PXIe-5831 Specifications

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PXIe-5831 Specifications

These specifications apply to the PXIe-5831 Vector Signal Transceiver for intermediate frequency (IF) and millimeter wave (mmWave) frequencies.

The PXIe-5831 IF only instrument configuration comprises the following modules:

- PXIe-5820 Vector Signal Transceiver
- PXIe-3622 Vector Signal Up/Down Converter

The PXIe-5831 IF and mmWave instrument configuration comprises the following modules:

- PXIe-5820 Vector Signal Transceiver
- PXIe-3622 Vector Signal Up/Down Converter
- PXIe-5653 RF Analog Signal Generator (LO source)
- One or two mmRH-5582 mmWave Radio Heads

There is no single instrument labeled "PXIe-5831."

Definitions

In this document, the terms ***RF***, ***RF Input***, and ***RF Output*** refer to the specifications applicable to the mmWave TRX ports. The terms ***IF***, ***IF Input***, and ***IF Output*** refer to the specifications applicable to the IF IN/OUT ports. ***Leveled power*** refers to an output power level setting that has been adjusted to meet the published amplitude accuracy specifications.

Warranted specifications describe the performance of a model under stated operating conditions and are covered by the model warranty. Warranted specifications account for measurement uncertainties, temperature drift, and aging. Warranted specifications are ensured by design or verified during production and calibration.

Characteristics 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.
- ***Measured*** specifications describe the measured performance of a representative model.

Specifications are ***Warranted*** unless otherwise noted.

Conditions

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

- 30 minutes warm-up time
- Self-calibration is performed after the specified warm-up period has completed
- Environment temperature is within the ambient range, and temperatures for individual PXIe-5820, PXIe-3622, PXIe-5653, and mmRH-5582 modules, as reported by their onboard temperature sensors, are within ±5 °C of the last self-calibration temperature, and temperature correction is enabled (default driver behavior)
- Calibration cycle is maintained
- Proper connector care and maintenance has been performed
- Modules are installed in an NI chassis with slot cooling capacity = 82 W
- The chassis fan mode is set to Auto and Cooling Profile is set to 58 W/82 W in NI Measurement & Automation Explorer (MAX)
- Empty chassis slots contain slot blockers and EMC filler panels to minimize temperature drift and reduce emissions
- Modules are connected with NI cables as shown in the ***PXIe-5831 Getting Started Guide***
- RFmx, NI-RFSA 19.6 or later, or NI-RFSG 19.6 or later instrument driver is used, and driver default settings are used unless otherwise noted
- Calibration IP is used properly during the creation of custom FPGA bitfiles
- LO Step Size is set to the default value and the LO Source is set to Onboard
- Acquisition Type is set to IQ

Warranted specifications are valid under the following condition unless otherwise noted.

- Over ambient temperature ranges of 0 °C to 45 °C for IF ports
- Over ambient temperature ranges of 23 °C± 5 °C for RF ports

Typical and Typical-95 specifications are valid under the following condition unless otherwise noted.

- Over ambient temperature ranges of 23 °C± 5 °C for IF and RF ports

Measured specifications do not include measurement uncertainty and are measured immediately after a device self-calibration is performed.

Typical specifications do not include measurement uncertainty.

Instrument Terminology

Refer to the following list for definitions of common PXIe-5831 instrument terms used throughout this document.

Table 1. Instrument Terminology Definitions

Term	Definition
IF IN/OUT Ports	Refers to the IF IN/OUT 0 and IF IN/OUT 1 connectors on the PXIe-3622 front panel for intermediate frequency (IF) signals.
TRX Ports	Refers to the DIRECT TRX PORTS or SWITCHED TRX PORTS on the mmRH-5582 front panel for RF signals.
DIRECT TRX PORTS	RF connectors 0, 1, or 8 on mmRH-5582 modules labeled with DIRECT TRX PORTS.
SWITCHED TRX PORTS	RF connectors 0 through 7 or 0 through 15 on mmRH-5582 modules labeled with SWITCHED TRX PORTS.
LO1	Refers to the local oscillator responsible for the up and down conversion between IF and mmWave frequencies.

Term	Definition
LO2	Refers to the local oscillator internal to the PXIe-3622 responsible for the up and down conversion between baseband and IF.
Onboard	Refers to the value of the LO Source property and changes purpose depending on the designated LO and instrument configuration. A value of Onboard configures the hardware as follows: • **PXIe-5831 IF only instrument**—LO1: N/A LO2: Sets the source of LO2 to one of the internal synthesizers of the PXIe-3622. • **PXIe-5831 IF and mmWave instrument**—LO1: Sets the source of LO1 to the PXIe-5653. LO2: Sets the source of the LO2 to one of the internal synthesizers of the PXIe-3622.
Secondary	Refers to the value of the LO Source property for LO1 in the PXIe-5831 IF and mmWave instrument configuration. The value of Secondary sets the source of LO1 to the internal PXIe-3622 synthesizers. This setting optimizes frequency settling time, but may worsen phase noise. NI recommends using this setting when LO sharing and speed optimization for spectral scanning is preferred.
Offset Mode is Automatic	Refers to the NI-RFSADownconverter Frequency Offset Mode property or NI-RFSGUpconverter Frequency Offset Mode property set to Automatic. The PXIe-5831 contains a direct conversion architecture. Offset mode allows the instrument to operate in low IF mode, which increases the separation between the signal of interest and the residual sideband image and residual LO leakage power. However, low IF mode limits the available instantaneous bandwidth. A setting of Automatic allows the driver to enable low IF mode when the signal bandwidth is small enough to allow it. Automatic is the default value. NI recommends keeping offset mode set to the default value.
Offset Mode is Enabled	Refers to the NI-RFSADownconverter Frequency Offset Mode

Term	Definition
	property or NI-RFSGUpconverter Frequency Offset Mode property set to Enabled. The PXIe-5831 contains a direct conversion architecture. Offset mode allows the instrument to operate in low IF mode, which increases the separation between the signal of interest and the residual sideband image and residual LO leakage power.
Offset Mode is User-Defined	Refers to the NI-RFSADownconverter Frequency Offset Mode property or NI-RFSGUpconverter Frequency Offset Mode property set to User-Defined. The PXIe-5831 contains a direct conversion architecture. Offset Mode set to User-Defined allows the instrument to operate with maximum instantaneous bandwidth. By default, the offset is selected to maximize the available instantaneous bandwidth.
dBr	For receivers, dBr refers to the power of a received signal with respect to the instrument's configured reference level. For example, if the reference level is set to -10 dBm but the received tone is -7 dBr, the actual power of the received CW is -17 dBm. For transmitters, dBr refers to the generated power of a CW with respect to the instrument's peak power setting. For example, with a peak power level setting of +5 dBm and a -3 dBr setting, the power of the transmitted CW is +2 dBm.

Related information:

- Refer to the PXIe-5831 section of the NI RF Vector Signal Transceivers Help for more information about instrument terminology.

Frequency

Frequency range[1]

IF IN/OUT 0, IF IN/OUT 1	5 GHz to 21 GHz
TRX ports (Transmit)	22.5 GHz to 31.3 GHz 37 GHz to 44 GHz
TRX ports (Receive)	22.5 GHz to 44 GHz
Frequency bandwidth	1 GHz within the specified frequency ranges
Tuning resolution[2]	4.45 uHz

Note The mmRH-5582 DIRECT TRX PORTS and SWITCHED TRX PORTS share the same frequency ranges and are only available on the PXIe-5831 mmWave instrument configurations.

Table 2. Default LO Step Size[3],[4]

Frequency Range	Step Size	
	Onboard	Secondary
5 GHz to 14.2 GHz	2 MHz	—
>14.2 GHz to 21 GHz	4 MHz	—
22.5 GHz to 44 GHz	<1 Hz	8 MHz

Frequency Settling Time

Table 3. PXIe-5653 Frequency Lock Time,Typical

Frequency Step Size	Frequency Lock Time (ms)
≤25 MHz	0.85
≤50 MHz	1.10

Frequency Step Size	Frequency Lock Time (ms)
≤75 MHz	1.35
≤80 MHz	1.35
≤90 MHz	1.35
≤100 MHz	1.35
≤250 MHz	1.80
≤500 MHz	6
≤1.0 GHz	10
≤2.0 GHz	13
≤3.0 GHz	15
≤5.1 GHz	17

Note LO1 Frequency Tuning Time consists of the PXIe-5653 Lock Time + PXIe-5831 (LO1) Settling Time to Required Accuracy. The PXIe-5653 Lock Time is dependent on the RF Center Frequency (CF) frequency step change from initial frequency to final frequency. The relationship between the CF and the PXIe-5653 frequency is governed by the equation: $F\_{PXIe-5653} = (F_{CF} + F_{IF})/8$. F_{IF} is determined by the CF. For CF = 22.5 GHz to 31.3 GHz, F_{IF} = 17.8 GHz; CF = >31.3 GHz to 40 GHz, F_{IF} = 12 GHz; CF = >40 GHz to 44 GHz, F_{IF} = 9 GHz For example, for a CF step change from 28 GHz to 39 GHz, first calculate the equivalent $F_{PXIe-5653}$ for 28 GHz, which is 5.725 GHz, then the equivalent CF frequency for 39 GHz, which is 6.375 GHz. The PXIe-5653 step size is 6.375 GHz - 5.725 GHz = 650 MHz. The corresponding PXIe-5653 maximum frequency lock time is 10 ms.

Table 4. PXIe-5831 Frequency Settling Time[5] (LO1), Typical

Settling Accuracy (Relative to Final Frequency)	Settling Time (ms)	
	Onboard*	Secondary
$\leq 1.0 \times 10^{-6}$	0.00	0.50
$\leq 0.1 \times 10^{-6}$	0.75	0.80
$\leq 0.01 \times 10^{-6}$	1.60	1.00

Settling Accuracy (Relative to Final Frequency)	Settling Time (ms)	
	Onboard*	Secondary

Note In Secondary mode, the LO1 frequency settling time includes the frequency lock time. In Onboard mode, the frequency lock time is defined in the previous table.

* LO1 Frequency Tuning Time consists of the PXIe-5653 Lock Time + PXIe-5831 (LO1) Settling Time to Required Accuracy. The PXIe-5653 Lock Time is dependent on the RF Center Frequency (CF) frequency step change from initial frequency to final frequency. The relationship between the CF and the PXIe-5653 frequency is governed by the equation: $F\_{PXIe-5653} = (F_{CF} + F_{IF})/8$. F_{IF} is determined by the CF. For CF = 22.5 GHz to 31.3 GHz, F_{IF} = 17.8 GHz; CF = >31.3 GHz to 40 GHz, F_{IF} = 12 GHz; CF = >40 GHz to 44 GHz, F_{IF} = 9 GHz For example, for a CF step change from 28 GHz to 39 GHz, first calculate the equivalent $F_{PXIe-5653}$ for 28 GHz, which is 5.725 GHz, then the equivalent CF frequency for 39 GHz, which is 6.375 GHz. The PXIe-5653 step size is 6.375 GHz - 5.725 GHz = 650 MHz. The corresponding PXIe-5653 maximum frequency lock time is 10 ms.

Table 5. PXIe-5831 Frequency Settling Time (LO2), Typical

Settling Accuracy (Relative to Final Frequency)	Settling Time (ms), Onboard
1.0×10^{-6}	0.50
0.1×10^{-6}	0.80
0.01×10^{-6}	1.00

The LO2 frequency settling time includes the frequency lock time and settling time.

Internal Frequency Reference

LO1 source	
Onboard	
Initial adjustment accuracy	$\pm 50 \times 10^{-9}$
Temperature stability	$\pm 50 \times 10^{-9}$

Aging	$\pm 100 \times 10^{-9}$ per year
Accuracy	***Initial adjustment accuracy*** ± ***Aging*** ± ***Temperature stability***
Secondary	
Initial adjustment accuracy	$\pm 5 \times 10^{-6}$
Temperature stability	$\pm 1 \times 10^{-6}$, maximum
Aging	$\pm 1 \times 10^{-6}$ per year, maximum
Accuracy	***Initial adjustment accuracy*** ± ***Aging*** ± ***Temperature stability***
LO2 source (Onboard)	
Initial adjustment accuracy	$\pm 5 \times 10^{-6}$
Temperature stability	$\pm 1 \times 10^{-6}$, maximum
Aging	$\pm 1 \times 10^{-6}$ per year, maximum
Accuracy	***Initial adjustment accuracy*** ± ***Aging*** ± ***Temperature stability***

Spectral Purity

Table 6. IF Single Sideband Phase Noise (IF IN/OUT Ports), Typical

Frequency	Phase Noise (dBc/Hz, Single Sideband)
5 GHz to 7.1 GHz	-103
>7.1 GHz to 14.2 GHz	-97
>14.2 GHz to 21 GHz	-95

Conditions: 20 kHz offset; module temperatures within ± 5 °C of last self-calibration temperature; LO2 LO Source: Onboard.

Table 7. RF Single Sideband Phase Noise (Direct/Switched TRX Ports), Typical

Frequency	Phase Noise (dBc/Hz, Single Sideband)	
	Onboard	Secondary
22.5 GHz to 31.3 GHz	-97	-86
>31.3 GHz to 40 GHz	-99	-86
40 GHz to 44 GHz	-103	-85

Conditions: 20 kHz offset; module temperatures within ± 5 °C of last self-calibration temperature; LO1 LO Source: Onboard or Secondary.

Figure 1. Onboard LO2 Phase Noise at 5.5 GHz, 10 GHz, and 18 GHz, Measured (Spurs Not Shown)

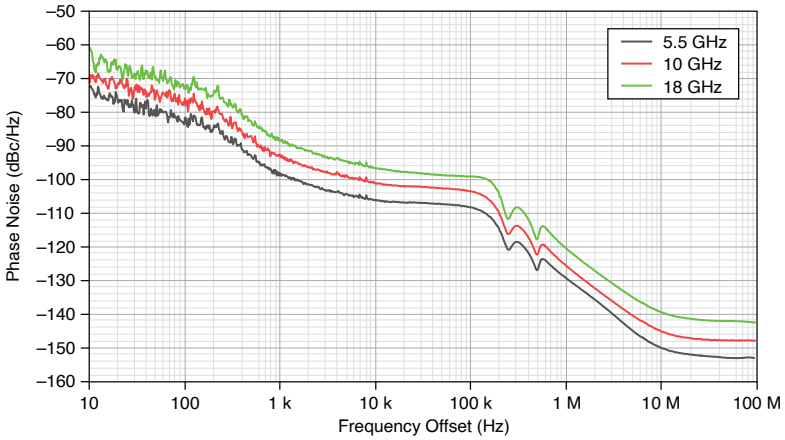
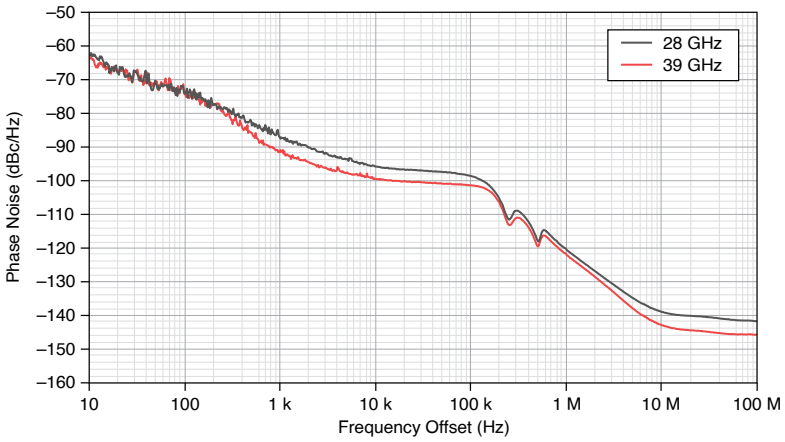


Figure 2. Onboard LO1 Phase Noise at 28 GHz and 39 GHz, Measured[6] (Spurs Not Shown)



Transmit (IF IN/OUT Ports)

IF Output Amplitude Range

Table 8. IF Output Maximum Power (dBm), CW

Upconverter Center Frequency	Leveled Power, Specification		Unleveled Power, Typical	
	IF0	IF1	IF0	IF1
5 GHz to 8 GHz	12	12	17	16
>8 GHz to 12 GHz	12	12	15	14
>12 GHz to 18 GHz	12	12	15	14
>18 GHz to 21 GHz	8	7	10	9

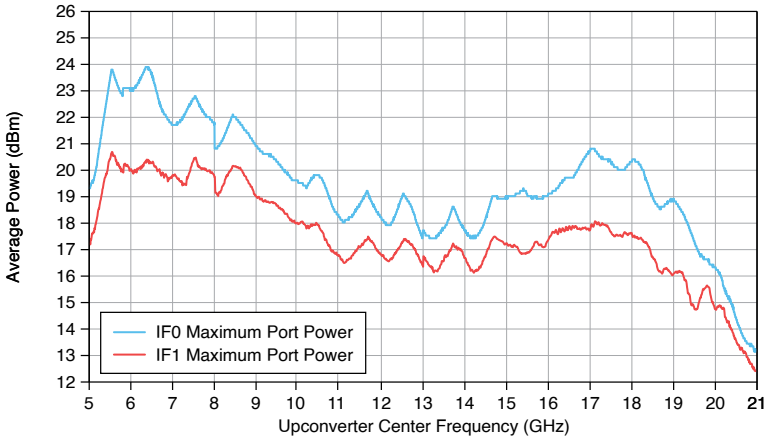
Conditions: Valid over 23 °C ± 5 °C with the last self-calibration performed at 23°C.

