

## SPECIFICATIONS

# PXIe-4135

PXIe,  $\pm 200$  V, 3 A, 10 fA Precision PXI Source Measure Unit

These specifications apply to the PXIe-4135.

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## Definitions

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*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.

## Conditions

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Specifications are valid under the following conditions unless otherwise noted.

- Ambient temperature<sup>1</sup> of 23 °C ± 5 °C
- Relative humidity between 10% and 70%, noncondensing up to 35 °C. Derate max relative humidity 3% per °C for ambient temperatures between 35 °C and 50 °C. From 50 °C to 55 °C, relative humidity between 10% and 25%, noncondensing. See *Current* for humidity performance restrictions.
- Calibration interval of 1 year
- 30 minutes warm-up time
- Self-calibration performed within the last 24 hours
- **niDCPower Aperture Time** property or NIDCPOWER\_ATTR\_APERTURE\_TIME attribute set to 2 power-line cycles (PLC)
- Fans set to the highest setting if the PXI Express chassis has multiple fan speed settings
- Triax cover installed on unused triax connections

## Cleaning Statement

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**Notice** Clean the hardware with a soft, nonmetallic brush. Make sure that the hardware is completely dry and free from contaminants before returning it to service.



**Caution** Due to high-impedance circuits used in the hardware, care should be taken to avoid contamination during handling or operation. Avoid use or storage of

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<sup>1</sup> The ambient temperature of a PXI system is defined as the temperature at the chassis fan inlet (air intake).

the hardware in an environment that allows dust to settle on the hardware. Avoid direct contact with the inner surfaces of triax connections. Triax covers should be used whenever triax connections are not in use.



**Notice** If the PXIe-4135 is uninstalled, clean the hardware with a soft, nonmetallic brush. Make sure that the hardware is completely dry and free from contaminants before returning it to service.

## Device Capabilities

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The following table and figure illustrate the voltage and the current source and sink ranges of the PXIe-4135.

**Table 1.** Current Source and Sink Ranges

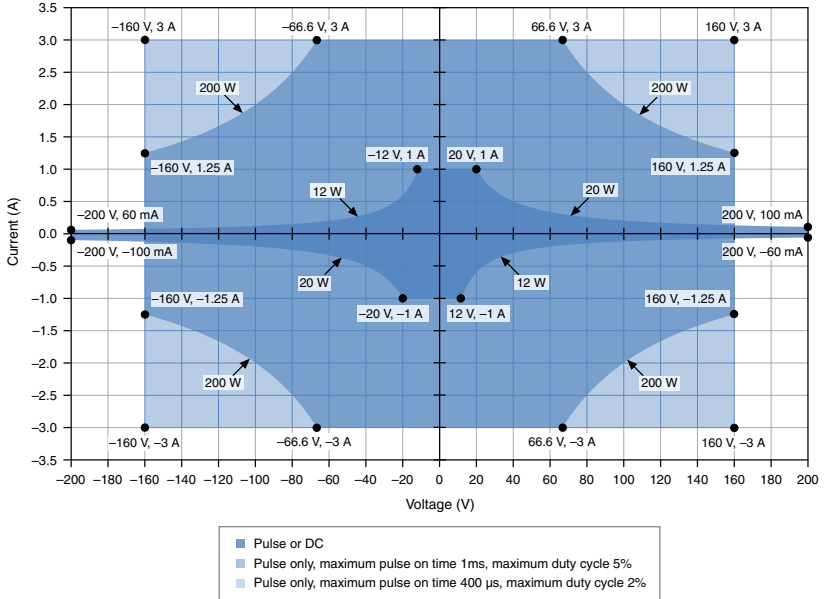
| DC voltage ranges  | DC current source and sink ranges |
|--------------------|-----------------------------------|
| 600 mV             | 10 nA                             |
| 6 V                | 1 $\mu$ A                         |
| 20 V               | 100 $\mu$ A                       |
| 200 V <sup>2</sup> | 1 mA                              |
|                    | 10 mA                             |
|                    | 100 mA                            |
|                    | 1 A                               |
|                    | 3 A <sup>3</sup>                  |

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<sup>2</sup> Voltage levels and limits  $>|40 \text{ VDC}|$  require the safety interlock input to be closed.

<sup>3</sup> Current is limited to 1 A DC. Higher levels are pulsing only.

Figure 1. Quadrant Diagram



DC sourcing power is limited to 20 W, regardless of output voltage.<sup>4</sup>



**Caution** Limit DC power sinking to 12 W. Additional derating applies to sinking power when operating at an ambient temperature of  $>45^{\circ}\text{C}$ . If the PXI Express chassis has multiple fan speed settings, set the fans to the highest setting.

