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# PXle-5413

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# PXIe-5413 Specifications

These specifications apply to the one-channel and two-channel PXIe-5413.

## 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  $\Omega$  to ground
- Load impedance set to 50  $\Omega$
- Amplitude set to 2.4 V<sub>pk-pk</sub>
- 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 or 2
Output type	Referenced single-ended
Connector type	SMA
DAC resolution	16 bits
<b>Amplitude range, in 0.16 dB steps</b>	
50 $\Omega$ load	0.00775 $V_{pk-pk}$ to 12 $V_{pk-pk}$
Open load	0.0155 $V_{pk-pk}$ to 24 $V_{pk-pk}$
Offset range	$\pm 50\%$ of <b>Amplitude Range</b> ( $V_{pk-pk}$ )
Offset resolution	16-bit full-scale range
<b>DC accuracy</b>	
Within $\pm 5$ °C of self-calibration temperature	$\pm 0.35\%$ of <b>Amplitude Range</b> $\pm 0.35\%$ of <b>Offset Requested</b> $\pm 500$ $\mu V$ , warranted

0 °C to 55 °C	$\pm 0.55\%$ of <b>Amplitude Range</b> $\pm 0.55\%$ of <b>Offset Requested</b> $\pm 500 \mu\text{V}$ , typical
AC amplitude accuracy (within $\pm 5$ °C of self-calibration temperature)	$\pm 1.0\% \pm 1 \text{ mV}_{\text{pk-pk}}$ , warranted
Output impedance	50 $\Omega$
Load impedance	Output waveform is compensated for user-specified impedances
Output coupling (ground referenced)	DC
Output enable	Software-selectable
Maximum output overload	$\pm 12 \text{ V}_{\text{pk-pk}}$ from a 50 $\Omega$ source
Waveform summing	Supported

## Standard Function

### Sine Waveform

Frequency range	0 MHz to 20 MHz
Frequency step size	2.84 $\mu\text{Hz}$

**Table 1.** Passband Flatness

Sine Frequency	Passband Flatness (dB), Warranted	
	0.06 $\text{V}_{\text{pk-pk}}$ to 2.75 $\text{V}_{\text{pk-pk}}$	$> 2.75 \text{ V}_{\text{pk-pk}}$
1 MHz	$\pm 0.4$	$\pm 0.4$
10 MHz	$\pm 0.4$	$\pm 0.4$
20 MHz	$\pm 0.4$	$\pm 0.6$

Figure 1. Passband Flatness

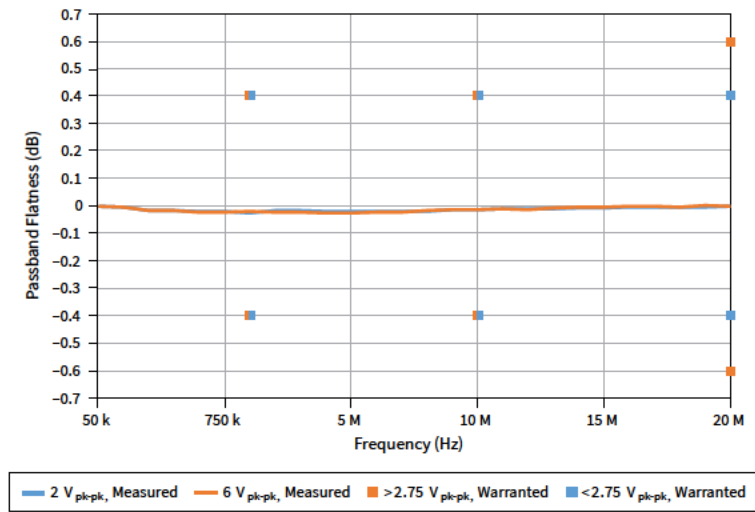


Table 2. Spurious-Free Dynamic Range (SFDR) with Harmonics

Sine Frequency	SFDR with Harmonics (dBc), Measured		
	0.1 V <sub>pk-pk</sub> to 1 V <sub>pk-pk</sub>	1 V <sub>pk-pk</sub> to 2.75 V <sub>pk-pk</sub>	>2.75 V <sub>pk-pk</sub>
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

