SPECIFICATIONS

PXIe-5170

PXIe, 4- or 8-Channel, 100 MHz Bandwidth, 14-Bit, Reconfigurable Oscilloscope

Contents

NATIONAL INSTRUMENTS

Definitions

Warranted specifications describe the performance of a model under stated operating conditions and are covered by the model warranty.

The following characteristic specifications describe values that are relevant to the use of the model under stated operating conditions but are not covered by the model warranty.

- *Typical* specifications describe the performance met by a majority of models.
- *Nominal* specifications describe an attribute that is based on design, conformance testing, or supplemental testing.
- *Measured* specifications describe the measured performance of a representative model.

Specifications are *Warranted* unless otherwise noted.

Conditions

Specifications are valid under the following conditions unless otherwise noted.

- All vertical ranges
- Sample rate set to 250 MS/s
- Onboard sample clock locked to onboard reference clock
- PXIe-5170 module warmed up for 15 minutes at ambient temperature. Warm-up begins after the chassis is powered, the device is recognized by the host, and the ADC clock is configured using either instrument design libraries or the NI-SCOPE device driver.
- 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. For more information about cooling, refer to the *Maintain Forced-Air Cooling Note to Users* available at *http://www.ni.com/manuals*.
- Calibration IP used properly when using LabVIEW Instrument Design Libraries for Reconfigurable Oscilloscopes (instrument design libraries) to create FPGA bitfiles. Refer to the *NI Reconfigurable Oscilloscopes Help* for more information about the calibration API.

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

- Ambient temperature range of 0 °C to 45 °C
- External calibration cycle maintained
- External calibration performed at 23 °C ± 3 °C

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

- Ambient temperature ranges of 0 °C to 45 °C with a 90% confidence level

Nominal and Measured specifications are valid under the following conditions unless otherwise noted.

- Room temperature, approximately 23 °C

Vertical

Analog Input

Number of channels	
PXIe-5170 (4 CH)	Four (simultaneously sampled)
PXIe-5170 (8 CH)	Eight (simultaneously sampled)
Input type	Referenced single-ended
Connectors	SMA

Impedance and Coupling

Input impedance	50 Ω ± 1.5%, typical
Input coupling	AC, DC

Figure 1. Voltage Standing Wave Ratio (VSWR), Nominal

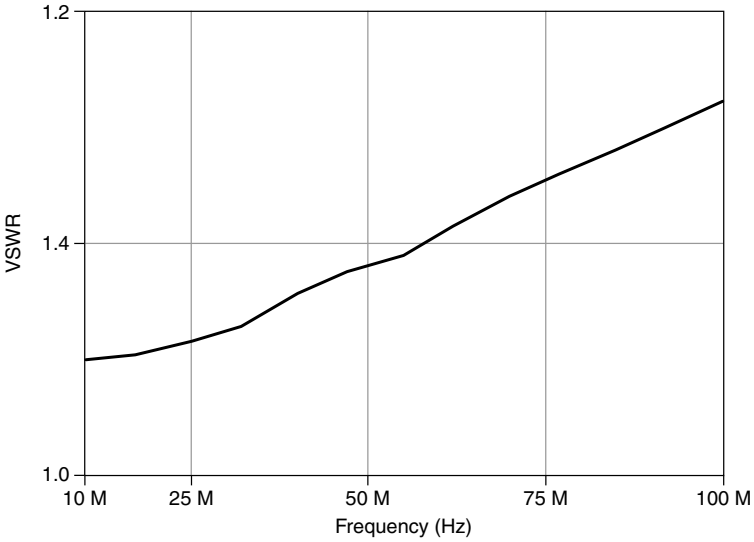
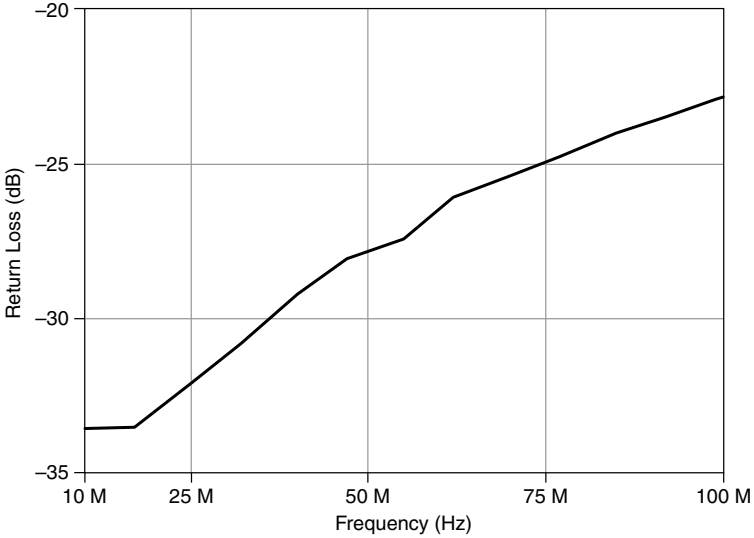