<sup>4</sup> Power limit defined by voltage measured between HI and LO terminals.

# Voltage

**Table 2.** Voltage Programming and Measurement Accuracy/Resolution

| Range  | Resolution<br>(noise limited) | Noise<br>(0.1 Hz to<br>10 Hz, peak<br>to peak),<br>Typical | Accuracy (23 °C ±5 °C) ± (%<br>of voltage + offset) <sup>5</sup> |                        | Tempco ± (% of<br>voltage +<br>offset)/°C, 0 °C<br>to 55 °C |
|--------|-------------------------------|--|--|------------------------|---|
|        |                               |  | T <sub>cal</sub> ±5 °C <sup>6</sup>                              | T <sub>cal</sub> ±1 °C |   |
| 600 mV | 100 nV                        | 2 µV   | 0.020% +<br>50 µV  | 0.017% +<br>30 µV      | 0.0005% + 1 µV  |
| 6 V    | 1 µV                          | 6 µV   | 0.020% +<br>320 µV   | 0.017% +<br>90 µV      |   |
| 20 V   | 10 µV                         | 20 µV  | 0.022% +<br>1 mV   | 0.017% +<br>400 µV     |   |
| 200 V  | 100 µV                        | 200 µV   | 0.025% +<br>10 mV  | 0.020% +<br>2.5 mV     |   |

## Related Information

[Load Regulation](#) on page 14

[Remote Sense](#) on page 16

<sup>5</sup> Accuracy is specified for no load output configurations. Refer to *Load Regulation* and *Remote Sense* sections for additional accuracy derating and conditions.

<sup>6</sup> T<sub>cal</sub> is the internal device temperature recorded by the PXIe-4135 at the completion of the last self-calibration.

# Current

**Table 3. Current Programming and Measurement Accuracy/Resolution**

| Range                   | Resolution<br>(noise limited) | Noise<br>(0.1 Hz to<br>10 Hz, peak<br>to peak),<br>Typical | Accuracy (23 °C ±5 °C) ± (%<br>of current + offset) <sup>7, 8</sup> |                        | Tempco ± (%<br>of current +<br>offset)/°C, 0 °C<br>to 55 °C |
|-------------------------|-------------------------------|--|---|------------------------|---|
|                         |                               |  | T <sub>cal</sub> ±5 °C <sup>9</sup>                                 | T <sub>cal</sub> ±1 °C |   |
| 10 nA <sup>10, 11</sup> | 10 fA                         | 150 fA <sup>12</sup>                                       | 0.06% + 2 pA  | 0.05% +<br>750 fA      | 0.0006% +<br>400 fA   |
| 10 nA <sup>13</sup>     | 10 fA                         | 1 pA   | 0.06% + 6 pA  | 0.05% + 5 pA           | 0.0006% +<br>400 fA   |
| 1 µA                    | 100 fA                        | 4 pA   | 0.03% +<br>100 pA   | 0.022% +<br>40 pA      | 0.0006% + 4 pA  |
| 100 µA                  | 10 pA                         | 200 pA   | 0.03% + 6 nA  | 0.022% +<br>2 nA       | 0.0006% +<br>200 pA   |
| 1 mA                    | 100 pA                        | 2 nA   | 0.03% +<br>60 nA  | 0.022% +<br>20 nA      | 0.0006% + 2 nA  |
| 10 mA                   | 1 nA                          | 20 nA  | 0.03% +<br>600 nA   | 0.022% +<br>200 nA     | 0.0006% +<br>20 nA  |
| 100 mA                  | 10 nA                         | 200 nA   | 0.03% + 6 µA  | 0.022% +<br>2 µA       | 0.0006% +<br>200 nA   |

<sup>7</sup> Relative humidity between 10% and 70%, noncondensing up to 35 °C. Derate max relative humidity 3% per °C for ambient temperatures between 35 °C and 50 °C. From 50 °C to 55 °C, relative humidity between 10% and 25%, noncondensing.

<sup>8</sup> Add 30 pA to accuracy specifications when operating with relative humidity greater than 50%.

<sup>9</sup> T<sub>cal</sub> is the internal device temperature recorded by the PXIe-4135 at the completion of the last self-calibration.

<sup>10</sup> Under the following additional specification conditions: 10 PLC, 11-point median filter, measurements made within one hour after offset null.

<sup>11</sup> Accuracy specifications typical for Revision E and earlier of the PXIe-4135.

<sup>12</sup> Measured with no connections to the PXIe-4135.

<sup>13</sup> Under default specification conditions.

