# PXIe-5433

2022-07-06

# Contents

# PXIe-5433 Specifications

These specifications apply to the one-channel and two-channel PXIe-5433.

## Definitions

**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.

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

## Conditions

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

- Signals terminated with 50 Ω to ground
- Load impedance set to 50 Ω
- Amplitude set to 2.4 $V_{pk-pk}$
- Analog Path property or NIFGEN_ATTR_ANALOG_PATH attribute set to Main (default)
- Reference Clock set to Onboard Reference Clock

Warranted and typical specifications are valid under the following conditions unless otherwise noted:

- Ambient temperature range of 0 °C to 55 °C
- 15-minute warm-up time before operation
- Self-calibration performed after instrument is stable
- External calibration cycle maintained and valid
- PXI Express chassis fan speed set to HIGH, foam fan filters removed if present, and empty slots contain PXI chassis slot blockers and filler panels

## Analog Output

| | |
|---|---|
| Number of channels[1] | 1 or 2 |
| Output type | Referenced single-ended |
| Connector type | SMA |
| DAC resolution | 16 bits |

**Amplitude range[2], in 0.16 dB steps**

| | |
|---|---|
| 50 Ω load | 0.00775 $V_{pk\text{-}pk}$ to 12 $V_{pk\text{-}pk}$ |
| Open load | 0.0155 $V_{pk\text{-}pk}$ to 24 $V_{pk\text{-}pk}$ |

| | |
|---|---|
| Offset range | ±50% of **Amplitude Range** ($V_{pk\text{-}pk}$)[3] |
| Offset resolution | 16-bit full-scale range |

**DC accuracy[4]**

| | |
|---|---|
| Within ±5 °C of self-calibration temperature | ±0.35% of **Amplitude Range** ± 0.35% of **Offset Requested** ± 500 µV, warranted[5] |
| 0 °C to 55 °C | ±0.55% of **Amplitude Range** ± 0.55% of **Offset Requested** ± 500 µV, typical |

| | |
|---|---|
| AC amplitude accuracy[6] (within ±5 °C of self-calibration temperature) | ±1.0% ± 1 $mV_{pk\text{-}pk}$, warranted |
| Output impedance | 50 Ω |
| Load impedance | Output waveform is compensated for user-specified impedances |
| Output coupling (ground referenced) | DC |
| Output enable[7] | Software-selectable |
| Maximum output overload[8] | ±12 $V_{pk\text{-}pk}$ from a 50 Ω source |
| Waveform summing | Supported[9] |

## Standard Function

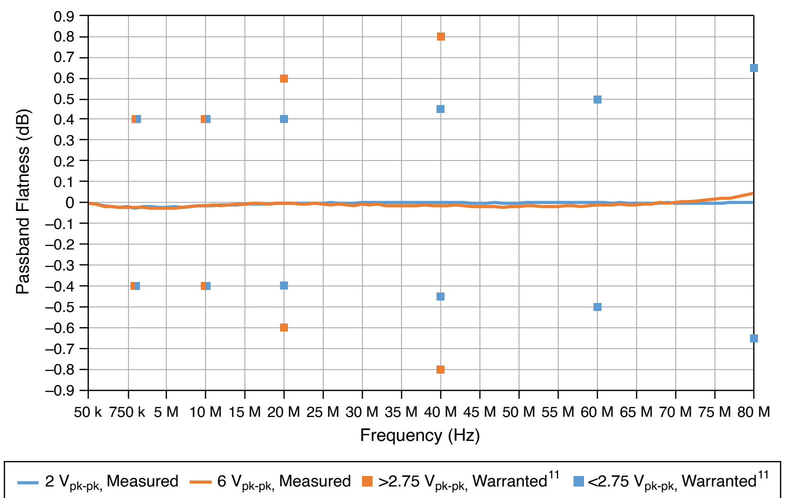
### Sine Waveform

| | |
|---|---|
| Frequency range | 0 MHz to 80 MHz |
| Frequency step size | 2.84 µHz |

| Sine Frequency | Passband Flatness (dB), Warranted | |
|---|---|---|
| | 0.06 $V_{pk-pk}$ to 2.75 $V_{pk-pk}$ | >2.75 $V_{pk-pk}$ |
| 1 MHz | ±0.4 | ±0.4 |
| 10 MHz | ±0.4 | ±0.4 |
| 20 MHz | ±0.4 | ±0.6 |
| 40 MHz[11] | ±0.45 | ±0.8 |
| 60 MHz[11] | ±0.5 | — |
| 80 MHz[11] | ±0.65 | — |

Table 1. Passband Flatness[10]

