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DEVICE SPECIFICATIONS

NI PXI-5660

RF Vector Signal Analyzer

This document lists specifications for the NI PXI-5660 (NI 5660) RF vector signal analyzer.

Specifications are warranted under the following conditions:

- 20 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.

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 15 °C to 35 °C with a 90% confidence level, based on measurements taken during development or production.

Specifications are subject to change without notice. For the most recent NI 5660 specifications, visit *ni.com/manuals*.

To access NI 5660 documentation, navigate to **Start»All Programs»National Instruments»NI-RFSA»Documentation**.

Note The published RF vector signal analyzer specifications assume use of the included cables. Substituting different cables may affect performance.

Hot Surface If the NI 5660 has been in use, it may exceed safe handling temperatures and cause burns. Allow the NI 5660 to cool before removing it from the chassis.

NATIONAL INSTRUMENTS

Contents

Ports

RF	1
IF output	1

Frequency Characteristics

Frequency range	9 kHz to 2.7 GHz
Instantaneous bandwidth	20 MHz
Resolution bandwidth	Fully adjustable (<1 Hz to 10 MHz)

Table 1. Selectivity

Window	60 dB : 3 dB Ratio
Flat Top	2.5, maximum
7-term Blackman-Harris	4.1, maximum

Table 2. Hardware Tuning Resolution

Hardware Module	Resolution
NI 5620 digitizer	0.015 Hz
NI 5600 downconverter	1 MHz, minimum

Table 3. NI 5600 Downconverter Tuning Speed (15 °C to 35 °C)

Accuracy	Settling Time
1% of step size	10 ms, maximum
0.01% of step size	20 ms, maximum
0.0001% of step size	30 ms, maximum

Internal Frequency Reference

Frequency	10 MHz
Temperature stability	±20 ppb, maximum (referenced to 25 °C)
Aging	
Per year	±100 ppb, maximum
Per day	±1 ppb after 72 hours
Initial achievable accuracy	±50 ppb, maximum
Locking range	±0.5 ppm, minimum
Lock time for the NI 5600 (to external reference)	10 s, maximum

Spectral Purity

Table 4. Phase Noise

Offset Frequency	Noise Density
1 kHz	-80 dBc/Hz, maximum
10 kHz	-90 dBc/Hz, maximum
30 kHz	-95 dBc/Hz, maximum
100 kHz	-110 dBc/Hz, maximum
1 MHz	-120 dBc/Hz, maximum
Note 100 MHz carrier, minimum.	

Residual FM 10 Hz_{pk-pk} in 10 ms, maximum

Spurious Responses

Table 5. Sideband Spurs

Offset Frequency	Level
≥10 kHz	-70 dBc, maximum
< 10 kHz	-55 dBc, maximum
Note -30 dBm input signal; 0 dB attenuation.	

Table 6. Second-Order Harmonic Distortion (Input IP_2)

Input Signal	Distortion[1, 2]	Mixer Input IP_2[3]
<120 MHz	-77 dBc, typical	42 dBm, typical
120 MHz to <400 MHz	-78 dBc, maximum	42 dBm, minimum
	-81 dBc. typical	45 dBm, typical

[1] Measurements performed with a single CW tone, -26 dBm at the RF input. Reference level set to -20 dBm and mixer level set to -30 dBm (RF attenuation = 10 dB).
[2] Above 35 °C, add an additional amplitude variation of 1 dB to the maximum *Distortion* levels.
[3] Calculated from *Distortion* levels.

Table 6. Second-Order Harmonic Distortion (Input IP_2) (Continued)

Input Signal	Distortion[1, 2]	Mixer Input IP_2[3]
400 MHz to <800 MHz	-70 dBc, maximum	34 dBm, minimum
	-75 dBc, typical	39 dBm, typical
800 MHz to <1.1 GHz	-74 dBc, maximum	38 dBm, minimum
	-80 dBc, typical	44 dBm, typical
1.1 GHz to <1.25 GHz	-70 dBc, maximum	34 dBm, minimum
	-74 dBc, typical	38 dBm, typical
1.25 GHz to 1.35 GHz	-65 dBc, maximum	28 dBm, minimum
	-71 dBc, typical	35 dBm, typical
>1.35 GHz[4]	—	—

Table 7. Third-Order Intermodulation Distortion (Input IP_3)

Input Signal	Distortion	Mixer Input IP_3
10 MHz to 1 GHz	-80 dBc, maximum	10 dBm, minimum
1 GHz to 2 GHz	-84 dBc, maximum	12 dBm, minimum
2 GHz to 2.7 GHz	-86 dBc, maximum	13 dBm, minimum

Note Mixer level -30 dBm; two -30 dBm input tones, ≥200 kHz apart.