Measured with a tone 10 MHz offset from upconverter center frequency. For 0 °C to 45 °C, the leveled power specification output powers are 3 dB less than that of 23 °C ± 5 °C.

Minimum output power	Noise floor

Output attenuator (analog power) resolution	1 dB, nominal
Digital attenuation resolution[7]	<0.1 dB

Figure 3. IF Output Maximum CW Average Power, Measured



IF Output Amplitude Settling Time

Note [8]

<0.5 dB of final value	27 µs, nominal
<0.1 dB of final value	40 µs, nominal

IF Output Amplitude Accuracy

Table 9. IF Output Absolute Amplitude Accuracy (dB) (Offset Mode is User-Defined)

Upconverter Center Frequency	23 °C ± 5 °C			0 °C to 45 °C
	Specification	Typical-95	Typical	Specification
5 GHz to 8 GHz	±1.2	±0.8	±0.5	±1.9
>8 GHz to 12 GHz	±1.4	±1.0	±0.6	±2.1

Upconverter Center Frequency	23 °C ± 5 °C			0 °C to 45 °C
	Specification	Typical-95	Typical	Specification
>12 GHz to 18 GHz	±1.8	±1.4	±0.8	±2.7
>18 GHz to 21 GHz	±2.1	±1.7	±1.0	±2.9

Conditions: Peak power level -30 dBm to IF Output maximum leveled power specification; measured with a CW signal at 10 MHz offset from the configured upconverter center frequency; Upconverter/Downconverter Frequency Offset Mode: User-Defined; measurement performed after the PXIe-5831 has settled.

This specification is valid only when the instrument is operating within the specified ambient temperature range and each module is within ±5 °C from the last self-calibration temperature, as measured with its onboard temperature sensors.

Table 10. IF Output Absolute Amplitude Accuracy (dB) (Offset Mode is Enabled)

Upconverter Center Frequency	23 °C ± 5 °C			0 °C to 45 °C
	Specification	Typical-95	Typical	Specification
5 GHz to 8 GHz	±1.2	±0.8	±0.5	±2.0
>8 GHz to 12 GHz	±1.4	±1.0	±0.6	±2.1
>12 GHz to 18 GHz	±1.8	±1.4	±0.8	±2.7
>18 GHz to 21 GHz	±2.1	±1.7	±1.0	±2.9

Conditions: Peak power level -30 dBm to IF Output maximum leveled power specification; measured with a CW signal at I/Q center frequency, where I/Q center frequency is offset 257.5 MHz offset from the configured upconverter center frequency where the driver automatically applies a 257.5 MHz offset for signals with 450 MHz bandwidth or less. Upconverter/Downconverter Frequency Offset Mode: Enabled; measurement performed after the PXIe-5831 has settled.

This specification is valid only when the instrument is operating within the specified ambient temperature range and each module is within ±5 °C from the last self-calibration temperature, as measured with its onboard temperature sensors.

Table 11. IF Output Relative Amplitude Accuracy (Offset Mode is User-Defined), Typical

Upconverter Center Frequency	Relative Amplitude Accuracy (dB)
5 GHz to 8 GHz	±0.25
>8 GHz to 12 GHz	±0.30
>12 GHz to 18 GHz	±0.40
>18 GHz to 21 GHz	±0.40

Conditions: Peak power level -30 dBm to IF Output maximum leveled power specification; measured with a CW signal at 10 MHz offset from the configured upconverter center frequency; Upconverter/Downconverter Frequency Offset Mode: User-Defined; measurement performed after the PXIe-5831 has settled.

Relative accuracy describes the residual absolute accuracy error when compared to the absolute accuracy error at 0 dBm.

This specification is valid only when the instrument is operating within the specified ambient temperature range and each module is within ±5 °C from the last self-calibration temperature, as measured with its onboard temperature sensors.

Table 12. IF Output Relative Amplitude Accuracy (Offset Mode is Enabled), Typical

Upconverter Center Frequency	Relative Amplitude Accuracy (dB)
5 GHz to 8 GHz	±0.25
>8 GHz to 12 GHz	±0.30
>12 GHz to 18 GHz	±0.40
>18 GHz to 21 GHz	±0.40

Conditions: Peak power level -30 dBm to IF Output maximum leveled power specification; measured with a CW signal at I/Q center frequency, where I/Q center frequency is offset 257.5 MHz offset from the configured upconverter center frequency; Upconverter/Downconverter Frequency Offset Mode: Enabled; measurement performed after the PXIe-5831 has settled.

Relative accuracy describes the residual absolute accuracy error when compared to the absolute accuracy error at 0 dBm.

This specification is valid only when the instrument is operating within the specified ambient

Upconverter Center Frequency	Relative Amplitude Accuracy (dB)

temperature range and each module is within ±5 °C from the last self-calibration temperature, as measured with the onboard temperature sensors.

IF Output Frequency Response

Table 13. IF Output Frequency Response (dB)

Upconverter Center Frequency	23 °C ± 5 °C			0 °C to 45 °C
	Specification	Typical-95	Typical	Specification
5 GHz to 8 GHz	1.45	0.95	0.80	1.90
>8 GHz to 12 GHz	1.45	0.85	0.75	1.95
>12 GHz to 18 GHz	1.70	1.10	0.95	2.25
>18 GHz to 21 GHz	1.95	1.30	1.10	2.55

Conditions: Peak power level -30 dBm to IF Output maximum leveled power specification; module temperature within ±5 °C of last self-calibration temperature.

Frequency response is defined as the maximum relative amplitude deviation from the reference offset frequency over the instantaneous bandwidth. For the PXIe-5831 IF output, the reference offset frequency is 10 MHz higher than the upconverter center frequency. For the absolute amplitude accuracy at the reference offset, refer to the IF Output Amplitude Accuracy section.

Figure 4. IF Output Frequency Response, 0 dBm, Peak Output Power Level, Equalized, Measured

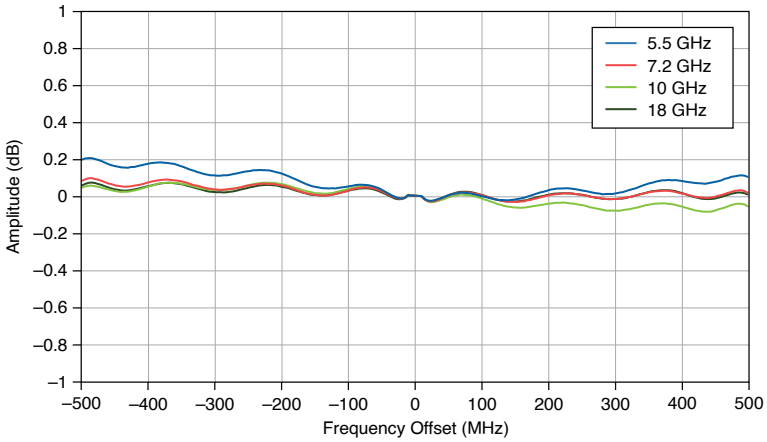
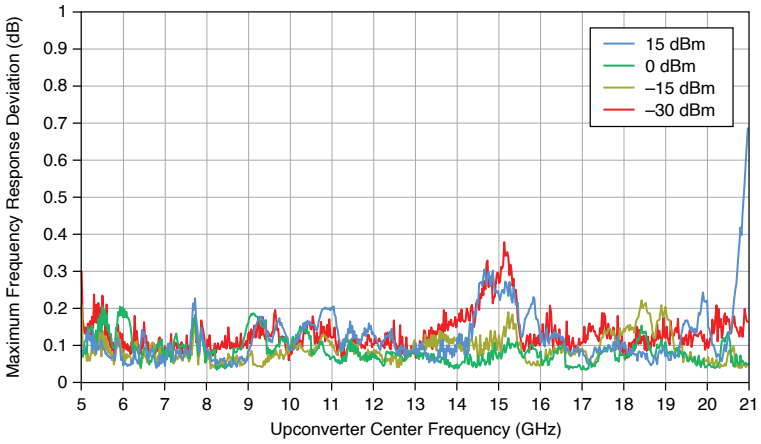


Figure 5. Maximum IF Output Frequency Response Deviation versus Upconverter Center Frequency,

Measured



IF Output Average Noise Density

Table 14. Output Average Noise Density (dBm/Hz), Typical

Upconverter Center Frequency	Output Power Level Setting		
	-10 dBm	0 dBm	15 dBm
5 GHz to 8 GHz	-156	-149	-135
>8 GHz to 12 GHz	-154	-148	-135
>12 GHz to 18 GHz	-151	-145	-132
>18 GHz to 21 GHz	-149	-145	-131

Conditions: 10 averages; 40 dB baseband signal attenuation; noise measurement frequency offset by 200 MHz from the upconverter center frequency; the instrument driver is in peak mode.

Measured on the PXIe-3622IF IN/OUT 1 port. The IF IN/OUT 0 port has a 1 dB to 5 dB degradation compared to the IF IN/OUT 1 port.

IF Output Third-Order Intermodulation

Table 15. IF Output Third-Order Intermodulation Distortion (IMD_3) (dBc), Typical

Upconverter Center Frequency	IF IN/OUT 0			IF IN/OUT 1		
	Output Power Level Setting			Output Power Level Setting		
	-30 dBm	0 dBm	15 dBm	-30 dBm	0 dBm	15 dBm
5 GHz to 8 GHz	-56	-56	-49	-45	-46	-46

Upconverter Center Frequency	IF IN/OUT 0			IF IN/OUT 1		
	Output Power Level Setting			Output Power Level Setting		
	-30 dBm	0 dBm	15 dBm	-30 dBm	0 dBm	15 dBm
>8 GHz to 12 GHz	-58	-57	-41	-53	-52	-39
>12 GHz to 18 GHz	-55	-55	-37	-53	-50	-35
>18 GHz to 21 GHz	-55	-54	—	-50	-50	—

Conditions: Measured by generating two -7 dBr tones at +95 MHz and +105 MHz off from the upconverter center frequency. The nominal peak envelope power is 1 dB below the ***Output Power Level Setting***; the instrument driver is in peak mode.

IF Output Harmonic Spurs

Table 16. IF Output Out of Band Spur Levels, Measured

Upconverter Center Frequency	Harmonic Level (dBc)
5 GHz to 8 GHz	-32
>8 GHz to 12 GHz	-34
>12 GHz to 21 GHz	-34
>18 GHz to 21 GHz	-48

Conditions: Peak power level 0 dBm; measured with a CW signal at 100 MHz offset from the configured upconverter center frequency; Upconverter/Downconverter Frequency Offset Mode: User-Defined; measurement performed after the PXIe-5831 has settled.

Includes CW and LO harmonics.

Measured at 23 °C ambient within ±5 °C from the last self-calibration temperature.

IF Output Nonharmonic Spurs

Table 17. IF Output Nonharmonic Spurs (dBc) (Default LO Step Size), Typical

Upconverter Center Frequency	Offset ≤ 500 kHz	500 kHz < Offset ≤ 20 MHz	Offset > 20 MHz
5 GHz to 8 GHz	-62	-44	<-70
>8 GHz to 12 GHz	-59	-51	<-70
>12 GHz to 18 GHz	-54	-51	<-70
>18 GHz to 21 GHz	-53	-59	<-70

Conditions: Measured relative to a 0 dBm output tone.

The maximum offset is limited to the instantaneous 1 GHz bandwidth at the referenced upconverter center frequency.

Note Offset refers to ± desired signal offset (Hz) around the current upconverter center frequency.

Table 18. IF Output Nonharmonic Spurs (dBc) (1 MHz LO Step Size), Measured

Upconverter Center Frequency	0 Hz ≤ Offset ≤ 5 MHz
5 GHz to 7.1 GHz	-64
>7.1 GHz to 14.2 GHz	-46
>14.2 GHz to 21 GHz	-40

Conditions: Measured relative to a 0 dBm output tone.

Note Offset refers to ± desired signal offset (Hz) around the current upconverter center frequency.

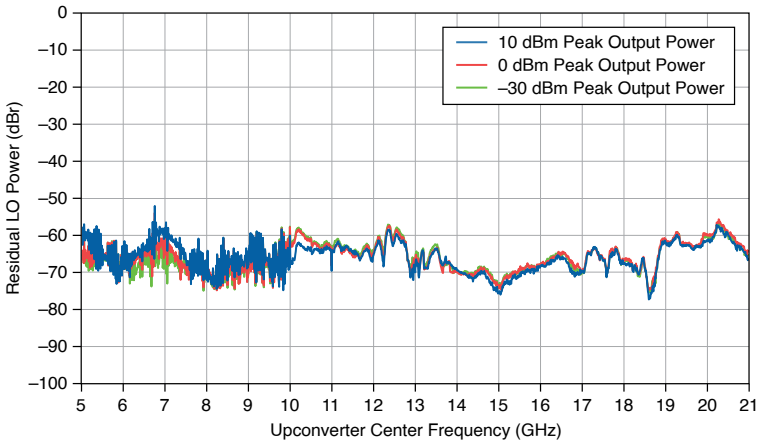
IF Output LO Residual Power

Table 19. IF Output LO Residual Power (dBr), Typical

Upconverter Center Frequency	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C
5 GHz to 8 GHz	-50	-47
>8 GHz to 12 GHz	-48	-36
>12 GHz to 18 GHz	-46	-35
>18 GHz to 21 GHz	-36	-28

Conditions: Peak output power levels -30 dBm up to the IF Output maximum leveled power specifications. The transmit output tone power at a maximum of -3 dBr. LO2 LO Source property set to Onboard.

