SPECIFICATIONS

PXIe-5646R-G

Reconfigurable 6 GHz Vector Signal Generator with 200 MHz Bandwidth

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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.

Within the specifications, self-calibration °C refers to the recorded device temperature of the last successful self-calibration.

Specifications are *Warranted* unless otherwise noted.

Conditions

Specifications are valid under the following conditions unless otherwise noted.

- 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.
- Calibration IP is used properly during the creation of custom FPGA bitfiles.
- Calibration Interconnect cable remains connected between CAL IN and CAL OUT front panel connectors.
- The cable connecting CAL IN to CAL OUT has not been removed or tampered with.
- Reference Clock source: Internal
- RF OUT power level: 0 dBm
- LO tuning mode: Fractional
- LO PLL loop bandwidth: Medium
- LO step size: 200 kHz
- LO frequency: 2.4 GHz
- LO source: Internal

VSG Frequency

Frequency range	65 MHz to 6 GHz

Table 1. PXIe-5646R-G Bandwidth

Center Frequency	Instantaneous Bandwidth
≤109 MHz	20 MHz
>109 MHz to <200 MHz	80 MHz
200 MHz to 6 GHz	200 MHz

Tuning resolution[1]	888 nHz
LO step size	
Fractional mode	Programmable step size, 200 kHz default
Integer mode	2 MHz, 5 MHz, 10 MHz, 25 MHz

[1] Tuning resolution combines LO step size capability and frequency shift DSP implemented on the FPGA.

Frequency Settling Time

Table 2. Maximum Frequency Settling Time

Settling Time	Maximum Time (ms)		
	Low Loop Bandwidth	Medium Loop Bandwidth[2] (default)	High Loop Bandwidth
$\leq 1 \times 10^{-6}$ of final frequency	1.1	0.95	0.38
$\leq 0.1 \times 10^{-6}$ of final frequency	1.2	1.05	0.4
The default medium loop bandwidth refers to a setting that adjusts PLL to balance tuning speed and phase noise, and it does not necessarily result in loop bandwidth between low and high. This specification includes only frequency settling and excludes any residual amplitude settling.			

Internal Frequency Reference

Initial adjustment accuracy	$\pm 200 \times 10^{-9}$
Temperature stability	$\pm 1 \times 10^{-6}$, maximum
Aging	$\pm 1 \times 10^{-6}$ per year, maximum
Accuracy	*Initial adjustment accuracy* ± *Aging* ± *Temperature stability*

Frequency Reference Input (REF IN)

Refer to the *REF IN* section.

Frequency Reference/Sample Clock Output (REF OUT)

Refer to the *REF OUT* section.

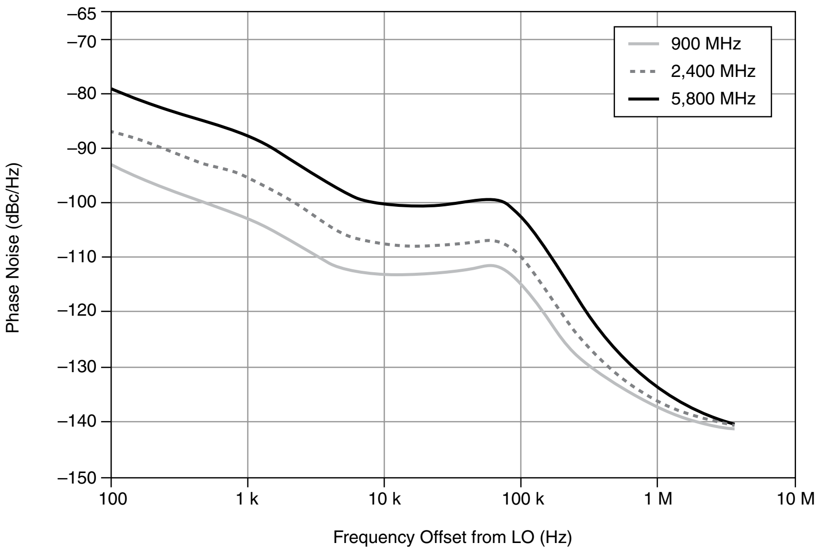
[2] Medium loop bandwidth is available only in fractional mode.

Spectral Purity

Table 3. Single Sideband Phase Noise

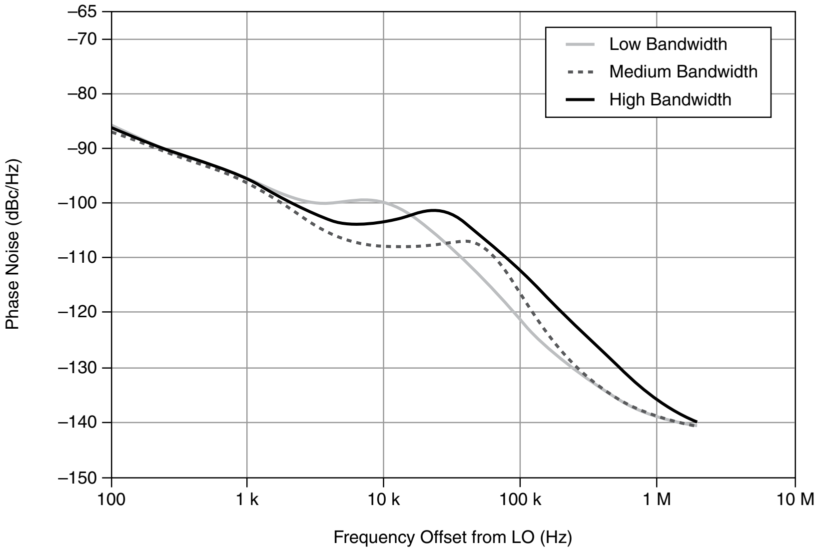
Frequency	Phase Noise (dBc/Hz), 20 kHz Offset (Single Sideband)		
	Low Loop Bandwidth	Medium Loop Bandwidth	High Loop Bandwidth
<3 GHz	-99	-99	-94
3 GHz to 4 GHz	-91	-93	-91
>4 GHz to 6 GHz	-93	-93	-87

Figure 1. Measured Phase Noise[3] at 900 MHz, 2.4 GHz, and 5.8 GHz



[3] Conditions: Measured Port: LO OUT; Reference Clock: internal; medium loop bandwidth.

