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PXIe-4190 Specifications

2023-03-21

Contents

PXIe-4190 Specifications

Notes on PXIe-4190 Variants

In this document, the 500 kHz and 2 MHz variants of the PXIe-4190 are referred to inclusively as the PXIe-4190. The information in this document applies to all variants of the PXIe-4190 unless otherwise specified.

To determine which version of the PXIe-4190 you have, locate the device name in one of the following places:

- On the device front panel.
- In MAX, the PXIe-4190 (2 MHz) appears as **NI PXIe-4190**. The PXIe-4190 (500 kHz) appears as **NI PXIe-4190 (500 kHz)**.

Definitions

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

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.
- **Nominal** specifications describe an attribute that is based on design, conformance testing, or supplemental testing.

Specifications are **Warranted** unless otherwise noted.

SMU Specifications

SMU Specifications Conditions

The following conditions must be met when operating in SMU Mode.

- Ambient temperature[1] of 23 °C ± 5 °C
- Relative humidity between 10% and 60%, noncondensing
- Chassis with slot cooling capacity ≥58 W
- Calibration interval of 1 year
- 30 minutes warm-up time
- Self-calibration performed within the last 24 hours
- NI-DCPower 21.8 or later installed
- Connections between force and sense leads are required and must be made while the **niDCPower Output Enabled** or **niDCPower Output Connected** properties are set to FALSE[2]
- **niDCPower Aperture Time** property or **NIDCPOWER_ATTR_APERTURE_TIME** attribute set to 2 power-line cycles (PLC)
- **niDCPower Cable Length** property or **NIDCPOWER_ATTR_CABLE_LENGTH** attribute set when using the lower two current ranges

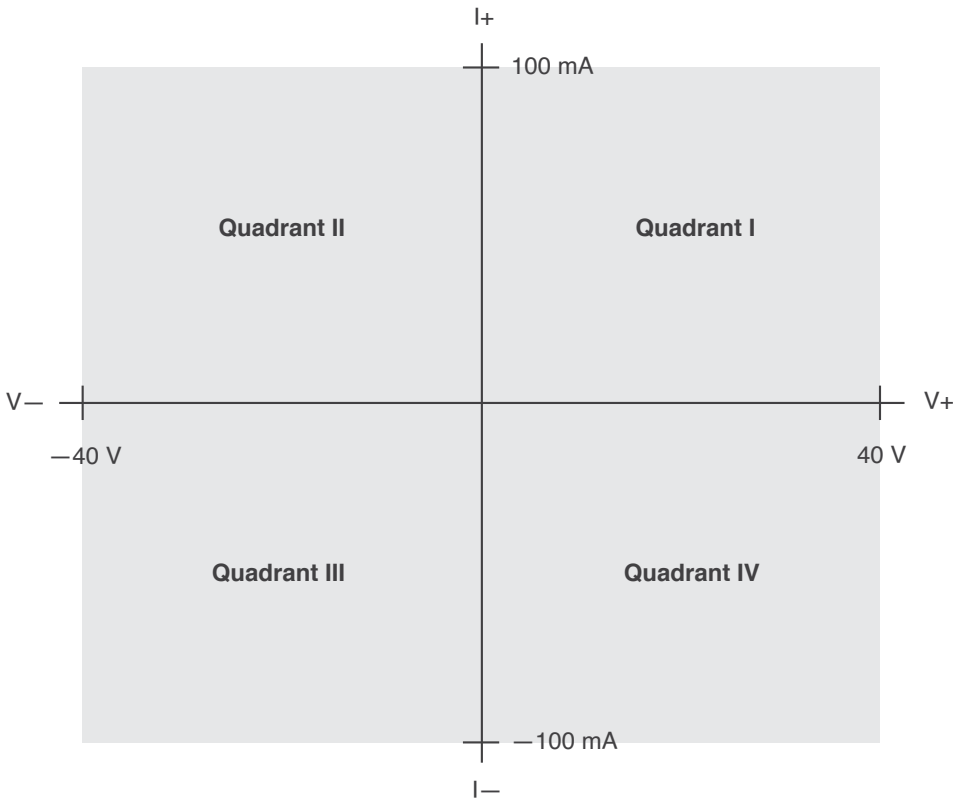
SMU Instrument Capabilities

PXIe-4190 (2 Mhz)