Figure 1. Passband Flatness




| Sine Frequency | SFDR with Harmonics (dBc), Measured | | |
|---|---|---|---|
| | 0.1 $V_{pk-pk}$ to 1 $V_{pk-pk}$ | 1 $V_{pk-pk}$ to 2.75 $V_{pk-pk}$ | >2.75 $V_{pk-pk}$[13] |
| 1 MHz | 62 | 76 | 77 |
| 3 MHz | 62 | 74 | 63 |
| 5 MHz | 61 | 74 | 58 |
| 10 MHz | 61 | 69 | 52 |
| 20 MHz | 61 | 63 | 44 |
| 30 MHz | 59 | 60 | 40 |
| 40 MHz | 55 | 58 | 35 |

| Sine Frequency | SFDR with Harmonics (dBc), Measured | | |
|---|---|---|---|
| | 0.1 $V_{pk\text{-}pk}$ to 1 $V_{pk\text{-}pk}$ | 1 $V_{pk\text{-}pk}$ to 2.75 $V_{pk\text{-}pk}$ | >2.75 $V_{pk\text{-}pk}$[13] |
| 80 MHz | 41 | 45 | — |

Table 2. Spurious-Free Dynamic Range (SFDR) with Harmonics[12]

| Sine Frequency | SFDR without Harmonics (dBc), Measured | | |
|---|---|---|---|
| | 0.1 $V_{pk\text{-}pk}$ to 1 $V_{pk\text{-}pk}$ | 1 $V_{pk\text{-}pk}$ to 2.75 $V_{pk\text{-}pk}$ | >2.75 $V_{pk\text{-}pk}$[13] |
| 1 MHz | 62 | 84 | 92 |
| 3 MHz | 62 | 84 | 92 |
| 5 MHz | 62 | 84 | 92 |
| 10 MHz | 61 | 83 | 90 |
| 20 MHz | 61 | 83 | 90 |
| 30 MHz | 61 | 83 | 83 |
| 40 MHz | 61 | 83 | 83 |
| 80 MHz | 61 | 83 | — |

Table 3. Spurious-Free Dynamic Range (SFDR) without Harmonics[12]

| Sine Frequency | THD (dBc), Measured | |
|---|---|---|
| | 0.1 $V_{pk\text{-}pk}$ to 2.75 $V_{pk\text{-}pk}$ | 2.75 $V_{pk\text{-}pk}$ to 12 $V_{pk\text{-}pk}$[13] |
| 1 MHz | 79 | 76 |
| 3 MHz | 73 | 62 |
| 5 MHz | 72 | 56 |
| 10 MHz | 68 | 49 |
| 20 MHz | 61 | 43 |
| 30 MHz | 58 | 39 |
| 40 MHz | 55 | 35 |
| 80 MHz | 40 | — |

Table 4. Total Harmonic Distortion (THD)[14]