Figure 6. IF Output LO Residual Power, Measured



IF Output Residual Sideband Image

Table 20. IF Output Residual Sideband Image (dBc), Typical

Upconverter Center Frequency	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C
5 GHz to 8 GHz	-39	-34
>8 GHz to 12 GHz	-48	-41

Upconverter Center Frequency	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C
>12 GHz to 18 GHz	-50	-46
>18 GHz to 21 GHz	-48	-43

Conditions: Peak output power levels -30 dBm up to the IF Output maximum leveled power specifications. Output tone power at a maximum of -3 dBr. LO2 LO Source property set to Onboard.

This specification describes the maximum residual sideband image within the 1 GHz device instantaneous bandwidth.

Figure 7. IF Output Residual Sideband Image, 0 dBm Peak Power, Measured

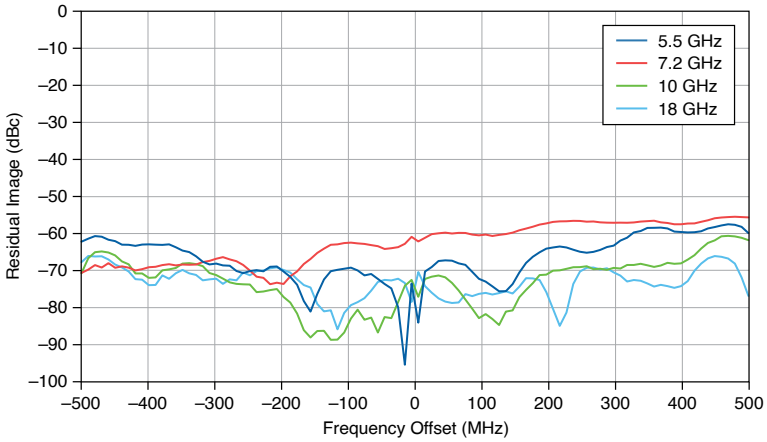
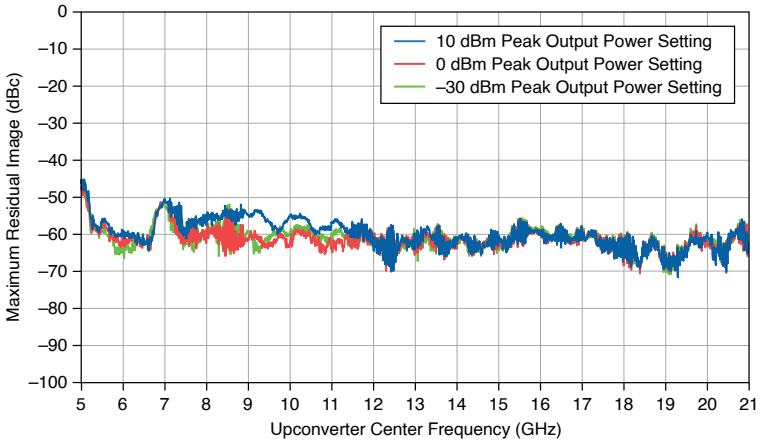


Figure 8. Maximum IF Output Residual Sideband Image Versus Upconverter Center Frequency, Measured



Transmit (TRX Ports)

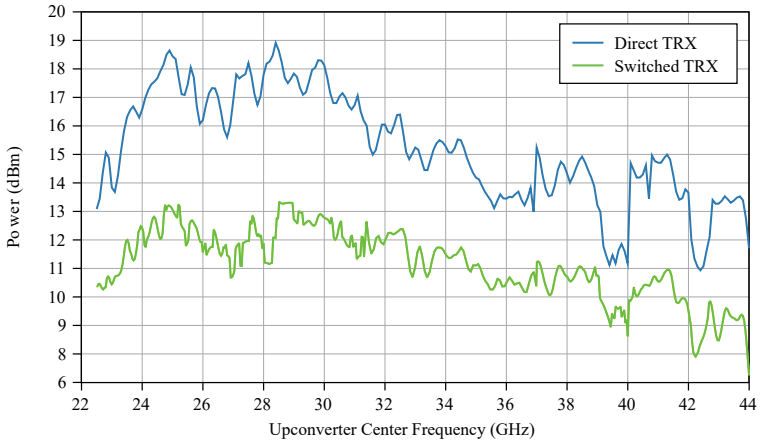
RF Output Amplitude Range

Table 21. RF Output Maximum Power (dBm), CW

Upconverter Center Frequency	Leveled Power, Specification		Unleveled Power, Typical	
	Direct TRX Ports	Switched TRX Ports	Direct TRX Ports	Switched TRX Ports
22.5 GHz to <24 GHz	10	6	14	10
24 GHz to 31 GHz	10	6	15	10
37 GHz to 40 GHz	6	0	11	7
>40 GHz to 44 GHz	2	0	11	5
Conditions: Valid over 23 °C ± 5 °C. Measured with a tone 10 MHz offset from upconverter center frequency.				

Minimum Output Power	Noise Floor
Output attenuator (analog power) resolution	1 dB, nominal
Digital attenuation resolution[9]	<0.1 dB

Figure 9. RF Output Maximum Unleveled CW Power, Measured



RF Output Amplitude Settling Time

Note Settling time refers to the time it takes the amplitude to settle once the hardware receives the amplitude change command. The additional time due to software-initiated amplitude changes is not included and varies by computer. When changing frequencies, reconfiguration time is dominated by the frequency settling. Refer to Frequency Settling Time for more information.

Note Varying RF output power range.

<0.5 dB of final value	31 µs, nominal
<0.1 dB of final value	43 µs, nominal

RF Output Amplitude Accuracy

Table 22. RF Output Absolute Amplitude Accuracy (dB) (Offset Mode is User-Defined)

Upconverter Center Frequency	Specification	Typical-95	Typical
22.5 GHz to 31.3 GHz	±2.1	±1.6	±1.1
37 GHz to 40 GHz	±2.2	±1.9	±1.2
>40 GHz to 44 GHz	±3.0	±2.2	±1.5

Upconverter Center Frequency	Specification	Typical-95	Typical
Conditions: Valid for RF output power levels from -40 dBm up to the RF Output maximum leveled power specifications for direct and switched ports; measured with a CW signal at 10 MHz offset from the configured upconverter center frequency; Upconverter/Downconverter Frequency Offset Mode: User- Defined; measurement performed after the PXIe-5831 has settled. This specification is valid over 23 °C ± 5 °C with the last self-calibration performed at 23°C.			

Table 23. RF Output Absolute Amplitude Accuracy (dB) (Offset Mode is Enabled), Typical

Upconverter Center Frequency	Direct TRX (dB)	Switched TRX (dB)
22.5 GHz to 31.3 GHz	±1.1	±1.4
37 GHz to 40 GHz	±1.2	±1.2
>40 GHz to 44 GHz	±1.5	±1.8
Conditions: Valid for RF output power levels from -40 dBm up to the RF Output maximum leveled power specifications for direct and switched ports; measured with a CW signal at I/Q center frequency, where I/Q center frequency is offset 257.5 MHz offset from the configured upconverter center frequency where the driver automatically applies a 257.5 MHz offset for signals with 450 MHz bandwidth or less; Upconverter/Downconverter Frequency Offset Mode: Enabled; measurement performed after the PXIe-5831 has settled. This specification is valid over 23 °C ± 5 °C with the last self-calibration performed at 23°C.		

Table 24. RF Output Relative Amplitude Accuracy (Offset Mode is User-Defined), Typical

Upconverter Center Frequency	Direct TRX (dB)	Switched TRX (dB)
22.5 GHz to 31.3 GHz	±0.50	±0.75
37 GHz to 40 GHz	±0.55	±0.80
>40 GHz to 44 GHz	±0.60	±0.85

Upconverter Center Frequency	Direct TRX (dB)	Switched TRX (dB)
Conditions: Valid for RF output power levels from -40 dBm up to the RF Output maximum leveled power specifications for direct and switched ports; measured with a CW signal at 10 MHz offset from the configured upconverter center frequency; Upconverter/Downconverter Frequency Offset Mode: User- Defined; measurement performed after the PXIe-5831 has settled. Relative accuracy describes the residual absolute accuracy error when compared to the absolute accuracy error at 0 dBm. This specification is valid only when the instrument is operating within the specified ambient temperature range and each module is within ±5 °C from the last self-calibration temperature, as measured with its onboard temperature sensors.		

Table 25. RF Output Relative Amplitude Accuracy (Offset Mode is Enabled), Typical

Upconverter Center Frequency	Direct TRX (dB)	Switched TRX (dB)
22.5 GHz to 31.3 GHz	±0.6	±0.8
37 GHz to 40 GHz	±0.55	±0.8
>40 GHz to 44 GHz	±0.75	±0.9
Conditions: Valid for RF output power levels from -40 dBm up to the RF Output maximum leveled power specifications for direct and switched ports; ; measured with a CW signal at I/Q center frequency, where I/Q center frequency is offset 257.5 MHz offset from the configured upconverter center frequency; Upconverter/Downconverter Frequency Offset Mode: Enabled; measurement performed after the PXIe-5831 has settled. Relative accuracy describes the residual absolute accuracy error when compared to the absolute accuracy error at 0 dBm. This specification is valid only when the instrument is operating within the specified ambient temperature range and each module is within ±5 °C from the last self-calibration temperature, as		

Upconverter Center Frequency	Direct TRX (dB)	Switched TRX (dB)
measured with its onboard temperature sensors.		

RF Output Frequency Response

Table 26. RF Output Frequency Response (dB)

Upconverter Center Frequency	Specification	Typical-95	Typical
22.5 GHz to 23 GHz	2.8	2.4	1.1
>23 GHz to 31.3 GHz	2.2	1.8	1.0
37 GHz to 40 GHz	2.3	1.9	1.1
>40 GHz to 44 GHz	2.8	2.6	1.4

Conditions: Valid for RF output power levels from -35 dBm up to the RF Output maximum leveled power specifications for direct and switched ports.

This specification is valid only when the instrument is operating within the specified ambient temperature range and each module is within ±5 °C from the last self-calibration temperature, as measured with its onboard temperature sensors.

Frequency response is defined as the maximum relative amplitude deviation from the reference offset frequency. For the PXIe-5831 RF output, the reference offset frequency is 10 MHz higher than the upconverter center frequency over the instantaneous bandwidth. For the absolute amplitude accuracy at the reference offset, refer to the RF Output Amplitude Accuracy section.

Figure 10. Direct TRX RF Output Frequency Response, 0 dBm, Peak Output Power Level, Equalized,

Measured

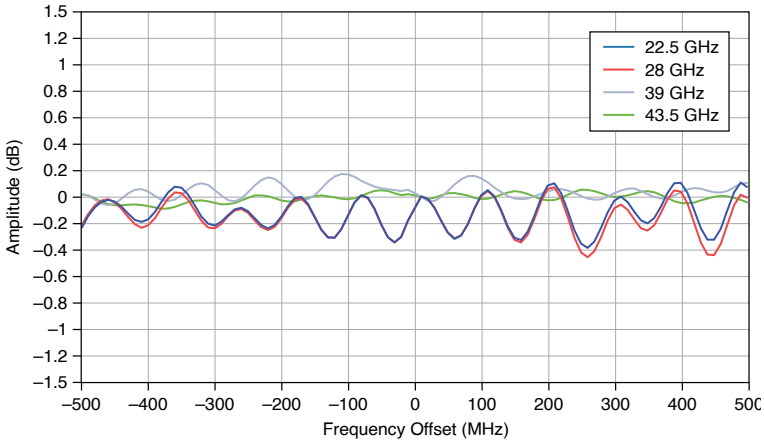


Figure 11. Direct TRX Maximum RF Output Frequency Response Deviation versus Upconverter Center Frequency, Measured

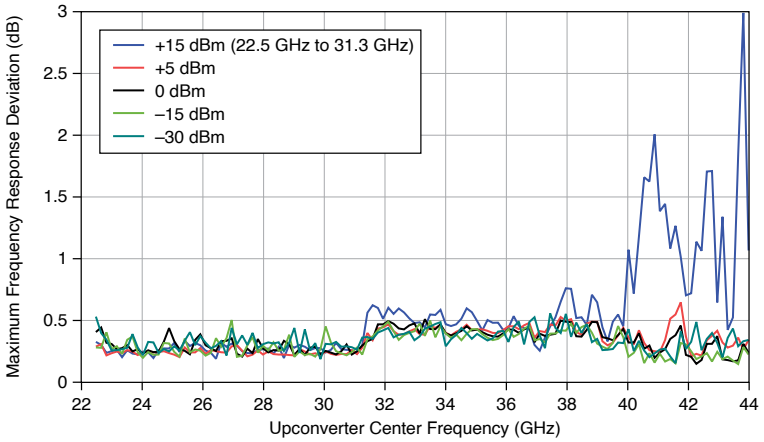
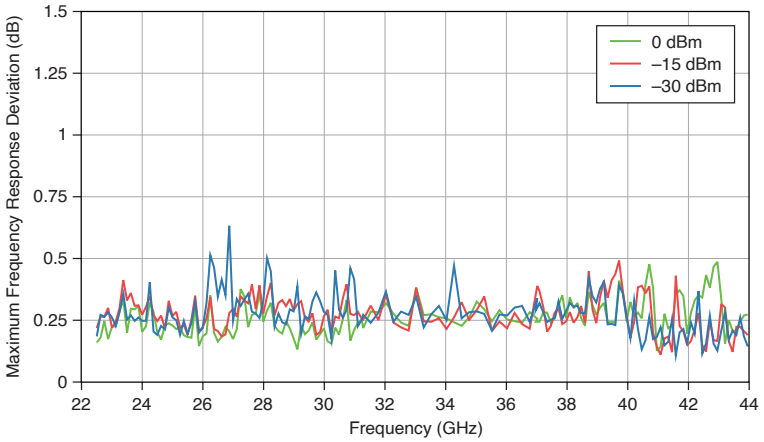


Figure 12. Switched RF Output Frequency Response Deviation versus Upconverter Center Frequency, Measured



RF Output Average Noise Density

Table 27. RF Output Average Noise Density (dBm/Hz), Measured

Upconverter Center Frequency	Output Power Level Setting		
	-10 dBm	0 dBm	+10 dBm (Direct TRX Ports Only)
22.5 GHz to 31.3 GHz	-153	-143	-132
37 GHz to 40 GHz	-153	-142	-131
>40 GHz to 44 GHz	-152	-144	-132

Conditions: Measured at both switched and direct TRX ports, +10 dBm valid for direct TRX ports only; 30 averages; 40 dB baseband signal attenuation; noise measurement frequency offset 200 MHz relative to the upconverter center frequency.

The instrument driver is in peak mode.

RF Output Third-Order Intermodulation

Table 28. Direct TRX RF Output Third-Order Intermodulation Distortion (IMD_3) (dBc), Typical

Upconverter Center Frequency	Output Power Level Setting		
	-20 dBm	0 dBm	10 dBm
22.5 GHz to 31.3 GHz	-48	-45	-41
37 GHz to 40 GHz	-54	-50	-36
>40 GHz to 44 GHz	-49	-48	-37

Conditions: Measured by generating two -7 dBr tones applied at +95 MHz and +105 MHz offset from the upconverter center frequency. The nominal peak envelope is 1 dB below the ***Output Power Level Setting***; the instrument driver is in peak mode.

