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Find the *National Instruments PXI-5661* at our website: *Click HERE*

DEVICE SPECIFICATIONS

NI PXI-5661

2.7 GHz RF Vector Signal Analyzer with Digital Downconversion

This document lists specifications for the NI PXI-5661 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 5661 specifications, visit *ni.com/manuals*.

To access NI 5661 documentation, navigate to **Start»All Programs»National Instruments»NI-RFSA»Documentation**.



Hot Surface If the NI 5661 has been in use, it may exceed safe handling temperatures and cause burns. Allow the NI 5661 to cool before removing it from the chassis.

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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)

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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	
	Internal Sample Clock Timebase	External Sample Clock Timebase
NI 5142 digitizer	355 nHz[1]	Sample Clock timebase/2^{48}
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

Digitizer tuning speed	1 ms

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

[1] With 100 MHz Sample Clock.

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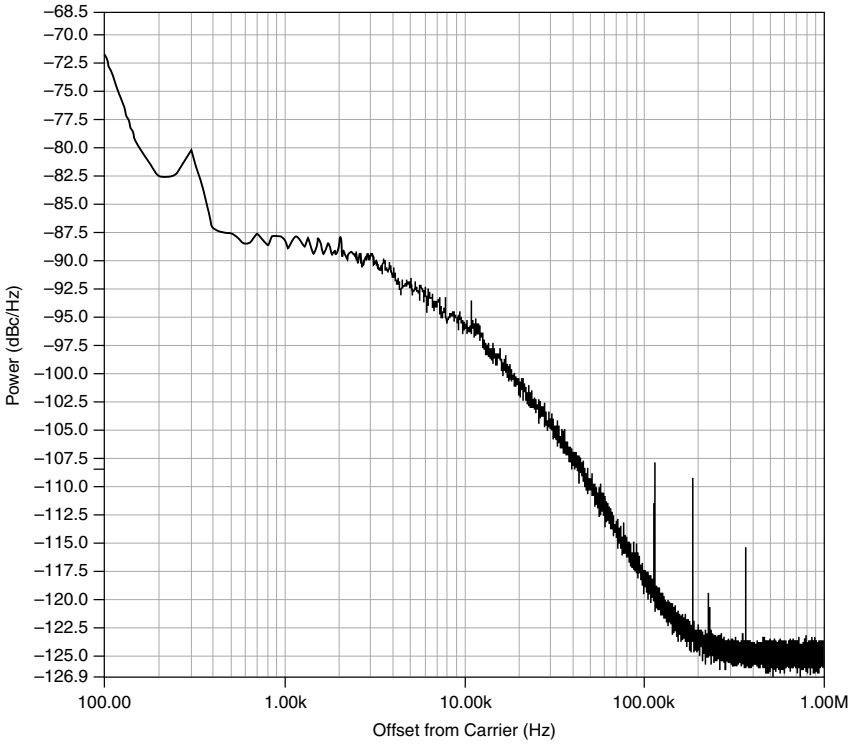
Spectral Purity

Table 4. Maximum Phase Noise

Offset Frequency	Noise Density
1 kHz	-80 dBc/Hz
10 kHz	-90 dBc/Hz
30 kHz	-95 dBc/Hz
100 kHz	-110 dBc/Hz
1 MHz	-120 dBc/Hz