Figure 2. Input Return Loss, Nominal



Voltage Levels

Full-scale (FS) input range (V_{pk-pk})	0.2 V 0.4 V 1 V 2 V 5 V
Maximum input overload[1]	|Peaks| ≤ 5 V, nominal

Accuracy

Notice Electromagnetic interference can adversely affect the measurement accuracy of this product. The coaxial channel inputs of this device (CH 0 to CH 7) are not protected for electromagnetic interference. As a result, this device may experience reduced measurement accuracy or other temporary performance degradation when connected cables are routed in an environment with radiated or conducted radio frequency electromagnetic interference. To limit radiated emissions and to ensure that this device functions within specifications in its operational electromagnetic environment, take precautions when designing, selecting, and installing measurement probes and cables.

Resolution	14 bits

[1] Signals exceeding the maximum input overload may cause damage to the device.

Table 1. DC Accuracy[2]

Input Range	Accuracy		Drift
	Typical[3]	Warranted[4]	Nominal[5]
V_{pk-pk}	±(% of |Reading| + % of FS + mV)	±(% of |Reading| + % of FS + mV)	±(% of |Reading| + % of FS + mV) per °C
0.2 V	±(0.45 + 0.6 + 0.2)	±(0.90 + 0.65 + 0.7)	±(0.015 + 0.002 + 0.004)
0.4 V	±(0.45 + 0.24 + 0.2)	±(0.80 + 0.25 + 0.7)	±(0.012 + 0.002 + 0.004)
1 V	±(0.45 + 0.2 + 0.2)	±(0.80 + 0.25 + 0.7)	±(0.010 + 0.002 + 0.004)
2 V	±(0.40 + 0.2 + 0.2)	±(0.60 + 0.25 + 0.7)	±(0.005 + 0.002 + 0.004)
5 V	±(0.40 + 0.2 + 0.2)	±(0.55 + 0.25 + 0.7)	±(0.005 + 0.002 + 0.004)

DC accuracy sampling drift, full bandwidth (±% of |Reading| per MHz from 250 MHz)[6]	±0.03, nominal
AC amplitude accuracy[2]	
Accuracy	±0.095 dB at 50 kHz, typical[3] ±0.15 dB at 50 kHz, warranted[4]
Drift[5]	±0.0013 dB per °C, nominal

[2] Verification of these specifications requires the *DC Adjustment Device Temperature (°C)* value. If you are using version 14.0 of the software, visit *ni.com/info* and enter the Info Code `exxpmp` for information on how to read this value. Otherwise, use NI-SCOPE to read the value.

[3] When the reading from the *Device Temperature* sensor is within ±10 °C of the *DC Adjustment Device Temperature (°C)* value.

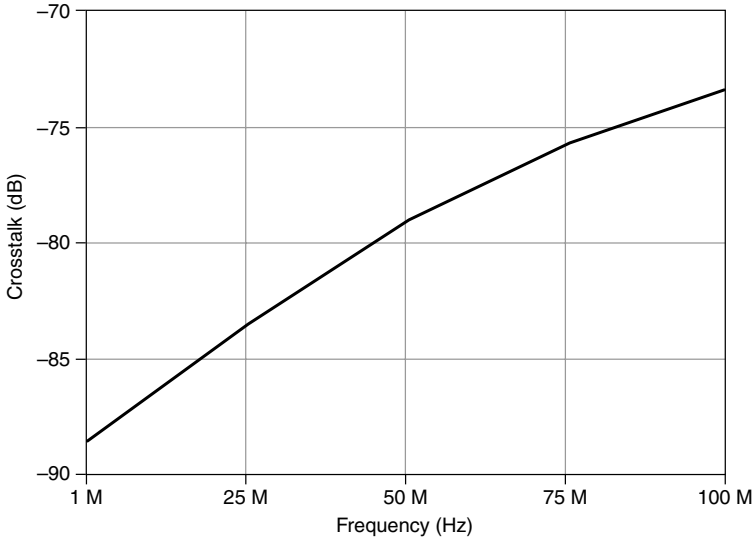
[4] When the reading from the *Device Temperature* sensor is within ±38 °C of the *DC Adjustment Device Temperature (°C)* value. This increased temperature span encompasses the majority of temperature differences between the last external calibration environment and the operating environment.