Figure 2. 5 MHz Spectrum[15] at 0.6 $V_{pk\text{-}pk}$, Measured

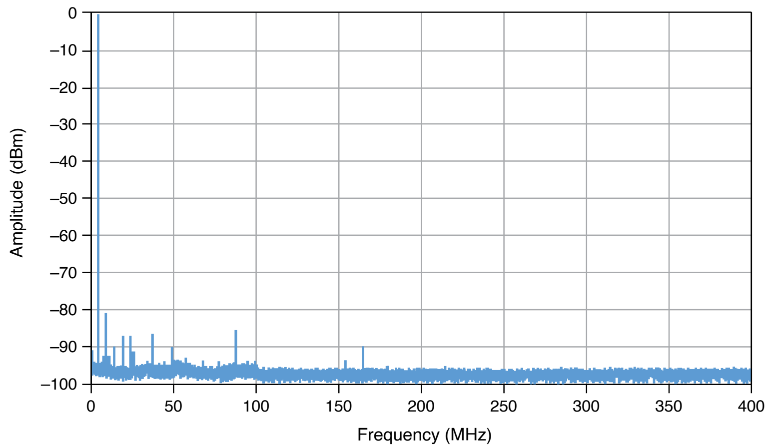



Figure 3. 10 MHz Spectrum[15] at 2 $V_{pk\text{-}pk}$, Measured

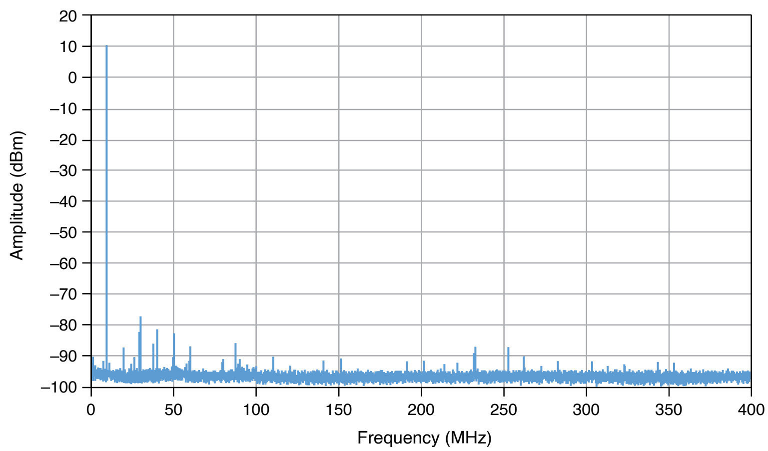
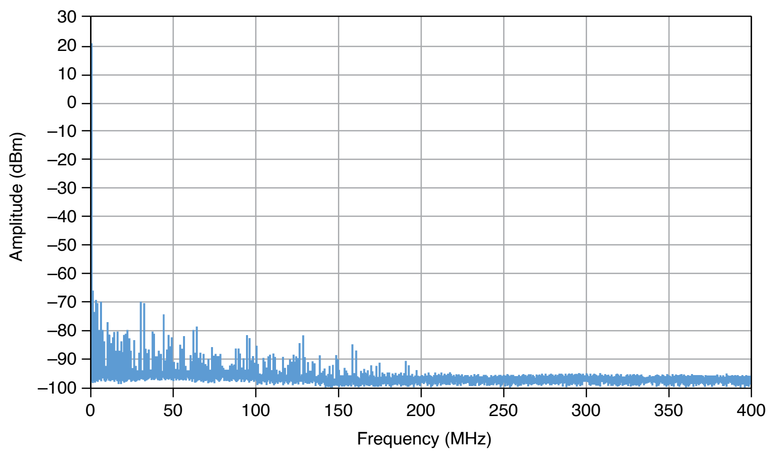


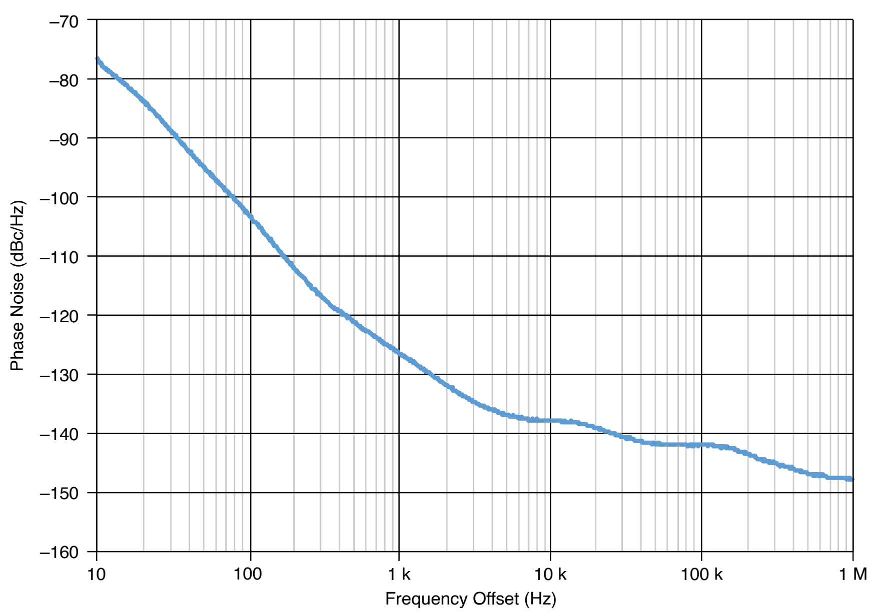

Figure 4. 1 MHz Spectrum[15] at 6.5 $V_{pk\text{-}pk}$, Measured



| Amplitude | Average Noise Density, Typical | |
|---|---|---|
| | dBm/Hz | $\frac{nV}{\sqrt{Hz}}$ |
| 0.06 $V_{pk-pk}$ | -154 | 3.9 |
| 0.1 $V_{pk-pk}$ | -154 | 3.9 |
| 0.4 $V_{pk-pk}$ | -150 | 5.8 |
| 1 $V_{pk-pk}$ | -145 | 13 |
| 2 $V_{pk-pk}$ | -141 | 20 |
| 4 $V_{pk-pk}$ | -132 | 53 |
| 12 $V_{pk-pk}$ | -125 | 107 |

Table 5. Average Noise Density[16]

Figure 1. Phase Noise[17], Measured




| | |
|---|---|
| Jitter (RMS)[18] | 207 fs |

## Square Waveform

| **Frequency range** |
|---|

| | |
|---|---|
| 2.75 $V_{pk-pk}$ | 0 MHz to 50 MHz |
| 12 $V_{pk-pk}$ | 0 MHz to 30 MHz |

| | |
|---|---|
| Frequency step size | 2.84 µHz |
| Minimum on/off time[19] | 8.25 ns |
| Duty cycle resolution | <0.001% |

**Rise/fall time[20]**

| | |
|---|---|
| <2.75 $V_{pk-pk}$ | 4.5 ns, measured |
| >2.75 $V_{pk-pk}$[21] | 5.4 ns, measured |