DC voltage ranges	1 V 10 V 40 V
DC current ranges	1 nA 100 nA 1 µA 10 µA 100 µA 1 mA 10 mA

	100 mA
Available DC output power	
Sourcing	4 W
Sinking	4 W

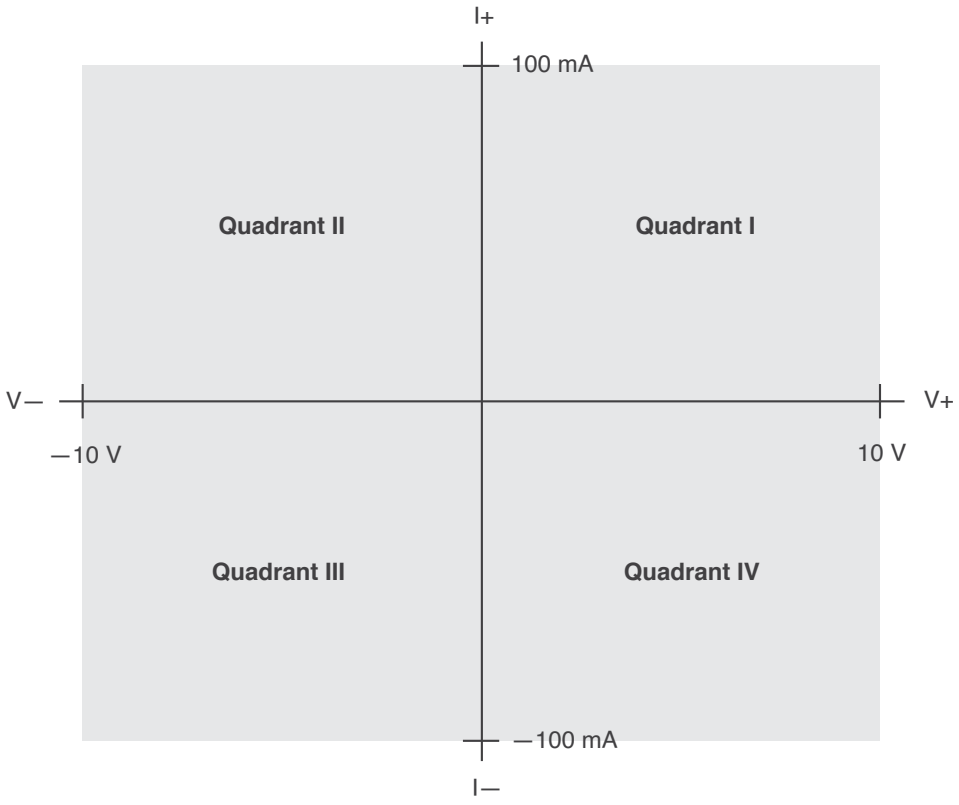
Figure 1. PXIe-4190 (2 MHz) Quadrant Diagram



PXIe-4190 (500 kHz)

DC voltage ranges	1 V 10 V
DC current ranges	10 µA 100 µA 1 mA 10 mA 100 mA
Available DC output power	
Sourcing	4 W
Sinking	4 W

Figure 2. PXIe-4190 (500 kHz) Quadrant Diagram



SMU Voltage

Table 1. Voltage Programming and Measurement Accuracy/Resolution

Range	Resolution (Noise Limited)	Noise (0.1 Hz to 10 Hz, peak-to-peak, typical)	Accuracy ± (% of Voltage + Offset)		Tempco[3] ± (% of Voltage + Offset)/°C
			$T_{ambient}$ 23 °C ±5 °C, T_{cal}[4] ±5 °C		
			% of Voltage	Offset	$T_{ambient}$ 0 °C to 30 °C, T_{cal} ±5 °C
1 V	100 nV	2 µV	0.009%	160 µV	0.0002% + 1 µV
10 V	1 µV	10 µV	0.008%	1 mV	
40 V [5]	4 µV	50 µV	.009%	4.1 mV	