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

Sine Frequency	SFDR without Harmonics (dBc), Measured		
	0.1 V <sub>pk-pk</sub> to 1 V <sub>pk-pk</sub>	1 V <sub>pk-pk</sub> to 2.75 V <sub>pk-pk</sub>	>2.75 V <sub>pk-pk</sub>
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

**Table 4.** Total Harmonic Distortion (THD)

Sine Frequency	THD (dBc), Measured	
	0.1 V <sub>pk-pk</sub> to 2.75 V <sub>pk-pk</sub>	2.75 V <sub>pk-pk</sub> to 12 V <sub>pk-pk</sub>
1 MHz	79	76
3 MHz	73	62
5 MHz	72	56
10 MHz	68	49
20 MHz	61	43

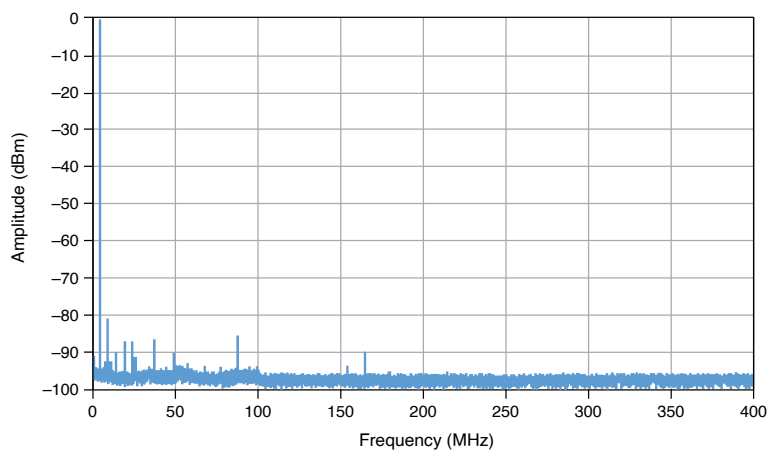
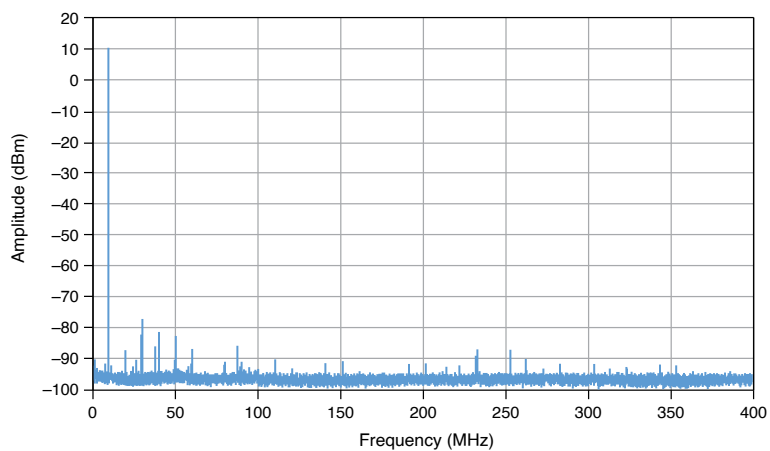
**Figure 2.** 5 MHz Spectrum at 0.6 V<sub>pk-pk</sub>, Measured**Figure 3.** 10 MHz Spectrum at 2 V<sub>pk-pk</sub>, Measured

