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PXIe-5601

NI PXIe-5663 Specifications

6.6 GHz RF Vector Signal Analyzer with Digital Downconversion

This document lists specifications for the NI PXIe-5663 RF vector signal analyzer (NI 5663). The NI 5663 comprises the NI PXIe-5601 RF downconverter module, NI PXIe-5622 IF digitizer module, and NI PXI-5652 RF signal generator module (used as an LO source). There is no physical device named “NI PXIe-5663.”

Specifications are warranted under the following conditions:

- 30 minutes warm-up time
- Calibration cycle maintained
- Chassis fan speed set to High
- NI-RFSA instrument driver used
- NI-RFSA instrument driver self-calibration performed after instrument temperature is stable
- Module locked to the PXI backplane
- NI 5601 module revision G or later

Specifications describe the warranted, traceable product performance over ambient temperature ranges of 0 °C to 55 °C, unless otherwise noted.

Typical values describe useful product performance beyond specifications that are not covered by warranty and do not include guardbands for measurement uncertainty or drift. Typical values may not be verified on all units shipped from the factory. Unless otherwise noted, typical values cover the expected performance of units over ambient temperature ranges of 23 °C $\pm$ 5 °C with a 90% confidence level, based on measurements taken during development or production.

Nominal values (or supplemental information) describe additional information about the product that may be useful, including expected performance that is not covered under *Specifications* or *Typical* values. Nominal values are not covered by warranty.

Specifications are subject to change without notice. For the most recent NI 5663 specifications, visit ni.com/manuals.



Hot Surface If the NI 5663 has been in use, the device or the shield may exceed safe handling temperatures and may cause burns. Allow the NI 5663 to cool before touching the shield or removing the device from the chassis.

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Frequency

Frequency range¹ 10 MHz to 6.6 GHz

Tuning resolution 533 nHz

Bandwidth

Equalized Bandwidth

Tuned Frequency	Equalized Bandwidth
10 MHz to <120 MHz	10 MHz
120 MHz to <330 MHz	20 MHz
330 MHz to 6.6 GHz	50 MHz
Note: Using automatic calibration correction through the NI-RFSA instrument driver.	

¹ The NI 5663 is operational to 1 MHz. The maximum tuned frequency = 6.6 GHz – ½ (frequency span).

Resolution Bandwidth

3 dB bandwidth.....Fully adjustable
(<1 Hz to 10 MHz)

Selectivity	
Window	60 dB : 3 dB Ratio
Flat Top	2.5, maximum
7-term Blackman-Harris	4.1, maximum
Note: The NI-RFSA instrument driver also supports additional window types.	

Frequency Reference

Refer to the *NI PXI-565X RF Signal Generator Specifications* for more information about frequency reference.

Internal Frequency Reference

Frequency10 MHz

Temperature stability $\pm 1 \times 10^{-6}$, maximum
(15 to 35°C)

Aging per year $\pm 5 \times 10^{-6}$, maximum

Initial achievable accuracy $\pm 3 \times 10^{-6}$, maximum

External Frequency Reference Input

Frequency10 MHz ($\pm 10 \times 10^{-6}$)

Amplitude0.2 V_{pk-pk} to 1.5 V_{pk-pk} into 50 Ω

Input impedance50 Ω

Lock time to external reference1 s, maximum

Spectral Purity

Phase Noise

Single Sideband (SSB) Phase Noise	
Tuned Frequency	Noise Density
100 MHz	<-125 dBc/Hz
500 MHz	<-112 dBc/Hz
1 GHz	<-105 dBc/Hz
2 GHz	<-98 dBc/Hz
3 GHz	<-95 dBc/Hz
4 GHz	<-93 dBc/Hz
5 GHz	<-90 dBc/Hz
6.6 GHz	<-90 dBc/Hz
Note: 10 kHz offset; measured using NI 5652 with internal Reference clock.	