**Aberration**

| | |
|---|---|
| <2.75 $V_{pk-pk}$ | 1.0%, measured |
| >2.75 $V_{pk-pk}$ | 5.0%, measured |

| | |
|---|---|
| Jitter (RMS)[22] | 1.5 ps, measured |

Figure 1. Square Waveform Step Response at 2.75 $V_{pk-pk}$, Measured

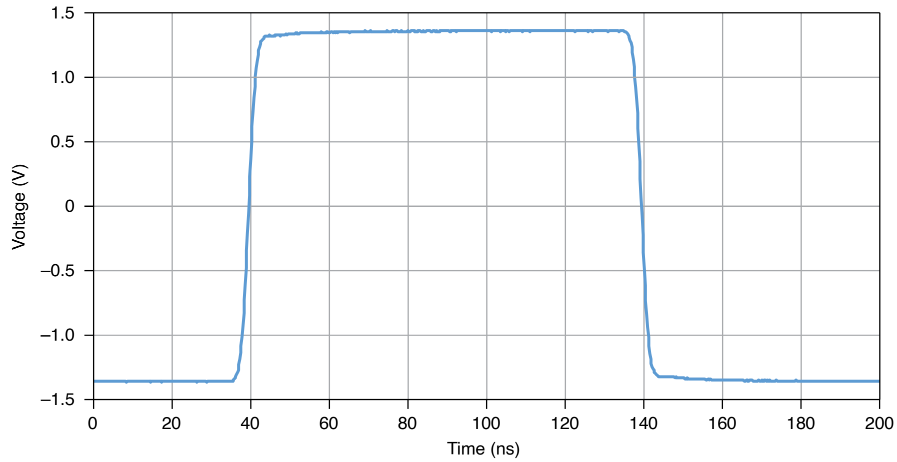
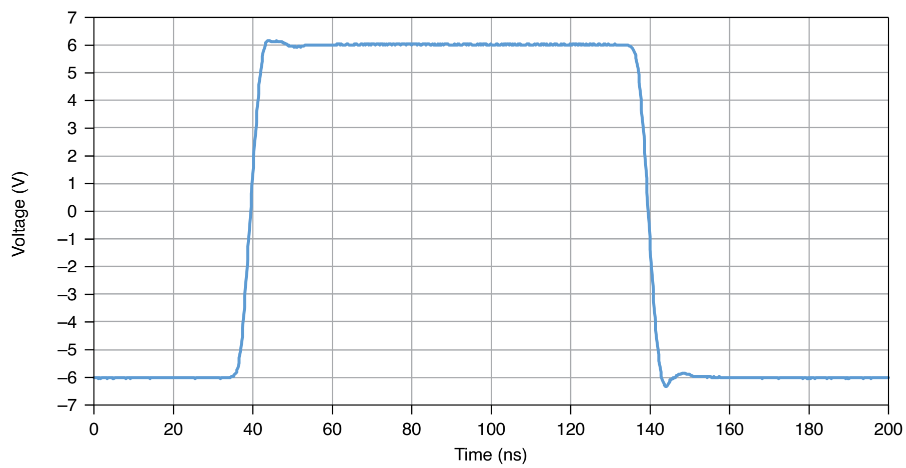



Figure 7. Square Waveform Step Response at 12 $V_{pk-pk}$, Measured




## Ramp and Triangle Waveforms

| **Frequency range** | |
|---|---|
| 2.75 $V_{pk-pk}$ | 0 MHz to 50 MHz |
| 12 $V_{pk-pk}$ | 0 MHz to 30 MHz |

## Noise Function

| | |
|---|---|
| **Gaussian noise** | |
| Bandwidth | 100 MHz, measured |
| Crest factor | 5, measured |
| Repetition period | 5,849 years |

## User-Defined Function

| | |
|---|---|
| Frequency range | 0 MHz to 80 MHz |
| Frequency step size | 2.84 µHz |
| Waveform points | 8,192 |

| | |
|---|---|
| **Step response rise time** | |
| 2.75 $V_{pk\text{-}pk}$ | 2.4 ns, measured |
| 12 $V_{pk\text{-}pk}$ | 2.7 ns, measured |

## Arbitrary Waveform

| | |
|---|---|
| Waveform size | 4 samples to 256,000,000 samples |

| | |
|---|---|
| **User sample rate** | |
| Digital filter enabled | 5.6 µS/s to 400 MS/s |

| | |
|---|---|
| Digital filter disabled | 10 S/s to 250 MS/s |
| **Waveform filters** | |
| Digital filter enabled | **Bandwidth** = 0.2 * **User Sample Rate** |
| Digital filter disabled | No reconstruction image rejection |
| Minimum quantum size | 1 sample |
| **Rise time**[23] | |
| Digital filter enabled | 4.7 ns, measured |
| Digital filter disabled | 3.4 ns, measured |
| Total onboard memory | 512 MB per channel |