[5] Used to calculate additional temperature error when the difference between the *Device Temperature* sensor and the *DC Adjustment Device Temperature (°C)* value is greater than ±10 °C (for typical specifications) or ±38 °C (for warranted specifications).

[6] Used to calculate additional DC accuracy error when using an external sample clock of frequency <250 MHz. To calculate the additional error, solve the following for the analog path of interest:

$$\frac{250\text{MHz} - \text{frequency}}{1,000,000} \times \text{DC accuracy sampling drift}$$

Figure 3. Channel-to-Channel Crosstalk, Nominal[7]



Bandwidth and Transient Response

Bandwidth (-3 dB)[8] 100 MHz

Table 2. Passband Amplitude Flatness[8]

Input Frequency	Full Bandwidth
<50 MHz	-0.5 dB to 0.5 dB
50 MHz to 90 MHz	-1.0 dB to 0.5 dB

AC-coupling cutoff (-3 dB)[9] 120 kHz, nominal

[7] Measured on one channel with test signal applied to another channel, with the same range setting on both channels.
[8] Normalized to 50 kHz.
[9] With AC coupling enabled, the input impedance is 260 kΩ to ground. Verified using a 50 Ω source.

Figure 4. Frequency Response, Full Bandwidth, Measured

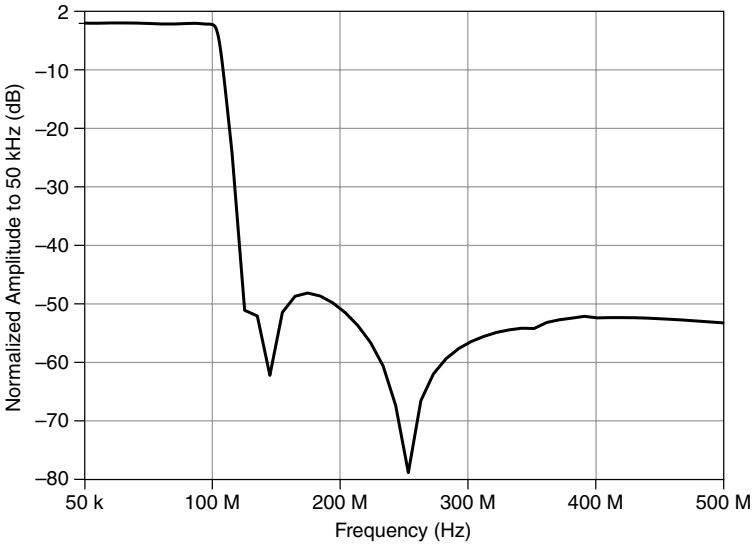
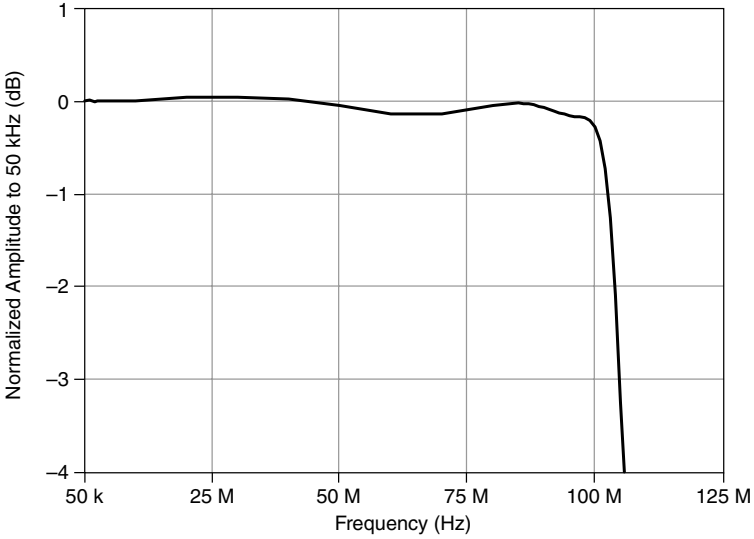