**Table 3. Current Programming and Measurement Accuracy/Resolution (Continued)**

| Range             | Resolution<br>(noise limited) | Noise<br>(0.1 Hz to<br>10 Hz, peak<br>to peak),<br>Typical | Accuracy (23 °C ±5 °C) ± (%<br>of current + offset) <sup>7, 8</sup> |                        | Tempco ± (%<br>of current +<br>offset)/°C, 0 °C<br>to 55 °C |
|-------------------|-------------------------------|--|---|------------------------|---|
|                   |                               |  | T <sub>cal</sub> ±5 °C <sup>9</sup>                                 | T <sub>cal</sub> ±1 °C |   |
| 1 A               | 100 nA                        | 2 µA   | 0.04% +<br>60 µA  | 0.035% +<br>20 µA      | 0.0006% +<br>2 µA   |
| 3 A <sup>14</sup> | 1 µA                          | 20 µA  | 0.08% +<br>900 µA   | 0.075% +<br>600 µA     | 0.0018% +<br>20 µA  |

## Noise

Wideband source noise

<25 mV peak-to-peak in 20 V range, device configured for normal transient response, 10 Hz to 20 MHz, typical

The following figures illustrate noise as a function of measurement aperture for the PXIe-4135.

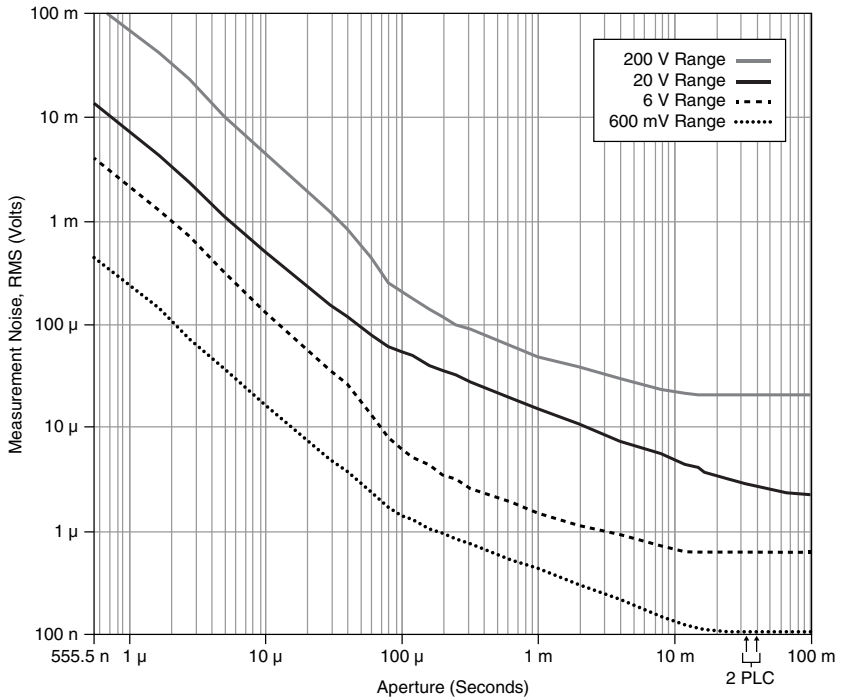
<sup>7</sup> Relative humidity between 10% and 70%, noncondensing up to 35 °C. Derate max relative humidity 3% per °C for ambient temperatures between 35 °C and 50 °C. From 50 °C to 55 °C, relative humidity between 10% and 25%, noncondensing.

<sup>8</sup> Add 30 pA to accuracy specifications when operating with relative humidity greater than 50%.

<sup>9</sup> T<sub>cal</sub> is the internal device temperature recorded by the PXIe-4135 at the completion of the last self-calibration.

<sup>14</sup> 3 A range above 1 A is for pulsing only.