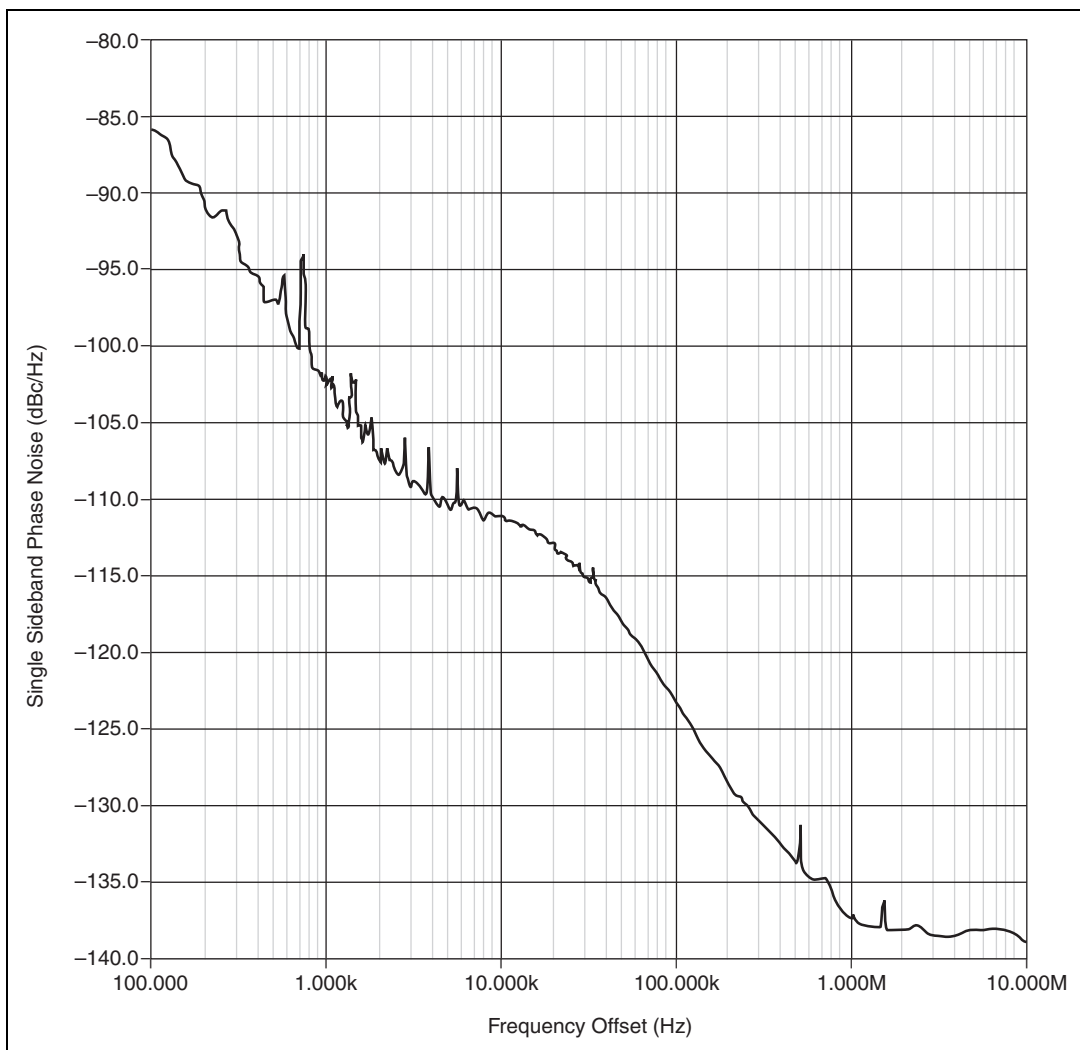


Figure 1. Typical Phase Noise at 1 GHz

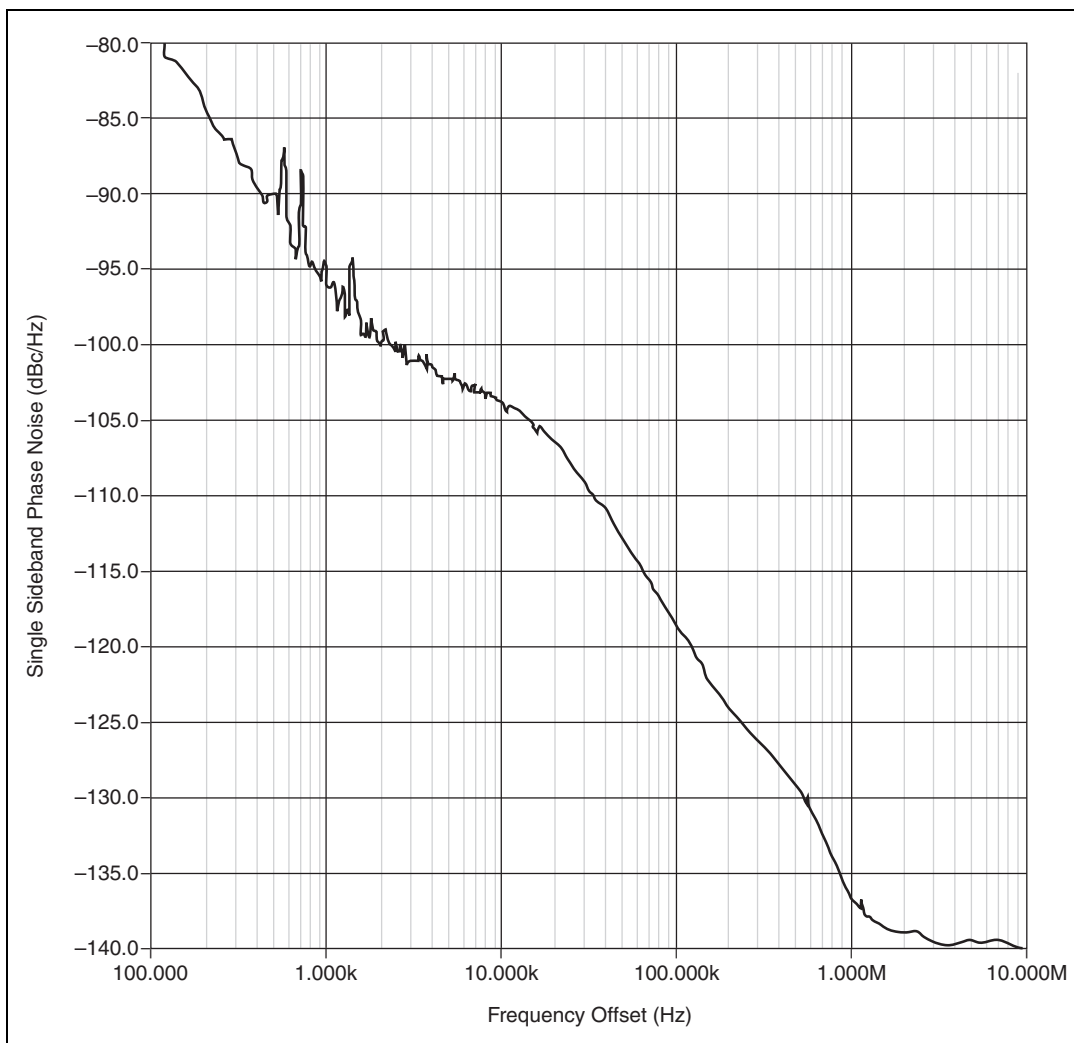


Figure 2. Typical Phase Noise at 2.4 GHz

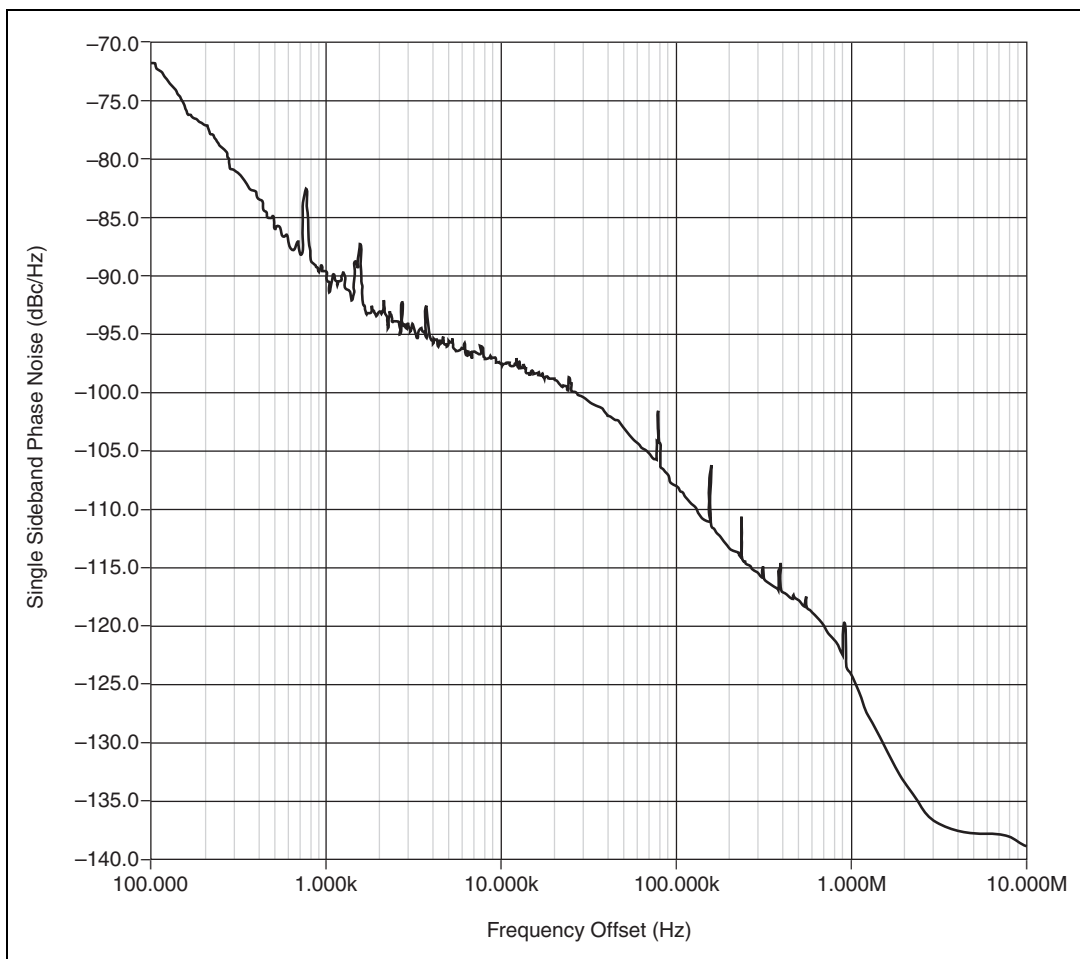


Figure 3. Typical Phase Noise at 5.8 GHz

Amplitude

Range

Amplitude range..... *Average Noise Level* to +30 dBm

RF input attenuation..... 0 dB to 50 dB in 1 dB steps,
nominal

Average Noise Level

Frequency	23 °C ± 5 °C	0 °C to 55 °C
10 MHz to <30 MHz	<–155 dBm/Hz <–157 dBm/Hz, typical	<–154 dBm/Hz <–156 dBm/Hz, typical
30 MHz to <120 MHz	<–159 dBm/Hz <–163 dBm/Hz, typical	<–158 dBm/Hz <–162 dBm/Hz, typical
120 MHz to <3 GHz	<–155 dBm/Hz <–158 dBm/Hz, typical	<–154 dBm/Hz <–157 dBm/Hz, typical
3.0 GHz to <5.0 GHz	<–153 dBm/Hz <–156 dBm/Hz, typical	<–152 dBm/Hz <–155 dBm/Hz, typical
5.0 GHz to 6.6 GHz	<–151 dBm/Hz <–154 dBm/Hz, typical	<–150 dBm/Hz <–153 dBm/Hz, typical
Notes: Input terminated; no input signal; 0 dB RF attenuation; –10 dBm reference level at frequencies <100 MHz, –50 dBm reference level elsewhere.		