Figure 8. Magnitude Response[24], Measured

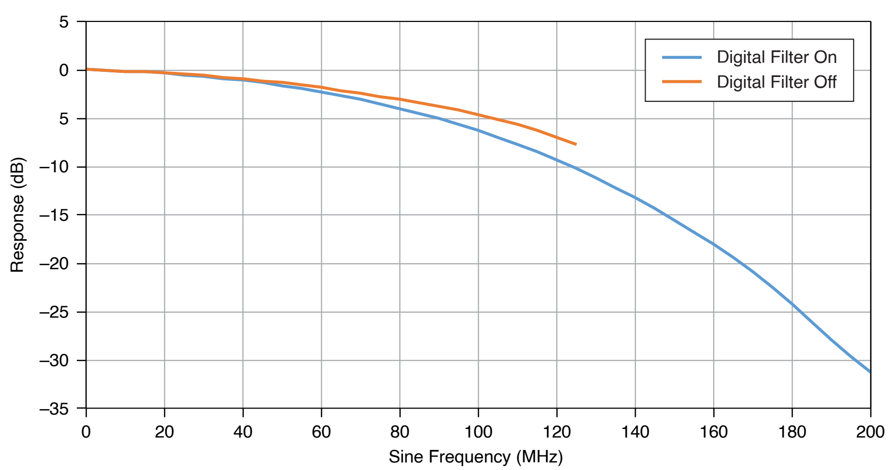


Figure 9. 10 MHz Single-Tone Spectrum[25], Measured

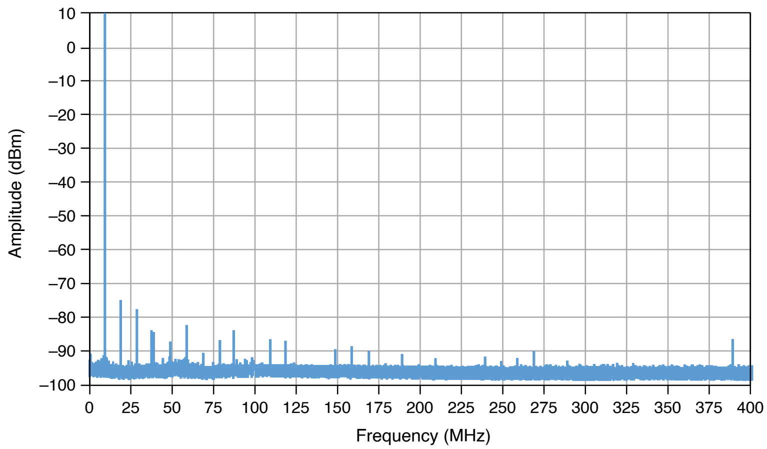
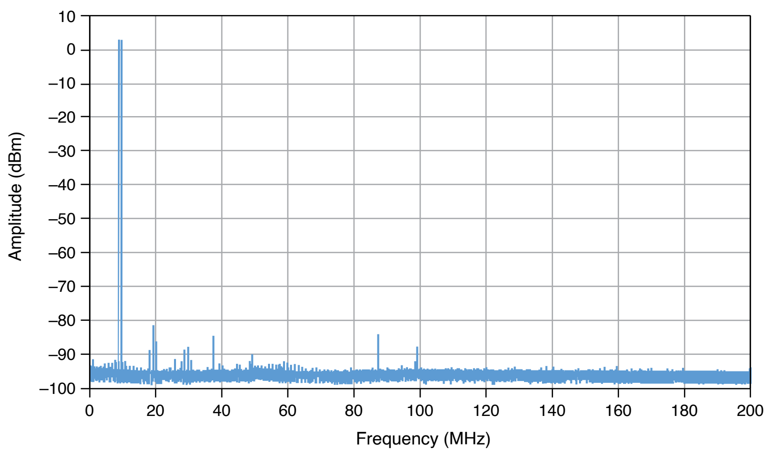



