SPECIFICATIONS

PXIe-5601

RF Signal Downconverter

Contents

NATIONAL INSTRUMENTS

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.
- *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.

- 30 minutes warm-up time
- Calibration cycle maintainied
- Chassis fan speed set to High
- PXIe-5652 used as a LO source
- Modules locked to the PXI backplane
- NI-RFSA instrument driver used with stored calibration data utilized
- PXIe-5601 module revision G or later

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

- Over ambient temperature ranges of 23 °C ± 5 °C

Frequency

Frequency range	10 MHz to 6.6 GHz

Tuning Resolution

Tuned frequency[1]	
10 MHz to <1.3 GHz	<1 Hz
1.3 GHz to <3.1 GHz	<2 Hz
3.1 GHz to 6.6 GHz	<4 Hz

Bandwidth

Instantaneous Bandwidth

Table 1. PXIe-5601 Instantaneous Bandwidth[2]

Tuned Frequency	3 dB Instantaneous Bandwidth
10 MHz to <120 MHz	>5 MHz (>10 MHz at 6 dB)
120 MHz to <330 MHz	>20 MHz
330 MHz to 6.6 GHz	>50 MHz, >300 MHz[3]

Spectral Purity

Phase Noise

Table 2. Single Sideband Phase Noise[4]

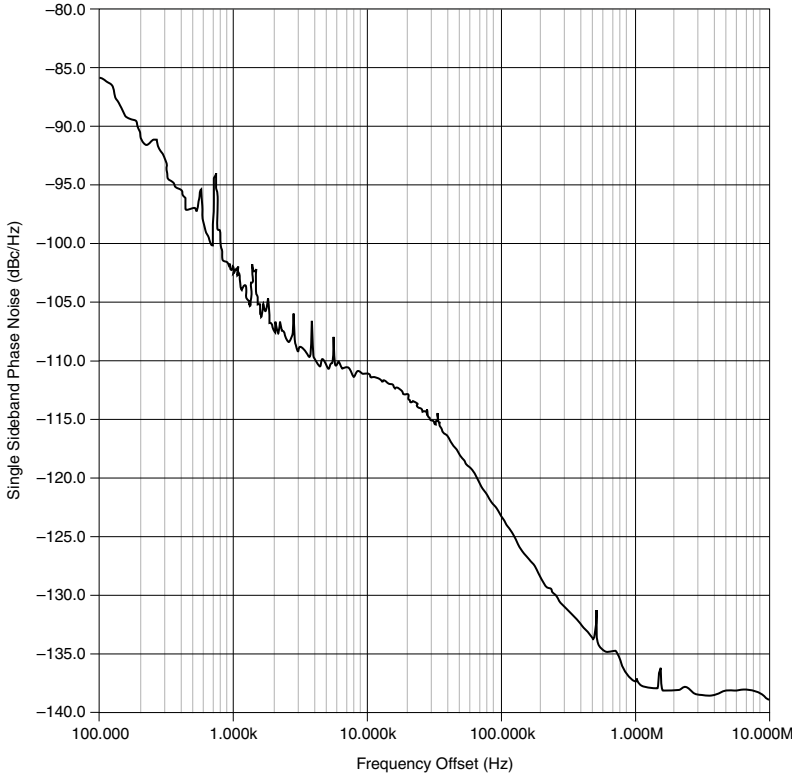
Tuned Frequency	Noise Density
100 MHz	<-125 dBc/Hz
500 MHz	<-112 dBc/Hz
1 GHz	<-105 dBc/Hz
2 GHz	<-98 dBc/Hz
3 GHz	<-95 dBc/Hz
4 GHz	<-93 dBc/Hz

1 Values determined using PXIe-5652 as the LO source.
2 Calibration data not used.
3 Bypass path selected, IF center frequency of 10 MHz to 310 MHz.
4 10 kHz offset; measured using the PXIe-5652 with internal Reference Clock.

Table 2. Single Sideband Phase Noise[4] (Continued)

Tuned Frequency	Noise Density
5 GHz	<-90 dBc/Hz
6.6 GHz	<-90 dBc/Hz

Figure 1. Typical Phase Noise at 1 GHz



[4] 10 kHz offset; measured using the PXIe-5652 with internal Reference Clock.