Table 29. Switched TRX RF Output Third-Order Intermodulation Distortion (IMD_3) (dBc), Typical

Upconverter Center Frequency	Output Power Level Setting		
	-30 dBm	0 dBm	5 dBm
22.5 GHz to 31.3 GHz	-51	-47	-48
37 GHz to 40 GHz	-59	-44	—
>40 GHz to 44 GHz	-52	-39	—

Conditions: Measured by generating two -7 dBr tones applied at +95 MHz and +105 MHz offset from the upconverter center frequency. The nominal peak envelope is 1 dB below the ***Output Power Level Setting***; the instrument driver is in peak mode. For >37 GHz, +5 dBm is outside the leveled power range and was not measured.

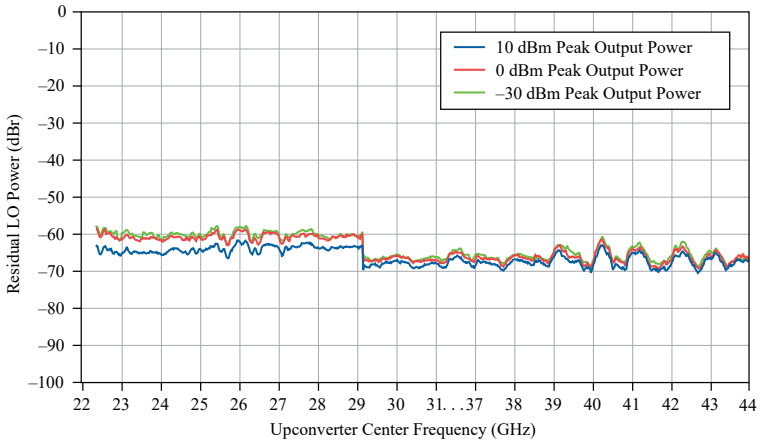
RF Output LO Residual Power

Table 30. RF Output LO Residual Power (dBr), Typical

Upconverter Center Frequency	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C
22.5 GHz to 31.3 GHz	-48	-34
37 GHz to 40 GHz	-50	-38
>40 GHz to 44 GHz	-47	-34

Conditions: Peak output power levels -30 dBm up to the RF Output maximum leveled power specifications for direct and switched ports. The transmit tone power at a maximum of -3 dBr. LO1 and LO2 LO Source property set to Onboard. The values are with respect to the peak power level setting, hence dBr.

Figure 13. RF Output LO Residual Power at Direct TRX Port, Measured



RF Output Residual Sideband Image

Table 31. RF Output Residual Sideband Image (dBc), Typical

Upconverter Center Frequency	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C
22.5 GHz to 31.3 GHz	-51	-41
37 GHz to 40 GHz	-50	-44
>40 GHz to 44 GHz	-45	-40

Conditions: Peak output power levels -30 dBm up to the RF Output maximum leveled power specifications for direct and switched ports. The transmit tone power at a maximum of -3 dBr. LO1 and LO2 LO Source property set to Onboard.

This specification describes the maximum residual sideband image within the 1 GHz device instantaneous bandwidth.

Figure 14. RF Output Residual Sideband Image, 0 dBm Peak Power Setting at Direct TRX Port,

Measured

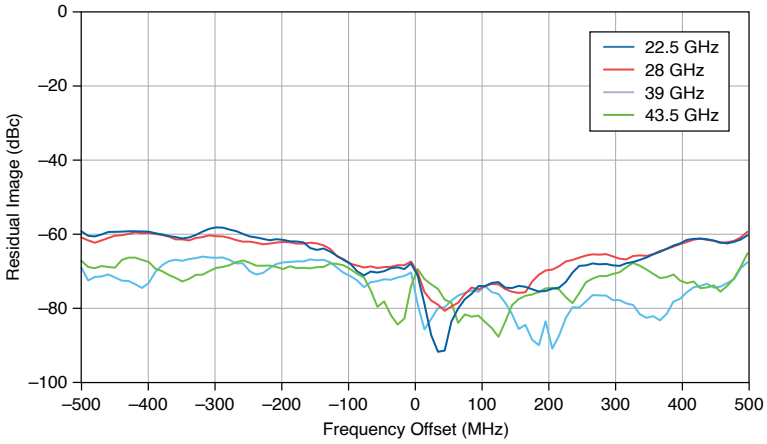
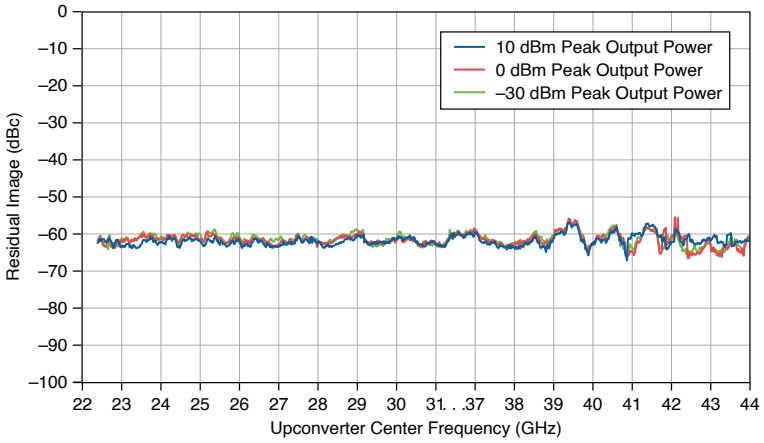


Figure 15. Maximum RF Output Residual Sideband Image Versus Upconverter Center Frequency at Direct TRX Port, Measured



RF Output In-Band and Out-of-Band Maximum Spur Levels

Table 32. RF Output Residual Spurs, Typical

Upconverter Center Frequency	LO1 x 2 (dBr)	In-Band (dBc)	Out-of-Band [500 MHz < offset < 5 GHz], (dBc)
22.5 GHz to 31.3 GHz	-32	-69	-60
37 GHz to 40 GHz	-80	-47	-37
>40 GHz to 44 GHz	-80	-60	-48
Conditions: 23 °C; peak output power is set to within -40 dBm to the RF output maximum leveled			

Upconverter Center Frequency	LO1 x 2 (dBr)	In-Band (dBc)	Out-of-Band [500 MHz < offset < 5 GHz], (dBc)

power specification for direct and switched TRX ports.

LO1 x 2 refers to out-of-band leakage where an LO1 harmonic product appears at the TRX port output as a function of the configured peak power level (hence dBr units), and upconverter center frequency (UCF). The relationship between the UCF frequency and the LO1 x 2 frequency is governed by the equation: $F_{LO1x2} = (F_{UCF}+F_{IF})/2$. F_{IF} is determined by the UCF. For UCF = 22.5 GHz to 31.3 GHz, F_{IF} = 17.8 GHz; UCF > 31.3 GHz to 40 GHz, F_{IF} = 12 GHz; UCF >40.0 GHz to 44 GHz, F_{IF} = 9 GHz. In the frequency range 22.5 GHz to 31.3 GHz, the minimum frequency for F_{LO1x2} is when CF = 22.5 GHz and here F_{LO1x2} = 20.15 GHz; the maximum frequency for F_{LO1X2} is when CF = 31.3 GHz and there F_{LO1x2} = 24.55 GHz. In all cases, LO1x2 is out-of-band.

The in-band residual spurs are a function of the transmit tone power (hence dBc units) and are measured to within the instantaneous 1 GHz bandwidth. This does not include carrier leakage and residual image.

The out-of-band spur numbers refer to spurs that are offset from the upconverter center frequency between 500 MHz to 5 GHz away, but does not include the LO1 x 2. These spurs are a function of the transmit tone power and hence have dBc units.

Figure 16. RF TRX Output Residual Spurs (Out-of-band and In-band) vs Upconverter Center Frequency, Measured[10]

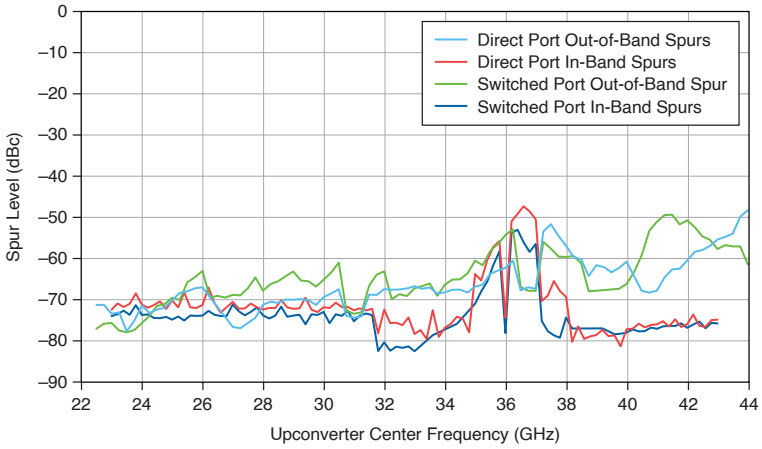


Table 33. RF Output Second and Third Harmonics at Direct TRX port, Measured

Upconverter Center Frequency	2nd Harmonic (dBc)	3rd Harmonic (dBc)
22.5 GHz to 26 GHz	-30	-105
>26 GHz to 31.3 GHz	-90	-98
>37 GHz to 40 GHz	-90	—
>40 GHz to 44 GHz	-93	—
The RF Output power is set to +10 dBm. Includes CW harmonics only. For >37 GHz, the 3rd harmonic frequency is >110 GHz and outside the measured range.		

Receive (IF IN/OUT Ports)

IF Input Amplitude Range

Amplitude range	Average noise level to +20 dBm (CW RMS)
Gain resolution	1 dB, nominal

Table 34. IF Input Analog Gain Range, Nominal

Downconverter Center Frequency	IF Analog Gain Range (dB)
5 GHz to 8 GHz	≥61
>8 GHz to 12 GHz	≥57
>12 GHz to 18 GHz	≥58
>18 GHz to 21 GHz	≥57

IF Input Amplitude Settling Time

Note Settling time refers to the time it takes the amplitude to settle once the hardware receives the amplitude change. The additional time due to software initiated amplitude changes is not included and varies by computer. When changing frequencies, reconfiguration time is dominated by the frequency settling. Refer to ***Frequency Settling Time*** for more information.

Note Constant RF input signal, varying input reference level.

<0.5 dB of final value	27 µs, nominal
<0.1 dB of final value	40 µs, nominal

IF Input Amplitude Accuracy

Table 35. IF Input Absolute Amplitude Accuracy (dB) (Offset Mode is User-Defined)

Downconverter Center Frequency	23 °C ± 5 °C			0 °C to 45 °C
	Specification	Typical-95	Typical	Specification
5 GHz to 8 GHz	±1.2	±0.8	±0.5	±1.6
>8 GHz to 12 GHz	±1.4	±1.0	±0.7	±1.6
>12 GHz to 18 GHz	±1.8	±1.4	±0.9	±2.0
>18 GHz to 21 GHz	±2.0	±1.5	±0.9	±2.6

Conditions: Reference level -30 dBm to 0 dBm for specification; -30 dBm to 20 dBm for typical; measured with a CW signal at 10 MHz offset from the configured downconverter center frequency when a user-defined frequency offset is not applied; Upconverter/Downconverter Frequency Offset Mode: User-Defined; measurement performed after the PXIe-5831 has settled.

This specification is valid only when the instrument is operating within the specified ambient temperature range and each module is within ±5 °C from the last self-calibration temperature, as measured with the onboard temperature sensors.

Table 36. IF Input Absolute Amplitude Accuracy (dB) (Offset Mode is Enabled)

Downconverter Center Frequency	23 °C ± 5 °C			0 °C to 45 °C
	Specification	Typical-95	Typical	Specification
5 GHz to 8 GHz	±1.2	±0.9	±0.5	±1.7
>8 GHz to 12 GHz	±1.4	±1.0	±0.7	±1.9
>12 GHz to 18 GHz	±1.8	±1.4	±0.9	±2.1
>18 GHz to 21 GHz	±2.0	±1.5	±0.9	±2.6

Conditions: Reference level -30 dBm to 0 dBm for specification; -30 dBm to 20 dBm for typical; measured with a CW signal at the I/Q center frequency, where the I/Q center frequency is 257.5 MHz offset from the configured downconverter center frequency where the driver automatically applies a 257.5 MHz offset for signals with 450 MHz bandwidth and less; Upconverter/Downconverter Frequency Offset Mode: Enabled; measurement performed after the PXIe-5831 has settled.

This specification is valid only when the instrument is operating within the specified ambient temperature range and each module is within ±5 °C from the last self-calibration temperature, as measured with the onboard temperature sensors.

Table 37. IF Input Relative Amplitude Accuracy (Offset Mode is User-Defined), Typical

Downconverter Center Frequency	Relative Amplitude Accuracy (dB)
5 GHz to 8 GHz	±0.25
>8 GHz to 12 GHz	±0.40
>12 GHz to 18 GHz	±0.40
>18 GHz to 21 GHz	±0.40

Conditions: Reference level -30 dBm to +20 dBm; measured with a CW signal at 10 MHz offset from the configured downconverter center frequency; Upconverter/Downconverter Frequency Offset Mode: User-Defined; measurement performed after the PXIe-5831 has settled.

Relative accuracy describes the residual absolute accuracy error when compared to the absolute accuracy at 0 dBm.

This specification is valid only when the instrument is operating within the specified ambient temperature range and each module is within ±5 °C from the last self-calibration temperature, as

Downconverter Center Frequency	Relative Amplitude Accuracy (dB)
measured with the onboard temperature sensors.	

Table 38. IF Input Relative Amplitude Accuracy (Offset Mode is Enabled), Typical

Downconverter Center Frequency	Relative Amplitude Accuracy (dB)
5 GHz to 8 GHz	±0.25
>8 GHz to 12 GHz	±0.40
>12 GHz to 18 GHz	±0.40
>18 GHz to 21 GHz	±0.40

Conditions: Reference level -30 dBm to +20 dBm; measured with a CW signal at ±257.5 MHz offset from the configured downconverter center frequency where the driver automatically applies at the I/Q center frequency, where the I/Q center frequency is 257.5 MHz offset for signals with 450 MHz bandwidth and less; Upconverter/Downconverter Frequency Offset Mode: Enabled; measurement performed after the PXIe-5831 has settled.

Relative accuracy describes the residual absolute accuracy error when compared to the absolute accuracy at 0 dBm.

This specification is valid only when the instrument is operating within the specified ambient temperature range and each module is within ±5 °C from the last self-calibration temperature, as measured with the onboard temperature sensors.

IF Input Frequency Response

Table 39. IF Input Frequency Response (dB)

Downconverter Center Frequency	23 °C ± 5 °C			0 °C to 45 °C
	Specification	Typical-95	Typical	Specification
5 GHz to 8 GHz	2.2	1.8	1.2	2.8
>8 GHz to 12 GHz	2.3	2.0	1.1	3.2
>12 GHz to 18 GHz	2.4	2.0	1.2	3.4
>18 GHz to 21 GHz	2.7	2.1	1.2	3.4

Downconverter Center Frequency	23 °C ± 5 °C			0 °C to 45 °C
	Specification	Typical-95	Typical	Specification

Conditions: Reference level -30 dBm to 0 dBm for specification; -30 dBm to 20 dBm for typical; module temperatures within ±5 °C of last self-calibration temperature.

Frequency response is defined as the maximum relative amplitude deviation from the reference offset frequency over the instantaneous bandwidth. For the PXIe-5831 IF input, the reference offset frequency is 10 MHz higher than the downconverter center frequency. For the absolute amplitude accuracy at the reference offset, refer to the IF Input Amplitude Accuracy section.