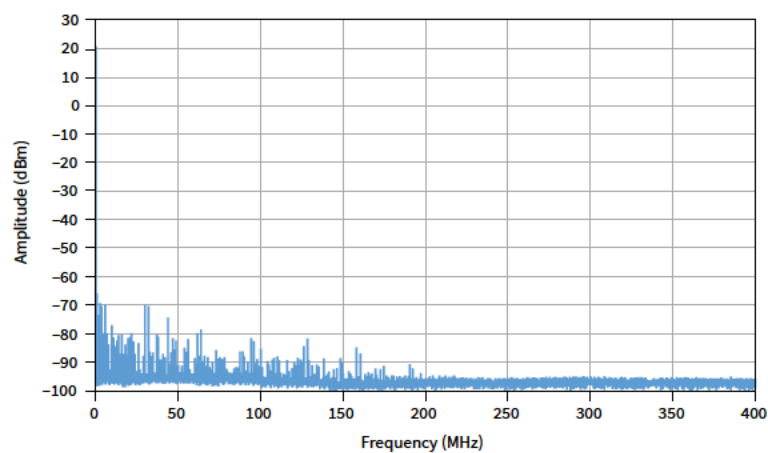
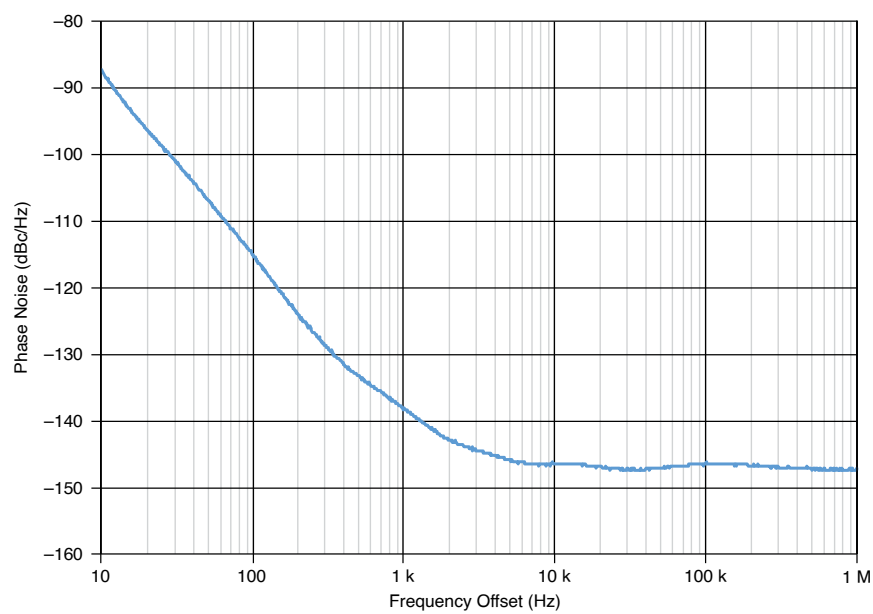
Figure 4. 1 MHz Spectrum at 6.5 V<sub>pk-pk</sub>, Measured