Figure 2. Typical Phase Noise at 2.4 GHz

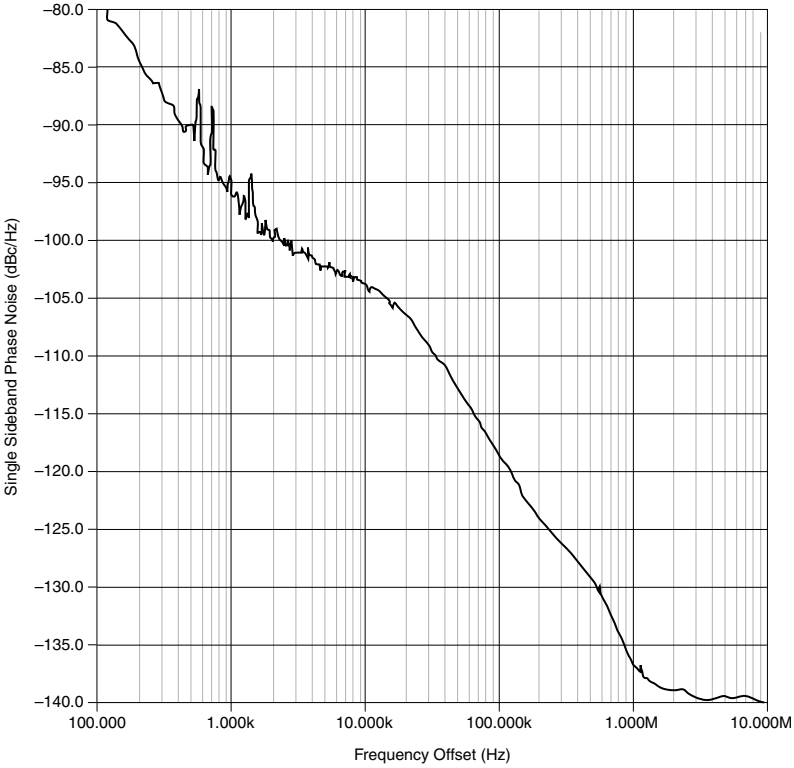
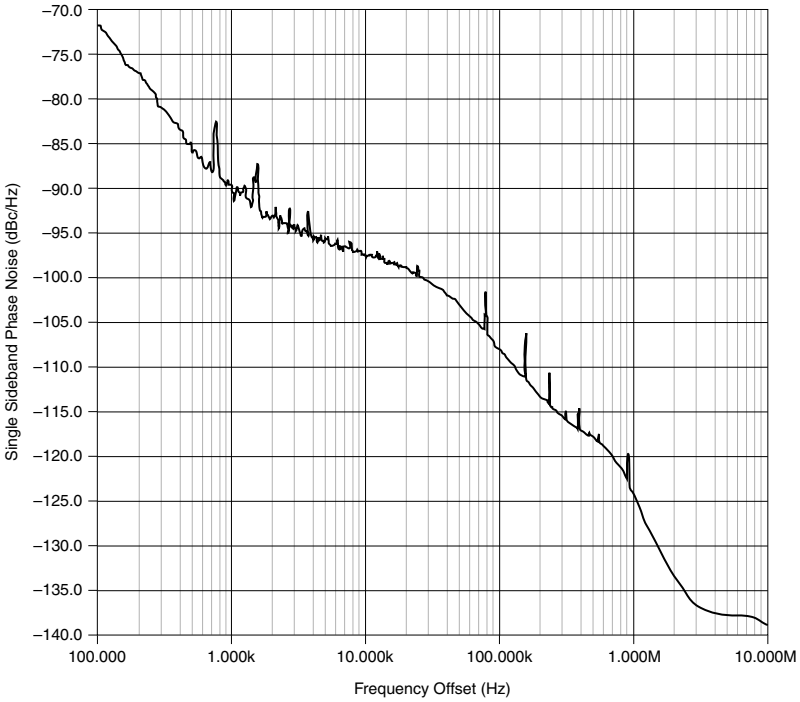


Figure 3. Typical Phase Noise at 5.8 GHz



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

Table 3. PXIe-5601 Average Noise Level

Frequency	23 °C ± 5 °C	0 °C to 55 °C
10 MHz to <30 MHz	<-159 dBm/Hz; <-161 dBm/Hz, typical	<-158 dBm/Hz; <-160 dBm/Hz, typical
30 MHz to <120 MHz	<-159 dBm/Hz; <-163 dBm/Hz, typical	<-158 dBm/Hz; <-162 dBm/Hz, typical

Table 3. PXIe-5601 Average Noise Level (Continued)

Frequency	23 °C ± 5 °C	0 °C to 55 °C
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
Conditions: Input terminated; no input signal; 0 dB RF attenuation; -10 dBm reference level at frequencies <100 MHz, -50 dBm reference level elsewhere.		