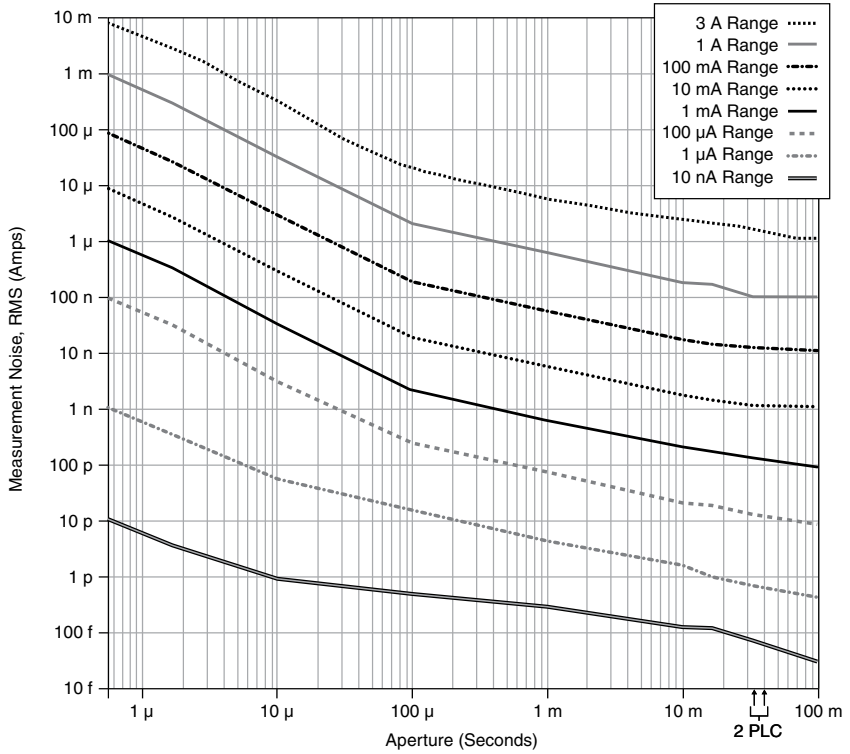
**Figure 2. Voltage Measurement Noise vs. Measurement Aperture, Nominal**



**Note** When the aperture time is set to 2 power-line cycles (PLCs), measurement noise differs slightly depending on whether the **niDCPower Power Line Frequency** property or `NIDCPOWER_ATTR_POWER_LINE_FREQUENCY` attribute is set to 50 Hz or 60 Hz.

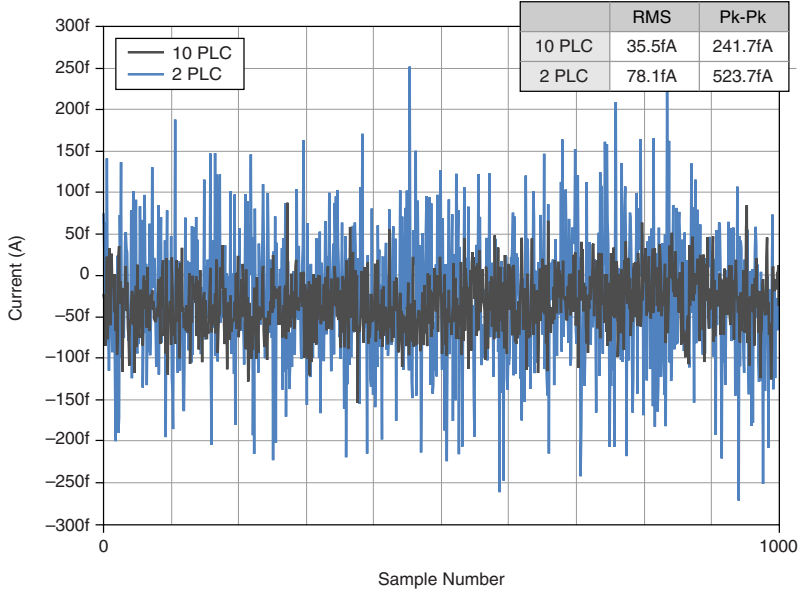


**Figure 3. Current Measurement Noise vs. Measurement Aperture, Nominal**

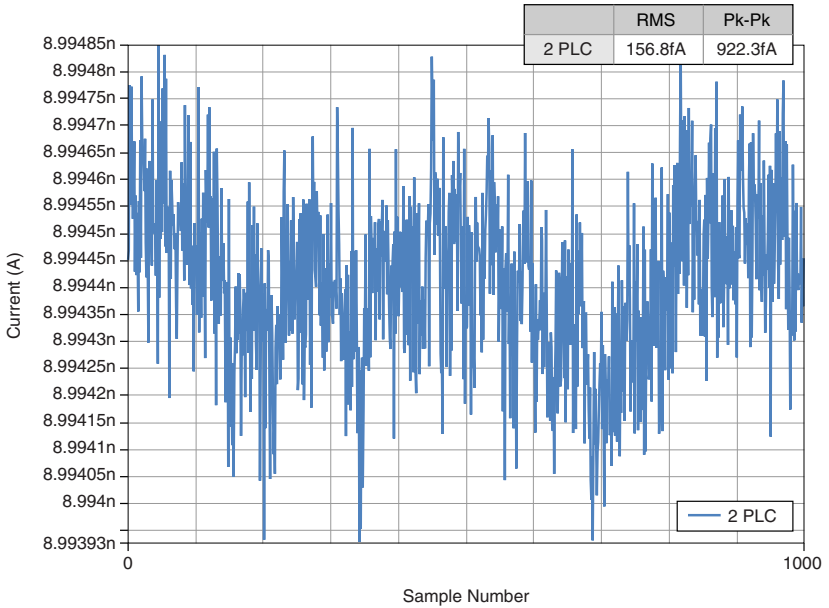


**Note** When the aperture time is set to 2 power-line cycles (PLCs), measurement noise differs slightly depending on whether the **niDCPower Power Line Frequency** property or `NIDCPOWER_ATTR_POWER_LINE_FREQUENCY` attribute is set to 50 Hz or 60 Hz.