Absolute Accuracy

Frequency	Accuracy	
	23 °C ± 5 °C	0 °C to 55 °C*
10 MHz to <120 MHz	±2.2 dB ±1.4 dB, typical	±2.3 dB ±1.5 dB, typical
120 MHz to < 400 MHz	±1.7 dB ±0.65 dB, typical	±1.8 dB ±0.75 dB, typical
400 MHz to < 3.0 GHz	±1.6 dB ±0.65 dB, typical	±1.8 dB ±0.75 dB, typical
3.0 GHz to < 5.5 GHz	±1.7 dB ±0.65 dB, typical	±1.8 dB ±0.75 dB, typical
5.5 GHz to 6.6 GHz	±1.6 dB ±0.65 dB, typical	±2.0 dB ±1.0 dB, typical
Notes: RF attenuation ≥8 dB; signal-to-noise ratio ≥20 dB. * Using automatic calibration correction of the NI-RFSA instrument driver, within ±5 °C of a self calibration by the niRFSA Self Cal VI or the niRFSA_SelfCal function.		

Spurious Responses

The single downconversion stage architecture does not provide RF image rejection.

IF Rejection¹

(Typical)

Tuned Frequency	Interference Frequency	Level
10 MHz to <120 MHz	187.5 MHz	<–75 dBc
120 MHz to <330 MHz	53 MHz	<–52 dBc
330 MHz to 6.6 GHz	187.5 MHz	<–52 dBc
Notes: –30 dBm input signal; –30 dBm reference level; 0 dB attenuation.		

¹ IF rejection is the suppression of an input signal at the IF frequency when the vector signal analyzer is tuned elsewhere.

Non-Input-Related Spurs (Residual Spurs)¹

10 MHz to 6.6 GHz² <–100 dBm, typical

Sideband Spurs³

(Typical)

>1 kHz to ≤ 100 kHz Offset

Tuned Frequency	Level
10 MHz to <3.3 GHz	<–65 dBc
3.3 GHz to 6.6 GHz	<–50 dBc
Notes: 0 dBm input level; 0 dBm reference level; automatic attenuation settings.	

>100 kHz Offset

Tuned Frequency	Level
10 MHz to <50 MHz	<–75 dBc
50 MHz to <3.3 GHz	<–70 dBc
3.3 GHz to 6.6 GHz	<–65 dBc
Notes: 0 dBm input level; 0 dBm reference level; automatic attenuation settings.	

Input-Related Spurs

(Typical)

RF Frequency	Level
10 MHz to <120 MHz	–70 dBc
120 MHz to <330 MHz	–50 dBc
330 MHz to <410 MHz	–35 dBc
410 MHz to <3.3 GHz	–65 dBc
3.3 GHz to 6.6 GHz	–50 dBc
Notes: 0 dB input level; 0 dBm reference level; automatic attenuation settings.	

¹ Residual responses are the responses observed when no input signal is present.

² Input terminated; no input signal; 0 dB attenuation; ≤–60 dBm reference level; does not include LO leakage.

³ Sideband spurs are due to system operation and appear on signals being observed.

LO Leakage¹

(Typical)

RF Input Port

RF Frequency	Level
10 MHz to <3.0 GHz	<−60 dBm
3.0 GHz to 6.6 GHz	<−55 dBm
Notes: 0 dB attenuation; −30 dBm reference level.	

Linearity

Third-Order Intermodulation Distortion (Input IP₃ (IIP₃))

(Typical)

−20 dBm Reference Level	
Frequency Range	Input IP ₃
10 MHz to <30 MHz	≥5 dBm
30 MHz to <330 MHz	≥7 dBm
330 MHz to <3.0 GHz	≥12 dBm
3.0 GHz to 6.6 GHz	≥9 dBm
Note: Two −24 dBm input tones = 200 kHz apart.	

0 dBm Reference Level	
Frequency Range	Input IP ₃
10 MHz to <30 MHz	≥21 dBm
30 MHz to <330 MHz	≥18 dBm
330 MHz to <3.0 GHz	≥21 dBm
3.0 GHz to 6.6 GHz	≥21 dBm
Note: Two −4 dBm input tones = 200 kHz apart.	

¹ LO leakage is the local oscillator signal that appears at the RF input port.

Dynamic Range¹

Dynamic Range (Noise and Third-Order Intermodulation Distortion (IMD3))

(Nominal)