Figure 17. IF Input Frequency Response, 0 dBm, Reference Level, Equalized, Measured

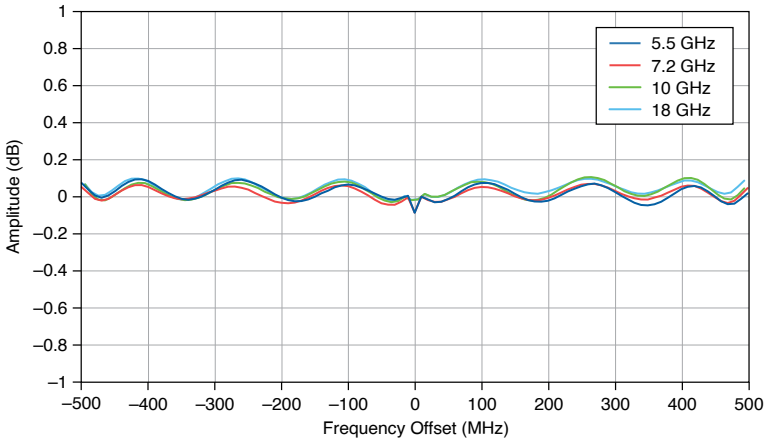
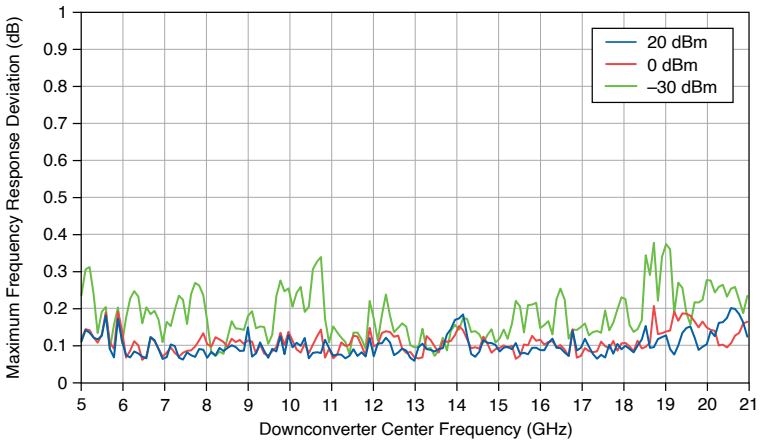


Figure 18. Maximum IF Input Frequency Response Deviation versus Downconverter Center Frequency, Measured



IF Input Average Noise Density

Table 40. Input Average Noise Density (dBm/Hz), Typical

Downconverter Center Frequency	-30 dBm Reference Level	0 dBm Reference Level
5 GHz to 8 GHz	-162	-142
>8 GHz to 12 GHz	-162	-142
>12 GHz to 18 GHz	-159	-141
>18 GHz to 21 GHz	-158	-141

Conditions: Input terminated with a 50 Ω load; 10 averages; noise measurement frequency offset by 6 MHz from the downconverter center frequency.

Measured on the PXIe-3622IF IN/OUT 1 port. The IF IN/OUT 0 port has a 2 dB degradation compared to the IF IN/OUT 1 port.

IF Input Third-Order Intermodulation

Table 41. IF Input Third-Order Intercept Point (IIP_3), Typical

Downconverter Center Frequency	Reference Level		
	-30 dBm	0 dBm	15 dBm
5 GHz to 8 GHz	-6	20	35
>8 GHz to 12 GHz	-4	19	33
>12 GHz to 18 GHz	-7	20	33
>18 GHz to 21 GHz	-7	16	31

Conditions: Measured with two -6 dBr tones applied at +95 MHz and +105 MHz offset from the

Downconverter Center Frequency	Reference Level		
	-30 dBm	0 dBm	15 dBm
downconverter center frequency.			

IF Input Residual Spurs

Table 42. IF Input Residual Spurs (dBm), Typical

Downconverter Center Frequency	60 kHz ≤ Offset < 60 MHz	Offset ≥ 60 MHz[11]
5 GHz to 8 GHz	-74	-74
>8 GHz to 12 GHz	-75	-75
>12 GHz to 18 GHz	-73	-77
>18 GHz to 21 GHz	-78	-78

Conditions : Reference level 0 dBm. Measured with the IF IN 1 port terminated with 50 Ω.

The maximum offset is limited to the instantaneous bandwidth at the referenced downconverter center frequency.

Note Offset refers to ± desired signal offset (Hz) around the current downconverter center frequency.

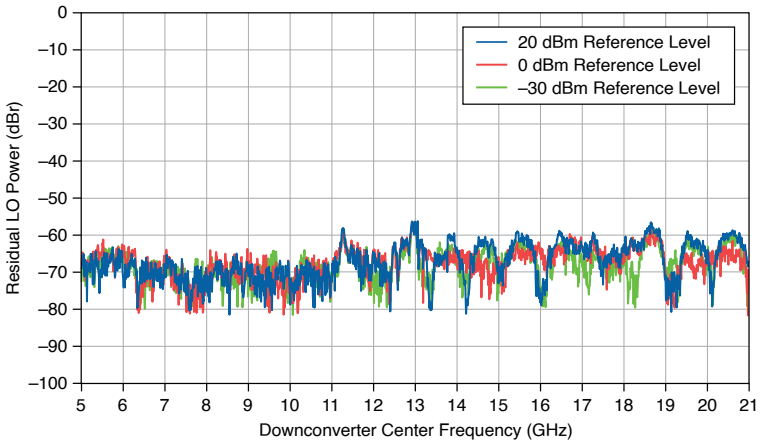
IF Input LO Residual Power

Table 43. IF Input LO Residual Power (dBr[12]), Typical

Downconverter Center Frequency	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C
5 GHz to 8 GHz	-54	-44
>8 GHz to 12 GHz	-47	-38
>12 GHz to 18 GHz	-49	-38
>18 GHz to 21 GHz	-44	-35

Downconverter Center Frequency	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C
Conditions: Reference level is -30 dBm to +15 dBm. Input tone power at a maximum of -3 dBr. LO2 LO Source property set to Onboard.		

Figure 19. IF Input LO Residual Power, Measured



IF Input Residual Sideband Image

Table 44. IF Input Residual Sideband Image (dBc), Typical

Downconverter Center Frequency	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C
5 GHz to 8 GHz	-47	-39
>8 GHz to 12 GHz	-51	-42
>12 GHz to 18 GHz	-50	-41
>18 GHz to 21 GHz	-50	-44

Conditions: Reference Level is -30 dBm to +15 dBm. LO2 LO Source property set to Onboard.

This specification describes the maximum residual sideband image within the 1 GHz device instantaneous bandwidth.

Figure 20. IF Input Residual Sideband Image, 0 dBm, Reference Level, Measured

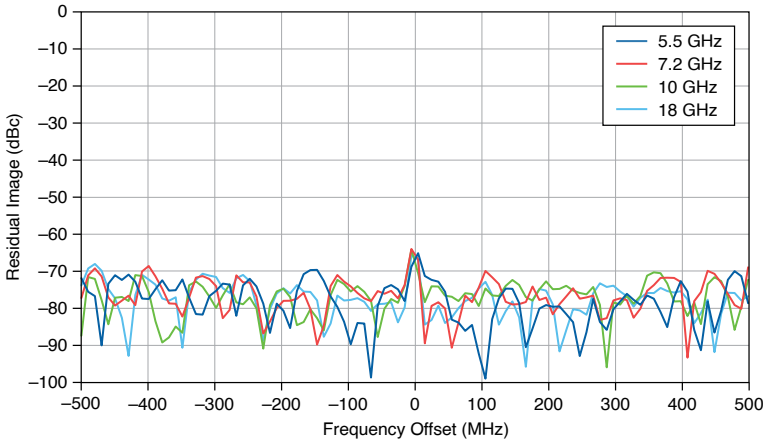
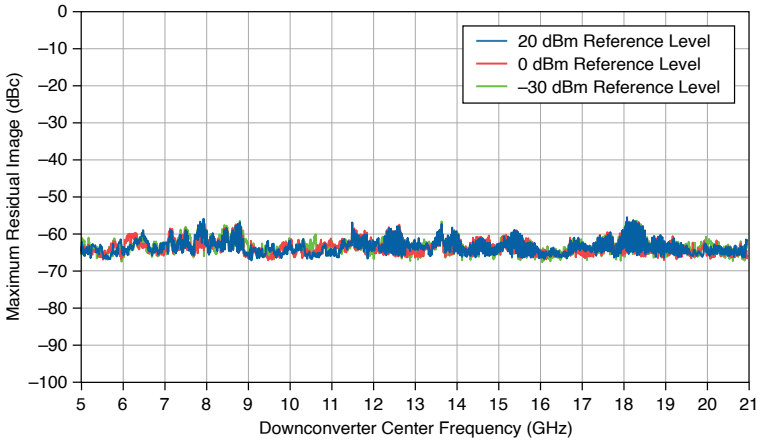


Figure 21. Maximum IF Input Residual Sideband Image Versus Downconverter Center Frequency, Measured



Receive (TRX Ports)

RF Input Amplitude Range

Amplitude range	Average noise level to +30 dBm (CW RMS)
RF gain resolution	1 dB, nominal

Table 45. Input RF Analog Gain Range, Nominal

Downconverter Center Frequency	RF Analog Gain Range (dB)
22.5 GHz to 31.3 GHz	≥66
>31.3 GHz to 37 GHz	≥69

Downconverter Center Frequency	RF Analog Gain Range (dB)
>37 GHz to 40 GHz	≥68
>40 GHz to 44 GHz	≥67

RF Input Amplitude Settling Time

Note Settling time refers to the time it takes the amplitude to settle once the hardware receives the amplitude change. The additional time due to software initiated amplitude changes is not included and varies by computer. When changing frequencies, reconfiguration time is dominated by the frequency settling. Refer to ***Frequency Settling Time*** for more information.

Note Constant RF input signal, varying input reference level.

<0.5 dB of final value	31 µs, nominal
<0.1 dB of final value	43 µs, nominal

RF Input Amplitude Accuracy

Table 46. Direct RF Input Absolute Amplitude Accuracy (dB) (Offset Mode is User-Defined)

Downconverter Center Frequency	Specification[13]	Typical-95[14]	Typical[14]
22.5 GHz to 31.3 GHz	±2.4	±1.9	±1.0
>31.3 GHz to 37 GHz	±2.1	±1.5	±0.8
>37 GHz to 40 GHz	±2.5	±2.0	±1.0
>40 GHz to 43.5 GHz	±2.6	±2.1	±1.1
>43.5 GHz to 44 GHz	±2.9	±2.7	±1.6
Conditions: Measured with a CW signal at 10 MHz offset from the configured downconverter center			

Downconverter Center Frequency	Specification[13]	Typical-95[14]	Typical[14]
frequency; Upconverter/Downconverter Frequency Offset Mode: User-Defined; measurement performed after the PXIe-5831 has settled. This specification is valid only when the instrument is operating within 23 °C ± 5 °C ambient temperature range and each module is within ±5 °C from the last self-calibration temperature, as measured with its onboard temperature sensors.			

Table 47. Switched RF Input Absolute Amplitude Accuracy (dB) (Offset Mode is User-Defined)

Downconverter Center Frequency	Specification[13]	Typical-95[14]	Typical[14]
22.5 GHz to 31.3 GHz	±2.4	±1.9	±1.0
>31.3 GHz to 37 GHz	±2.2	±1.9	±1.0
>37 GHz to 40 GHz	±2.5	±2.0	±1.0
>40 GHz to 43.5 GHz	±2.9	±2.5	±1.2
>43.5 GHz to 44 GHz	±3.2	±2.7	±1.6

Conditions: Measured with a CW signal at 10 MHz offset from the configured downconverter center frequency; measurement performed after the PXIe-5831 has settled; Upconverter/Downconverter Frequency Offset Mode: User-Defined.

This specification is valid only when the instrument is operating within 23 °C ± 5 °C ambient temperature range and within ±5 °C from the last self-calibration temperature, as measured with the onboard temperature sensors.

Table 48. RF Input Relative Amplitude Accuracy (dB) (Offset Mode is User-Defined), Typical

Downconverter Center Frequency	Direct TRX	Switched TRX
22.5 GHz to 31.3 GHz	±0.5	±0.5
>31.3 GHz to 37 GHz	±0.6	±0.6
>37 GHz to 40 GHz	±0.7	±0.7
>40 GHz to 43.5 GHz	±0.7	±0.7
>43.5 GHz to 44 GHz	±1.0	±1.0

Conditions: Reference level -30 dBm to +30 dBm; measured with a CW signal at 10 MHz offset from the configured downconverter center frequency; Downconverter Frequency Offset Mode: User-Defined; measurement performed after the PXIe-5831 has settled.

Relative accuracy describes the residual absolute accuracy error when compared to the absolute accuracy at 0 dBm.

This specification is valid over 23 °C ± 5 °C with the last self-calibration performed at 23 °C.

Table 49. RF Input Absolute Amplitude Accuracy (dB) (Offset Mode is Enabled), Typical

Downconverter Center Frequency	Direct TRX	Switched TRX
22.5 GHz to 31.3 GHz	±1.0	±1.0
>31.3 GHz to 37 GHz	±1.4	±1.4
>37 GHz to 40 GHz	±1.4	±1.4
>40 GHz to 43.5 GHz	±1.4	±1.4

Downconverter Center Frequency	Direct TRX	Switched TRX
>43.5 GHz to 44 GHz	±1.6	±1.6

Conditions: Valid for reference level -30 dBm to +30 dBm; measured with a CW signal at the I/Q center frequency, where the I/Q center frequency is257.5 MHz offset from the configured downconverter center frequency where the driver automatically applies a 257.5 MHz offset for signals with 450 MHz bandwidth and less; Upconverter/Downconverter Frequency Offset Mode: Enabled; measurement performed after the PXIe-5831 has settled.

This specification is valid over 23 °C ± 5 °C with the last self-calibration performed at 23 °C.

Table 50. RF Input Relative Amplitude Accuracy (dB) (Offset Mode is Enabled), Typical

Downconverter Center Frequency	Direct TRX	Switched TRX
22.5 GHz to 31.3 GHz	±0.8	±0.8
>31.3 GHz to 37 GHz	±0.9	±0.9
>37 GHz to 40 GHz	±1.0	±1.0
>40 GHz to 43.5 GHz	±0.9	±0.9
>43.5 GHz to 44 GHz	±1.1	±1.1

Conditions: Reference level -30 dBm to +30 dBm; measured with a CW signal at the I/Q center frequency, where the I/Q center frequency is 257.5 MHz offset from the configured downconverter center frequency where the driver automatically applies a 257.5 MHz offset for signals with 450 MHz bandwidth and less; Downconverter Frequency Offset Mode: Enabled; measurement performed after the PXIe-5831 has settled.

Relative accuracy describes the residual absolute accuracy error when compared to the absolute

Downconverter Center Frequency	Direct TRX	Switched TRX
accuracy at 0 dBm. This specification is valid over 23 °C ± 5 °C with the last self-calibration performed at 23 °C.		

RF Input Frequency Response

Table 51. TRX RF Input Frequency Response (dB)

Downconverter Center Frequency	Specification[]	Typical-95[]	Typical[]
22.5 GHz to 31.3 GHz	2.4	1.5	1.2
>31.3 GHz to 37 GHz	2.5	1.3	1.1
>37 GHz to 40 GHz	2.6	1.4	1.3
>40 GHz to 44 GHz	3.2	1.8	1.6

Conditions: Valid over 23 °C ± 5 °C with self-calibration at 23 °C; for Direct and Switched TRX ports; input reference level -30 dBm to 0 dBm for specification; -30 dBm to 30 dBm for typical.