Figure 10. 9.5 MHz and 10.5 MHz Dual-Tone Spectrum[26], Measured



# All Output Modes

Figure 11. Amplitude Versus Recommended Sine Wave Frequency

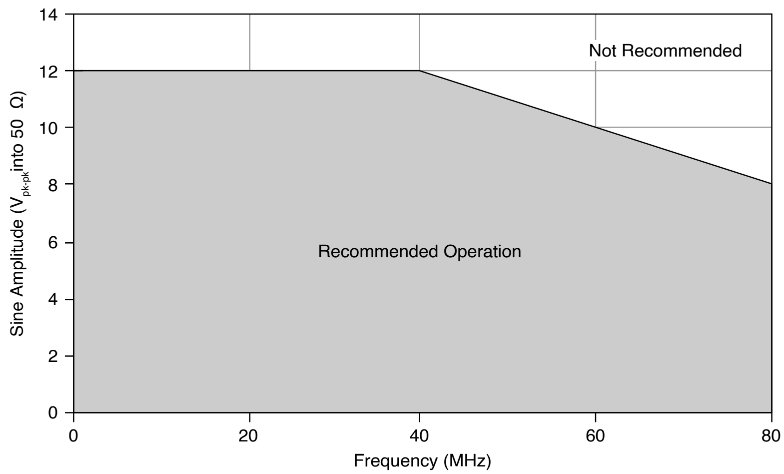



Figure 1. Channel-To-Channel Crosstalk, Measured

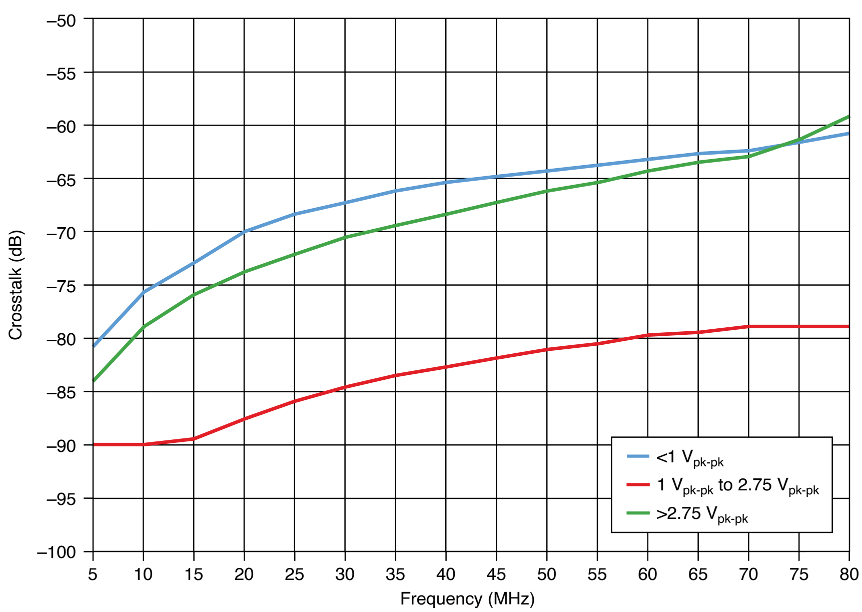
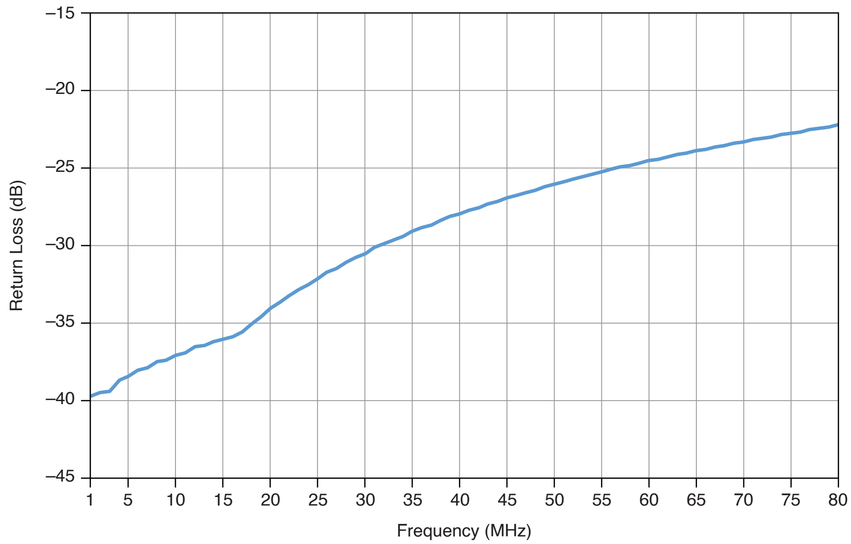


Figure 1. Return Loss, Measured




## Clock

| | |
|---|---|
| Reference Clock source | Internal<br><br>PXIe_CLK100 (backplane connector) |
| Reference Clock frequency | 100 MHz (<±25 ppm) |
| Sample Clock rate | 800 MHz |

**Internal timebase accuracy[27]**

| | |
|---|---|
| Initial calibrated accuracy | 1.5 ppm, warranted |
| Time drift[28] | 1 ppm per year, warranted |
| Accuracy | **Initial Calibrated Accuracy** ± **Time Drift**, warranted |

## Synchronization

| Channel-to-channel skew, between the channels of a multichannel PXIe-5433[29] | |
|---|---|
| <2.75 Vpk-pk | ±110 ps |
| >2.75 Vpk-pk | ±275 ps |

**Note** The channels of a multichannel PXIe-5433 are automatically synchronized when they are in the same NI-FGEN session.