Accuracy

Absolute Gain Accuracy

Table 4. ≥-49 dBm Reference Levels

Frequency	Accuracy	
	23 °C ± 5 °C	0 °C to 55 °C
10 MHz to <300 MHz	±1.5 dB; ±0.7 dB, typical	±1.5 dB; ±0.7 dB, typical
300 MHz to <400 MHz	±1.4 dB; ±0.7 dB, typical	±1.65 dB; ±0.95 dB, typical
400 MHz to <5.5 GHz	±1.3 dB; ±0.6 dB, typical	±1.4 dB; ±0.7 dB, typical
5.5 GHz to <6.6 GHz	±1.3 dB; ±0.65 dB, typical	±2.15 dB; ±1.45 dB, typical
Conditions: RF attenuation ≥8 dB; signal-to-noise ratio ≥20 dB; using calibration data stored internal to the PXIe-5601.		

Table 5. <-49 dBm Reference Levels

Frequency	Accuracy	
	23 °C ± 5 °C	0 °C to 55 °C
10 MHz to <300 MHz	±1.5 dB; ±0.7 dB, typical	±1.5 dB; ±0.7 dB, typical
300 MHz to <400 MHz	±1.4 dB; ±0.7 dB, typical	±1.4 dB; ±0.7 dB, typical
400 MHz to <5.5 GHz	±1.3 dB; ±0.6 dB, typical	±1.3 dB; ±0.6 dB, typical
5.5 GHz to <6.6 GHz	±2.5 dB; ±1.3 dB, typical	±2.7 dB; ±1.5 dB, typical
Conditons: RF attenuation ≥8 dB; signal-to-noise ratio ≥20 dB; using calibration data stored internal to the PXIe-5601.		