Figure 2. Measured Phase Noise[4] at 2.4 GHz versus Loop Bandwidth



RF Output

Power Range

Table 4. Power Range

Output Type	Frequency	Power Range	
CW	<4 GHz	Noise floor to +10 dBm, average power[5]	Noise floor to +15 dBm, average power, nominal
	≥4 GHz	Noise floor to +7 dBm, average power[5]	Noise floor to +12 dBm, average power, nominal

[4] Conditions: Measured Port: LO OUT; Reference Clock: internal.
[5] Higher output is uncalibrated and may be compressed.

Table 4. Power Range (Continued)

Output Type	Frequency	Power Range	
Modulated[6]	<4 GHz	Noise floor to +6 dBm, average power	—
	≥4 GHz	Noise floor to +3 dBm, average power	—

Output attenuator resolution	2 dB, nominal
Digital attenuation resolution[7]	0.1 dB or better

Amplitude Settling Time

0.1 dB of final value[8]	50 µs
0.5 dB of final value[9], with LO retuned	300 µs

Output Power Level Accuracy

Table 5. Output Power Level Accuracy (dB)

Center Frequency	15 °C to 35 °C		0 °C to 55 °C	
	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C
65 MHz to <109 MHz	—	±0.70	—	±0.90
	—	±0.55 (95th percentile, ≈ 2σ)	—	±0.65 (95th percentile, ≈ 2σ)
	±0.26, typical	±0.40, typical	±0.36, typical	±0.50, typical

6 Up to 12 dB crest factor, based on 3GPP LTE uplink requirements.
7 Average output power ≥ -100 dBm.
8 Constant LO frequency, varying RF output power range. Power levels ≤ 0 dBm. 175 µs for power levels > 0 dBm.
9 LO tuning across harmonic filter bands.

Table 5. Output Power Level Accuracy (dB) (Continued)

Center Frequency	15 °C to 35 °C		0 °C to 55 °C	
	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C
109 MHz to <270 MHz[10]		±0.75		±0.90
		±0.60 (95th percentile; ≈ 2σ)		±0.70 (95th percentile; ≈ 2σ)
	±0.26, typical	±0.45, typical	±0.36, typical	±0.55, typical
270 MHz to <375 MHz	—	±0.70	—	±0.90
	—	±0.55 (95th percentile, ≈ 2σ)	—	±0.65 (95th percentile, ≈ 2σ)
	±0.26, typical	±0.40, typical	±0.36, typical	±0.50, typical
375 MHz to <2 GHz	—	±0.75	—	±0.90
	—	±0.55 (95th percentile, ≈ 2σ)	—	±0.65 (95th percentile, ≈ 2σ)
	±0.26, typical	±0.40, typical	±0.36, typical	±0.50, typical
2 GHz to <4 GHz	—	±0.75	—	±0.90
	—	±0.60 (95th percentile, ≈ 2σ)	—	±0.70 (95th percentile, ≈ 2σ)
	±0.26, typical	±0.40, typical	±0.36, typical	±0.50, typical

10 Harmonic suppression is reduced in this frequency range. As a result, offset errors may occur depending on whether you are using a true RMS device, such as a power meter.

Table 5. Output Power Level Accuracy (dB) (Continued)

Center Frequency	15 °C to 35 °C		0 °C to 55 °C	
	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C
4 GHz to 6 GHz	—	±1.00	—	±1.15
	—	±0.80 (95th percentile, ≈ 2σ)	—	±0.90 (95th percentile, ≈ 2σ)
	±0.28, typical	±0.40, typical	±0.38, typical	±0.60, typical

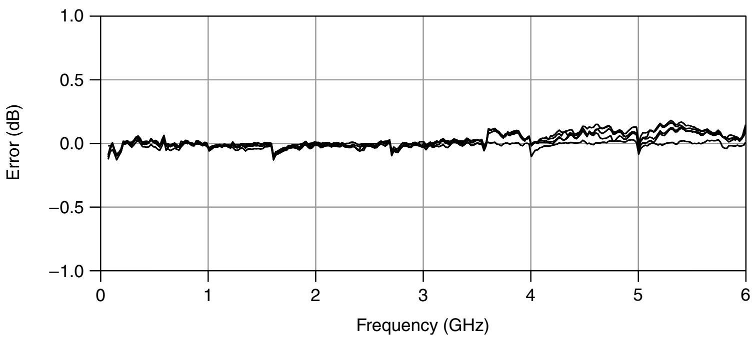
Conditions: CW average power -70 dBm to +10 dBm.

For power <-70 dBm, highly accurate generation can be achieved using digital attenuation, which relies on DAC linearity.

The absolute amplitude accuracy is measured at 3.75 MHz offset from the configured center frequency. The absolute amplitude accuracy measurements are made after the PXIe-5646R-G has settled.

This specification is valid only when the module is operating within the specified ambient temperature range and within the specified range from the last self-calibration temperature, as measured with the onboard temperature sensors.

Figure 3. Relative Power Accuracy, -40 dBm to 10 dBm, 10 dB Steps, Typical



Frequency Response

Table 6. VSG Frequency Response (dB) (Amplitude, Equalized)

Output Frequency	Bandwidth	Self-Calibration °C ± 5 °C
≤109 MHz	20 MHz	±0.9 dB
>109 MHz to <200 MHz	40 MHz	±0.5 dB
	80 MHz	±0.5 dB, typical
		±0.9 dB
≥200 MHz to 6 GHz	80 MHz	±0.5 dB
	200 MHz	±0.5 dB, typical
		±1.1 dB
Conditions: Reference level -30 dBm to +30 dBm. This specification is valid only when the module is operating within the specified ambient temperature range and within the specified range from the last self-calibration temperature, as measured with the onboard temperature sensors. Frequency response represents the relative flatness within a specified instantaneous bandwidth. Frequency response specifications are valid within any given frequency range and not the LO frequency itself.		