SMU Current

Table 2. Current Programming and Measurement Accuracy/Resolution

Range	Resolution (Noise Limited)	Noise (0.1 Hz to 10 Hz, peak-to-peak, typical)	Accuracy ± (% of Current + Offset)		Tempco[6] ± (% of Current + Offset)/°C
			$T_{ambient}$ 23 °C ±5 °C, T_{cal}[] ±5 °C		
			% of Current	Offset +	$T_{ambient}$ 0 °C to 30 °C, T_{cal} ±5 °C
1 nA[7], [8]	1 fA	30 fA	0.14%	2 pA	0.0003% + 20 fA
1 nA[9], [8]		60 fA			
100 nA[7], [8]	10 fA	300 fA	0.091%	11 pA	
100 nA[9], [8]		700 fA			
1 µA	100 fA	2 pA	0.032%	140 pA	
10 µA	1 pA	15 pA	0.026%	1 nA	
100 µA	10 pA	120 pA	0.024%	10 nA	
1 mA	100 pA	1.2 nA	0.023%	100 nA	
10 mA	1 nA	12 nA	0.022%	1 µA	
100 mA	10 nA	120 nA	0.028%	10 µA	

Range	Resolution (Noise Limited)	Noise (0.1 Hz to 10 Hz, peak-to-peak, typical)	Accuracy ± (% of Current + Offset)		Tempco[6] ± (% of Current + Offset)/°C
			$T_{ambient}$ 23 °C ±5 °C, T_{cal}[] ±5 °C		
			% of Current	Offset +	$T_{ambient}$ 0 °C to 30 °C, T_{cal} ±5 °C
+Add 10 pA to current accuracy specifications when using DSUB-DSUB cable accessory (SHDB13W6-DB13W6-LL)					

SMU Noise

Wideband source noise	<20 mV pk-pk, typical[10]

SMU Remote Sense

Maximum sense lead resistance	200 Ω
Maximum lead drop per lead	1 V

SMU Guard Output Characteristics

Cable guard	
Output impedance	<100 mΩ, nominal
Offset voltage	1 mV, typical

SMU Measurement and Update Timing

Available sample rates[11]	(600 kS/s)/N, nominal

where

- N = 1, 2, 3, … 2^{24}
- S is samples

Sample rate accuracy	Equal to PXIe_CLK100 accuracy, nominal
Maximum measure rate to host	600 kS/s, nominal
Input trigger to	
Source event delay	10 µs nominal
Source event jitter	2 µs pk-pk, nominal
Measure event jitter	2 µs pk-pk, nominal

[1] The ambient temperature of a PXI system is defined as the temperature at the chassis fan inlet (air intake).

[2] Disconnecting the sense leads while both these properties are set to TRUE may result in output protection errors or long settling tails due to the feedback path for the control loop being open. If the PXIe-4190 is run open loop due to accidental sense lead disconnection, allow a minimum of 1 minute after establishing proper lead connections before making measurements.

[3] Temperature coefficient applies beyond 23 °C ±5 °C ambient within ±5 °C of T_{cal}.

[4] T_{cal} is the internal device temperature recorded by the PXIe-4190 at the completion of the last self-calibration

[5] PXIe-4190 (2 MHz) only

[6] Temperature coefficient applies beyond 23 °C ±5 °C ambient within ±5 °C T_{cal}.

[7] Under the following additional conditions: with 10 PLC, and 11-point median filter.

[8] PXIe-4190 (2 MHz) only

[9] Under default specification conditions.

[10] 10 Hz to 20 MHz bandwidth, PXIe-4190 configured for normal transient response.