Conversion Gain

Figure 4. PXIe-5601 Typical Conversion Gain

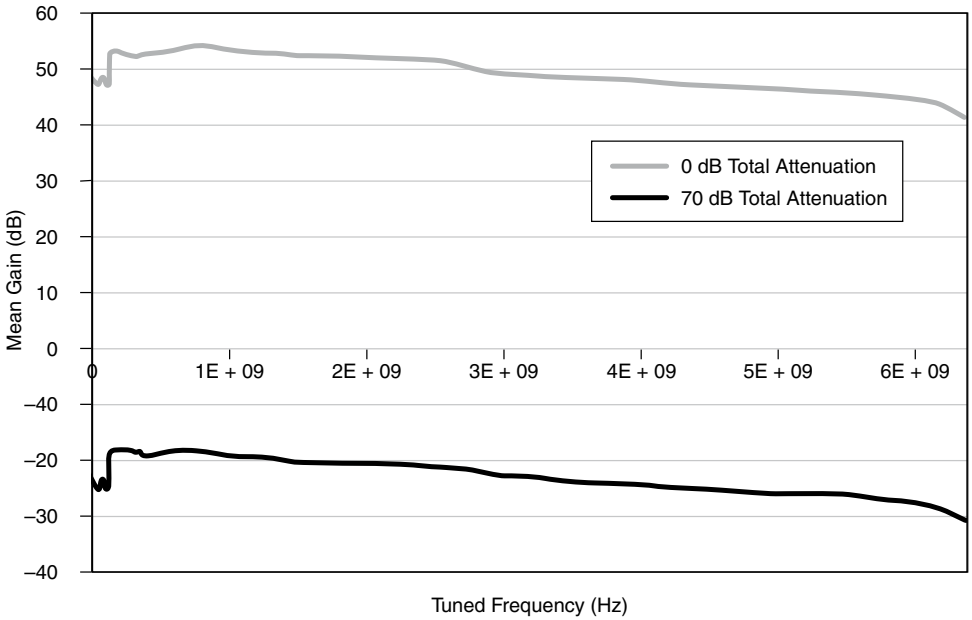
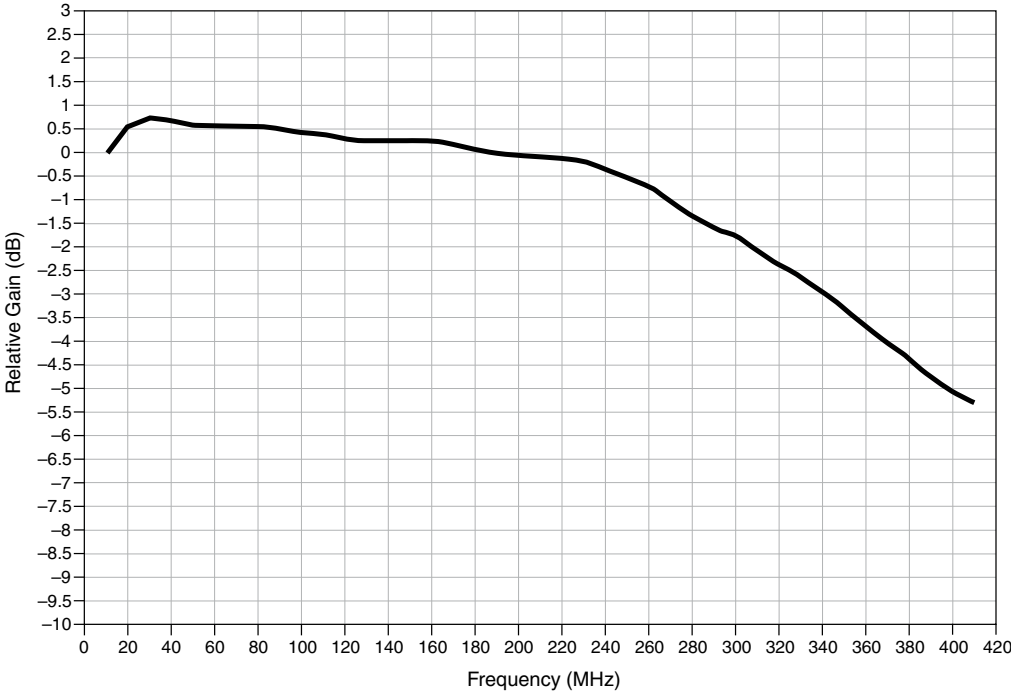


Figure 5. PXIe-5601Typical Bypass Response



Gain step size	1 dB

Spurious Responses[5]

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

IF Rejection

Table 6. PXIe-5601 IF Rejection[6], 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

[5] Spurious response specifications assume the use of the PXIe-5652 as the LO source.

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

Table 6. PXIe-5601 IF Rejection[6], Typical (Continued)

Tuned Frequency	Interference Frequency	Level
330 MHz to 6.6 GHz	187.5 MHz	<-52 dBc
Conditions: -30 dBm input signal; -30 dBm reference level; 0 dB attenuation.		

Non-Input-Related Spurs (Residual Spurs)[7]

10 MHz to 6.6 GHz[8] <-100 dBm, typical

Sideband Spurs[9]

Table 7. Typical Sideband Spurs, >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
Conditions: 0 dBm input level; 0 dBm reference level; automatic attenuation settings.	

Table 8. Typical Sideband Spurs, >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
Conditions: 0 dBm input level; 0 dBm reference level; automatic attenuation settings.	

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

[7] Residual responses are the responses observed when no input signal is present.

[8] Input terminated; no input signal; 0 dB attenuation; ≤ -60 dBm reference level; does not include LO leakage.

[9] Sideband spurs are due to system operation and appear on signals being observed.

Input-Related Spurs

Table 9. PXIe-5601 Typical Input-Related Spurs

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
Conditions: 0 dB input level; 0 dBm reference level; automatic attenuation settings.	