**Figure 4. Measurement Noise, 10 nA Range, No Load, 0 V, 3 m Cables, Nominal**



**Figure 5. Measurement Noise, 10 nA Range, 1 GΩ Load, 9 V, 3 m Cables, Nominal**



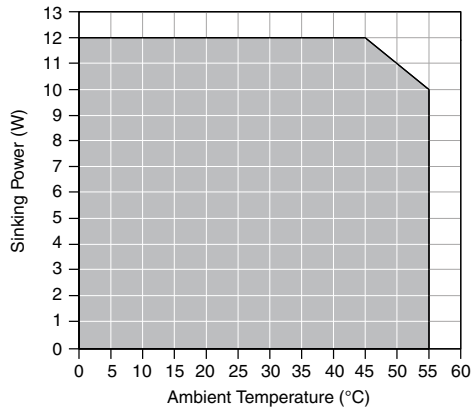


**Note** Measurement noise vs. aperture plot measurements were taken with no load and no cabling. When using small aperture times, measurement noise may be impacted by system cabling.

## Sinking Power vs. Ambient Temperature Derating

The following figure illustrates sinking power derating as a function of ambient temperature for the PXIe-4135.

**Figure 6.** Sinking Power vs. Ambient Temperature Derating



# Output Resistance Programming Accuracy

**Table 4.** Output Resistance Programming Accuracy

| Current Level/Limit Range | Programmable Resistance Range, Voltage Mode | Programmable Resistance Range, Current Mode | Accuracy $\pm$ (% of resistance setting), $T_{cal} \pm 5^\circ\text{C}^{15}$ |
|---------------------------|---|---|--|
| 10 nA                     | 0 to $\pm 500\text{ M}\Omega$               | $\pm 500\text{ M}\Omega$ to $\pm$ infinity  | 0.03%  |
| 1 $\mu\text{A}$           | 0 to $\pm 5\text{ M}\Omega$                 | $\pm 5\text{ M}\Omega$ to $\pm$ infinity    |  |
| 100 $\mu\text{A}$         | 0 to $\pm 50\text{ k}\Omega$                | $\pm 50\text{ k}\Omega$ to $\pm$ infinity   |  |
| 1 mA                      | 0 to $\pm 5\text{ k}\Omega$                 | $\pm 5\text{ k}\Omega$ to $\pm$ infinity    |  |
| 10 mA                     | 0 to $\pm 500\ \Omega$                      | $\pm 500\ \Omega$ to $\pm$ infinity         |  |
| 100 mA                    | 0 to $\pm 50\ \Omega$                       | $\pm 50\ \Omega$ to $\pm$ infinity          |  |
| 1 A                       | 0 to $\pm 5\ \Omega$                        | $\pm 5\ \Omega$ to $\pm$ infinity           |  |
| 3 A <sup>16</sup>         | 0 to $\pm 500\text{ m}\Omega$               | $\pm 500\text{ m}\Omega$ to $\pm$ infinity  |  |

## Overvoltage Protection

|   |  |
|---|--|
| Accuracy <sup>17</sup> (% of OVP limit + offset)                    | 1% + 200 mV, typical                     |
| Temperature coefficient (% of OVP limit + offset)/ $^\circ\text{C}$ | 0.01% + 3 mV/ $^\circ\text{C}$ , typical |
| Measurement location  | Local sense                              |
| Maximum OVP limit value   | 210 V                                    |
| Minimum OVP limit value   | 2 V                                      |

<sup>15</sup>  $T_{cal}$  is the internal device temperature recorded by the PXIe-4135 at the completion of the last self-calibration.

<sup>16</sup> 3 A range above 1 A is for pulsing only.

<sup>17</sup> Overvoltage protection accuracy is valid with an ambient temperature of  $23^\circ\text{C} \pm 5^\circ\text{C}$  and with  $T_{cal} \pm 5^\circ\text{C}$ .  $T_{cal}$  is the internal device temperature recorded by the PXIe-4135 at the completion of the last self-calibration.