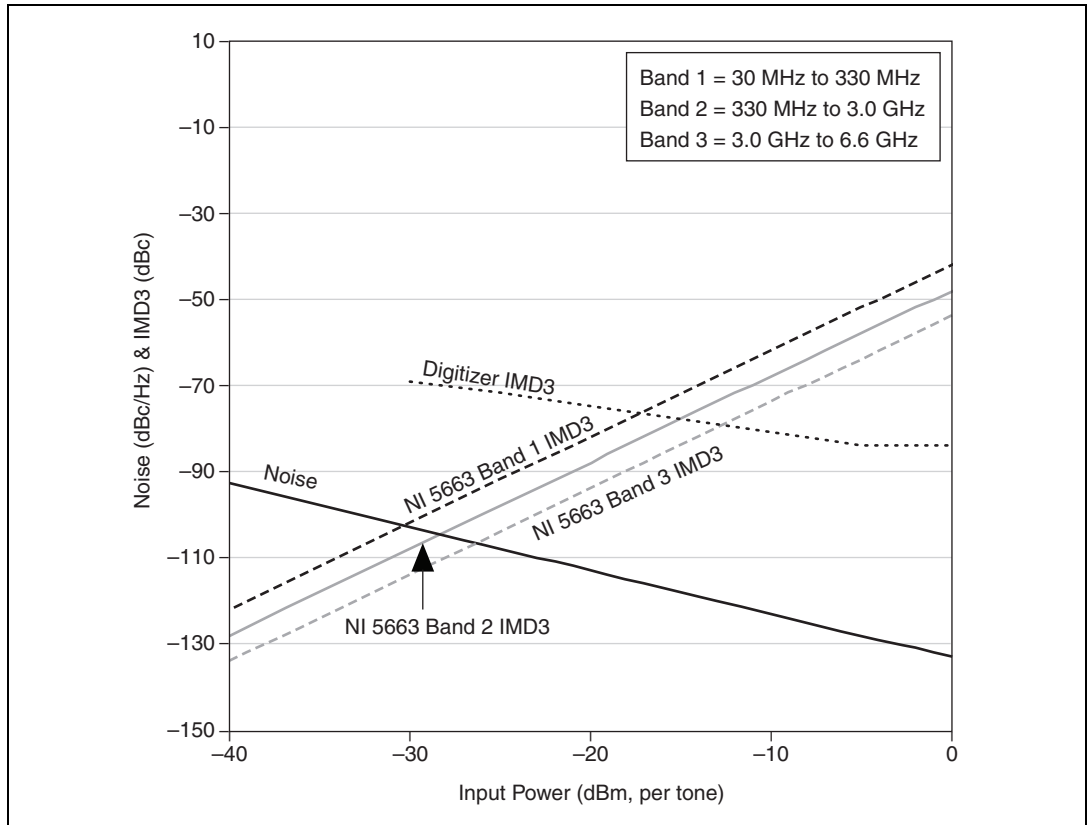


Figure 4. NI 5663 Vector Signal Analyzer Nominal Dynamic Range, 0 dBm Reference Level

¹ Reference level allows 10 dB headroom for single-tone input signals before digitizer clipping occurs.

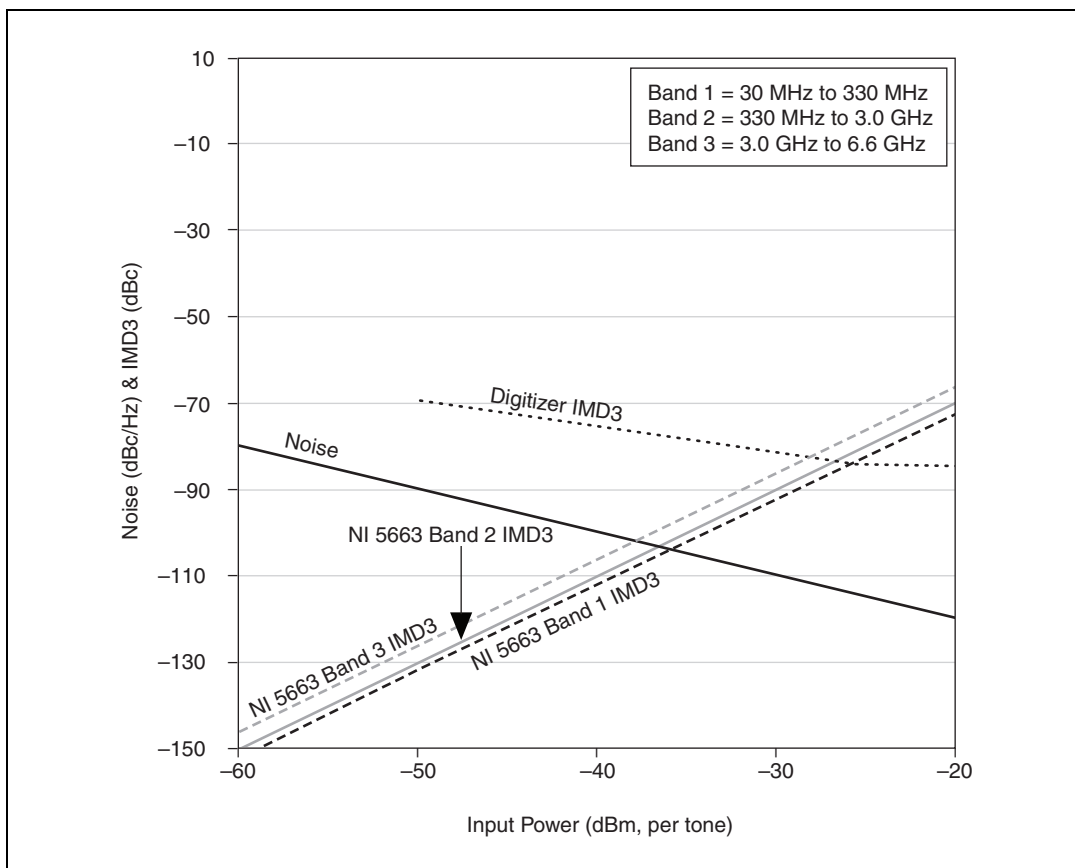


Figure 5. NI 5663 Vector Signal Analyzer Nominal Dynamic Range, -20 dBm Reference Level

The dynamic range plots in the two preceding figures show nominal performance with NI-RFSA automatic coupled settings that are optimized for noise performance. If you use the RF attenuation manual settings, IMD3 performance can improve with minimal degradation in noise floor, thus increasing the effective SFDR in the power per tone signal range of -10 dB to 0 dB below reference level.