LO Leakage [10]

Table 10. PXIe-5601 LO Leakage

Port	Frequency	Level
RF	10 MHz to <3.0 GHz	<-60 dBm, typical
	3.0 GHz to 6.6 GHz	<-55 dBm, typical
IF	10 MHz to <120 MHz	<-25 dBm, typical
	120 MHz to 6.6 GHz	<-55 dBm, typical
Conditions: 0 dB attentuation; -30 dBm reference level.		

Linearity

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

Table 11. -20 dBm Reference Level, Typical

Frequency Range	Input IP_3
10 MHz to < 30 MHz	≥4 dBm
30 MHz to <330 MHz	≥8 dBm

[10] LO leakage is the local oscillator signal that appears at the RF input and IF output port.

Table 11. -20 dBm Reference Level, Typical (Continued)

Frequency Range	Input IP_3
330 MHz to <3.0 GHz	≥12 dBm
3.0 GHz to 6.6 GHz	≥11 dBm
Conditions: Two -30 dBm input tones = 200 kHz apart.	

Table 12. 10 dBm Reference Level, Typical

Frequency Range	Input IP_3
10 MHz to < 30 MHz	≥31 dBm
30 MHz to <330 MHz	≥30 dBm
330 MHz to <3.0 GHz	≥34 dBm
3.0 GHz to 6.6 GHz	≥25 dBm
Conditions: Two 0 dBm input tones = 200 kHz apart.	

Gain Compression

Table 13. PXIe-5601 Typical Gain Compression

Frequency	1 dB Compression Point
10 MHz to <30 MHz	<0 dBm
30 MHz to <100 MHz	<4 dBm
100 MHz to <6.6 GHz	<8 dBm
Conditions: At the RF IN connector; -10 dBm reference level.	

Dynamic Range

Compression (1 dB)-to-Noise Dynamic Range (DR)

Table 14. Typical Compression (1 dB)-to-Noise DR

Frequency	Compression-to-Noise DR
30 MHz to <100 MHz	>136 dB
100 MHz to 6.6 GHz	>138 dB
Conditions: Noise normalized to 1 Hz bandwidth; 0 dB RF attenuation; -10 dBm reference level.	

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

Table 15. Nominal Maximum Dynamic Range (Spurious-Free Dynamic Range (SFDR))

Frequency	+10 dBm Reference Level[11]	-20 dBm Reference Level[12]
30 MHz to <330 MHz	105 dB	105 dB
330 MHz to <3.3 GHz	106 dB	105 dB
3.3 GHz to 6.6 GHz	105 dB	104 dB
Conditions: SFDR = $\frac{2}{3}$ (IIP_3 – Average Noise Level); noise normalized to 1 Hz.		

[11] Signal level = 0 dBm for +10 dBm Reference Level.
[12] Signal level = -30 dBm for -20 dBm Reference Level.

Figure 6. PXIe-5601 Dynamic Range, +10 dBm Reference Level

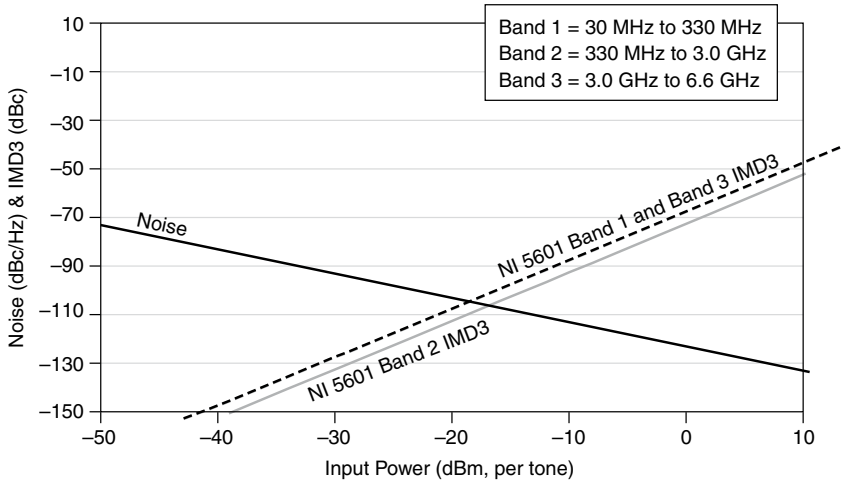
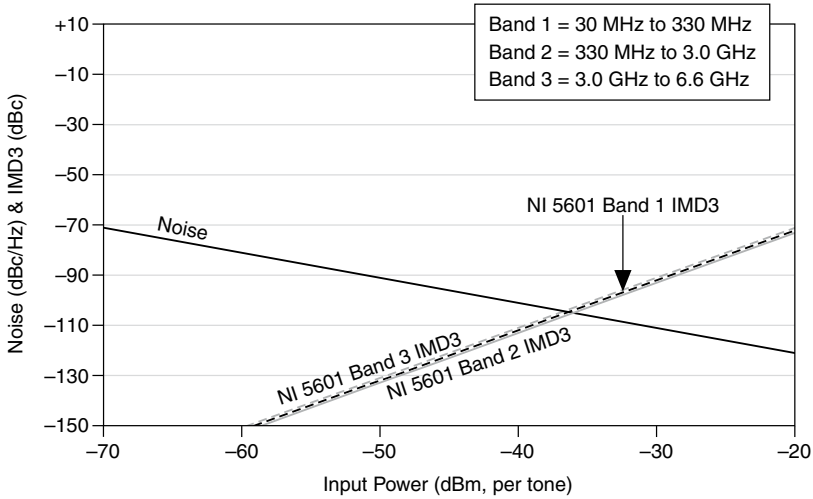