# Extended Range Pulsing <sup>18</sup>

## Maximum pulse

|                          |        |
|--------------------------|--------|
| Voltage                  | 160 V  |
| Current                  | 3 A    |
| On time <sup>19</sup>    | 1 ms   |
| Minimum pulse cycle time | 5 ms   |
| Energy                   | 200 mJ |
| Cycle average power      | 10 W   |
| Duty cycle               | 5%     |

## Transient Response and Settling Time

### Transient response<sup>20</sup>

|                               |                      |
|-------------------------------|----------------------|
| 3 A to 100 $\mu$ A ranges     | <70 $\mu$ s, typical |
| 1 $\mu$ A range <sup>21</sup> | <1 ms, typical       |
| 10 nA range <sup>21</sup>     | <10 ms, typical      |

### Settling time<sup>22</sup>

|   |                       |
|---|-----------------------|
| Voltage mode, 180 V step, unloaded <sup>23</sup>                        | <500 $\mu$ s, typical |
| Voltage mode, 5 V step or smaller, unloaded <sup>24</sup>               | <70 $\mu$ s, typical  |
| Current mode, full-scale step, 3 A to 100 $\mu$ A ranges <sup>25</sup>  | <50 $\mu$ s, typical  |
| Current mode, full-scale step, 3 A to 1 $\mu$ A range <sup>21, 25</sup> | <2 ms, typical        |
| Current mode, full-scale step, 3 A to 10 nA range <sup>21, 25</sup>     | <15 ms, typical       |

<sup>18</sup> Extended range pulse currents fall outside DC range limits. In-range pulse currents fall within DC range limits. In-range pulses are not subject to extended range pulsing limitations.

<sup>19</sup> *Pulse on time* is measured from the start of the leading edge to the start of the trailing edge.

<sup>20</sup> Time to recover within 0.1% of voltage range after a load current change from 10% to 90% of range, device configured for fast transient response.

<sup>21</sup> Measured with guarded load and HI/Sense HI triax cable  $\leq 3$  m

<sup>22</sup> Measured as the time to settle to within 0.1% of step amplitude, device configured for fast transient response.

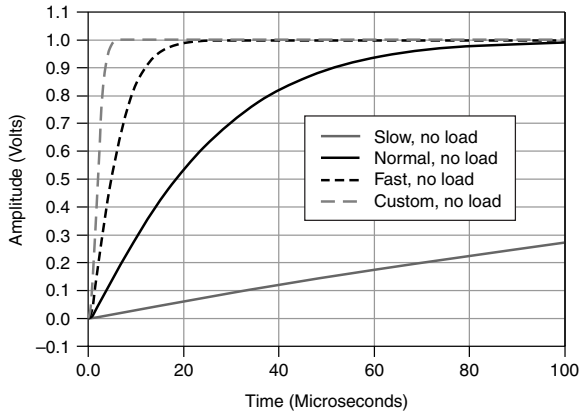
<sup>23</sup> Current limit set to  $\geq 60$   $\mu$ A and  $\geq 60\%$  of the selected current limit range.

<sup>24</sup> Current limit set to  $\geq 20$   $\mu$ A and  $\geq 20\%$  of selected current limit range.

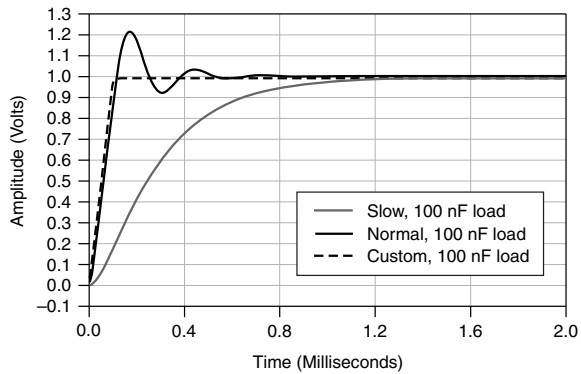
<sup>25</sup> Voltage limit set to  $\geq 2$  V, resistive load set to 1 V/selected current range.

The following figures illustrate the effect of the transient response setting on the step response of the PXIe-4135 for different loads.

**Figure 7. 1 mA Range, No Load Step Response, Nominal**



**Figure 8. 1 mA Range, 100 nF Load Step Response, Nominal**



## Load Regulation

### Voltage

|                                    |  |
|------------------------------------|--|
| Device configured for local sense  | 225 mV per A of output load change (measured between output channel terminals) , typical |
| Device configured for remote sense | 100 μV per A of output load change (measured between sense terminals) , typical          |