[11] When source-measuring, both the NI-DCPower **Source Delay** and **Aperture Time** properties affect the sampling rate. When taking a measure record, only the **Aperture Time** property affects the sampling rate.

LCR Specifications

LCR Specifications Conditions

The following conditions must be met when operating in LCR Mode.

- Ambient temperature[1] of 23 °C ± 5 °C
- Relative humidity between 10% and 60%, noncondensing
- Chassis with slot cooling capacity ≥58 W
- Calibration interval of 1 year
- 30 minutes warm-up time
- Self-calibration performed within the last 24 hours
- NI-DCPower 21.8 or later installed
- Automatic Level Control (ALC) is On
- LCR Measurement Time is Long unless otherwise stated
- Open and short compensation has been completed
- Connections between force and sense leads are required and must be made while the **niDCPower Output Enabled** or **niDCPower Output Connected** properties are set to FALSE[2]
- Four-terminal pair (4TP) connections to load[3]
- **niDCPower Cable Length** property or **NIDCPOWER_ATTR_CABLE_LENGTH** attribute set
- Impedance range is within 30% of DUT impedance
- Temperature is within ±5 °C of last self-calibration
- DC bias is off
- SHDB13W6-4BNCM-LL Cable, 1 m (NI part number 788280-01)

LCR Instrument Capabilities

Maximum AC voltage	7.07 V RMS
Maximum AC current	70.7 mA RMS
Maximum DC bias voltage range - PXIe-4190 (2 MHz)	±40 V, including peak test signal
Maximum DC bias voltage range - PXIe-4190 (500 kHz)	±10 V, including peak test signal

Maximum DC bias current range	±100 mA, including peak test signal
Measurement times	
Short	1 ms
Medium	10 ms
Long	100 ms
Custom	User-defined

Note Measurement times round to the nearest positive integer number of cycles of the stimulus frequency.

LCR Measurements

- **Z**—Impedance
- **Y**—Admittance
- **Ls**—Inductance using series-equivalent circuit model
- **Cs**—Capacitance using series-equivalent circuit model
- **Rs**—Resistance using series-equivalent circuit model
- **Lp**—Inductance using parallel-equivalent circuit model
- **Cp**—Capacitance using parallel-equivalent circuit model
- **Rp**—Resistance using parallel-equivalent circuit model
- **D**—Dissipation factor
- **Q**—Quality factor
- **V DC**—DC voltage measurement
- **I DC**—DC current measurement
- **AC voltage**—AC voltage magnitude and phase angle
- **AC current**—AC current magnitude and phase angle

LCR Test Signal

Voltage stimulus

Maximum	7.07 V RMS
Minimum	7.07 mV RMS
Resolution	<1 µV RMS
Maximum current	70.7 mA RMS
Accuracy (ALC on)	
≤10 kHz	±0.2%
10 kHz to Maximum Frequency (500 kHz or 2 MHz)	±6%
Current stimulus	
Maximum	70.7 mA RMS
Minimum	707 nA RMS
Resolution	<100 pA RMS
Maximum voltage	7.07 V RMS
Accuracy (ALC on)	
≤10 kHz	±0.2%
10 kHz to Maximum Frequency (500 kHz or 2 MHz)	±6%

LCR DC Bias

Voltage DC bias - PXIe-4190 (2 MHz)	
Maximum	±40 V, including peak AC signal
Resolution	<10 µV
Accuracy	0.02% + 5 mV
Voltage DC bias - PXIe-4190 (500 kHz)	
Maximum	±10 V, including peak AC signal
Resolution	<10 µV

Accuracy	0.02% + 5 mV
Current DC bias	
Maximum	±100 mA, including peak AC signal
Resolution	<10 nA
Accuracy	0.04% + 10 µA

LCR Frequency

Accuracy	Equal to PXIe_CLK100 accuracy, nominal

LCR Measurement Accuracy

Table 3. Absolute Impedance Magnitude Accuracy, 708 mV RMS to 7.07 V RMS Stimulus Voltage