Figure 4. Measured 80 MHz Frequency Response, 0 dBm Output Power Level, Equalized

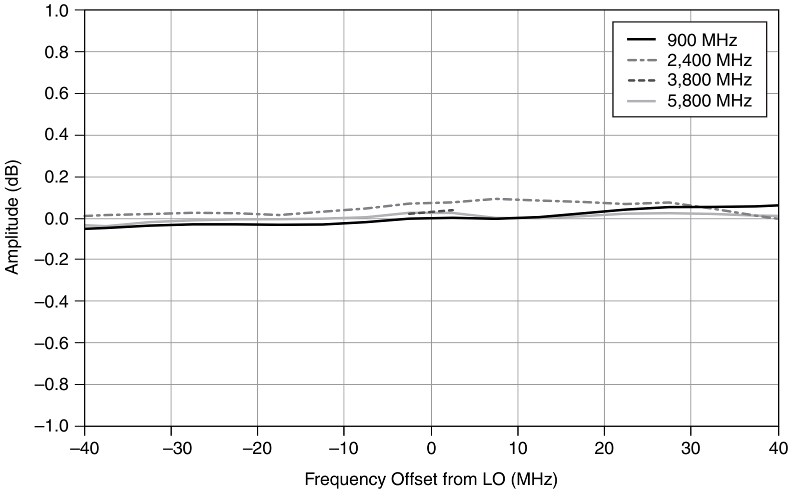


Figure 5. Measured 80 MHz Frequency Response, -50 dBm Output Power Level, Equalized

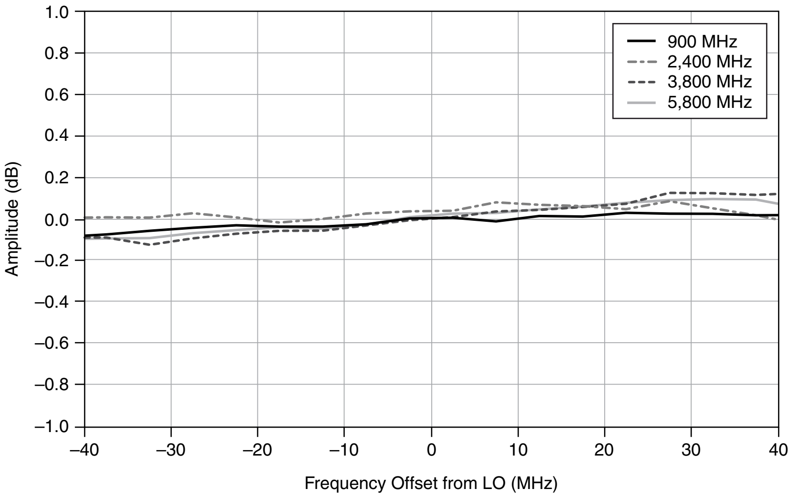


Figure 6. Measured 200 MHz Frequency Response, 0 dBm Output Power Level, Equalized

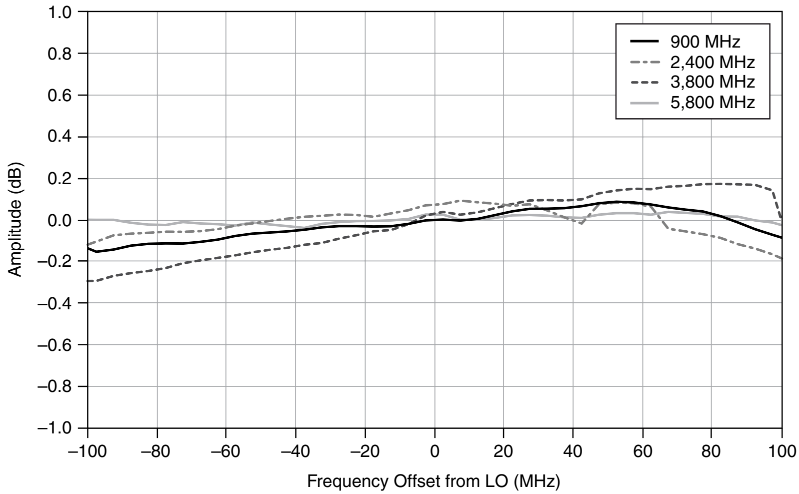
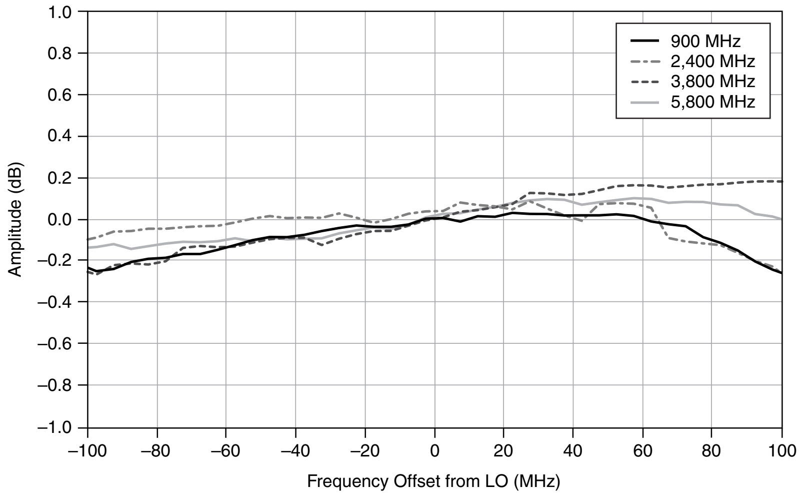


Figure 7. Measured 200 MHz Frequency Response, -50 dBm Output Power Level, Equalized



Output Noise Density

Table 7. Average Output Noise Level (dBm/Hz)

Center Frequency	Power Setting		
	-30 dBm	0 dBm	10 dBm
65 MHz to 500 MHz	—	—	—
	-168, typical	-150, typical	-130, typical
>500 MHz to 1 GHz	—	—	—
	-168, typical	-147, typical	-137, typical
>1 GHz to 2.5 GHz	—	-149	-141
	-168, typical	-151, typical	-143, typical
>2.5 GHz to 3.5 GHz	—	-150	-140
	-168, typical	-153, typical	-143, typical
>3.5 GHz to 5 GHz	—	-144	-136
	-168, typical	-147, typical	-138, typical
>5 GHz to 6 GHz	—	-147	-138
	-168, typical	-149, typical	-140, typical
Conditions: Averages: 200 sweeps; baseband signal attenuation: -40 dB; noise measurement frequency offset: 4 MHz relative to output tone frequency.			