Table 5. Average Noise Density

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



Figure 5. Phase Noise, Measured

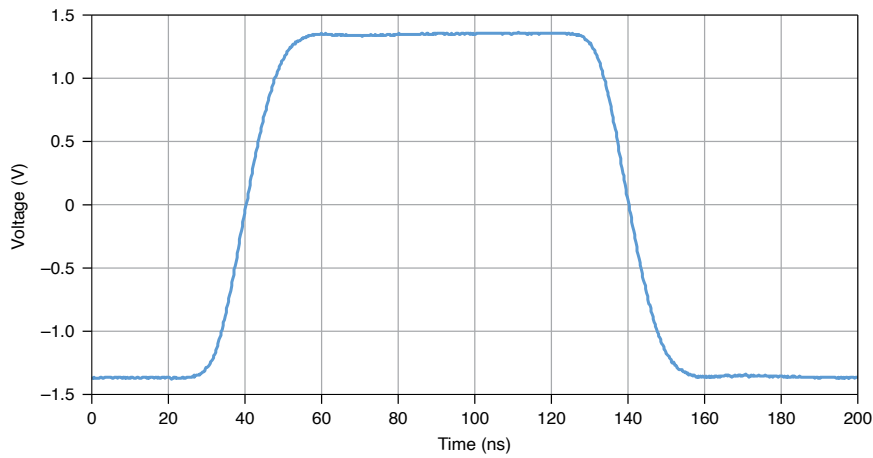


Jitter (RMS)	239 fs
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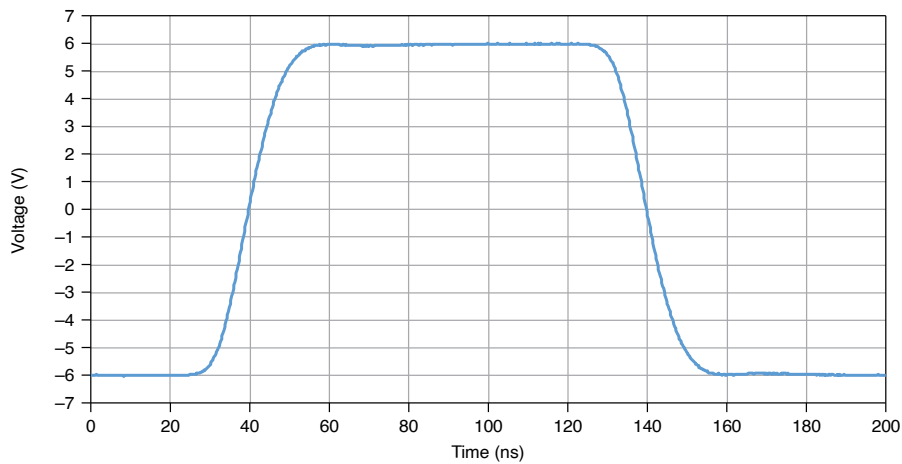
Square Waveform

Frequency range	0 MHz to 10 MHz
Frequency step size	2.84 $\mu$ Hz
Minimum on/off time	38.5 ns
Duty cycle resolution	<0.001%
Rise/fall time	17 ns, measured
Aberration	1.0%, measured
Jitter (RMS)	5 ps, measured

**Figure 6. Square Waveform Step Response at 2.75 V<sub>pk-pk</sub>, Measured**



**Figure 7. Square Waveform Step Response at 12 V<sub>pk-pk</sub>, Measured**



## Ramp and Triangle Waveforms

Frequency range	0 MHz to 1 MHz
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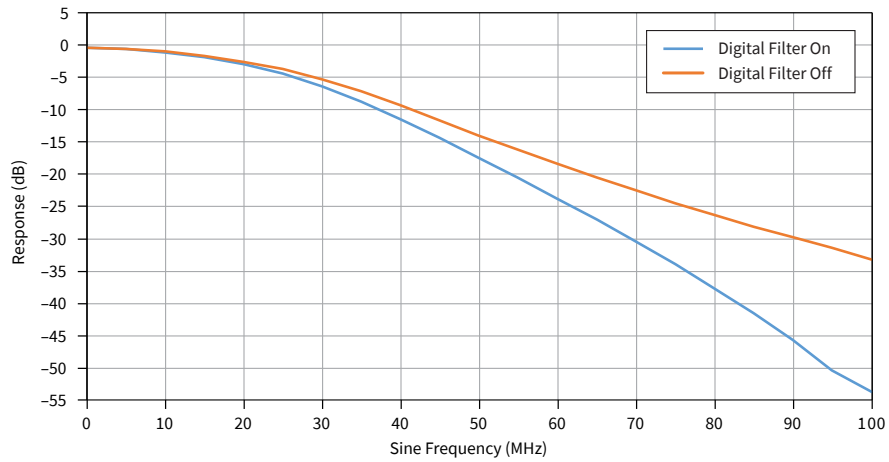
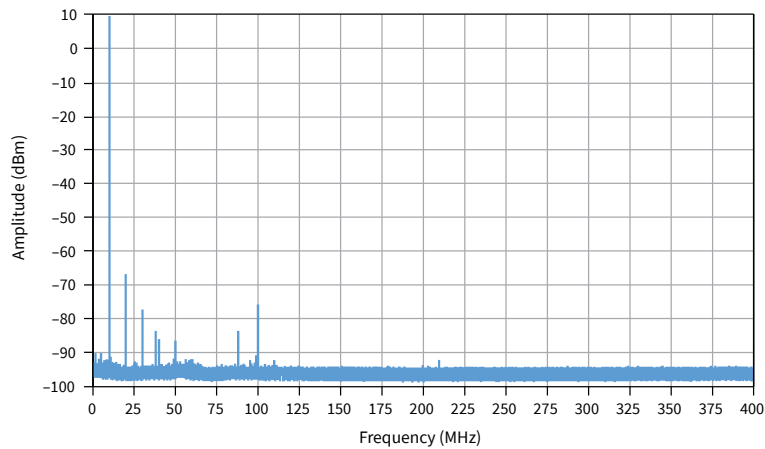
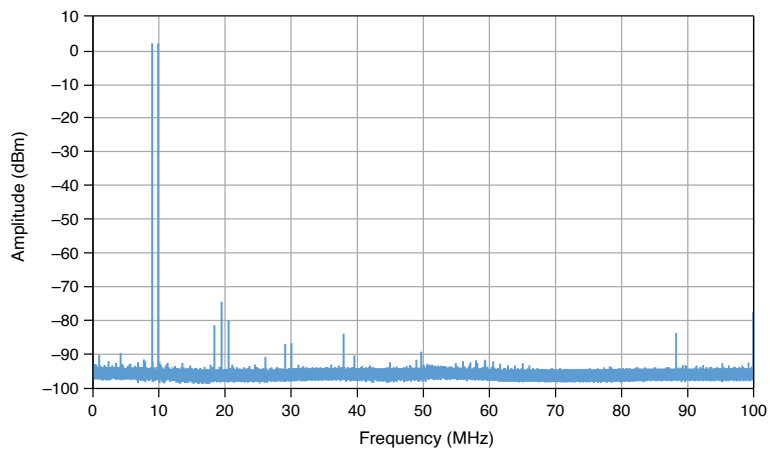
## User-Defined Function