Modulation

IF Flatness

(Typical)

IF Amplitude Flatness, 23 °C ± 5 °C		
Tuned Frequency	Bandwidth	Amplitude Flatness
10 MHz to <75 MHz	5 MHz	±0.25 dB
	10 MHz	±0.3 dB
75 MHz to <120 MHz	5 MHz	±0.4 dB
	10 MHz	±0.6 dB
120 MHz to <140 MHz	5 MHz	±0.45 dB
	10 MHz	±0.65 dB
	20 MHz	±0.9 dB
140 MHz to <330 MHz	5 MHz	±0.2 dB
	10 MHz	±0.4 dB
	20 MHz	±0.5 dB
330 MHz to <6.6 GHz	10 MHz	±0.2 dB
	20 MHz	±0.35 dB
	50 MHz	±0.60 dB
Notes: RF attenuation ≥8 dB, 18 °C to 28 °C, with calibration correction; bandwidth centered about tuned frequency. <i>Typical</i> represents the worst ripple expected for <i>any</i> reference level setting across the specified frequency range.		

IF Amplitude Flatness, 0 °C to 55 °C		
Tuned Frequency	Bandwidth	Amplitude Flatness
10 MHz to <75 MHz	5 MHz	±0.3 dB
	10 MHz	±0.45 dB
75 MHz to <120 MHz	5 MHz	±0.35 dB
	10 MHz	±0.6 dB
120 MHz to <140 MHz	5 MHz	±0.55 dB
	10 MHz	±0.85 dB
	20 MHz	±1.1 dB
140 MHz to <330 MHz	5 MHz	±0.35 dB
	10 MHz	±0.8 dB
	20 MHz	±0.8 dB
330 MHz to <6.6 GHz	10 MHz	±0.25 dB
	20 MHz	±0.4 dB
	50 MHz	±0.7 dB
Notes: RF attenuation ≥8 dB, 0 °C to 55 °C, with calibration correction; bandwidth about tuned frequency. <i>Typical</i> represents the worst ripple expected for <i>any</i> reference level setting across the specified frequency range.		

IF Phase Linearity

(Typical)

Tuned Frequency	Bandwidth	Maximum Phase Deviation*
10 MHz to <120 MHz	10 MHz	±3.0 degrees
120 MHz to <330 MHz	10 MHz	±1.5 degrees
	20 MHz	±5.0 degrees
330 MHz to 6.6 GHz	10 MHz	±1.0 degree
	20 MHz	±2.0 degrees
	40 MHz	±3.0 degrees
	50 MHz	±4.5 degrees
* Measured at 23 °C ambient temperature.		

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

(Nominal)

Data length in the following three tables is 1,250 symbols pseudorandom bit sequence (PRBS) at –30 dBm power level. These results were obtained using the NI 5663 onboard clock (the NI 5652 LO source onboard clock) and do not include software equalization using the NI Modulation Toolkit. Results are the composite effect of both the NI 5663 and the NI 5673 RF vector signal generator.

825 MHz Carrier Frequency				
QAM Order	Symbol Rate (kS/s)	α_{RRC}	EVM (% RMS)	MER (dB)
M = 4	160	0.25	0.3	52
	800	0.25	0.4	49
	4,090	0.22	0.5	46
M = 16	17,600	0.25	0.7	41
	32,000	0.25	1.0	37
M = 64	5,360	0.15	0.4	44
	6,952	0.15	0.5	43
	40,990	0.22	1.1	35
M = 256	6,952	0.15	0.4	43

3.4 GHz Carrier Frequency				
QAM Order	Symbol Rate (kS/s)	α_{RRC}	EVM (% RMS)	MER (dB)
M = 4	160	0.25	0.65	44
	800	0.25	0.65	44
	4,090	0.22	0.74	43
M = 16	17,600	0.25	1.13	36
	32,000	0.25	1.94	32
M = 64	5,360	0.15	0.59	41
	6,952	0.15	0.66	40
	40,990	0.22	2.15	30
M = 256	6,952	0.15	0.64	40

5.8 GHz Carrier Frequency				
QAM Order	Symbol Rate (kS/s)	α_{RRC}	EVM (% RMS)	MER (dB)
M = 4	160	0.25	0.89	41
	800	0.25	0.85	41
	4,090	0.22	1.04	40
M = 16	17,600	0.25	1.49	34
	32,000	0.25	2.00	31
M = 64	5,360	0.15	0.83	38
	6,952	0.15	0.90	37
	40,990	0.22	2.06	30
M = 256	6,952	0.15	1.00	36

Measurement Speed

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

Frequency Settling Time¹

(Nominal)

Accuracy	Frequency Settling Time*
0.1×10^{-6} of final frequency	1.5 ms
0.01×10^{-6} of final frequency	6.5 ms
*Typical for tuning between any two frequencies. Settling time can be reduced using a wide downconverter loop bandwidth.	

Amplitude Settling Time¹

(Nominal)

Accuracy	Amplitude Settling Time
0.1 dB of final amplitude	62.5 μ s*, 1.2 ms
*Mechanical attenuator not used.	

Tuning Time

(Nominal)

Accuracy	Tuning Time*	
	Narrow Loop Bandwidth	Wide Loop Bandwidth
0.1×10^{-6} of final frequency, 0.1 dB of final amplitude	7.0 ms	3.7 ms
0.01×10^{-6} of final frequency, 0.1 dB of final amplitude	14.1 ms	10.0 ms
*Typical for tuning between any two frequencies.		

¹ Frequency and amplitude settling times partially overlap.