Table 8. Input-Related Spurs

Frequency	Level
≥5 MHz	-70 dBc, maximum
<5 MHz	-60 dBc, maximum

Note -30 dBm input signal; 0 dB attenuation.

1 Measurements performed with a single CW tone, -26 dBm at the RF input. Reference level set to -20 dBm and mixer level set to -30 dBm (RF attenuation = 10 dB).
2 Above 35 °C, add an additional amplitude variation of 1 dB to the maximum *Distortion* levels.
3 Calculated from *Distortion* levels.
4 Frequencies above 1.35 GHz produce a second harmonic distortion outside the specified tuning frequency range of the device.

Table 9. Residual Spurs

Frequency	Level
≥12 MHz	-100 dBm, maximum
<12 MHz	-70 dBm, maximum

Note Input terminated; no input signal; 0 dB attenuation.

Table 10. Noise Density

Frequency	Averaged Noise Level
20 MHz to 1 GHz	-135 dBm/Hz, maximum
	-140 dBm/Hz, typical
1 GHz to 2 GHz	-134 dBm/Hz, maximum
	-137 dBm/Hz, typical
2 GHz to 2.5 GHz	-130 dBm/Hz, maximum
	-135 dBm/Hz, typical
2.5 GHz to 2.7 GHz	-129 dBm/Hz, maximum
	-132 dBm/Hz, typical

Note Input terminated; no input signal; 0 dB attenuation.

Amplitude Specifications

Input Levels

Amplitude range < *Averaged Noise Level* to +30 dBm

Table 11. Maximum Safe Continuous RF Power

RF Attenuation	Level
Enabled (≥10 dB)	+30 dBm
Disabled (0 dB)	+20 dBm

RF input attenuation 0 dB to 50 dB in 10 dB steps

Accuracy

Table 12. Relative Accuracy

Frequency	Accuracy
25 MHz to 2 GHz	±0.75 dB
	±0.5 dB, typical
>2 GHz	±1.25 dB
	±0.9 dB, typical

Note With respect to 100 MHz; 15 °C to 35 °C, with calibration correction.

Table 13. Absolute Accuracy

Frequency	Accuracy
25 MHz to 2 GHz	±1 dB
	±0.6 dB, typical
>2 GHz	±1.5 dB
	±1 dB, typical

Note 15 °C to 35 °C, with calibration correction.

Group Delay Variation (15 °C to 35 °C)

20 MHz bandwidth ±15 ns, maximum (30 $ns_{pk\text{-}pk}$)

Linearity (NI PXI-5600 Downconverter Only)[5]

Table 14. Mixer 1 dB Gain Compression Point

Frequency	1 dB Compression Point
10 MHz to 1 GHz	0 dBm, minimum
1 GHz to 2 GHz	2 dBm, minimum

Table 14. Mixer 1 dB Gain Compression Point (Continued)

Frequency	1 dB Compression Point
2 GHz to 2.7 GHz	4 dBm, minimum

Note At RF input port, 0 dB RF attenuation.

Dynamic Range (NI PXI-5600 Downconverter Only)[6]

Table 15. Compression (1 dB) to Noise Dynamic Range (DR)

Frequency	Compression-Noise DR
10 MHz to 1 GHz	135 dB, minimum
1 GHz to 2 GHz	136 dB, minimum
2 GHz to 2.7 GHz	134 dB, minimum

Note Resolution bandwidth = 1 Hz; 0 dB RF attenuation.

Table 16. Maximum Intermodulation Distortion (SFDR) Dynamic Range (DR)

Frequency	Intermodulation DR
10 MHz to 1 GHz	96 dB, minimum
1 GHz to 2 GHz	97 dB, minimum
2 GHz to 2.7 GHz	95 dB, minimum

Note $2/3 \times (IP_3$ - *Averaged Noise Level*); resolution bandwidth = 1 Hz; mixer level = -30 dBm.