Spurious Responses

Harmonics

Table 8. Second Harmonic Level (dBc)

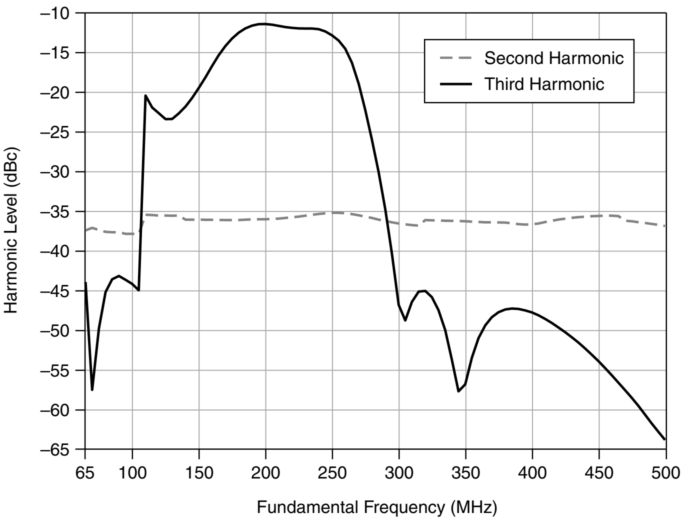
Fundamental Frequency	23 °C ± 5 °C	0 °C to 55 °C
65 MHz to 3.5 GHz	-27	-24
	-29, typical	-27, typical
>3.5 GHz to 4.5 GHz	-26	-24
	-28, typical	-26, typical

Table 8. Second Harmonic Level (dBc) (Continued)

Fundamental Frequency	23 °C ± 5 °C	0 °C to 55 °C
>4.5 GHz to 6 GHz	-28	-26
	-33, typical	-31, typical
Conditions: Measured using 1 MHz baseband signal -1 dBFS; fundamental signal measured at +6 dBm CW; second harmonic levels nominally <-30 dBc for fundamental output levels of ≤5 dBm		

Note Higher order harmonic suppression is degraded in the range of 109 MHz to 270 MHz and third harmonic performance is shown in the following figure. For frequencies outside the range of 109 MHz to 270 MHz, higher order harmonic distortion is equal to or better than the second harmonic level as specified in the previous table.

Figure 8. Harmonic Level,[11] 65 MHz to 500 MHz, Measured



[11] Measured using 1 MHz baseband signal -1 dBFS; fundamental signal measured at +6 dBm CW.

Nonharmonic Spurs

Table 9. Nonharmonic Spurs (dBc)

Frequency	<100 kHz Offset	≥100 kHz Offset	>1 MHz Offset
65 MHz to 3 GHz	<-55, typical	<-62	<-75
>3 GHz to 6 GHz	<-55, typical	<-57	<-70
Conditions: Output full scale level ≥-30 dBm. Measured with a single tone at -1 dBFS.			

Third-Order Output Intermodulation

Table 10. Third-Order Output Intermodulation Distortion (IMD_3) (dBc), 0 dBm Tones

Fundamental Frequency	Baseband DAC: -2 dBFS	Baseband DAC: -6 dBFS
65 MHz to 1 GHz	-55, typical	-60, typical
>1 GHz to 3 GHz	-53, typical	-53, typical
>3 GHz to 5 GHz	-49, typical	-50, typical
>5 GHz to 6 GHz	-44, typical	-45, typical
Conditions: Two 0 dBm tones, 500 kHz apart at RF OUT. RF gain applied to achieve the desired output power per tone.		

Table 11. Third-Order Output Intermodulation Distortion (IMD_3) (dBc), -6 dBm Tones

Fundamental Frequency	Baseband DAC: -2 dBFS	Baseband DAC: -6 dBFS
65 MHz to 1.5 GHz	-50	-59
	-54, typical	-62, typical
>1.5 GHz to 3.5 GHz	-54	-59
	-57, typical	-62, typical
>3.5 GHz to 5 GHz	-50	-55
	-53, typical	-58, typical

Table 11. Third-Order Output Intermodulation Distortion (IMD_3) (dBc), -6 dBm Tones (Continued)

Fundamental Frequency	Baseband DAC: -2 dBFS	Baseband DAC: -6 dBFS
>5 GHz to 6 GHz	-47	-51
	-50, typical	-54, typical
Conditions: Two -6 dBm tones, 500 kHz apart at RF OUT. RF gain applied to achieve the desired output power per tone.		

Table 12. Third-Order Output Intermodulation Distortion (IMD_3) (dBc), -36 dBm Tones

Fundamental Frequency	Baseband DAC: -2 dBFS	Baseband DAC: -6 dBFS
65 MHz to 200 MHz	-52	-57
	-54, typical	-60, typical
>200 MHz to 6 GHz	-52	-55
	-54, typical	-58, typical
Conditions: Two -36 dBm tones, 500 kHz apart at RF OUT. RF gain applied to achieve the desired output power per tone.		

LO Residual Power

Table 13. VSG LO Residual Power (dBc)

Center Frequency	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C
≤109 MHz	—	—
	-60, typical	-49, typical
>109 MHz to 375 MHz	—	-45
	-52, typical	-50, typical
>375 MHz to 1 GHz	—	-53
	-59, typical	-57, typical

Table 13. VSG LO Residual Power (dBc) (Continued)

Center Frequency	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C
1 GHz to 2 GHz	—	-55
	-60, typical	-63, typical
2 GHz to 3 GHz	—	-50
	-60, typical	-53, typical
3 GHz to 5 GHz	—	-53
	-58, typical	-55, typical
5 GHz to 6 GHz	—	-48
	-56, typical	-53, typical
Conditions: Configured power levels -50 dBm to +10 dBm. This specification is valid only when the module is operating within the specified ambient temperature range and within the specified range from the last self-calibration temperature, as measured with the onboard temperature sensors. For optimal performance, NI recommends running self-calibration when the PXIe-5646R-G temperature drifts ± 5 °C from the temperature at the last self-calibration. For temperature changes >± 5 °C from self-calibration, LO residual power is -40 dBc.		