Figure 5. Frequency Response (Zoomed), Full Bandwidth, Measured



Spectral Characteristics

Table 3. Spurious-Free Dynamic Range (SFDR), Nominal[10]

Input Range (V_{pk-pk})	Input Frequency	Full Bandwidth
0.2 V to 2 V	<10 MHz	-80.0 dBc
	≥10 MHz to <30 MHz	-76.0 dBc
5 V	<10 MHz	-77.0 dBc
	≥10 MHz to <30 MHz	-73.0 dBc

Table 4. Total Harmonic Distortion (THD), Nominal[11]

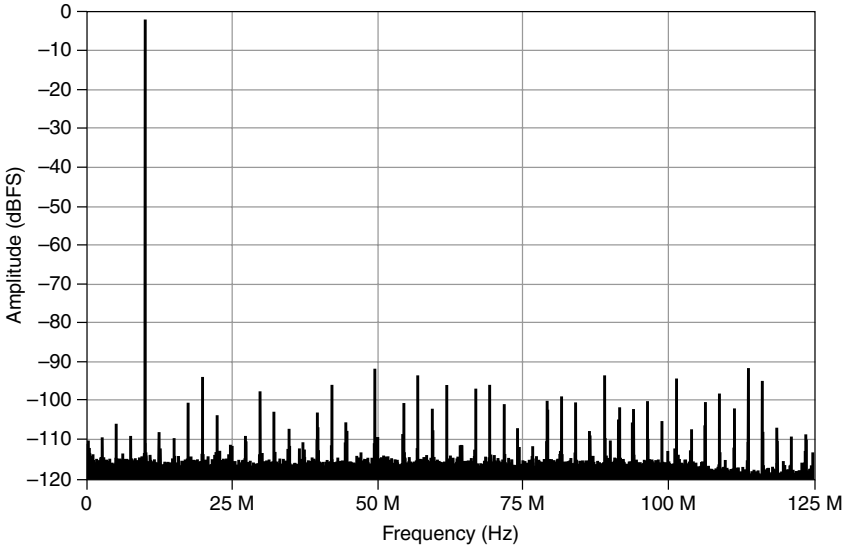
Input Frequency	Full Bandwidth
<10 MHz	-77.0
≥10 MHz to <30 MHz	-73.0

Table 5. Effective Number of Bits (ENOB), Nominal[10]

Input Range (V_{pk-pk})	Input Frequency	Full Bandwidth
0.2 V	<30 MHz	10.8
All other input ranges	<30 MHz	11.0

[10] -1 dBFS input signal corrected to FS. 358 Hz resolution bandwidth (RBW).
[11] Includes the second through the fifth harmonics. -1 dBFS input signal.

Figure 6. Single-Tone Spectrum, 2.98 dBm Input Signal at Connector, 1 V_{pk-pk} Input Range, 9.9 MHz Input Tone, Full Bandwidth, Measured



Noise

RMS noise[12] 0.017% of FS, typical

Table 6. Average Noise Density (dBm/Hz), Typical[12]

Input Range (V_{pk-pk})	Full Bandwidth (dBm/Hz)
0.2 V	-159.2 dBm/Hz
0.4 V	-153.7 dBm/Hz
1 V	-145.7 dBm/Hz
2 V	-139.7 dBm/Hz
5 V	-131.7 dBm/Hz

[12] Verified using a 50 Ω terminator connected to input.