Table 17. Second Harmonic[7]

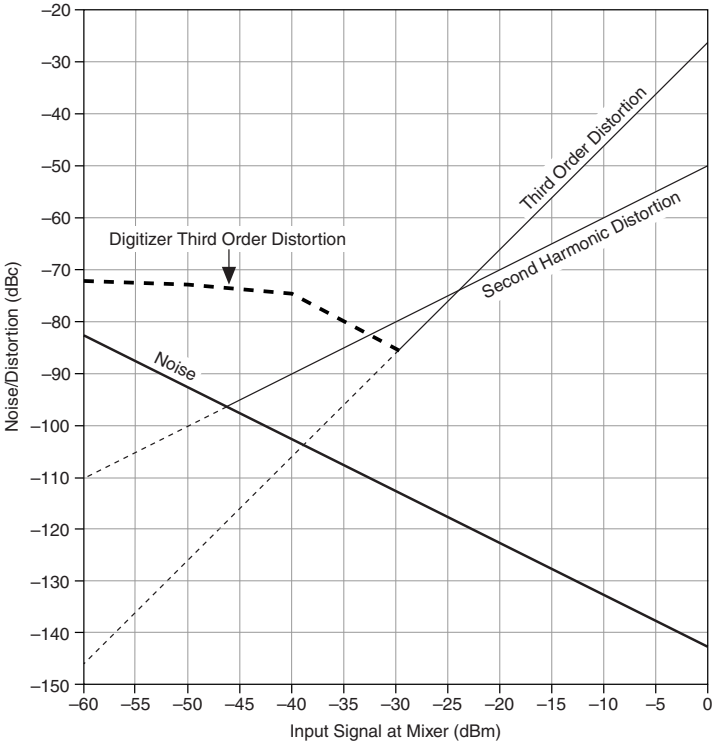
Frequency	Second Harmonic
<120 MHz	88 dB
120 MHz to 400 MHz	88 dB
400 MHz to 800 MHz	84 dB

[5] For NI PXI-5600 downconverter only, digitizer may clip under certain conditions.
[6] For NI PXI-5600 downconverter only, digitizer may clip under certain conditions.
[7] $1/2 \times (IP_2$ - *Averaged Noise Level*); resolution bandwidth = 1 Hz; mixer level = -36 dBm.

Table 17. Second Harmonic[7] (Continued)

Frequency	Second Harmonic
800 MHz to 1.1 GHz	86 dB
1.1 GHz to 1.25 GHz	84 dB
1.25 GHz to 1.35 GHz	81 dB
>1.35 GHz	—

Figure 1. Typical Dynamic Range (1 Hz Resolution Bandwidth at 1 GHz)



[7] 1/2 × (IP_2 - *Averaged Noise Level*); resolution bandwidth = 1 Hz; mixer level = -36 dBm.

Modulation Specifications

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

Table 18. 800 MHz Carrier Frequency (Typical)

QAM Order	Symbol Rate (kHz)	System Equalization Enabled[8]		System Equalization Disabled	
		EVM (% rms)	MER (dB)	EVM (% rms)	MER (dB)
M = 4	270	—	—	1.1	39
	1,220	1.0	40	1.9	35
	3,840	1.4	37	2.3	32
	5,360	1.6	36	2.5	32
M = 16	270	—	—	0.8	39
	1,220	1.0	40	1.4	34
	3,840	0.9	39	1.8	32
	5,360	1.1	39	1.9	32
M = 64	270	—	—	0.7	39
	1,220	0.6	41	1.3	35
	3,840	0.7	40	1.6	32
	5,360	0.8	39	1.7	32

Note Root-raised-cosine filter; alpha = 0.25; 2,000 symbols.

[8] System equalization applied using NI Modulation Toolkit software version 3.0, which removes linear distortion effects from modulation quality measurements. This data includes linear distortions from the signal source, the channel, and the receiver.

Table 19. 1,900 MHz Carrier Frequency

QAM Order	Symbol Rate (kHz)	System Equalization Enabled[9]		System Equalization Disabled	
		EVM (% rms)	MER (dB)	EVM (% rms)	MER (dB)
M = 4	270	—	—	1.2	38
	1,220	1.0	40	1.9	34
	3,840	1.4	37	2.4	32
	5,360	1.6	36	2.6	32
M = 16	270	—	—	0.9	39
	1,220	0.8	40	1.5	34
	3,840	0.8	40	1.8	32
	5,360	0.9	39	1.9	32
	10,000	1.0	38	2.4	30
M = 64	270	—	—	0.9	38
	1,220	0.7	40	1.4	34
	3,840	0.7	40	1.6	32
	5,360	0.8	39	1.7	32
	10,000	0.8	37	2.2	30

Note Root-raised-cosine filter; alpha = 0.25; 2,000 symbols.