Current, device configured for local or remote sense

Load regulation effect included in current accuracy specifications, typical

## Related Information

[Voltage](#) on page 5

# Measurement and Update Timing Characteristics

|  |   |
|--|---|
| Available sample rates <sup>26</sup>             | (1.8 MS/s)/ $N$ where $N = 1, 2, 3, \dots 2^{24}$ , nominal |
| Sample rate accuracy                             | Equal to PXIe_CLK100 accuracy, nominal                      |
| Maximum measure rate to host                     | 1.8 MS/s per channel, continuous, nominal                   |
| Maximum source update rate <sup>27</sup>         | 100,000 updates/s, nominal                                  |
| Input trigger to                                 |   |
| Source event delay                               | 10 $\mu$ s, nominal   |
| Source event jitter                              | 1 $\mu$ s, nominal  |
| Measure event jitter                             | 1 $\mu$ s, nominal  |
| Pulse timing and accuracy                        |   |
| Minimum pulse on time <sup>28</sup>              | 50 $\mu$ s, nominal   |
| Minimum pulse off time <sup>29</sup>             | 50 $\mu$ s, nominal   |
| Pulse on time or off time programming resolution | 100 ns, nominal   |
| Pulse on time or off time programming accuracy   | $\pm 5$ $\mu$ s, nominal                                    |
| Pulse on time or off time jitter                 | 1 $\mu$ s, nominal  |

<sup>26</sup> When sourcing while measuring, both the **niDCPower Source Delay** and **niDCPower Aperture Time** properties affect the sampling rate. When taking a measure record, only the **niDCPower Aperture Time** property affects the sampling rate.

<sup>27</sup> As the source delay is adjusted or if advanced sequencing is used, maximum source rates vary. Limited to 80,000 updates/s when the **Sequence Step Delta Time Enabled** property is set to TRUE.

<sup>28</sup> *Pulse on time* is measured from the start of the leading edge to the start of the trailing edge.

<sup>29</sup> Pulses fall inside DC limits. *Pulse off time* is measured from the start of the trailing edge to the start of a subsequent leading edge.

# Remote Sense

|                               |   |
|-------------------------------|---|
| Voltage accuracy              | Add 3 ppm of voltage range per volt of HI lead drop plus 1 $\mu$ V per volt of lead drop per $\Omega$ of corresponding sense lead resistance to voltage accuracy specifications |
| Maximum sense lead resistance | 100 $\Omega$  |
| Maximum lead drop per lead    | 3 V, maximum 202 V between HI and LO terminals  |



**Note** Exceeding the maximum lead drop per lead value may cause the driver to report a sense lead error.

## Related Information

[Voltage](#) on page 5

# Safety Interlock

The safety interlock feature is designed to prevent users from coming in contact with hazardous voltage generated by the SMU in systems that implement protective barriers with controlled user access points.



**Caution** Hazardous voltages of up to the maximum voltage of the PXIe-4135 may appear at the output terminals if the safety interlock terminal is closed. Open the safety interlock terminal when the output connections are accessible. With the safety interlock terminal open, the output voltage level/limit is limited to  $\pm 40$  V DC, and protection will be triggered if the voltage measured between the device HI and LO terminals exceeds  $\pm(42 \text{ Vpk} \pm 0.4 \text{ V})$ .



**Caution** Do not apply voltage to the safety interlock connector inputs. The interlock connector is designed to accept passive, normally open contact closure connections only.

## Safety interlock terminal open

|          |                         |
|----------|-------------------------|
| Output   | $<\pm 42.4 \text{ Vpk}$ |
| Setpoint | $<\pm 40 \text{ VDC}$   |

## Safety interlock terminal closed

|          |                                |
|----------|--------------------------------|
| Output   | Maximum voltage of the device  |
| Setpoint | Maximum selected voltage range |



# Examples of Calculating Accuracy Specifications<sup>30</sup>

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## Example 1: Calculating 5 °C Accuracy

Calculate the accuracy of 900 nA output in the 1 µA range under the following conditions:

|                             |   |
|-----------------------------|---|
| Ambient temperature         | 28 °C   |
| Internal device temperature | within $T_{cal} \pm 5 \text{ °C}$ <sup>31</sup> |
| Self-calibration            | within the last 24 hours                        |

### Solution

Because the device internal temperature is within  $T_{cal} \pm 5 \text{ °C}$  and the ambient temperature is within  $23 \text{ °C} \pm 5 \text{ °C}$ , the appropriate accuracy specification is the following value:

$$0.03\% + 200 \text{ pA}$$

Calculate the accuracy using the following formula:

$$\begin{aligned} \text{Accuracy} &= 900 \text{ nA} * 0.03\% + 200 \text{ pA} \\ &= 270 \text{ pA} + 200 \text{ pA} \\ &= 470 \text{ pA} \end{aligned}$$

Therefore, the actual output is within 470 pA of 900 nA.

## Example 2: Calculating Remote Sense Accuracy

Calculate the remote sense accuracy of 500 mV output in the 600 mV range. Assume the same conditions as in Example 1, with the following differences:

|                          |     |
|--------------------------|-----|
| HI path lead drop        | 3 V |
| HI sense lead resistance | 2 Ω |

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<sup>30</sup> Specifications listed in examples are for demonstration purposes only and do not necessarily reflect specifications for this device.