Frequency response is defined as the maximum relative amplitude deviation from the reference offset frequency over the instantanous bandwidth. For the PXIe-5831 RF input, the reference offset frequency is 10 MHz higher than the downconverter center frequency. For the absolute amplitude accuracy at the reference offset, refer to the RF Input Amplitude Accuracy section.

Figure 22. RF Input Frequency Response, 0 dBm, Reference Level, Equalized, Measured at Direct TRX

Port

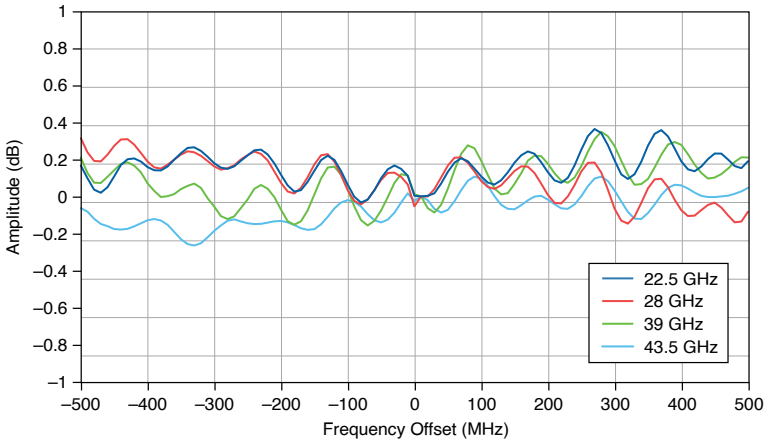


Figure 23. Maximum RF Input Frequency Response Deviation Versus Downconverter Center Frequency, Measured at Direct TRX Port

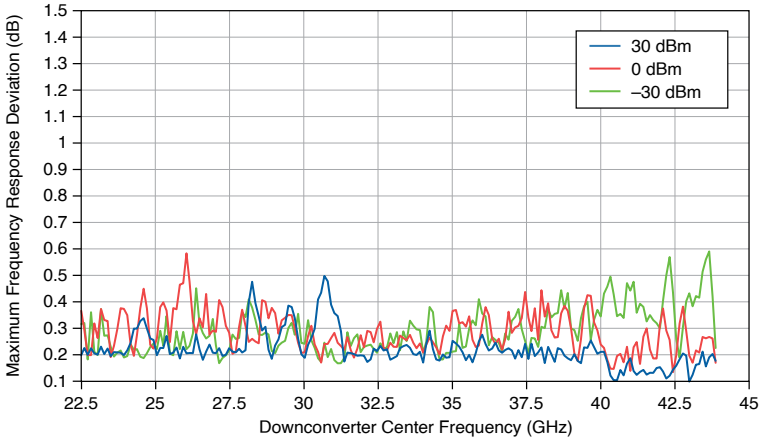
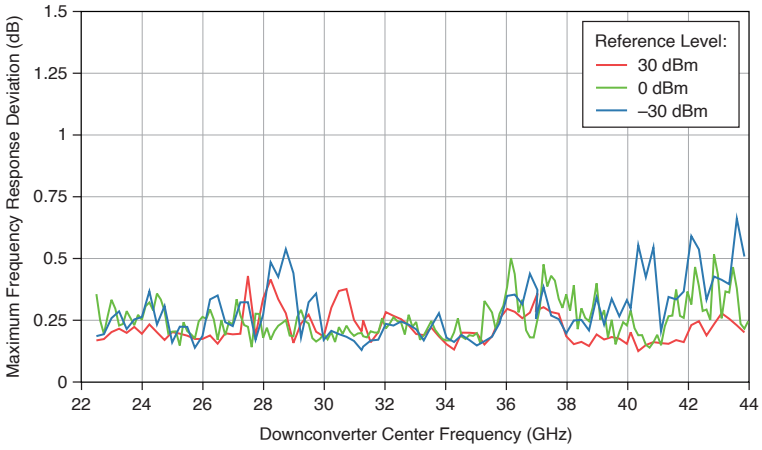


Figure 24. Maximum RF Input Frequency Response Deviation versus Downconverter Center Frequency, Measured at Switched Port



RF Input Average Noise Density

Table 52. RF Input Average Noise Density (dBm/Hz), Typical

Downconverter Center Frequency	-30 dBm Reference Level		0 dBm Reference Level	
	Direct TRX Ports	Switched TRX Ports	Direct TRX Ports	Switched TRX Ports
22.5 GHz to 31.3 GHz	-161	-156	-137	-136
>31.3 GHz to 37 GHz	-163	-158	-141	-139
>37 GHz to 40 GHz	-162	-157	-139	-139
>40 GHz to 44 GHz	-160	-155	-139	-138
Conditions: Input terminated with a 50 Ω load; 30 averages; 40 dB baseband signal attenuation; noise measurement frequency offset by 6 MHz from the downconverter center frequency.				

RF Input Third-Order Intermodulation

Table 53. Direct RF Input Third-Order Intercept Point (IIP_3) (dBm), Typical

Downconverter Center Frequency	Reference Level		
	-30 dBm	0 dBm	15 dBm
22.5 GHz to 31.3 GHz	-15	15	28
>31.3 GHz to 37 GHz	-21	10	26
>37 GHz to 40 GHz	-23	9	25
>40 GHz to 44 GHz	-20	10	26
Conditions: Measured by generating two -6 dBr tones centered at +95 MHz and +105 MHz offset			

Downconverter Center Frequency	Reference Level		
	-30 dBm	0 dBm	15 dBm
from the downconverter center frequency.			

Table 54. Switched RF Input Third-Order Intercept Point (IIP_3) (dBm), Typical

Downconverter Center Frequency	Reference Level		
	-30 dBm	0 dBm	15 dBm
22.5 GHz to 31.3 GHz	-18	13	26
>31.3 GHz to 37 GHz	-17	10	26
>37 GHz to 40 GHz	-18	9	24
>40 GHz to 44 GHz	-23	8	25
Conditions: Measured by generating two -6 dBr tones centered at +95 MHz and +105 MHz offset from the downconverter center frequency.			

RF Input Residual Spurs

Table 55. RF Input Residual Spurs (dBm), Typical

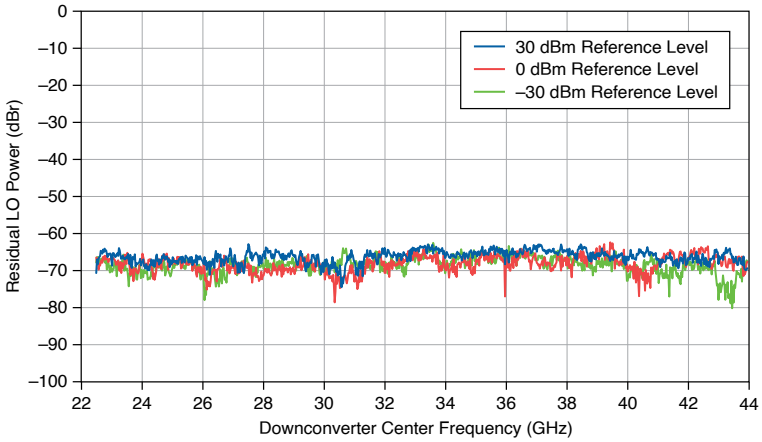
Frequency	Direct TRX Port	Switched TRX Port
22.5 GHz to 31.3 GHz	-74	-78
>31.3 GHz to 37 GHz	-75	-72
>37 GHz to 40 GHz	-73	-72
>40 GHz to 44 GHz	-78	-79
Conditions: Reference level 0 dBm. Measured with the TRX ports terminated with 50 Ω.		

RF Input LO Residual Power

Table 56. RF Direct and Switched TRX Input LO Residual Power (dBr[15]), Typical

Downconverter Center Frequency	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C
22.5 GHz to 31.3 GHz	-52	-40
>31.3 GHz to 37 GHz	-52	-40
>37 GHz to 40 GHz	-52	-40
>40 GHz to 44 GHz	-53	-40
Conditions: Reference level is -30 dBm to +15 dBm. Input tone power at a maximum of -3 dBr. LO1 and LO2 LO Source property set to Onboard.		

Figure 25. RF Input LO Residual Power, Measured



RF Input Residual Sideband Image

Table 57. RF Direct and Switched TRX Input Residual Sideband Image (dBc), Typical

Downconverter Center Frequency	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C
22.5 GHz to 31.3 GHz	-53	-43
>31.3 GHz to 37 GHz	-60	-54
>37 GHz to	-60	-53

Downconverter Center Frequency	Self-Calibration °C ± 1 °C	Self-Calibration °C ± 5 °C
40 GHz		
>40 GHz to 44 GHz	-55	-45

Conditions: Peak input power levels -30 dBm to +15 dBm. LO1 and LO2 LO Source property set to Onboard.

This specification describes the maximum residual sideband image within the 1 GHz device instantaneous bandwidth.

Figure 26. RF Input Residual Sideband Image, 0 dBm, Input Power Level, Measured at Direct TRX Port

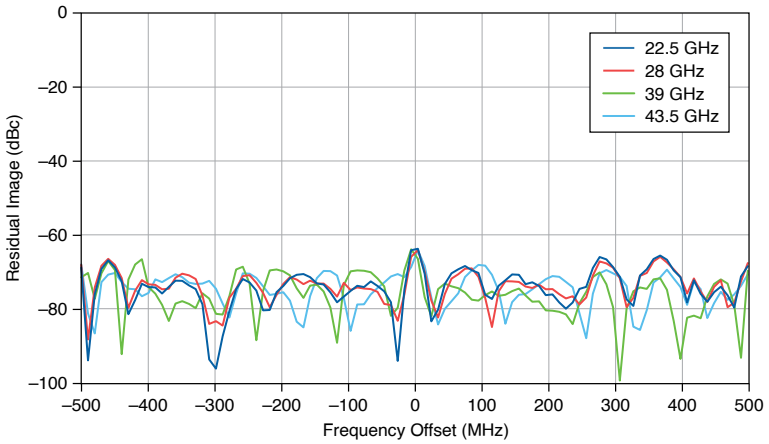
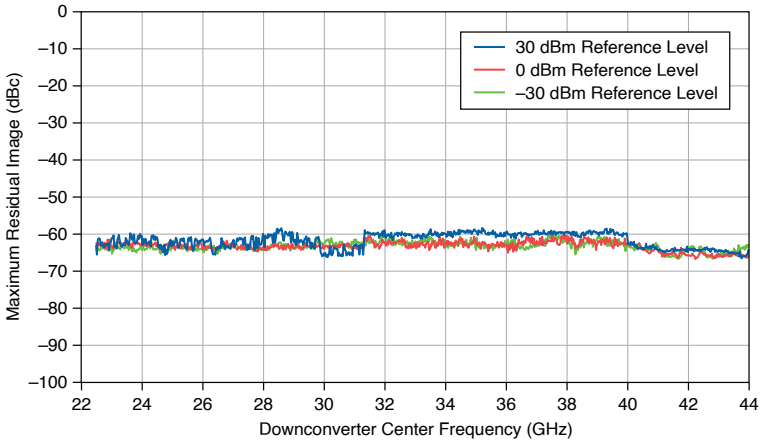


Figure 27. Maximum RF Input Residual Sideband Image Versus Downconverter Center Frequency, Measured at Direct TRX Port



Application-Specific Modulation Quality

WLAN 802.11ax

IF IN/OUT Ports

The following measurements were taken using RFmx and corresponding RFmx default values.

Table 58. WLAN 802.11ax RMS EVM (dB), Shared Onboard LO2, Nominal[16],[17]

I/Q Carrier Frequency	Signal Bandwidth	
	80 MHz	160 MHz
5.1 GHz to 7.2 GHz	-50	-47

Figure 28. WLAN 802.11ax RMS EVM Versus Average Power, Measured[16]

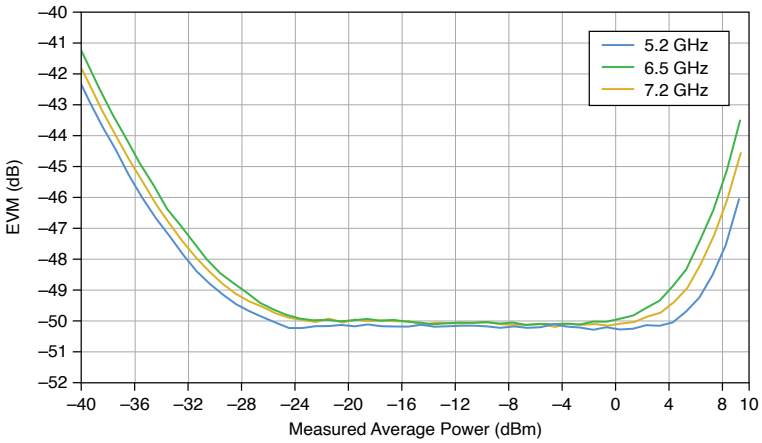


Figure 29. WLAN 802.11ax RMS EVM Versus Frequency, Nominal[16],[17]

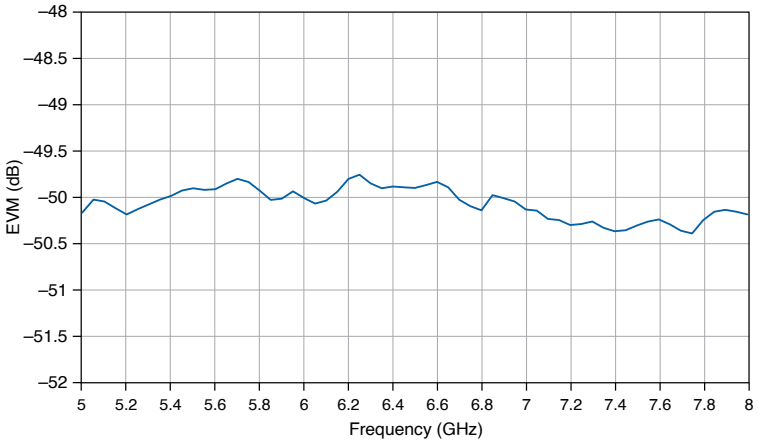


Figure 30. WLAN 802.11ax 80 MHz RMS EVM Versus Average Power, Measured [18],[19]

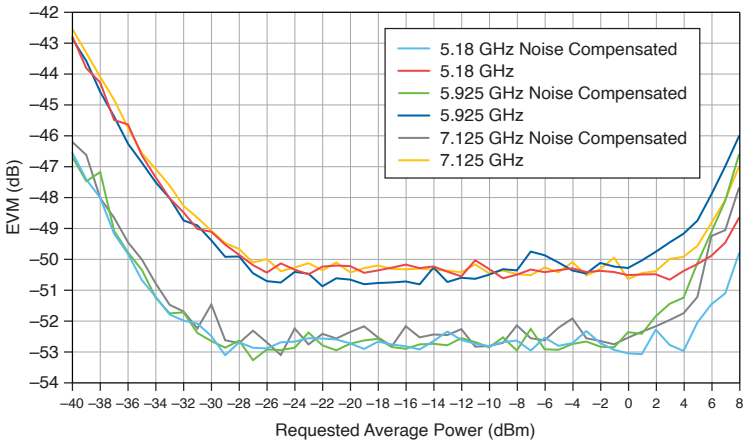


Figure 31. WLAN 802.11ax 160 MHz RMS EVM Versus Average Power, Measured [18],[19]