Frequency range	0 MHz to 20 MHz
Frequency step size	2.84 $\mu$ Hz

Waveform points	8,192
Step response rise time	14.8 ns, measured

## Arbitrary Waveform

Waveform size	2 samples to 64,000,000 samples
<b>User sample rate</b>	
Digital filter enabled	5.6 $\mu$ S/s to 200 MS/s
Digital filter disabled	3.125 MS/s to 200 MS/s
<b>Waveform filters</b>	
Digital filter enabled	<b>Bandwidth = 0.2 * User Sample Rate</b>
Digital filter disabled	No reconstruction image rejection
Minimum quantum size	1 sample
<b>Rise time</b>	
Digital filter enabled	20.3 ns, measured
Digital filter disabled	16.3 ns, measured
Total onboard memory	128 MB per channel

**Figure 8. Magnitude Response, Measured****Figure 9. 10 MHz Single-Tone Spectrum, Measured****Figure 10. 9.5 MHz and 10.5 MHz Dual-Tone Spectrum, Measured**

## All Output Modes

Figure 11. Channel-To-Channel Crosstalk, Measured

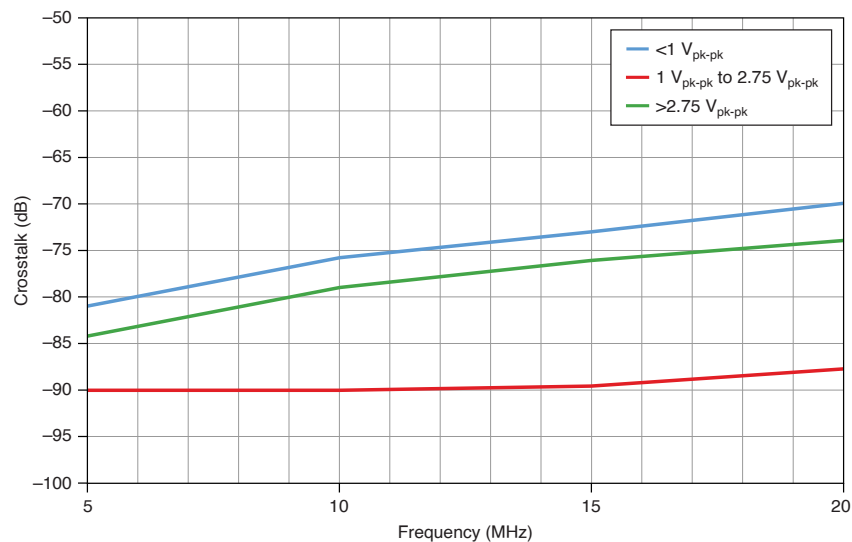
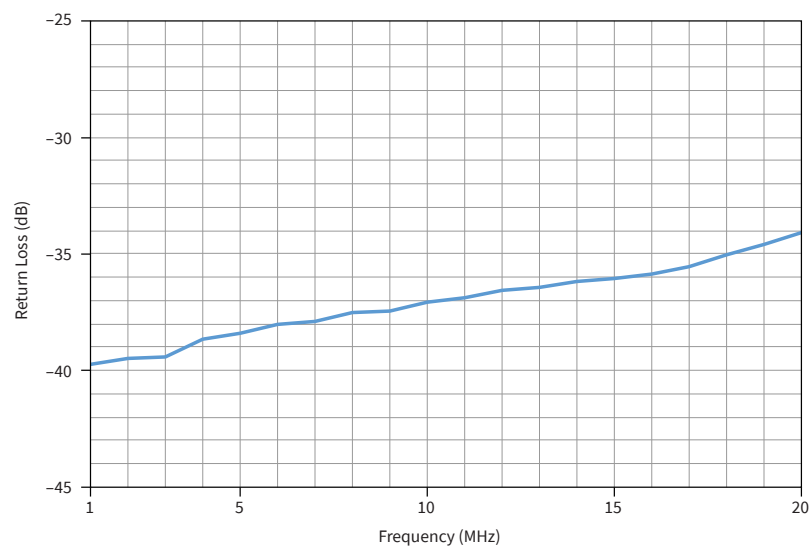