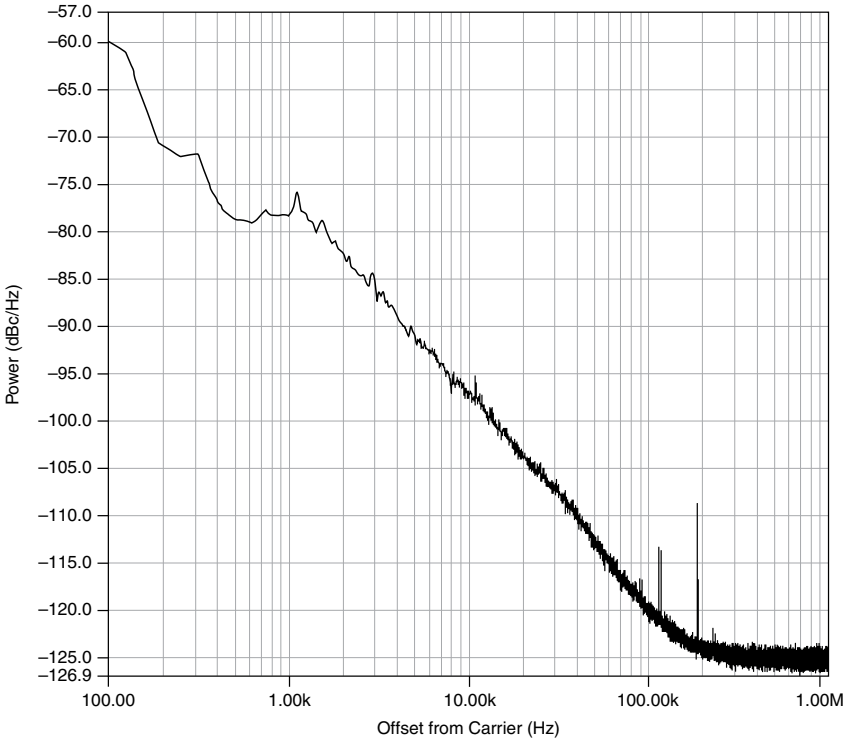
Note 1 GHz carrier; instantaneous bandwidth ≤ 10 MHz.

Figure 1. Typical Phase Noise at 1 GHz (Instantaneous Bandwidth ≤ 10 MHz)



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Figure 2. Typical Phase Noise at 1 GHz (Instantaneous Bandwidth >10 MHz)



Residual FM (Continuous wave, 300 Hz to 3 kHz integration bandwidth)	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; -30 dBm reference level.

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

Input Signal	Distortion[2, 3]	Mixer Input IP_2[4]
<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
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[5]	—	—

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 Two -30 dBm input tones, ≥200 kHz apart; -30 dBm reference level; mixer level -30 dBm.

[2] 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).
[3] Above 35 °C, add an additional amplitude variation of 1 dB to the maximum *Distortion* levels.
[4] Calculated from *Distortion* levels.
[5] Frequencies above 1.35 GHz produce a second harmonic distortion outside the specified tuning frequency range of the device.

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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; -30 dBm reference level.

Table 9. Residual Spurs

Frequency	Level
≥20 MHz	-100 dBm, maximum
<20 MHz	-70 dBm, maximum

Note Input terminated; no input signal; 0 dB attenuation; -30 dBm reference level.

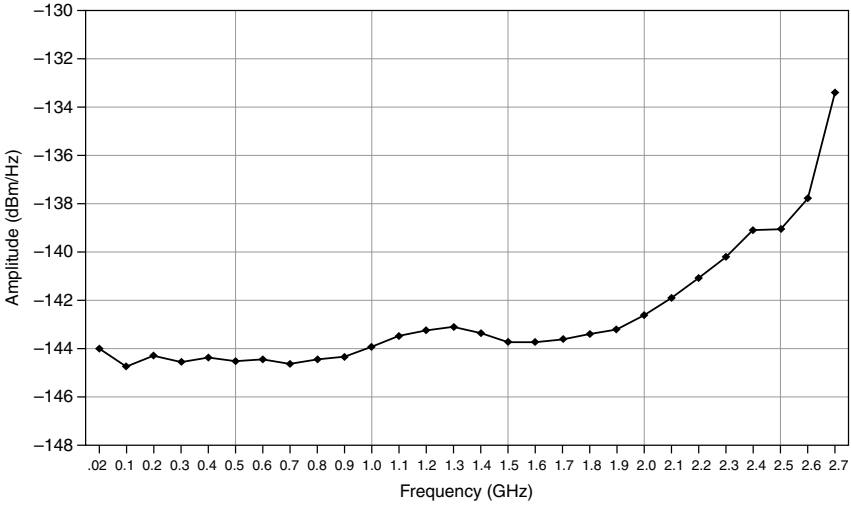
Table 10. Noise Density

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

Note Input terminated; no input signal; 0 dB attenuation; -30 dBm reference level.

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Figure 3. Typical Noise Density[6]



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

[6] Input terminated; no input signal; 0 dB attenuation; -30 dBm reference level.