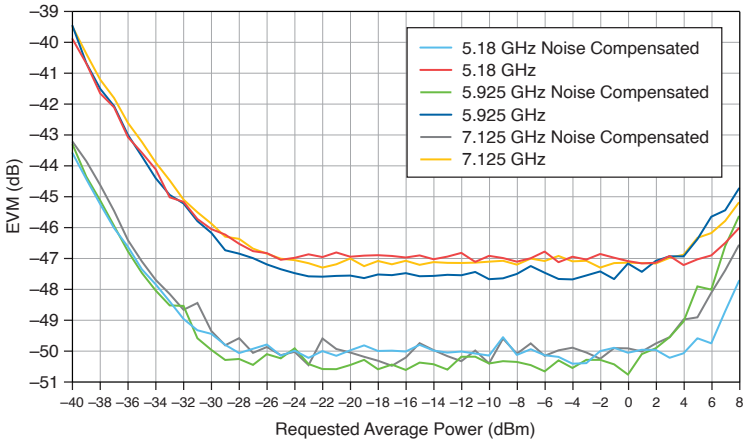
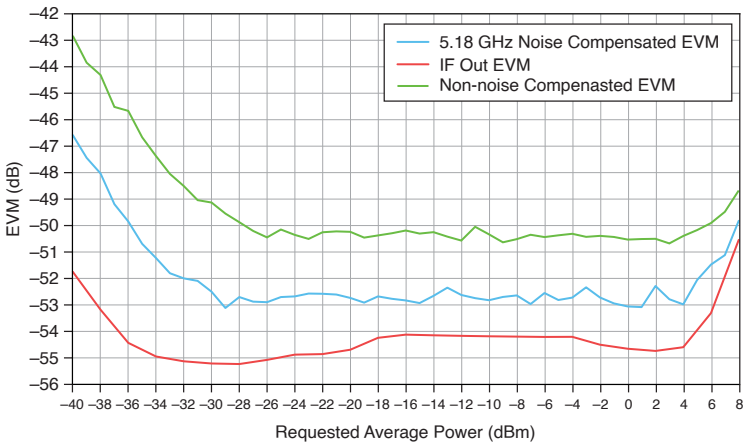


Figure 32. WLAN 802.11ax 80 MHz RMS EVM Versus Average Power (Loopback vs IF Out EVM), Measured [18],[19]



5G New Radio (NR)

IF 5G NR (IF IN/OUT Ports)

Table 59. IF 5G NR EVM (dB), Shared Onboard LO2, Typical[20]

I/Q Carrier Frequency	NR Carrier Configuration		
	1 × 100 MHz [21]	2 × 100 MHz [22]	1 × 400 MHz [23]
5 GHz to 8 GHz	-50	-47	-43
>8 GHz to 12 GHz	-49	-46	-43
>12 GHz to 18 GHz	-47	-44	-41
>18 GHz to 21 GHz	-44	-43	-41
Conditions: IF average power level is -25 dBm to 0 dBm. LO2 LO Source: SG_SA_Shared.			

Table 60. IF 5G NR EVM (dB), Independent Onboard LO2, Typical[20]

I/Q Carrier Frequency	NR Carrier Configuration		
	1 × 100 MHz [21]	2 × 100 MHz [22]	1 × 400 MHz [23]
5 GHz to 8 GHz	-41	-41	-40
>8 GHz to 12 GHz	-39	-39	-38
>12 GHz to 18 GHz	-35	-35	-35
>18 GHz to 21 GHz	-35	-35	-35
Conditions: IF average power level is -25 dBm to 0 dBm. LO2 LO Source: Onboard.			

Figure 33. IF 5G NR 1 CC x 100 MHz RMS EVM versus Average Power, Measured[20],[21]

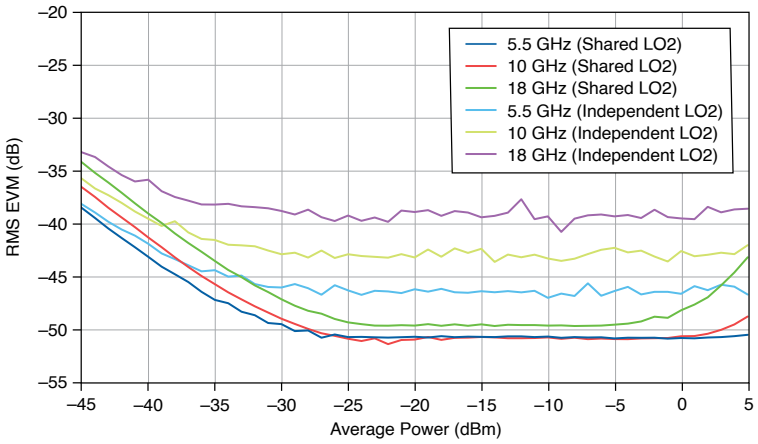


Figure 34. IF 5G NR 2 CC x 100 MHz RMS EVM versus Average Power, Measured[20],[22]

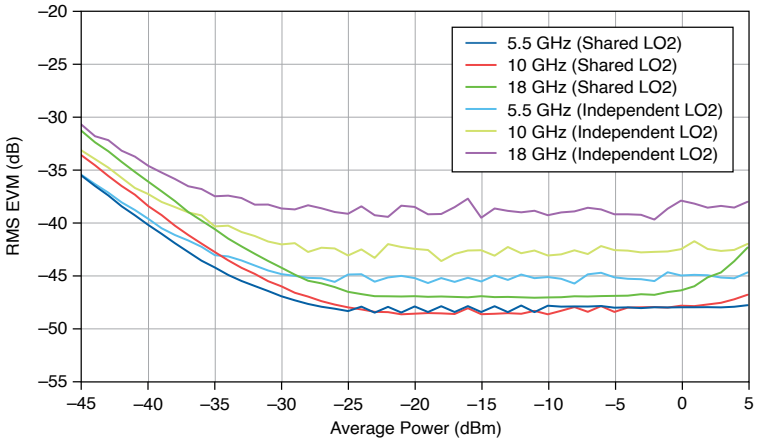


Figure 35. IF 5G NR 1 CC x 400 MHz RMS EVM versus Average Power, Measured[20],[23]

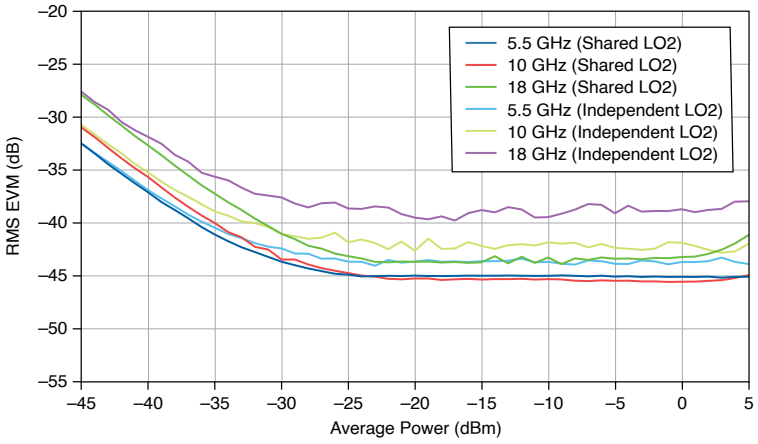


Figure 36. IF 5G NR 2 CC x 400 MHz RMS EVM versus Average Power, Measured[20],[24]

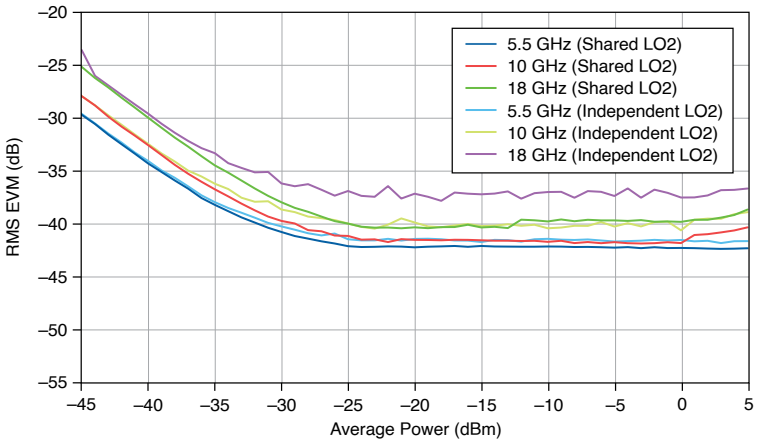


Figure 37. IF 5G NR RMS EVM versus Frequency (Shared LO2), Measured[20],[25],[26]

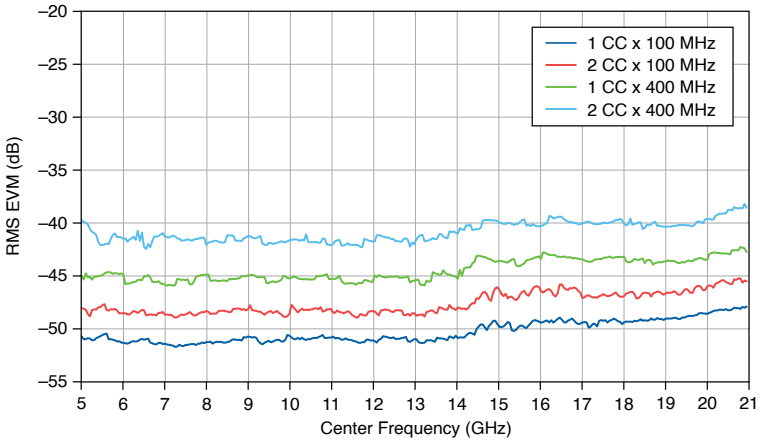


Figure 38. IF 5G NR RMS EVM versus Frequency (Independent LO2), Measured[20],[25],[26]

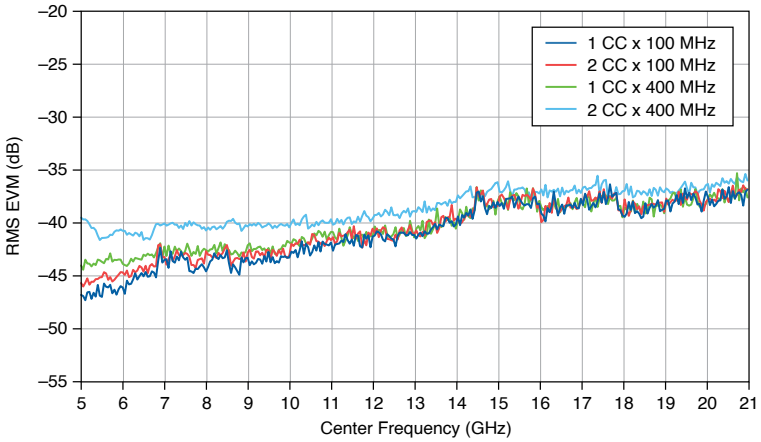


Table 61. Direct TRX to Direct TRX RF 5G NR EVM (dB), Nominal[27],[28]

I/Q Carrier Frequency	Shared Onboard LO2	Independent Onboard LO2
22.5 GHz to 31.3 GHz	-45	-40
37 GHz to 40 GHz	-43	-40
>40 GHz to 44 GHz	-43	-42
Conditions: RF average power level is -10 dBm. LO1 LO Source: Onboard.		

Table 62. Switched to Switched RF 5G NR EVM (dB), Nominal[27],[28]

I/Q Carrier Frequency	Shared Onboard LO2	Independent Onboard LO2
22.5 GHz to 31.3 GHz	-42	-39
37 GHz to 40 GHz	-43	-41
>40 GHz to 44 GHz	-42	-41
Conditions: RF average power level is -10 dBm. LO1 LO Source: Onboard.		

Table 63. Direct TRX to Switched or Switched to Direct TRX RF 5G NR EVM (dB), Nominal[27],[28]

I/Q Carrier Frequency	Shared Onboard LO2	Independent Onboard LO2
22.5 GHz to 31.3 GHz	-43	-39
37 GHz to 40 GHz	-43	-40
>40 GHz to 44 GHz	-42	-41
Conditions: RF average power level is -10 dBm. LO1 LO Source: Onboard.		

Figure 39. Direct TRX to Direct TRX RF 5G NR 1 CC × 100 MHz RMS EVM versus Average Power,

Measured[27],[28]

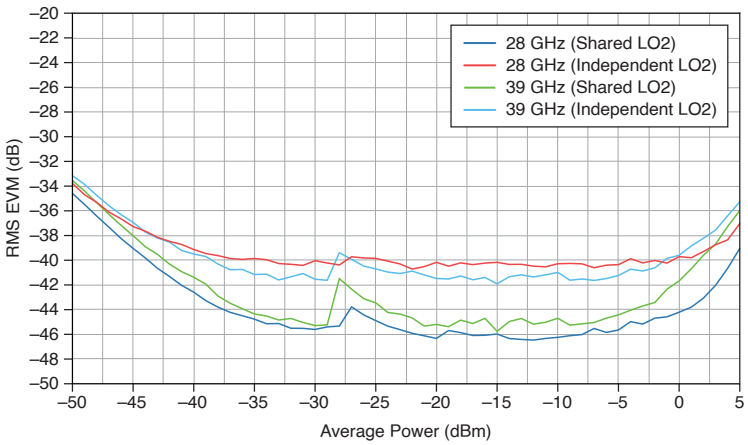


Figure 40. Switched to Switched RF 5G NR 1 CC x 100 MHz RMS EVM versus Average Power, Measured[27],[28]

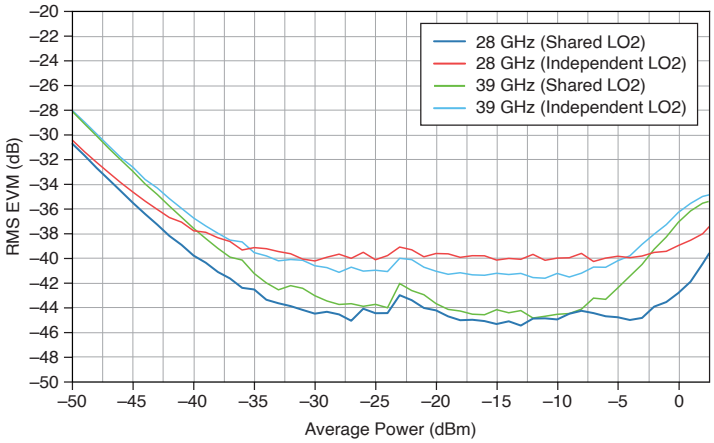
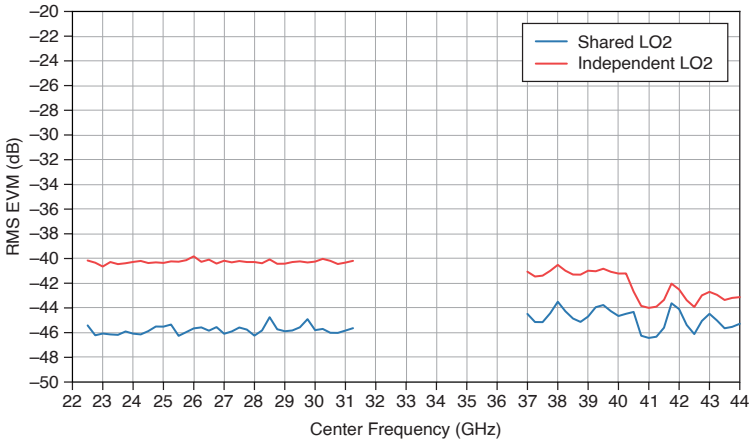


Figure 41. Direct TRX to Direct TRX RF 5G NR RMS EVM versus Frequency, Measured[27],[28],[29]



Front Panel I/O

PXIe-5820

Refer to the PXIe-5820 Specifications for more information about characteristics of the PXIe-5820 front panel input and output.