Impedance Range	Frequency						
	40 Hz to 100 Hz	100 Hz to 1 kHz	1 kHz to 10 kHz	10 kHz to 200 kHz	200 kHz to 500 kHz	500 kHz to 1 MHz[4]	1 MHz to 2 MHz[4]
100 MΩ to 1 GΩ	1.00%	1.00%	—	—	—	—	—
10 MΩ to 100 MΩ	0.15%	0.15%	0.15%	—	—	—	—
1 MΩ to 10 MΩ	0.06%	0.06%	0.15%	0.30%	—	—	—
100 kΩ to 1 MΩ	0.05%	0.05%	0.08%	0.30%	0.30%*	0.30%†	0.60%‡
10 kΩ to 100 kΩ	0.05%	0.05%	0.08%	0.30%	0.30%	0.30%	0.60%
1 kΩ to 10 kΩ	0.05%	0.05%	0.08%	0.20%	0.20%	0.20%	0.50%
300 Ω to 1 kΩ	0.08%	0.08%	0.08%	0.20%	0.20%	0.50%	1.60%
10 Ω to 300 Ω	0.80%	0.80%	0.80%	0.90%	0.90%	1.20%	2.00%

Impedance Range	Frequency						
	40 Hz to 100 Hz	100 Hz to 1 kHz	1 kHz to 10 kHz	10 kHz to 200 kHz	200 kHz to 500 kHz	500 kHz to 1 MHz[4]	1 MHz to 2 MHz[4]

Note: When on boundary, use lower adjacent value.

* Up to 640 kΩ impedance range.

† Up to 255 kΩ impedance range.

‡ Up to 130 kΩ impedance range.

Table 4. Absolute Impedance Magnitude Accuracy, 150 mV RMS to 707 mV RMS Stimulus Voltage

Impedance Range	Frequency						
	40 Hz to 100 Hz	100 Hz to 1 kHz	1 kHz to 10 kHz	10 kHz to 200 kHz	200 kHz to 500 kHz	500 kHz to 1 MHz[5]	1 MHz to 2 MHz[5]
10 MΩ to 100 MΩ	0.20%	0.40%	1.10%	—	—	—	—
1 MΩ to 10 MΩ	0.06%	0.06%	0.20%	0.90%	—	—	—
100 kΩ to 1 MΩ	0.05%	0.05%	0.08%	0.90%	0.60%*	0.60%†	0.60%‡
10 kΩ to 100 kΩ	0.05%	0.05%	0.08%	0.30%	0.30%	0.30%	0.50%
1 kΩ to 10 kΩ	0.05%	0.05%	0.08%	0.20%	0.20%	0.20%	0.50%
300 Ω to 1 kΩ	0.08%	0.08%	0.08%	0.20%	0.20%	0.20%	1.60%
10 Ω to 300 Ω	0.80%	0.80%	0.80%	0.90%	0.90%	1.20%	2.00%

Note: When on boundary, use lower adjacent value.

* Up to 640 kΩ impedance range.

† Up to 255 kΩ impedance range.

‡ Up to 130 kΩ impedance range.

Table 5. Absolute Impedance Magnitude Accuracy Multiplier for Stimuli Below 150 mV RMS

	10 Ω to 300 Ω	300 Ω to 10 MΩ	10 MΩ to 100 MΩ
50 mV RMS to 150 mV RMS	1	2	3
7.08 mV RMS to 50 mV RMS, typical	2	11	—

Note: Absolute accuracy is the **Absolute Impedance Magnitude Accuracy, 150 mV RMS to 707 mV RMS Stimulus Voltage** table value times the respective multiplier.