RF Input Characteristics

Nominal impedance	50 Ω
Input coupling	AC
Maximum DC input voltage	±25 VDC[10]

[9] System equalization applied using NI Modulation Toolkit software version 3.0, which removes linear distortion effects from modulation quality measurements. This data includes linear distortions from the signal source, the channel, and the receiver.

[10] DC levels up to ±25 VDC at input will not damage the NI 5660. However, high transient currents from low-impedance DC step voltages at input can cause damage.

Voltage Standing Wave Ratio (VSWR)

Table 20. NI 5660 VSWR

Attenuation	Frequency	VSWR
Enabled (10 dB to 50 dB)[11]	9 kHz to 2.2 GHz	1.3:1 maximum
	2.2 GHz to 2.7 GHz	1.5:1 maximum
Disabled (0 dB)	9 kHz to 2.2 GHz	1.6:1 maximum
	2.2 GHz to 2.7 GHz	2.5:1 maximum

LO emission from RF input	<-87 dBm, maximum

IF/Baseband

Resolution	14 bits
IF input level	0 dBm nominal, +10 dBm full-scale
IF frequency range	5 MHz to 25 MHz
Sample rate	64 MS/s integer divisions to 1 kS/s
Onboard memory	16 MS, 32 MS optional

Note Refer to the *NI PXI-5620 Specifications* document for additional IF/baseband specifications.

Front Panel I/O

NI 5600 RF Downconverter Module

INPUT	
Connector	SMA female
Impedance	50 Ω
Coupling	AC
OUTPUT	
Connector	SMA female
Impedance	50 Ω

[11] Available in 10 dB steps.

Frequency	5 MHz to 25 MHz
Amplitude	0 dBm full scale
FREQ REF IN	
Connector	SMA 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 ± 0.5 ppm
10 MHz OUT (2 ports)	
Connector	SMA female
Impedance	50 Ω
Signal	Square wave
Amplitude	± 0.5 V (+7 dBm) into 50 Ω (± 1 V into open circuit)
Accuracy	Refer to the *Internal Frequency Reference* section
PXI 10 MHz I/O	
Connector	SMA female
Impedance	50 Ω
Input amplitude	-5 dBm to +15 dBm
Output amplitude	0.5 V (+7 dBm) into 50 Ω

NI 5620 IF Digitizer Module

INPUT	
Connector	SMA female
Impedance	50 Ω
Input amplitude	0 dBm nominal, +10 dBm full-scale
Maximum safe input level	+20 dBm
Maximum safe DC input voltage	± 2 V
REF CLK IN	
Connector	SMA female
Impedance	50 Ω
Input amplitude	-5 dBm to +15 dBm

Maximum safe input level	+16 dBm
Maximum safe DC input voltage	± 10 V
Input frequency range	10 MHz ± 0.5 ppm
PFI 1	
Connector	SMB male
Level	TTL
Maximum input voltage	5.5 V

Power Requirements

Table 21. Power Requirements (Voltages ±5%)

Module	+3.3 VDC	+5 VDC	+12 VDC	-12 VDC
NI 5600 RF downconverter	920 mA	2.3 A	700 mA	115 mA
NI 5620 IF digitizer	600 mA	1.5 A	450 mA	35 mA

Calibration

Interval[12]	1 year

Physical Dimensions

NI 5600	3U, Three Slot, PXI/cPCI module 21.6 cm × 6.0 cm × 13.0 cm (8.5 in. × 2.4 in. × 5.1 in.)
NI 5620	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 (combined unit)	1,165 g (41.1 oz)

Environment

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

[12] Factory calibration is invalidated if the NI 5600 RF downconverter module enclosure is opened. To preserve guaranteed calibration, do not disassemble the NI 5600 RF downconverter module.

Indoor use only.

Operating Environment

Ambient temperature range	0 °C to 50 °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	-20 °C to 70 °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

Operational shock	30 g peak, half-sine, 11 ms pulse (Tested in accordance with IEC 60068-2-27. Test profile developed in accordance with MIL-PRF-28800F.)
Random vibration	
Operating	5 Hz to 500 Hz, 0.31 g_{rms} (Tested in accordance with IEC 60068-2-64.)
Nonoperating	5 Hz to 500 Hz, 2.46 g_{rms} (Tested in accordance with IEC 60068-2-64. Test profile exceeds the requirements of MIL-PRF-28800F, Class 3.)

Maximum Working Voltage

Input to earth	0 VDC, Installation Category I

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 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
- AS/NZS CISPR 11: Group 1, 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 CE

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

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; 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*.

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