PXIe-3622

I/Q IN	
Connectors	MMPX (female)
Input coupling, per terminal	DC
Input type	Differential
Number of channels	2
Differential impedance	100 Ω
I/Q OUT	
Connectors	MMPX (female)
Output coupling, per terminal	DC
Output type	Differential
Number of channels	2

Impedance	100 Ω
LO1 IN and LO2 IN	
Connectors	MMPX (female)
Frequency range[30]	3.55 GHz to 7.1 GHz
Input power range[31]	+6 dBm to +10 dBm, nominal
Input return loss	10 dB, nominal
Absolute maximum input power	+10 dBm
LO1 coupling	AC coupled
LO2 coupling	DC coupled to ground
Impedance	50 Ω
LO1 OUT and LO2 OUT	
Connectors	MMPX (female)
Frequency range	3.55 GHz to 7.1 GHz
Absolute maximum output power	+10 dBm

LO1 coupling	AC coupled
LO2 coupling	DC coupled to ground
Output power resolution[32]	0.5 dB, nominal
Impedance	50 Ω
Output return loss	10 dB, nominal
DIO	
Connector	Mini HDMI
IF OUT mmWave	
Connectors	SMA 27 GHz (female)
Output impedance	50 Ω
Return loss	10 dB, nominal
Coupling	AC coupled
IF IN mmWave	
Connectors	SMA 27 GHz (female)

Input impedance	50 Ω
Return loss	10 dB, nominal
Coupling	AC coupled
IF IN/OUT	
Connectors	SMA 27 GHz (female)
Impedance	50 Ω during active mode, ∞ impedance after reboot and reset
Coupling	AC coupled
Absolute maximum input power	+25 dBm
Absolute maximum reverse power	Not to exceed the active RF output power setting

Figure 42. PXIe-3622 IF IN Port Return Loss, Measured

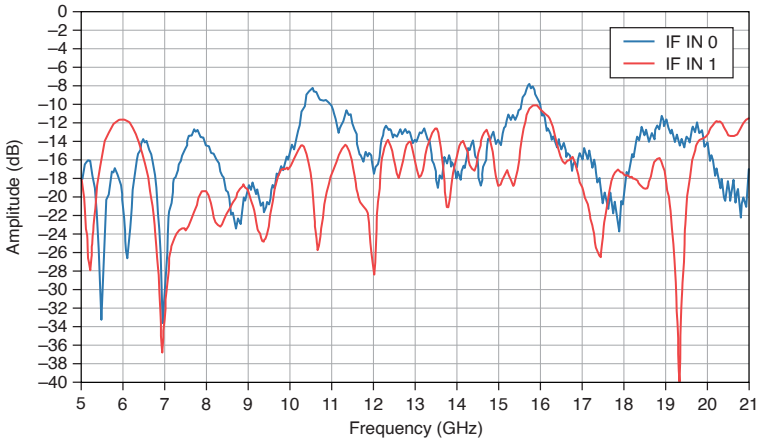
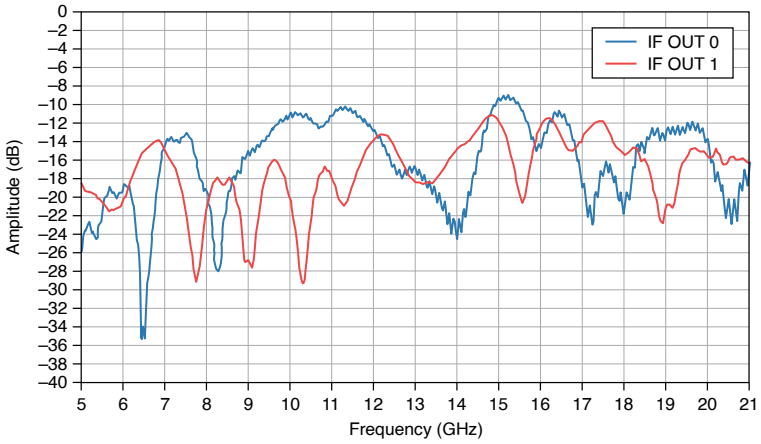


Figure 43. PXIe-3622 IF OUT Port Return Loss, Measured



LO1 0 mmWave	
Connector	SMA 27 GHz (female)
Frequency range	3.55 GHz to 14.2 GHz
LO1 1 mmWave	
Connector	SMA 27 GHz (female)
Frequency range	3.55 GHz to 14.2 GHz
REF IN/OUT	
Connectors	MMPX (female)
Frequency	10 MHz
Input tolerance[33]	$\pm 10 \times 10^{-6}$

Input amplitude[34]	0.7 V pk-pk to 3.3 V pk-pk, typical
Coupling	DC
Output amplitude	1.65 V pk-pk into 50 Ω, nominal
Impedance	50 Ω

PXIe-5653

Table 64. LO Output Level

LO	Minimum	Nominal	Maximum
LO1 (from 3.2 GHz to 8.2 GHz)	***Nominal Value*** - 2.5 dB	Varies by frequency according to the following equation: $10.5 - 3\left(\frac{Frequency(GHz) - 3.2GHz}{5.0GHz}\right)(dBm)$	***Nominal Value*** + 2.5 dB
LO1 (at 8.3 GHz)	+4 dBm	+6.5 dBm	+9 dBm
LO2	+6.5 dBm	+9 dBm	+13 dBm
LO3	+7 dBm	+9 dBm	+13 dBm

Note The PXIe-5653LO2 OUT and LO3 OUT connectors are not used in any PXIe-5831 instrument configuration.

mmRH-5582

DIRECT TRX PORTS	
Connectors	2.4 mm (female)
Absolute maximum input power	

Reference power ≤+30 dBm	Reference power + 6 dB
Reference power >+30 dBm	+36 dBm
Impedance	50 Ω
Absolute maximum reverse power	Not to exceed the active RF output power setting
Coupling	AC

Figure 44. mmRH-5582 RF Input Port Return Loss, Measured at Direct TRX Port

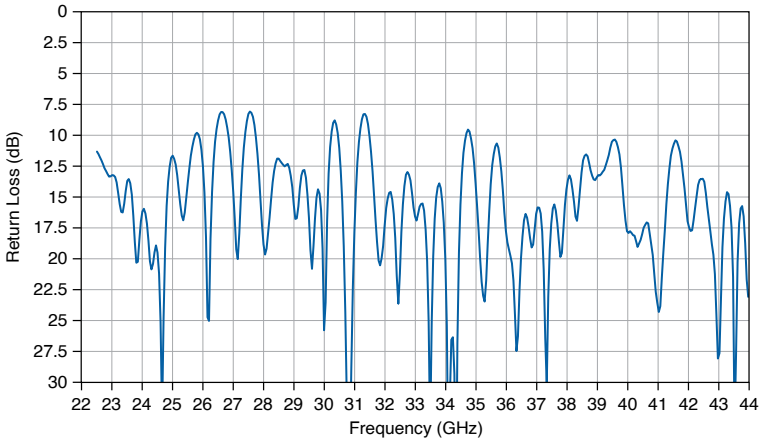


Figure 45. mmRH-5582 RF Output Port Return Loss, Measured at Direct TRX Port

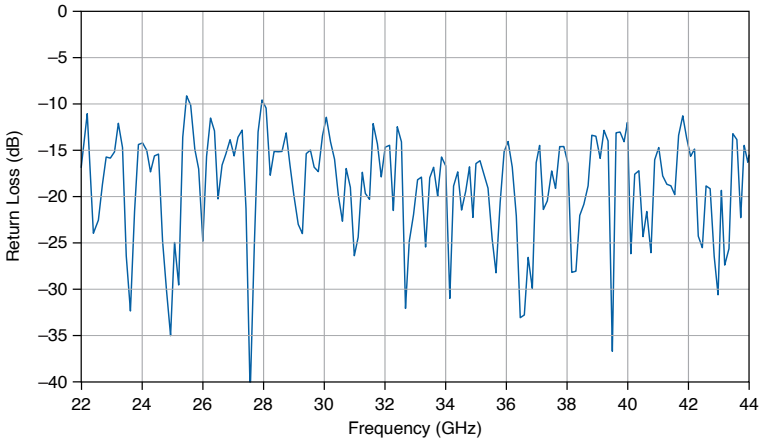


Figure 46. mmRH-5582 RF Input Port Return Loss, Measured at Switched TRX Port

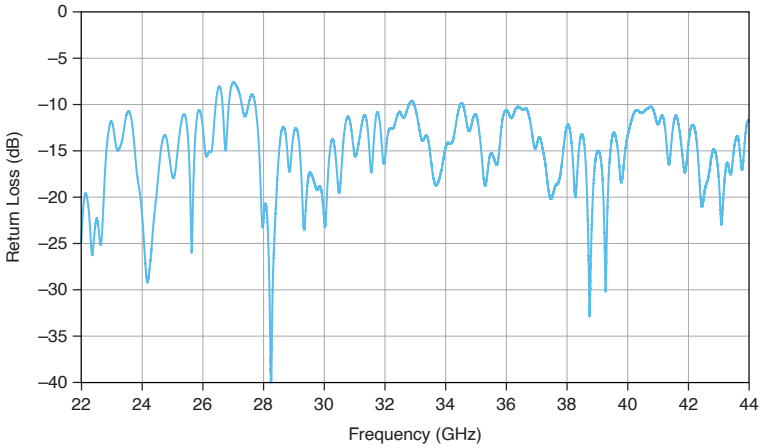
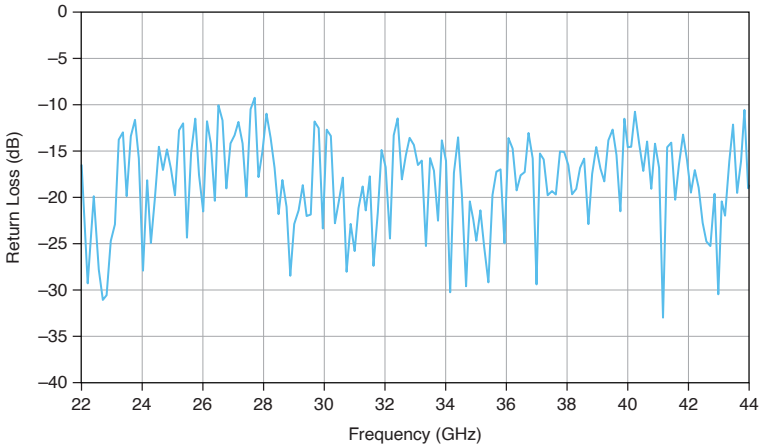


Figure 47. mmRH-5582 RF Output Port Return Loss, Measured at Switched TRX Port



SWITCHED TRX PORTS	
Connectors	2.4 mm (female)
Absolute maximum input power	
Reference power ≤+30 dBm	Reference power + 6 dB
Reference power >+30 dBm	+36 dBm
Impedance	50 Ω

Absolute maximum reverse power	Not to exceed the active RF output power setting
Coupling	AC
IF OUT	
Connector	SMA 27 GHz (female)
Impedance	50 Ω
LO IN	
Connector	SMA 27 GHz (female)
Frequency range	10 GHz to 13.5 GHz
Input power	+5 dBm, nominal
Impedance	50 Ω, nominal
Absolute maximum input power	+20 dBm
Coupling	DC
IF IN	
Connector	SMA 27 GHz (female)

Impedance	50 Ω, nominal
Absolute maximum input power	+10 dBm
Coupling	AC
DIO IN	
Connector	Mini HDMI
DIO OUT	
Connector	Mini HDMI

Power Requirements

Table 65. PXIe-5831 Power Requirements, Nominal

Module	+3.3 VDC	+12 VDC	Total Power (W)
PXIe-5820	3.3 A (10.89 W)	6.0 A (72.0 W)	82.89
PXIe-3622	5.0 A (6.93 W)	5.0 A (67.2 W)	74.13
PXIe-5653	1.10 A (3.63 W)	4.0 A (48.0 W)	51.63
PXIe-5831 (combined instrument)	—	—	208.65

Table 66. mmRH-5582 Power Requirements

Module	+12 VDC	Total Power (W)
mmRH-5582 (Direct TRX Ports Only)	3.8 A	45.6
mmRH-5582 (Switched and Direct TRX Ports)	4.1 A	49.2
mmRH-5582 (Switched TRX Ports Only)	4.4 A	52.8

Calibration

Interval	1 year [35]

Physical Characteristics

Table 67. PXIe-5831 Physical Characteristics, Nominal

Module	Dimensions	Weight	
		Grams	Ounces
PXIe-5820	3U, 2 slots	795	28.0
PXIe-3622	3U, 2 slots	1,066	37.6
PXIe-5653	3U, 2 slots	1,076	37.8
PXIe-5831 (combined instrument)	3U, 6 slots	2,937	103.4

Table 68. mmRH-5582 Physical Characteristics, Nominal

Module	Dimensions	Weight	
		Grams	Ounces
mmRH-5582 (Direct TRX Ports Only)	21.9 cm × 15.5 cm × 9.9 cm (8.65 in. × 6.11 in. × 3.91 in.)	2,940	103.7
mmRH-5582 (Switched and Direct TRX Ports)		3,132	110.5
mmRH-5582 (Switched TRX Ports Only)		3,324	117.3

Environmental Characteristics

Temperature

Operating	0 °C to 45 °C
Storage	-41 °C to 71 °C
Humidity	
Operating	10% to 90%, noncondensing
Storage	5% to 95%, noncondensing
Pollution Degree	2
Maximum altitude	2,000 m (800 mbar) (at 25 °C ambient temperature)
Shock and Vibration	
Operating vibration	5 Hz to 500 Hz, 0.3 g RMS
Non-operating vibration	5 Hz to 500 Hz, 2.4 g RMS
Operating shock	30 g, half-sine, 11 ms pulse

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 ***Engineering a Healthy Planet*** 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.

EU and UK Customers

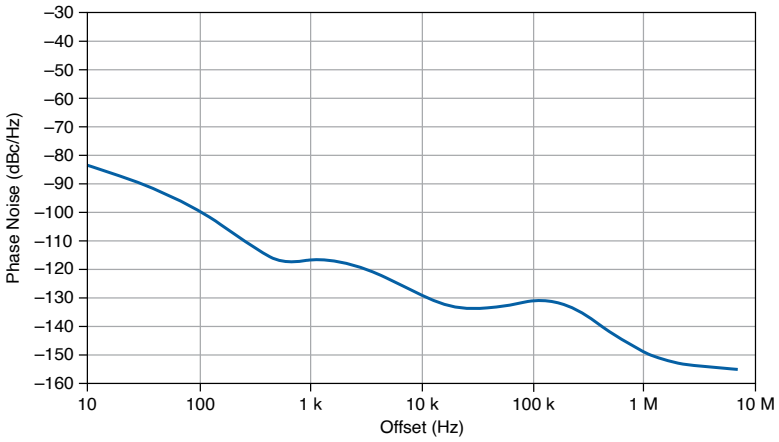
- **Waste Electrical and Electronic Equipment (WEEE)**—At the end of the product life cycle, all NI products must be disposed of according to local laws and regulations. For more information about how to recycle NI products in your region, visit ni.com/environment/weee.

电子信息产品污染控制管理办法（中国RoHS）

- **中国RoHS**— NI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NI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`.)

Appendix A: PXIe-5653 LO1 Single Sideband Phase Noise

Figure 48. PXIe-5653 Phase Noise, Measured[36] (Spurs Not Shown)



Appendix B: PXIe-3622 Single Sideband Phase Noise

Figure 49. PXIe-3622 Internal LO1 VCO Phase Noise, Measured[37] (Spurs Not Shown)