NZS CISPR 11: Group 1, Class A emissions
- AS/NZS CISPR 22: Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions

Note In the United States (per FCC 47 CFR), Class A equipment is intended for use in commercial, light-industrial, and heavy-industrial locations. In Europe, Canada, Australia, and New Zealand (per CISPR 11), Class A equipment is intended for use only in heavy-industrial locations.

Note Group 1 equipment (per CISPR 11) is any industrial, scientific, or medical equipment that does not intentionally generate radio frequency energy for the treatment of material or inspection/analysis purposes.

Note For EMC declarations, certifications, and additional information, refer to the *Online Product Certification* section.

CE Compliance

This product meets the essential requirements of applicable European Directives, as follows:

- 2014/35/EU; Low-Voltage Directive (safety)
- 2014/30/EU; Electromagnetic Compatibility Directive (EMC)

Online Product Certification

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit *ni.com/certification*, search by model number or product line, and click the appropriate link in the Certification column.

Environmental Management

NI is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial to the environment and to NI customers.

For additional environmental information, refer to the *Minimize Our Environmental Impact* web page at *ni.com/environment*. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)

EU Customers At the end of the product life cycle, all NI products must be disposed of according to local laws and regulations. For more information about how to recycle NI products in your region, visit *ni.com/environment/weee*.

电子信息产品污染控制管理办法（中国 RoHS）

中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令(RoHS)。关于 National Instruments 中国 RoHS 合规性信息，请登录 `ni.com/environment/rohs_china`。(For information about China RoHS compliance, go to `ni.com/environment/rohs_china`.)

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