Figure 9. VSG LO Residual Power,[12] 109 MHz to 6 GHz, Typical

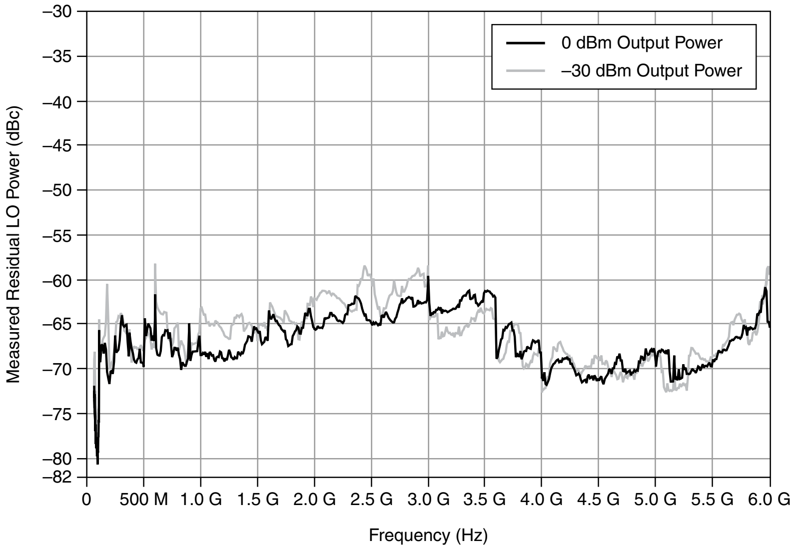


Table 14. VSG LO Residual Power (dBc), Low Power

Center Frequency	Self-Calibration °C ± 5 °C
≤109 MHz	—
	-49, typical
>109 MHz to 375 MHz	—
	-50, typical
>375 MHz to 2 GHz	—
	-60, typical
>2 GHz to 3 GHz	—
	-53, typical
>3 GHz to 5 GHz	—
	-58, typical

12 Measurement performed after self-calibration.

Table 14. VSG LO Residual Power (dBc), Low Power (Continued)

Center Frequency	Self-Calibration °C ± 5 °C
>5 GHz to 6 GHz	—
	-55, typical
Conditions: configured power levels < -50 dBm to -70 dBm. This specification is valid only when the module is operating within the specified ambient temperature range and within the specified range from the last self-calibration temperature, as measured with the onboard temperature sensors. For optimal performance, NI recommends running self-calibration when the PXIe-5646R-G temperature drifts ± 5 °C from the temperature at the last self-calibration. For temperature changes >± 5 °C from self-calibration, LO residual power is -40 dBc.	

Residual Sideband Image

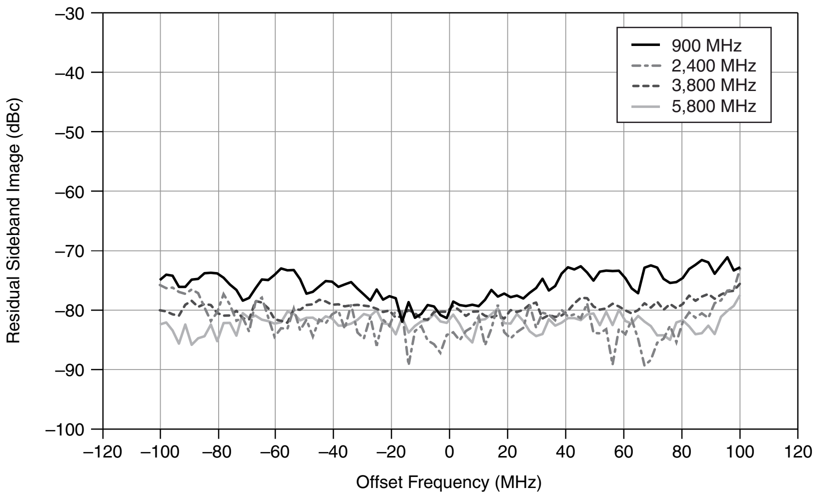
Table 15. VSG Residual Sideband Image (dBc)

Center Frequency	Bandwidth	Self-Calibration °C ± 1°C	Self-Calibration °C ± 5 °C
≤109 MHz	20 MHz	—	-40
		-55, typical	-42, typical
>109 MHz to 200 MHz	80 MHz	—	—
		-45, typical	-40, typical
>200 MHz to 500 MHz	200 MHz	—	-45
		-45, typical	-50, typical
>500 MHz to 1 GHz	≤180 MHz	—	-60
		-70, typical	-63, typical
	≤180 MHz to 200 MHz	—	-57
		-70, typical	-60, typical
>1 GHz to 2 GHz	200 MHz	—	-60
		-70, typical	-63, typical

Table 15. VSG Residual Sideband Image (dBc) (Continued)

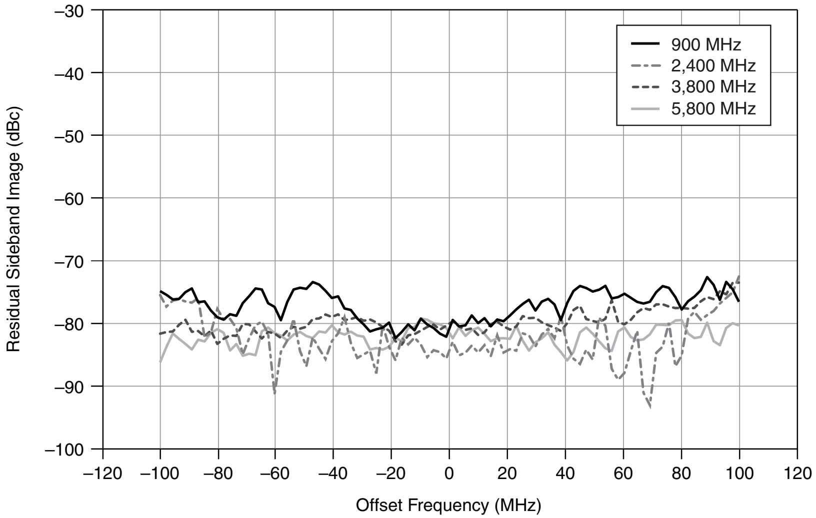
Center Frequency	Bandwidth	Self-Calibration °C ± 1°C	Self-Calibration °C ± 5 °C
>2 GHz to 6 GHz	200 MHz	—	-50
		-65, typical	-55, typical
Conditions: Reference levels -30 dBm to +30 dBm. This specification describes the maximum residual sideband image within a 200 MHz bandwidth at a given RF center frequency. Bandwidth is restricted to 20 MHz for LO frequencies ≤109 MHz. This specification is valid only when the module is operating within the specified ambient temperature range and within the specified range from the last self-calibration temperature, as measured with the onboard temperature sensors. For optimal performance, NI recommends running self-calibration when the PXIe-5646R-G temperature drifts ± 5 °C from the temperature at the last self-calibration. For temperature changes >± 5 °C from self-calibration, residual image suppression is -40 dBc.			