## Synchronization with the NI-TClk API[30]

NI-TClk is an API that enables system synchronization of supported PXI modules in one or more PXI chassis, which you can use with the PXIe-5433 and NI-FGEN.

NI-TClk uses a shared Reference Clock and triggers to align the Sample Clocks of PXI modules and synchronize the distribution and reception of triggers. These signals are routed through the PXI chassis backplane without external cable connections between PXI modules in the same chassis.

**Module-to-module skew, between PXIe-5433 modules using NI-TClk[31]**

| NI-TClk synchronization without manual adjustment[32] | |
|---|---|
| Skew, peak-to-peak[33] | 300 ps, typical |
| Jitter, peak-to-peak[34] | 125 ps, typical |

| NI-TClk synchronization with manual adjustment[32] | |
|---|---|
| Skew, average | <10 ps |

| | |
|---|---|
| Jitter, peak-to-peak[34] | 5 ps |
| Sample Clock delay/adjustment resolution | 3.8E(-6) * **Sample Clock period**<br><br>For example, at 100 MS/s, 3.8E(-6) * (1/100 MS/s) = 38 fs. |

## PFI I/O

| | |
|---|---|
| Number of terminals | 10 |
| **Connector type** | |
| PFI 0 and PFI 1 | SMA |
| AUX 0/PFI <0..7> | MHDMR |
| Logic level | 3.3 V |
| Maximum input voltage | +5 V |
| $V_{IH}$ | 2 V |
| $V_{IL}$ | 0.8 V |
| Frequency range | 0 MHz to 25 MHz |
| PFI-to-channel crosstalk | -80 dBc, measured |

# Trigger

| | |
|---|---|
| Sources/destinations | PFI <0..1> (SMA front panel connectors) |

| | |
|---|---|
| | AUX 0/PFI <0..7> (MHDMR front panel connector)<br>PXI_Trig <0..7> (backplane connector) |
| Supported triggers | Start Trigger<br>Script Trigger |
| Trigger type | Rising edge |
| Trigger modes[35] | Single<br>Continuous<br>Stepped<br>Burst |
| Input impedance (DC) | >100 kΩ |

## Marker

| | |
|---|---|
| Destinations | PFI <0..1> (SMA front panel connectors)<br>AUX 0/PFI <0..7> (MHDMR front panel connector)<br>PXI_Trig <0..7> (backplane connector) |
| Pulse width | 200 ns |

**Marker to output skew**

| | |
|---|---|
| PFI <0..1> and AUX 0/PFI <0..7> | ±2 ns |

| | |
|---|---|
| PXI_Trig <0..7> | ±20 ns |
| Maximum number of marker outputs per waveform | 4 |

## Calibration

| | |
|---|---|
| Self-calibration | An onboard reference is used to calibrate the DC gain and offset. The self-calibration is initiated by the user through the software and takes approximately 2 minutes to complete. |
| External calibration | External calibration calibrates the TCXO, voltage reference, and DC gain and offset. Appropriate constants are stored in nonvolatile memory. |
| Calibration interval | Specifications valid within 2 years of external calibration |
| Warm-up time[36] | 15 minutes |

## Power

| | |
|---|---|
| **Current** | |
| +3.3 V rail | 2.3 A |
| +12 V rail | 1.8 A |
| Total power | 29 W |

## Environment

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

| | |
|---|---|
| Pollution Degree | 2 |

Indoor use only.

## Operating Environment

| | |
|---|---|
| Ambient temperature range | 0 °C to 55 °C (Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2. Meets MIL-PRF-28800F Class 3 low temperature limit and MIL-PRF-28800F Class 2 high temperature limit.) |
| Relative humidity range | 10% to 90%, noncondensing (Tested in accordance with IEC 60068-2-56.) |

## Storage Environment

| | |
|---|---|
| Ambient temperature range | -40 °C to 71 °C (Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2. Meets MIL-PRF-28800F Class 3 limits.) |
| Relative humidity range | 5% to 95%, noncondensing (Tested in accordance with IEC 60068-2-56.) |

## Shock and Vibration

| | |
|---|---|
| Operating shock | 30 g peak, half-sine, 11 ms pulse (Tested in accordance with IEC 60068-2-27. Meets MIL-PRF-28800F Class 2 limits.) |

**Random vibration**

| | |
|---|---|
| Operating | 5 Hz to 500 Hz, 0.3 $g_{rms}$ (Tested in accordance with IEC 60068-2-64.) |
| Nonoperating | 5 Hz to 500 Hz, 2.4 $g_{rms}$ (Tested in accordance with IEC 60068-2-64. Test profile exceeds the requirements of MIL-PRF-28800F, Class 3.) |

## Physical

| | |
|---|---|
| Dimensions | 21.6 cm × 2.0 cm × 13.0 cm (8.5 in. × 0.8 in. × 5.1 in.) 3 U, one slot, PXI Express module |

**Weight**

| | |
|---|---|
| One channel | 369 g (13.0 oz) |
| Two channels | 376 g (13.3 oz) |

**Bus interface**

| | |
|---|---|
| Form factor | Gen 1 x4 module |
| Slot compatibility | PXI Express or hybrid |

## Compliance and Certifications

### Safety Compliance Standards

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 Product Certifications and Declarations 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)

## Product Certifications and Declarations

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for NI products, 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.)