Analysis Time vs. Span

(Nominal)

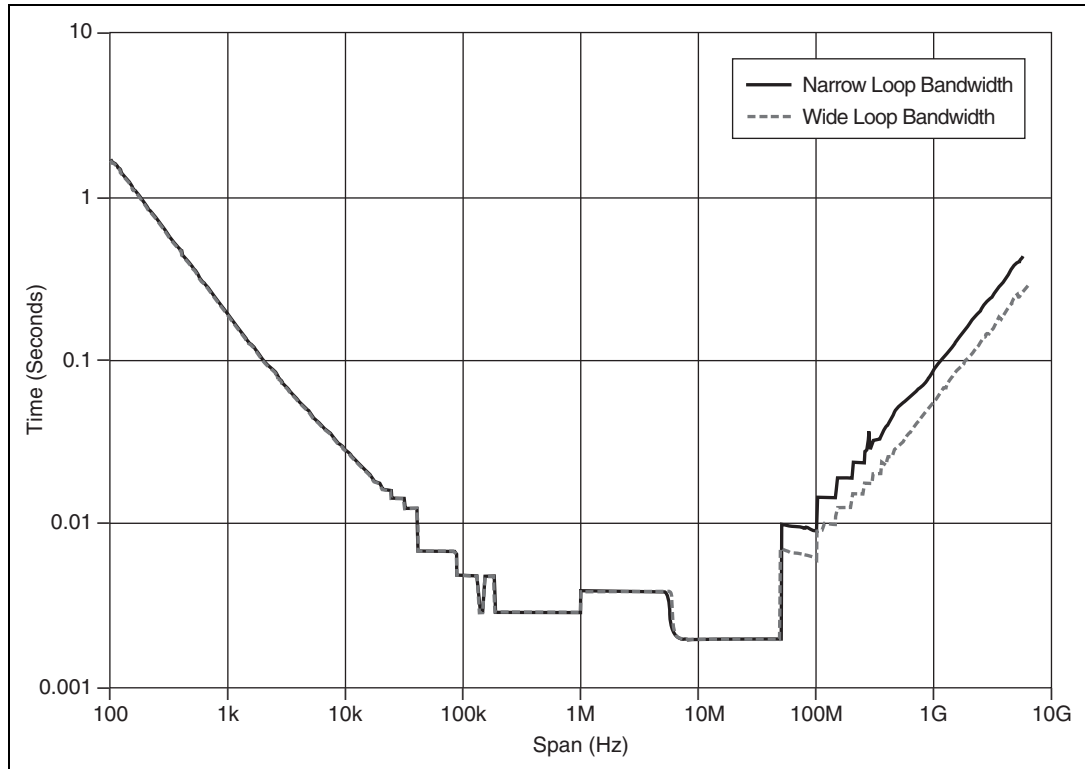


Figure 6. NI 5663 Measurement Time

Analysis Time vs. Span was measured with a tuned frequency ≥ 330 MHz. Below 1 MHz span, 190 frequency points were measured; above 1 MHz span, 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.

Data Streaming¹

(Nominal)

Maximum continuous transfer rate.....300 MB/s

¹ Refer to the *NI PXIe-5622 Specifications* for more information about data streaming. Data streaming specification measured using the NI PXIe-1065 chassis and the NI PXIe-8130 controller. Performance is system dependent.

Input and Output Characteristics

(Nominal)

IF/Baseband

(NI 5622 IF digitizer)

Resolution	16 bits
System IF frequency range	187.5 MHz $\pm$ 25 MHz ¹ or 53 MHz $\pm$ 10 MHz ²
Sample rate.....	150 MS/s
Digital downconverter (OSP) bandwidth.....	Adjustable between 60 MHz and 0.9 kHz using 150 MS Sample clock timebase. ³
Onboard memory	64 MB 256 MB



Note Refer to the *NI PXIe-5622 Specifications* document for additional IF/baseband and onboard signal processing (OSP) specifications.

NI 5601 RF Downconverter Module

RF IN

Connector	SMA female
Impedance	50 Ω , nominal
Coupling.....	AC
Maximum safe DC input voltage....	$\pm$ 5 V, nominal

Maximum Safe Continuous RF Power

RF Attenuation	Level
Enabled ($\geq$ 8 dB)	+30 dBm
Disabled (0 dB)	+20 dBm

¹ When input RF frequency is $\geq$ 10 MHz to <120 MHz, and $\geq$ 330 MHz to 6.6 GHz.

² When input RF frequency is $\geq$ 120 MHz to <330 MHz.

³ The OSP bandwidth is 0.4 times the sample rate in real acquisition mode, where sample rate varies between 150 MS/s to 2.289 kS/s.

(Nominal)

*Available in 1 dB steps.

Connector	SMA female
Impedance	50 Ω , nominal
Coupling	AC
Amplitude	4 dBm, digitizer full-scale, -6 dBm, nominal, with reference level input
Maximum IF output level	+23 dBm
Maximum reverse power level	+20 dBm
Maximum safe DC voltage	± 5 V
IF center frequency	53 MHz, 187.5 MHz ¹ , or Bypass ² , nominal

53 MHz.....	2.1:1
187.5 MHz.....	1.65:1
Bypass	1.4:1 ²

² 10 MHz to 300 MHz

LO IN and LO OUT

Connector	SMA female
Impedance	50 Ω , nominal
Coupling	AC
Frequency	173 MHz to 6.4125 GHz, nominal
Amplitude	0 dBm, nominal, input and output
Maximum safe RF input level	+20 dBm
Maximum reverse power level	+20 dBm
Maximum safe DC voltage	± 5 V
LO input to output noise figure	15 dB, nominal