Figure 10. VSG Residual Sideband Image,[13] 0 dBm Average Output Power, Typical



13 Measurement performed after self-calibration.

Figure 11. VSG Residual Sideband Image,[13] -30 dBm Average Output Power, Typical



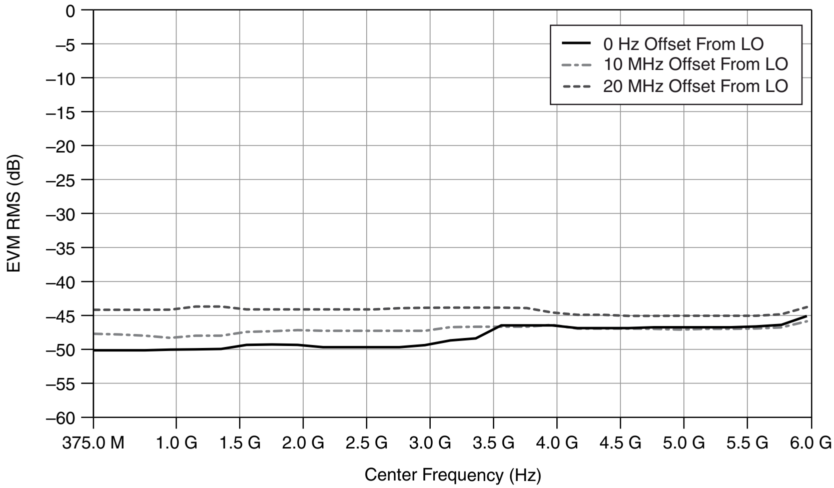
Error Vector Magnitude (EVM)

VSG EVM

20 MHz bandwidth 64-QAM EVM[14] 375 MHz to 6 GHz	-40 dB, typical

[14] Conditions: EVM signal: 20 MHz bandwidth; 64 QAM signal. Pulse-shape filtering: root-raised cosine, alpha=0.25; PXIe-5646R-G peak output power: -10 dBm; Reference Clock source: internal. Measurement instrument: PXIe-5665; reference level: -10 dBm; Reference Clock source: internal; record length: 300 μs.

Figure 12. RMS EVM (dB) versus Measured Average Power (dBm), Typical [15]



Application-Specific Modulation Quality

Typical performance assumes the PXIe-5646R-G is operating within ± 5 °C of the previous self-calibration temperature, and that the ambient temperature is 0 °C to 55 °C.

WLAN 802.11ac

OFDM[16]	
80 MHz bandwidth	-45 dB (rms), typical
80 MHz bandwidth (channel tracking enabled, preamble and data)	-50 dB (rms), typical
160 MHz bandwidth	-43 dB (rms), typical
160 MHz bandwidth (channel tracking enabled, preamble and data)	-47 dB (rms), typical

[15] Conditions: 20 MHz bandwidth, 64 QAM; centered at LO frequency or offset digitally as listed.

[16] Conditions: PXIe-5646R-G connected to RF IN of a PXIe-5646R; 5,800 MHz; average power: -30 dBm to -5 dBm; 20 packets; 16 OFDM data symbols; MCS=9; 256 QAM.

Figure 13. WLAN 802.11ac RMS EVM (dB) versus Measured Average Power (dBm)

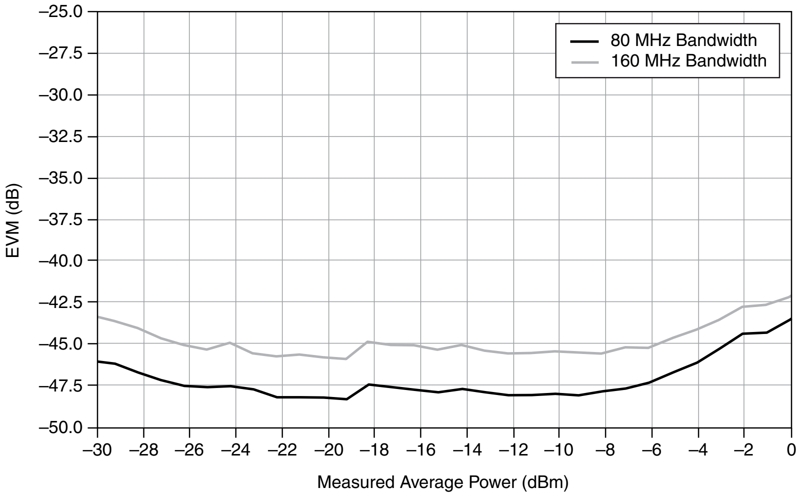
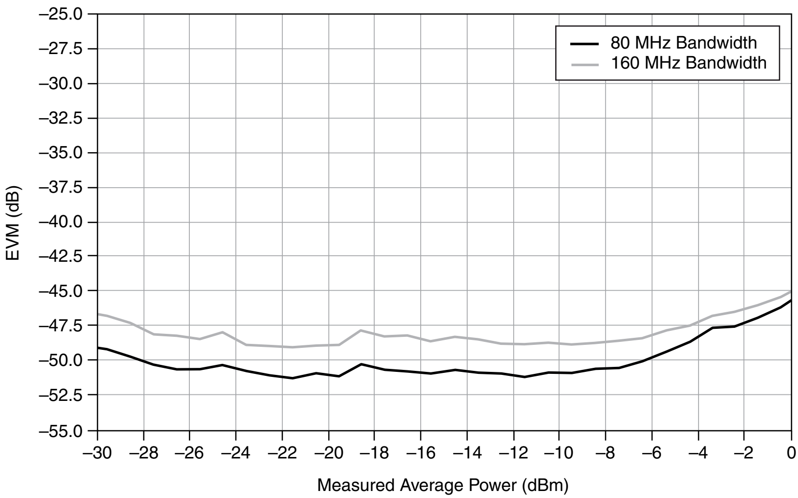