[1] Channels support independent waveform generation.

[2] Amplitude values assume the full scale of the DAC is utilized. NI-FGEN uses waveforms less than the full scale of the DAC to create amplitudes smaller than the minimum value.

[3] For example, a 5.5 $V_{pk-pk}$ range equals ±2.75 V maximum offset. Offset range has a limitation of ±12 V absolute signal swing into high-impedance loads (**Amplitude** + |**Offset**| ≤ 12 V into high-impedance load or 6 V into 50 Ω load).

[4] Terminated with high-impedance load (load impedance set to 1 MΩ). The analog path is calibrated for amplitude, gain, and offset errors.

[5] Where **Amplitude Range** is the requested amplitude in $V_{pk-pk}$. For example, a DC signal with an amplitude range of 16 $V_{pk-pk}$ and offset of 1.5 will calculate DC accuracy using the following equation: ±[(0.35% * 16 V) + (0.35% * 1.5 V) + 500 µV] = ±61.75 mV. The DC standard function always uses the 24 $V_{pk-pk}$ amplitude range.

[6] With 50 kHz sine wave and terminated with high-impedance load.

[7] When the output path is disabled, the channel output is terminated to ground with a 50 Ω, 1 W resistor.

[8] No damage occurs if the analog output channels are shorted to ground indefinitely.

[9] The output terminals of multiple PXIe-5433 waveform generators can be connected together.

[10] Normalized to 50 kHz.

[11] With sine frequencies 40 MHz or higher and ambient temperatures above 45 °C, add ±0.015 dB/°C to the passband flatness specification.

[12] At amplitude of -1 dBFS with 0 V DC offset, measured from DC to 400 MHz, and limited to a -90 dBm spur at low amplitudes.

[13] Full-scale amplitude follows operation curve in Figure 11.

[14] At amplitude of -1 dBFS and measured from DC to the sixth harmonic.

[15] Noise floor is limited by the noise floor of the measurement device.

16 At small amplitudes, average noise density is limited by a -154 dBm/Hz noise floor.

17 With 80 MHz carrier and locked to the internal timebase with spurs removed.

18 With 80 MHz carrier, integrated from 100 Hz to 100 kHz, and locked to the internal timebase.

19 Used for calculating duty cycle limit:
**Minimum Duty Cycle** = (100% * **Minimum On Time**) ÷ $\mathbf{T}_{period}$
and **Maximum Duty Cycle** = 100% - **Minimum Duty Cycle**. For more information about the relationship between minimum on/off time and duty cycle specifications, refer to ni.com.

20 Rise time measured from 10% to 90%.

21 Rise time will vary with amplitude due to operational amplifier slew rate saturation.

22 Integrated from 10 Hz to 10 MHz using a 27 MHz square wave.

23 At maximum user sample rate.

24 Relative to 50 kHz and at 2 $V_{pk-pk}$ and maximum user sample rate.

25 With the digital filter enabled and at -1 dBFS, 2 $V_{pk-pk}$, and 400 MS/s. Noise floor is limited by the noise floor of the measurement device.

26 With the digital filter enabled and at -7 dBFS, 2 $V_{pk-pk}$, and 400 MS/s. Noise floor is limited by the noise floor of the measurement device.

27 If locked to an external Reference Clock source, timebase accuracy is equal to the external Reference Clock accuracy.

28 Where time drift starts at the latest external calibration date.

29 With a 20 MHz sine wave and both channels configured with the same amplitude.

[30] NI-TClk synchronization support for the PXIe-5433 was first available in NI-FGEN 18.1. NI-TClk installs with NI-FGEN.

[31] Specifications are valid for any number of PXIe-5433 modules installed in one chassis, with each PXIe-5433 module using a single NI-FGEN session and having all analog parameters set to identical values, and Sample Clock set to 100 MS/s. For other configurations, including multi-chassis systems, contact NI Technical Support at ni.com/support.

[32] Manual adjustment is the process of minimizing synchronization jitter and skew by adjusting Trigger Clock (TClk) signals using the instrument driver.

[33] Caused by clock and analog path delay differences.

[34] Synchronization jitter is the variation in module alignment across calls to NI-TClk Synchronize.

[35] In frequency list, arbitrary waveform, and arbitrary sequence output modes.

[36] Warm up begins after the chassis is powered and the PXIe-5433 is recognized by the host and configured using NI-FGEN. Self-calibration is recommended following the warm-up time.