Table 6. Absolute Impedance Phase Accuracy, 708 mV RMS to 7.07 V RMS Stimulus Voltage

Impedance Range	Frequency						
	40 Hz to 100 Hz	100 Hz to 1 kHz	1 kHz to 10 kHz	>10 kHz to 200 kHz	200 kHz to 500 kHz	500 kHz to 1 MHz[6]	1 MHz to 2 MHz[6]
100 MΩ to 1 GΩ	0.55 °	0.55 °	—	—	—	—	—
10 MΩ to 100 MΩ	0.19 °	0.08 °	0.25 °	—	—	—	—
1 MΩ to 10 MΩ	0.02 °	0.03 °	0.21 °	0.19 °	—	—	—
100 kΩ to 1 MΩ	0.01 °	0.02 °	0.19 °	0.19 °	0.14 °*	0.16 °†	0.26 °‡
10 kΩ to 100 kΩ	0.01 °	0.02 °	0.10 °	0.11 °	0.12 °	0.13 °	0.26 °
1 kΩ to 10 kΩ	0.01 °	0.02 °	0.09 °	0.10 °	0.10 °	0.12 °	0.31 °
300 Ω to 1 kΩ	0.01 °	0.03 °	0.12 °	0.08 °	0.13 °	0.21 °	0.34 °
10 Ω to 300 Ω	0.01 °	0.03 °	0.13 °	0.08 °	0.09 °	0.11 °	0.15 °

Note: When on boundary, use lower adjacent value.

* Up to 640 kΩ impedance range.

† Up to 255 kΩ impedance range.

‡ Up to 130 kΩ impedance range.

Table 7. Absolute Impedance Phase Accuracy, 150 mV RMS to 707 mV RMS Stimulus Voltage

Impedance Range	Frequency						
	40 Hz to 100 Hz	100 Hz to 1 kHz	1 kHz to 10 kHz	>10 kHz to 200 kHz	200 kHz to 500 kHz	500 kHz to 1 MHz[7]	1 MHz to 2 MHz[7]
10 MΩ to 100 MΩ	0.14 °	0.30 °	0.50 °	—	—	—	—
1 MΩ to 10 MΩ	0.03 °	0.03 °	0.14 °	0.45 °	—	—	—
100 kΩ to 1 MΩ	0.02 °	0.03 °	0.14 °	0.45 °	0.22 °*	0.22 °†	0.34 °‡
10 kΩ to 100 kΩ	0.01 °	0.02 °	0.07 °	0.15 °	0.14 °	0.14 °	0.34 °
1 kΩ to 10 kΩ	0.01 °	0.02 °	0.07 °	0.15 °	0.09 °	0.11 °	0.20 °
300 Ω to 1 kΩ	0.01 °	0.02 °	0.07 °	0.08 °	0.09 °	0.12 °	0.34 °
10 Ω to 300 Ω	0.01 °	0.04 °	0.22 °	0.08 °	0.10 °	0.13 °	0.18 °

Note: When on boundary, use lower adjacent value.

* Up to 640 kΩ impedance range.

† Up to 255 kΩ impedance range.

‡ Up to 130 kΩ impedance range.

Table 8. Absolute Impedance Phase Accuracy Multiplier for Stimuli Below 150 mV RMS

	10 Ω to 300 Ω	300 Ω to 1 kΩ	1 kΩ to 10 kΩ	>10 kΩ to 100 kΩ	100 kΩ to 1 MΩ	1 MΩ to 10 MΩ	10 MΩ to 100 MΩ
50 mV RMS to 150 mV RMS	2	2	2	2	2	2	3
7.08 mV RMS to 50 mV RMS, typical	20	70	25	25	10	8	8

	10 Ω to 300 Ω	300 Ω to 1 kΩ	1 kΩ to 10 kΩ	>10 kΩ to 100 kΩ	100 kΩ to 1 MΩ	1 MΩ to 10 MΩ	10 MΩ to 100 MΩ
Note: Absolute accuracy is the **Absolute Impedance Phase Accuracy, 150 mV RMS to 707 mV RMS Stimulus Voltage** table value times the respective multiplier.							

[1] The ambient temperature of a PXI system is defined as the temperature at the chassis fan inlet (air intake).