Figure 14. WLAN 802.11ac RMS EVM (dB) versus Measured Average Power (dBm), Channel Tracking Enabled



WLAN 802.11n

Table 16. 802.11n OFDM EVM (rms) (dB), Typical

Frequency	20 MHz Bandwidth	40 MHz Bandwidth
2,412 MHz	-50	-50
5,000 MHz	-48	-46
Conditions: PXIe-5646R-G connected to RF IN of a PXIe-5646R; average power: -10 dBm; reference level: auto-leveled based on real-time average power measurement; 20 packets; 3/4 coding rate; 64 QAM.		

WLAN 802.11a/g/j/p

Table 17. 802.11a/g/j/p OFDM EVM (rms) (dB), Typical

Frequency	20 MHz Bandwidth
2,412 MHz	-53
5,000 MHz	-50
Conditions: PXIe-5646R-G connected to RF IN of a PXIe-5646R; average power: -10 dBm; reference level: auto-leveled based on real-time average power measurement; 20 packets; 3/4 coding rate; 64 QAM.	

WLAN 802.11g

Table 18. 802.11g DSSS-OFDM EVM (rms) (dB), Typical

Frequency	20 MHz Bandwidth
2,412 MHz	-53
5,000 MHz	-50
Conditions: PXIe-5646R-G connected to RF IN of a PXIe-5646R; average power: -10 dBm; reference level: auto-leveled based on real-time average power measurement; 20 packets; 3/4 coding rate; 64 QAM.	

WLAN 802.11b/g

DSSS[17]	-48 EVM (rms) dB, typical

LTE

Table 19. SC-FDMA[18] (Uplink FDD) EVM (rms) (dB), Typical

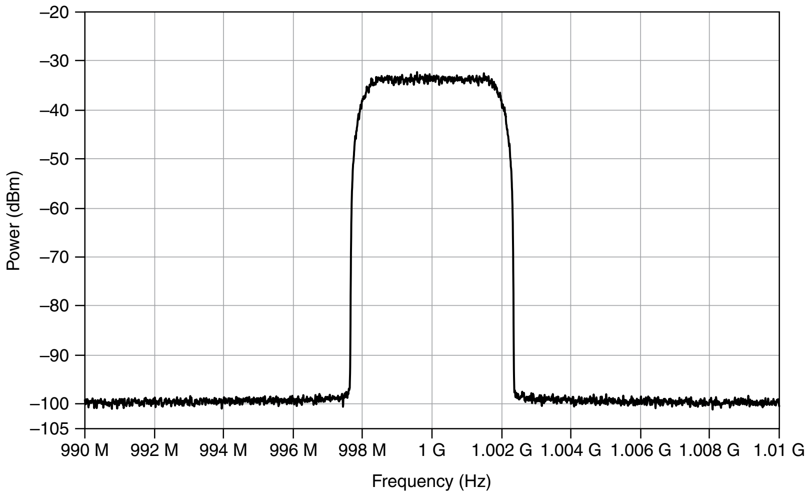
Frequency	5 MHz Bandwidth	10 MHz Bandwidth	20 MHz Bandwidth
700 MHz	-56	-56	-54
900 MHz	-55	-55	-53
1,430 MHz	-54	-54	-53
1,750 MHz	-51	-50	-50
1,900 MHz	-51	-50	-50
2,500 MHz	-50	-49	-49

[17] Conditions: PXIe-5646R-G connected to RF IN of a PXIe-5646R; 2,412 MHz; 20 MHz bandwidth; average power -10 dBm; reference level: auto-leveled based on real-time average power measurement; averages: 10; pulse-shaping filter: Gaussian reference; CCK 11 Mbps.

[18] Single channel uplink only.

WCDMA

Figure 15. WCDMA Measured Spectrum[19] (ACP)



Baseband Characteristics

Digital-to-analog converters (DACs)	
Resolution	16 bits
Sample rate[20]	250 MS/s
I/Q data rate[21]	4 kS/s to 250 MS/s

Onboard FPGA

FPGA	Xilinx Virtex-6 LX240T
LUTs	150,720
Flip-flops	301,440
DSP48 slices	768
Embedded block RAM	14,976 kbits

[19] Conditions: DL Test Model 1 (64DPCH); RF output level: -10 dBm average; PXIe-5646R-G connected to RF IN of a PXIe-5646R; measured results better than -65 dB.
[20] DACs are dual-channel components with each channel assigned to I and Q, respectively. DAC sample rate is internally interpolated to 1 GS/s, automatically configured.
[21] I/Q data rates lower than 250 MS/s are achieved using fractional interpolation.

Data transfers	DMA, interrupts, programmed I/O
Number of DMA channels	16

Onboard DRAM

Memory size	2 banks, 512 MB per bank
Theoretical maximum data rate	2.1 GB/s per bank

Onboard SRAM

Memory size	2 MB
Maximum data rate (read)	40 MB/s
Maximum data rate (write)	36 MB/s

Front Panel I/O

RF OUT

Connector	SMA (female)
Output impedance	50 Ω, nominal, AC coupled
Absolute maximum reverse power[22]	
<4 GHz	+33 dBm (CW RMS)
≥4 GHz	+30 dBm (CW RMS)

Output Return Loss (VSWR)

Table 20. Output Return Loss (dB) (VSWR)

Frequency	Typical
109 MHz ≤ f < 2 GHz	19.0 (1.25:1)
2 GHz ≤ f < 5 GHz	14.0 (1.50:1)
5 GHz ≤ f ≤ 6 GHz	11.0 (1.78:1)
Return loss for frequencies < 109 MHz is typically better than 20 dB (VSWR < 1.22:1).	