Figure 7. PXIe-5601 Dynamic Range, -20 dBm Reference Level



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.

Measurement Speed

Frequency Settling Time[13]

Table 16. Nominal Frequency Settling Time

Accuracy	Frequency Settling Time[14]
0.1×10^{-6} of final frequency	1.5 ms
0.01×10^{-6} of final frequency	6.5 ms

Amplitude Settling Time[15]

Amplitude Settling Time[16]	
Mechanical attenuator not used	62.5 µs, nominal
Mechanical attenuator used	1.2 ms, nominal

Input and Output Characteristics

PXIe-5601

RF IN (PXIe-5601)

Connector	SMA female
Impedance	50 Ω, nominal
Coupling	AC
Maximum safe DC input voltage	±5 V, nominal

Maximum Safe Continuous RF Power Level (PXIe-5601)

RF attenuation enabled (≥ 8 dB)	+30 dBm
RF attenuation disabled (0 dB)	+20 dBm

[13] Frequency and amplitude settling times partially overlap.
[14] Typical for tuning between any two frequencies. You can reduce settling time using a wide downconverter loop bandwidth.
[15] Frequency and amplitude settling times partially overlap.
[16] Accuracy of 0.1 dB of final amplitude.

Voltage Standing Wave Ratio (VSWR)

Table 17. PXIe-5601 VSWR, Nominal

Attenuation	Frequency	VSWR
Enabled (≥8 dB)[17]	10 MHz to <1.3 GHz	1.4:1
	1.3 GHz to <5.0 GHz	2.0:1
	5.0 GHz to 6.6 GHz	3.0:1
Disabled (0 dB)	10 MHz to <5.0 GHz	2.0:1
	5.0 GHz to 6.6 GHz	3.0:1

IF OUT (PXIe-5601)

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[18], or Bypass[19], nominal
VSWR	
53 MHz	2.1:1
187.5 MHz	1.65:1
Bypass	1.4:1[19]

LO IN and LO OUT (PXIe-5601)

Connector	SMA female
Impedance	50 Ω, nominal
Coupling	AC
Frequency	173 MHz to 6.4125 GHz, nominal
Amplitude	0 dBm, nominal, input and output

[17] Available in 1 dB steps.
[18] Dependent on frequency range of RF input signal.
[19] 10 MHz to 300 MHz.

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

Power Requirements [20]

+3.3 VDC	640 mA
+12 VDC	740 mA

Calibration

Interval	1 year

Dimensions and Weight

Hot Surface If the PXIe-5601 has been in use, it may exceed safe handling temperatures and cause burns. Allow the PXIe-5601 to cool before removing it from the chassis.

Dimensions	3U, One Slot, PXI Express module, 21.6 cm × 2.0 cm × 13.0 cm (8.5 in. × 0.8 in. × 5.1 in.)
Weight	454 g (16.0 oz)

Environment

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

Indoor use only.

[20] Voltages ±5%.

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`.)

375026C-01 December 14, 2017