Table 7. Average Noise Density (dBFS/Hz), Typical[12]

Input Range (V_{pk-pk})	Full Bandwidth
0.2 V	149.2 dBFS/Hz
All other input ranges	149.7 dBFS/Hz

Table 8. Average Noise Density (nV/√Hz), Typical[12]

Input Range (V_{pk-pk})	Full Bandwidth (nV/√Hz)
0.2 V	3.5 nV/√Hz
0.4 V	6.5 nV/√Hz
1 V	16.4 nV/√Hz
2 V	32.7 nV/√Hz
5 V	81.8 nV/√Hz

Skew

Channel-to-channel skew	<120 ps, nominal[13]

Horizontal

Sample Clock

Sources	
Internal	Onboard clock (internal VCXO)
External	AUX I/O CLK IN (front panel MHDMR connector) PXIe_DStarA (backplane connector)
Sample rate range, real-time[14]	3.815 kS/s to 250 MS/s
Timebase frequency	250 MHz

[13] For input frequencies less than 75 MHz.

[14] Divide by *n* decimation from 250 MS/s. For more information about the sample clock and decimation, refer to the *NI Reconfigurable Oscilloscopes Help* at ni.com/manuals.

Timebase accuracy	
Phase-locked to onboard clock	±25.0 ppm
Phase-locked to external clock	Equal to the external clock accuracy
Duty cycle tolerance	45% to 55%

Phase-Locked Loop (PLL) Reference Clock

Sources	
Internal	Onboard clock (internal VCXO) PXI_Clk10 (backplane connector)
External (10 MHz)	AUX I/O CLK IN (front panel MHDMR connector)
Duty cycle tolerance	45% to 55%

External Sample Clock

Source	AUX I/O CLK IN (front panel MHDMR connector)
Impedance	50 Ω, nominal
Coupling	AC
Input voltage range	
As a 250 MHz sine wave	1 dBm through 18 dBm
As a fast slew rate input (square wave, V_{pk-pk})	0.4 V to 5 V
Maximum input overload	
As a 250 MHz sine wave	20 dBm
As a fast slew rate input (square wave, V_{pk-pk})	6 V

External Reference Clock In

Source	AUX I/O CLK IN (front panel MHDMR connector)
Impedance	50 Ω, nominal
Coupling	AC
Frequency[15]	10 MHz

[15] The PLL reference clock frequency must be accurate to ±25 ppm.

Input voltage range	
As a 250 MHz sine wave	1 dBm through 18 dBm
As a fast slew rate input (square wave, V_{pk-pk})	6 V
Duty cycle tolerance	45% to 55%

Reference Clock Out

Source	PXI_Clk10 (backplane connector)
Destination	AUX I/O CLK OUT (front panel MHDMR connector)
Output impedance	50 Ω, nominal
Logic type	3.3 V LVCMOS
Maximum current drive	±8 mA, nominal

PXIe_DStarA

Source	System timing slot
Destinations	Onboard clock (internal VCXO) FPGA

PXI_Clk100

Source	PXI backplane
Destination	FPGA

Trigger

Note The following characteristic behaviors are valid when using the device with the NI-SCOPE API. When using instrument design libraries, these characteristics may not be valid.

Supported trigger	Reference (Stop) Trigger
Trigger types	Edge Window Hysteresis Digital Immediate Software

Trigger sources	PXIe-5170 (8CH): CH 0 to CH 7 PXIe-5170 (4CH): CH 0 to CH 3 PFI <0..7> PXI_Trig <0..6> Software
Time resolution	
Analog triggers	Sample Clock timebase period
Digital triggers	8 ns
Rearm time[16]	
With interpolation	936 ns
Without interpolation	496 ns
Dead time	40 ns, nominal
Holdoff	From dead time to [(2^{64} - 1) × Sample Clock timebase period]
Trigger delay	From 0 to [(2^{51} - 1) × Sample Clock timebase period]
Trigger accuracy[17]	0.5% of full scale, nominal
Trigger jitter[17]	15 ps_{rms}, nominal
Minimum threshold duration[18]	Sample Clock period

Related Information

For information about when to self-calibrate the device, refer to the NI High-Speed Digitizers Help at ni.com/manuals.

For more information about triggers, refer to the NI High-Speed Digitizers Help at ni.com/manuals.

Programmable Function Interface (PFI 0..7, AUX I/O Front Panel Connector)

Connector	AUX I/O
Direction	Bidirectional per channel
Direction control latency	25 ns

[16] Trigger interpolation is used when the Enable TDC NI-SCOPE attribute is set to `TRUE`. Otherwise, trigger interpolation is not used.

[17] Analog triggers. For input frequencies less than 90 MHz.