22 For modulated signals, peak instantaneous power not to exceed corresponding peak power of specified CW.

CAL IN, CAL OUT

Connector	SMA (female)
Impedance	50 Ω, nominal

Caution Do not disconnect the cable that connects CAL IN to CAL OUT. Removing the cable from or tampering with the CAL IN or CAL OUT front panel connectors voids the product calibration and specifications are no longer warranted.

LO OUT (RF OUT 0)

Connectors	SMA (female)
Frequency range	65 MHz to 6 GHz
Power (65 MHz to 6 GHz)	0 dBm ± 2 dB, typical
Output power resolution	0.25 dB, nominal
Output impedance	50 Ω, nominal, AC coupled
Output return loss	>11.0 dB (VSWR <1.8:1), typical
Output isolation (state: disabled)	
<2.5 GHz tuned LO	-45 dBc, nominal
≥2.5 GHz tuned LO	-35 dBc, nominal

LO IN (RF OUT 0)

Connectors	SMA (female)
Frequency range	65 MHz to 6 GHz
Expected input power (65 MHz to 6 GHz)	0 dBm ± 3 dB, nominal
Input impedance	50 Ω, nominal, AC coupled
Input return loss	>11.7 dB (VSWR <1.7:1), typical
Absolute maximum power	+15 dBm
Maximum DC voltage	±5 VDC

REF IN

Connector	SMA (female)
Frequency	10 MHz
Tolerance[23]	$\pm 10 \times 10^{-6}$

[23] *Frequency Accuracy = Tolerance × Reference Frequency*

Amplitude	
Square	0.7 V_{pk-pk} to 5.0 V_{pk-pk} into 50 Ω, typical
Sine[24]	1.4 V_{pk-pk} to 5.0 V_{pk-pk} into 50 Ω, typical
Input impedance	50 Ω, nominal
Coupling	AC

REF OUT

Connector	SMA (female)
Frequency	
Reference Clock[25]	10 MHz, nominal
Sample Clock	250 MHz, nominal
Amplitude	1.65 Vpk-pk into 50 Ω, nominal
Output impedance	50 Ω, nominal
Coupling	AC

PFI 0

Connector	SMA (female)
Voltage levels[26]	
Absolute maximum input range	-0.5 V to 5.5 V
V_{IL}	0.8 V
V_{IH}	2.0 V
V_{OL}	0.2 V with 100 µA load
V_{OH}	2.9 V with 100 µA load
Input impedance	10 kΩ, nominal
Output impedance	50 Ω, nominal
Maximum DC drive strength	24 mA
Minimum required direction change latency[27]	48 ns + 1 clock cycle

DIGITAL I/O

Connector	VHDCI

24 1 V_{rms} to 3.5 V_{rms}, typical. Jitter performance improves with increased slew rate of input signal.
25 Refer to the *Internal Frequency Reference* for accuracy.
26 Voltage levels are guaranteed by design through the digital buffer specifications.
27 Clock cycle refers to the FPGA clock domain used for direction control.

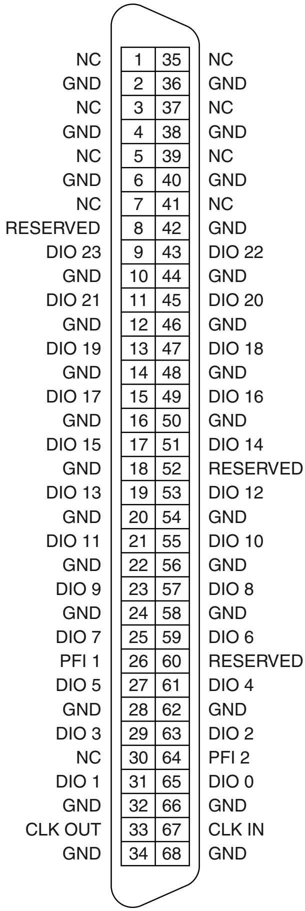
Table 21. DIGITAL I/O Signal Characteristics

Signal	Direction	Port Width
DIO <23..20>	Bidirectional, per port	4
DIO <19..16>	Bidirectional, per port	4
DIO <15..12>	Bidirectional, per port	4
DIO <11..8>	Bidirectional, per port	4
DIO <7..4>	Bidirectional, per port	4
DIO <3..0>	Bidirectional, per port	4
PFI 1	Bidirectional	1
PFI 2	Bidirectional	1
Clock In	Input	1
Clock Out	Output	1

Voltage levels[28]	
Absolute maximum input range	-0.5 V to 4.5 V
V_{IL}	0.8 V
V_{IH}	2.0 V
V_{OL}	0.2 V with 100 µA load
V_{OH}	2.9 V with 100 µA load
Input impedance	
DIO <23..0>, CLK IN	10 kΩ, nominal
PFI 1, PFI 2	100 kΩ pull up, nominal
Output impedance	50 Ω, nominal
Maximum DC drive strength	12 mA
Minimum required direction change latency[29]	48 ns + 1 clock cycle
Maximum toggle rate	125 MHz, typical

28 Voltage levels are guaranteed by design through the digital buffer specifications.
29 Clock cycle refers to the FPGA clock domain used for direction control.

Figure 16. DIGITAL I/O VHDCI Connector



Power Requirements

Table 22. Power Requirements

Voltage (V_{DC})	Typical Current (A)	Maximum Current (A)
+3.3	4.7	5.4
+12	3.5	4.2
Power is 58 W, typical. Consumption is from both PXI Express backplane power connectors.		

Calibration

Interval	1 year

Note For the two-year calibration interval, add 0.2 dB to one year specifications for *Output Power Level Accuracy* and RF output *Frequency Response*.

Physical Characteristics

PXIe-5646R-G module	3U, three slot, PXI Express module 6.1 cm × 12.9 cm × 21.1 cm (2.4 in. × 5.6 in. × 8.3 in.)
Weight	1,360 g (48.0 oz)

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	-40 °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 CE

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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