NI 5622 IF Digitizer Module

IF IN

Connector	SMA female
Impedance	50 Ω

PFI 1

Connector	SMB
Impedance	150 k Ω

CLK IN

Connector	SMA female
Impedance	50 Ω
Input amplitude, sine wave	0.63 V _{pp} to 2.8 V _{pp} (0 dBm to +13 dBm)
Input amplitude, square wave	0.25 V _{pp} to 2.8 V _{pp}
Maximum input overload	6.3 V _{pp} (+20 dBm)

CLK OUT

Connector	SMA
Output impedance	50 Ω
Output amplitude, 50 Ω load	>+10 dBm
Output amplitude, 1 k Ω load	>2 V _{pp}

NI 5652 LO Source Module

RF OUT

ConnectorSMA Female
Impedance.....50 Ω

REF IN/OUT

ConnectorSMA Female
Impedance.....50 Ω
Input amplitude.....-5 dBm to +15 dBm
Maximum safe input level.....+16 dBm
Maximum DC input voltage.....±5 V
Input frequency range.....10 MHz ±100 Hz

Power Requirements

(Nominal)

Module	+3.3 VDC	+5 VDC	+12 VDC	-12 VDC
NI 5601 RF downconverter	640 mA	—	740 mA	—
NI 5622 IF digitizer	1.75 A	—	2.25 A	—
NI 5652 LO source	500 mA	700 mA	550 mA	90 mA
Note: Voltages ±5%.				

Calibration

Interval.....1 year for NI 5601, NI 5622,
NI 5652

Hardware Front Panels

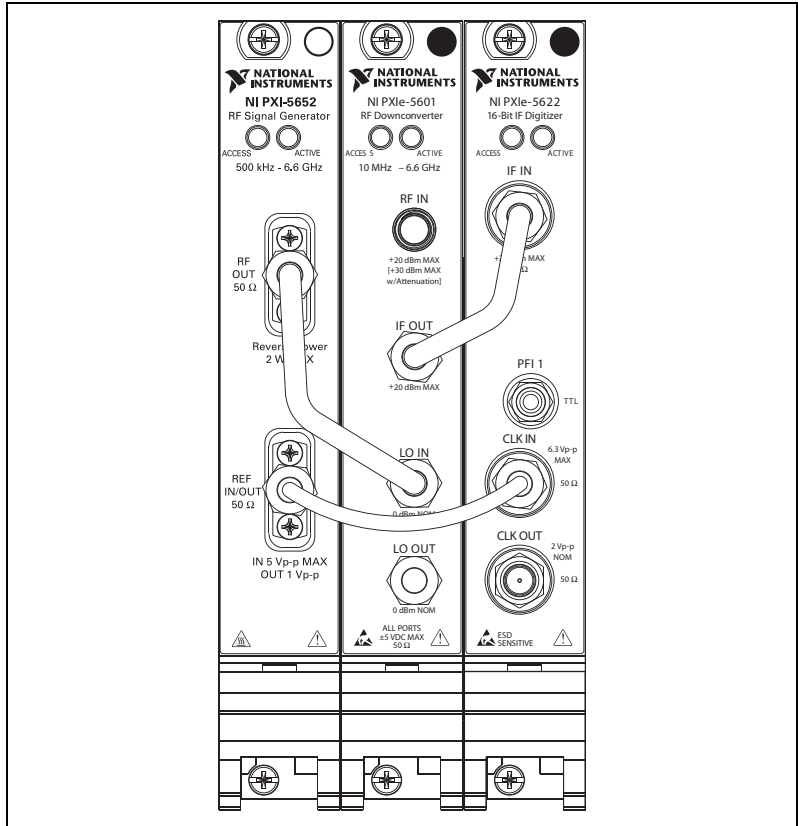


Figure 7. NI 5663 Front Panels

Physical Dimensions

NI 5601 (1 PXIe slot)	3U, One Slot, PXI Express module 21.6 cm × 2.0 cm × 13.0 cm (8.5 in. × 0.8 in. × 5.1 in.)
NI 5622 (1 PXIe slot)	3U, One Slot, PXI Express module 21.6 cm × 2.0 cm × 13.0 cm (8.5 in. × 0.8 in. × 5.1 in.)
NI 5652 (1 PXI slot)	3U, One Slot, PXI/cPCI module 21.6 cm × 2.0 cm × 13.0 cm (8.5 in. × 0.8 in. × 5.1 in.)
Weight	
NI 5601	454 g (16.0 oz)
NI 5622	376 g (13.3 oz)
NI 5652	415 g (14.6 oz)
Combined unit	1,245 g (43.9 oz)

Environmental

Specifications in this document are guaranteed under the following specified environmental conditions unless otherwise stated.	
Altitude	0 m to 2,000 m (at 25 °C ambient temperature)
Pollution Degree	2
Indoor use only.	

Operating Environment

Warm-up time	30 minutes
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}
Non-operating	5 Hz to 500 Hz, 2.4 g _{rms} (Tested in accordance with IEC 60068-2-64. Nonoperating test profile exceeds the requirements of MIL PRF-28800F, Class 3.)

Safety, Electromagnetic Compatibility, and CE Compliance

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

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1



Note For UL and other safety certifications, refer to the product label or visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

Electromagnetic Compatibility

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

- EN 61326 EMC requirements; Minimum Immunity
- EN 55011 Emissions; Group 1, Class A
- CE, C-Tick, ICES, and FCC Part 15 Emissions; Class A



Note For EMC compliance, operate this device according to product documentation.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)



Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain 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 not only to the environment but also to NI customers.

For additional environmental information, refer to the *NI and the Environment* 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 their life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit ni.com/environment/weee.htm.

电子信息产品污染控制管理办法（中国 RoHS）



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