[18] Data must exceed each corresponding trigger threshold for at least the minimum duration to ensure analog triggering.

As an Input (Trigger)	
Destination	FPGA diagram Start Trigger (Acquisition Arm) Reference (Stop) Trigger Arm Reference Trigger Advance Trigger
Input impedance	10 kΩ, nominal
V_{IH}	2 V
V_{IL}	0.8 V
Maximum input overload	0 V to 3.3 V nominal, 5 V tolerant
Minimum pulse width	10 ns
As an Output (Event)	
Sources	FPGA diagram Ready for Start Start Trigger (Acquisition Arm) Ready for Reference Reference (Stop) Trigger End of Record Ready for Advance Advance Trigger Done (End of Acquisition)
Output impedance	50 Ω, nominal
Logic type	3.3 V CMOS
Maximum current drive	12 mA, nominal
Minimum pulse width	10 ns

Power Output (+3.3 V)

Connector	AUX I/O/+3.3 V front panel connector
Voltage output	3.3 V ± 10%, nominal
Maximum current drive	200 mA, nominal
Output impedance	<1 Ω, nominal

Waveform Specifications

Onboard memory size[19]	
PXIe-5170 (4 CH)	0.75 GB
PXIe-5170 (8 CH)	1.5 GB
Minimum record length	1 sample
Number of pretrigger samples	Zero up to (record length - 1)
Number of posttrigger samples	Zero up to record length

Figure 7. Maximum Number of Records in Onboard Memory

$$\frac{\text{total onboard memory}}{48 \times \text{number of channels}}$$

where *number of channels* is the number of channels enabled rounded up to the nearest power of two

Figure 8. Allocated Onboard Memory Per Record

$$\text{Roundup}\left(\text{Roundup}\left(\frac{\text{coerced number of samples} + \text{number of samples per sample word}}{\text{number of samples per memory word}}\right) \times \text{number of samples per memory word} + 3 \times \text{number of samples per memory word}\right) \times \text{bytes per sample} \times \text{number of channels}$$

where

number of samples per sample word = 16 samples / number of channels

number of samples per memory word = 48 samples / number of channels

coerced number of samples is the number of pretrigger samples rounded up to the next multiple of *number of samples per sample word* + the number of posttrigger samples rounded up to the next multiple of *number of samples per sample word*

number of channels is the number of channels enabled rounded up to the nearest power of two

Memory Sanitization

For information about memory sanitization, refer to the letter of volatility for your device, which is available at *ni.com/manuals*.

FPGA

FPGA support	Xilinx Kintex-7 XC7K325T FPGA

[19] Onboard memory is shared among all enabled channels.

Xilinx Kintex-7 XC7K325T FPGA Resources	
Slice registers	407,600
Slice look-up tables (LUT)	203,800
DSPs	840
18 Kb block RAMs	890

Note Note that some of these resources are consumed by the logic necessary to operate the device and integrate with software, and are thus out of the control of users.

Calibration

External Calibration

External calibration corrects for gain, offset, and timing errors at all input ranges.

All calibration constants are stored in nonvolatile memory.

Self-Calibration

Self-calibration is done on software command. The calibration corrects for intermodule synchronization errors.

Related Information

For information about when to self-calibrate the device, refer to the NI High-Speed Digitizers Help at ni.com/manuals.

Calibration Specifications

Interval for external calibration	2 years
Warm-up time[20]	15 minutes

Software

Driver Software

This device was first supported in LabVIEW Instrument Design Libraries for Reconfigurable Oscilloscopes 14.0 and NI-SCOPE 15.1. NI-SCOPE is an IVI-compliant driver that allows

[20] Warm-up begins after the chassis is powered, the device is recognized by the host, and the device is configured using the instrument design libraries or NI-SCOPE. Running an included sample project or running self-calibration using NI-MAX will configure the device and start warm-up.

you to configure, control, and calibrate the device. NI-SCOPE provides application programming interfaces for many development environments.

Related Information

For information about the available software options, refer to the PXIe-5170/5171 Getting Started Guide.

Application Software

NI-SCOPE provides programming interfaces, documentation, and examples for the following application development environments:

- LabVIEW
- LabWindows™/CVI™
- Measurement Studio
- Microsoft Visual C/C++
- .NET (C# and VB.NET)

LabVIEW Instrument Design Libraries for Reconfigurable Oscilloscopes allows the use of the LabVIEW FPGA Module to customize the device FPGA to create application-specific instrument designs.