[2] Disconnecting the sense leads while both these properties are set to TRUE may result in output protection errors or long settling tails due to the feedback path for the control loop being open. If the PXIe-4190 is run open loop due to accidental sense lead disconnection, allow a minimum of 1 minute after establishing proper lead connections before making measurements.

[3] Refer to the **PXIe-4190 Getting Started** for more information on 4TP connections.

[4] PXIe-4190 (2 MHz) only

[5] PXIe-4190 (2 MHz) only

[6] PXIe-4190 (2 MHz) only

[7] PXIe-4190 (2 MHz) only

General Specifications

Isolation

Isolation voltage, any pin to earth ground	40 V DC, Measurement Category I, functional

Note Pins are functionally isolated from chassis ground to prevent ground loops, but do not meet IEC 61010-1 for safety isolation.

Note The PXIe-4190 contains an internal switch controlled by the **niDCPower Isolation State** property or the **NIDCPOWER_ATTR_ISOLATION_STATE** attribute that can connect the GUARD terminal to chassis ground and prevent the module output from floating. Isolation ratings only apply when this property/attribute is set to **Isolated**.

Protection

Absolute maximum voltage	
Output HI/Output LO/Sense HI/Sense LO to Output HI/Output LO/Sense HI/Sense LO	±42 V
Output HI/Sense HI to GUARD/Isolated Shield	± 6 V
GUARD/Isolated Shield to Chassis GND	±42 V
Absolute maximum current	
All terminals	±150 mA
Output channel protection	
Output HI to GUARD/Isolated Shield	
Overvoltage	Automatic output disable
Output LO to all terminals	
Overcurrent	Automatic output disable
Sense HI/Sense LO to all terminals	
Overcurrent	Current limiter protects inputs up to absolute maximum voltage specification
Overtemperature	Automatic output disable

Physical Characteristics

Dimensions	3U, one-slot, PXI Express/CompactPCI Express module 2.0 cm x 13.0 cm x 21.6 cm (0.8 in. x 5.1 in. x 8.5 in.)
Weight	481 g (17.1 oz)
Front panel connectors	Custom 6 coaxial socket, 7 standard socket, mixed layout D-SUB, female

Triggers

Input triggers	
Types	Start Source Sequence Advance Measure
Sources (PXI trigger lines 0 to 7)	
Polarity	Active high (not configurable)
Minimum pulse width	100 ns
Destinations[2] (PXI trigger lines 0 to 7)	
Polarity	Active high (not configurable)
Minimum pulse width	200 ns
Output triggers (events)	
Types	Source Complete Sequence Iteration Complete Sequence Engine Done Measure Complete
Destinations (PXI trigger lines 0 to 7)[3]	
Polarity	Active high (not configurable)
Pulse width	230 ns

Calibration Interval

Recommended calibration interval	1 year

Power Requirements

+3.3 V	1.0 A

+12 V	2.7 A

Environmental Characteristics

Temperature	
Operating	0 °C to 55 °C [4]
Storage	-40 °C to 71 °C
Humidity	
Operating	10% RH to 90% RH, noncondensing [5]
Storage	5% RH to 95% RH, 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

[1] Pulse widths and logic levels are compliant with **PXI Express Hardware Specification Revision 1.0 ECN 1**.

[2] Input triggers can come from any source (PXI trigger or software trigger) and be exported to any PXI trigger line. This allows for easier multi-board synchronization regardless of the trigger source.

[3] Pulse widths and logic levels are compliant with **PXI Express Hardware Specification Revision 1.0 ECN 1**.

[4] Not all chassis can achieve this ambient temperature range. Refer to PXI chassis specifications to determine the ambient temperature ranges your chassis can achieve.

[5] Accuracy specifications are only warranted for operating environments with temperatures below 30 °C and relative humidity levels below 60%. When transitioning the product from a storage or operating environment with relative

humidity above 60%, you should allow the product to stabilize in the lower humidity environment for several hours before using it.