Figure 12. Return Loss, Measured



## Clock

Reference Clock source	Internal
	PXIe_CLK100 (backplane connector)

Reference Clock frequency	100 MHz ( $\leq \pm 25$ ppm)
Sample Clock rate	800 MHz
<b>Internal timebase accuracy</b>	
Initial calibrated accuracy	1.5 ppm, warranted
Time drift	1 ppm per year, warranted
Accuracy	<b>Initial Calibrated Accuracy <math>\pm</math> Time Drift,</b> warranted

## Synchronization

<b>Channel-to-channel skew, between the channels of a multichannel PXIe-5413</b>	
$< 2.75$ Vpk-pk	$\pm 110$ ps
$> 2.75$ Vpk-pk	$\pm 275$ ps



**Note** The channels of a multichannel PXIe-5413 are automatically synchronized when they are in the same NI-FGEN session.

## Synchronization with the NI-TClk API

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-5413 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.

<b>Module-to-module skew, between PXIe-5413 modules using NI-TClk</b>
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<b>NI-TClk synchronization without manual adjustment</b>	
Skew, peak-to-peak	300 ps, typical
Jitter, peak-to-peak	125 ps, typical
<b>NI-TClk synchronization with manual adjustment</b>	
Skew, average	<10 ps
Jitter, peak-to-peak	5 ps
Sample Clock delay/adjustment resolution	<b><math>3.8E(-6) * \text{Sample Clock period}</math></b>  For example, at 100 MS/s, $3.8E(-6) * (1/100 \text{ MS/s}) = 38 \text{ fs.}$

## PFI I/O

Number of terminals	10
<b>Connector type</b>	
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> (MHDMM front panel connector)  PXI_Trig <0..7> (backplane connector)
Supported triggers	Start Trigger
Trigger type	Rising edge
Trigger modes	Single  Continuous  Stepped  Burst
Input impedance (DC)	>100 k $\Omega$

## Marker

Destinations	PFI <0..1> (SMA front panel connectors)  AUX 0/PFI <0..7> (MHDMM front panel connector)
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	PXI_Trig <0..7> (backplane connector)
Pulse width	200 ns
<b>Marker to output skew</b>	
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	15 minutes

## Power

<b>Current</b>	
+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.)
<b>Random vibration</b>	
Operating	5 Hz to 500 Hz, 0.3 g <sub>rms</sub> (Tested in accordance with IEC 60068-2-64.)
Nonoperating	5 Hz to 500 Hz, 2.4 g <sub>rms</sub> (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
<b>Weight</b>	
One channel	369 g (13.0 oz)
Two channels	376 g (13.3 oz)
<b>Bus interface</b>	
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

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](http://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](http://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](https://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](https://ni.com/environment/rohs_china)。(For information about China RoHS compliance, go to [ni.com/environment/rohs\\_china](https://ni.com/environment/rohs_china).)