Interactive Soft Front Panel and Configuration

When you install NI-SCOPE on a 64-bit system, you can monitor, control, and record measurements from the PXIe-5170 using InstrumentStudio.

InstrumentStudio is a software-based front panel application that allows you to perform interactive measurements on several different device types in a single program.

Note InstrumentStudio is supported only on 64-bit systems. If you are using a 32-bit system, use the NI-SCOPE–specific soft front panel instead of InstrumentStudio.

Interactive control of the PXIe-5170 was first available via InstrumentStudio in NI-SCOPE 18.1 and via the NI-SCOPE SFP in NI-SCOPE 15.1. InstrumentStudio and the NI-SCOPE SFP are included on the NI-SCOPE media.

NI Measurement & Automation Explorer (MAX) also provides interactive configuration and test tools for the PXIe-5170. MAX is included on the driver media.

TClk Specifications

You can use the NI TClk synchronization method and the NI-TClk driver to align the Sample clocks on any number of supported devices, in one or more chassis. For more information about TClk synchronization, refer to the *NI-TClk Synchronization Help*, which is located within the *NI High-Speed Digitizers Help*. For other configurations, including multichassis systems, contact NI Technical Support at *ni.com/support*.

Intermodule Synchronization Using NI-TClk for Identical Modules

Synchronization specifications are valid under the following conditions:

- All modules are installed in one PXI Express chassis.
- The NI-TClk driver is used to align the Sample clocks of each module.
- All parameters are set to identical values for each module.
- Modules are synchronized without using an external Sample Clock.
- All filters are disabled.

Note Although you can use NI-TClk to synchronize non-identical SMC-based modules, these specifications apply only to synchronizing identical modules.

Skew[21]	300 ps, nominal
Skew after manual adjustment	≤10 ps, nominal
Sample Clock delay/adjustment resolution	3.5 ps

Power

Note Power consumed depends on the FPGA image and driver software used. Specifications for instrument design libraries reflect the performance of a device using the FPGA image from the Multirecord Acquisition sample project. Maximum power consumption occurs at highest operating temperature.

Table 9. PXIe-5170 (4CH) Power Consumption, Typical

	Instrument Design Libraries	NI-SCOPE
+3.3 VDC	6.0 W	5.9 W
+12 VDC	14.5 W	13.4 W
Total power	20.5 W	19.3 W

[21] Caused by clock and analog path delay differences. No manual adjustment performed. Tested with an NI PXIe-1082 chassis with a maximum slot-to-slot skew of 100 ps. Valid within ±1 °C of self-calibration.

Table 10. PXIe-5170 (8CH) Power Consumption, Typical

	Instrument Design Libraries	NI-SCOPE
+3.3 VDC	6.4 W	6.3 W
+12 VDC	17.0W	17.2W
Total power	23.4 W	23.5 W

Total maximum power allowed	38.25 W

Dimensions and Weight

Dimensions	18.5 cm × 2.0 cm × 13.0 cm (7.3 in. × 0.8 in. × 5.1 in.) 3U, 1 slot, PXI Express Gen 2 x8 Module
Weight	
PXIe-5170 (4CH)	462 g (16.3 oz.)
PXIe-5170 (8CH)	484 g (17.1 oz.)

Environment

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

Indoor use only.

Operating Environment

Ambient temperature range	0 °C to 45 °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 4 high temperature limit.)
Relative humidity range	10% to 90%, noncondensing (Tested in accordance with IEC 60068-2-56.)

Storage Environment

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

Shock and Vibration

Operating shock	30 g peak, half-sine, 11 ms pulse (Tested in accordance with IEC 60068-2-27. Meets MIL-PRF-28800F Class 2 limits.)
Random vibration	
Operating	5 Hz to 500 Hz, 0.3 g_{rms} (Tested in accordance with IEC 60068-2-64.)
Nonoperating	5 Hz to 500 Hz, 2.4 g_{rms} (Tested in accordance with IEC 60068-2-64. Test profile exceeds the requirements of MIL-PRF-28800F, Class 3.)

Compliance and Certifications

Safety 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 61326-2-1 (IEC 61326-2-1): 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.)

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