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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

20 MHz bandwidth 30 $ns_{pk\text{-}pk}$ (15 °C to 35 °C)

Linearity (NI PXI-5600 Downconverter Only)[7]

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

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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)[8]

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[9]

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

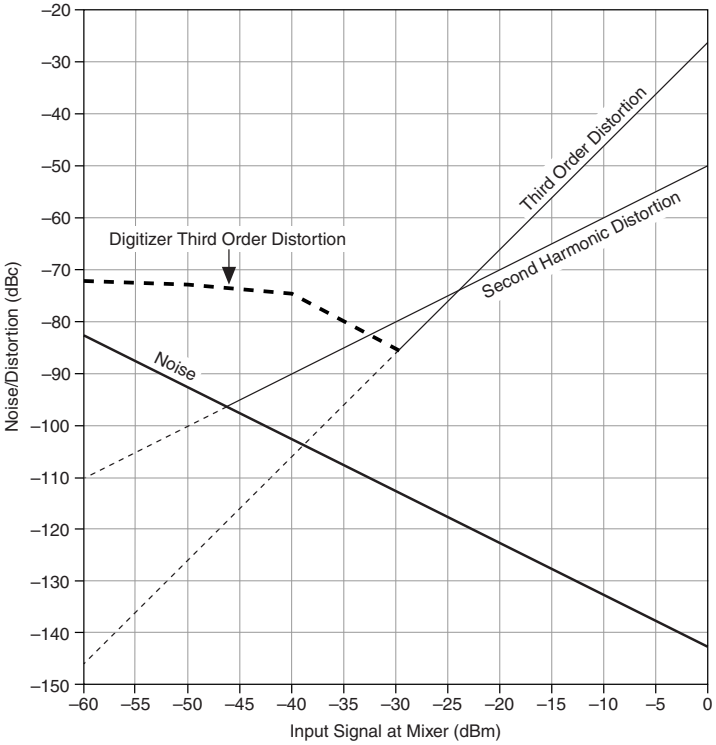
[7] For NI PXI-5600 downconverter only, digitizer may clip under certain conditions.
[8] For NI PXI-5600 downconverter only, digitizer may clip under certain conditions.
[9] $1/2 \times (IP_2$ - *Averaged Noise Level*); resolution bandwidth = 1 Hz; mixer level = -36 dBm.

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Table 17. Second Harmonic[9] (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 4. Typical Dynamic Range (1 Hz Resolution Bandwidth at 1 GHz)



[9] 1/2 × (IP_2 - *Averaged Noise Level*); resolution bandwidth = 1 Hz; mixer level = -36 dBm.

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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[10]		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.

[10] 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.

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Table 19. 1,900 MHz Carrier Frequency

QAM Order	Symbol Rate (kHz)	System Equalization Enabled[11]		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[12]

[11] 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.

[12] DC levels up to ±25 VDC at input will not damage the NI 5661. However, high transient currents from low-impedance DC step voltages at input can cause damage.

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Voltage Standing Wave Ratio (VSWR)

Table 20. NI 5661 VSWR

Attenuation	Frequency	VSWR
Enabled (10 dB to 50 dB)[13]	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
System IF frequency range	5 MHz to 25 MHz
Sample rate	100 MS/s
Digital downconverter (OSP) bandwidth	20 MHz to 4.88 kHz using 100 MS Sample Clock timebase
Onboard memory	64 MB, 256 MB

Note Refer to the *NI PXI/PCI-5142 Specifications* document for additional IF/baseband and onboard signal processing (OSP) 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

[13] Available in 10 dB steps.

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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 5142 IF Digitizer Module

CH0, CH1	
Connector	BNC female
Impedance	50 Ω

Maximum input overload 7 V_{rms} with |Peaks| ≤ 10 V(30 dBm)

CLK IN	
Connector	SMB female
Impedance	50 Ω
Input amplitude	-10 dBm to +13 dBm (Square Wave)

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Maximum input overload 7 V_{rms} with |Peaks| ≤ 10 V(30 dBm)

CLK OUT	
Connector	SMB
Output impedance	50 Ω
Logic type	3.3 V CMOS
Maximum driver current	± 48 mA
PFI 0, PFI 1	
Connector	9-pin mini-circular DIN
Logic type	3.3 V CMOS
Maximum input voltage	5.5 V

Power Requirements

Table 21. NI 5661 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 5142 IF digitizer	1 A	1.7 A	800 mA	270 mA

Calibration

Interval	
NI 5600	1 year
NI 5142	2 years

Physical Characteristics

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 5142	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)

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Environment

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

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	-40 °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

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}
Nonoperating	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.)

Maximum Working Voltage

Input to earth	0 VDC, Installation Category I

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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/*

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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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