<sup>31</sup>  $T_{cal}$  is the internal device temperature recorded by the PXIe-4135 at the completion of the last self-calibration.

|                          |       |
|--------------------------|-------|
| LO path lead drop        | 2.5 V |
| LO sense lead resistance | 1.5 Ω |

**Solution**

Because the device internal temperature is within  $T_{cal} \pm 5 \text{ }^\circ\text{C}$  and the ambient temperature is within  $23 \text{ }^\circ\text{C} \pm 5 \text{ }^\circ\text{C}$ , the appropriate accuracy specification is the following value:

$$0.02\% + 100 \text{ } \mu\text{V}$$

Because the device is using remote sense, use the following remote sense accuracy specification:

Add 3 ppm of voltage range + 11 μV per volt of HI lead drop plus 1 μV per volt of lead drop per Ω of corresponding sense lead resistance to voltage accuracy specifications.

Calculate the remote sense accuracy using the following formula:

$$\begin{aligned} \text{Accuracy} &= \left( 500 \text{ mV} * 0.02 \% + 100 \text{ } \mu\text{V} \right) + \frac{600 \text{ mV} * 3 \text{ ppm} + 11 \text{ } \mu\text{V}}{1 \text{ V of lead drop}} * 3 \text{ V} \\ &+ \frac{1 \text{ } \mu\text{V}}{\text{V} * \Omega} * 3 \text{ V} * 2 \text{ } \Omega + \frac{1 \text{ } \mu\text{V}}{\text{V} * \Omega} * 2.5 \text{ V} * 1.5 \Omega \\ &= 100 \mu\text{V} + 100 \mu\text{V} + 12.8 \mu\text{V} * 3 + 6 \mu\text{V} + 3.8 \mu\text{V} \\ &= 248.2 \text{ } \mu\text{V} \end{aligned}$$

Therefore, the actual output is within 248.2 μV of 500 mV.

**Example 3: Calculating Accuracy with Temperature Coefficient**

Calculate the accuracy of 900 nA output in the 1 μA range. Assume the same conditions as in Example 1, with the following differences:

|                     |       |
|---------------------|-------|
| Ambient temperature | 15 °C |
|---------------------|-------|

**Solution**

Because the device internal temperature is within  $T_{cal} \pm 5 \text{ }^\circ\text{C}$ , the appropriate accuracy specification is the following value:

$$0.03\% + 200 \text{ pA}$$

Because the ambient temperature falls outside of  $23 \text{ }^\circ\text{C} \pm 5 \text{ }^\circ\text{C}$ , use the following temperature coefficient per °C outside the  $23 \text{ }^\circ\text{C} \pm 5 \text{ }^\circ\text{C}$  range:

$$0.0006\% + 4 \text{ pA}$$

Calculate the accuracy using the following formula:

$$\text{TemperatureVariation} = (23\text{ }^{\circ}\text{C} - 5\text{ }^{\circ}\text{C}) - 15\text{ }^{\circ}\text{C} = 3\text{ }^{\circ}\text{C}$$

$$\text{Accuracy} = \left( 500\text{ nA} * 0.03\% + 200\text{ pA} \right) + \frac{900\text{ nA} * 0.0006\% + 4\text{ pA} * 3\text{ }^{\circ}\text{C}}{1\text{ }^{\circ}\text{C}}$$

$$= 350\text{ pA} + 28.2\text{ pA}$$

$$= 378.2\text{ pA}$$

Therefore, the actual output is within 378.2 pA of 900 nA.

## Trigger Characteristics

---

### Input triggers

|  |   |
|--|---|
| Types  | Start, Source, Sequence Advance, Measure, Pulse |
| Sources (PXI trigger lines <0...7>) <sup>32</sup>                    |   |
| Polarity   | Configurable                                    |
| Minimum pulse width  | 100 ns, nominal                                 |
| Destinations <sup>33</sup> (PXI trigger lines <0...7>) <sup>32</sup> |   |
| Polarity   | Active high (not configurable)                  |
| Pulse width  | >200 ns, typical                                |

### Output triggers (events)

|  |   |
|--|---|
| Types  | Source Complete, Sequence Iteration Complete, Sequence Engine Done, Measure Complete, Pulse Complete, Ready for Pulse |
| Destinations (PXI trigger lines <0...7>) <sup>32</sup> |   |
| Polarity   | Configurable  |
| Pulse width  | Configurable between 250 ns and 1.6 μs, nominal   |

<sup>32</sup> Pulse widths and logic levels are compliant with *PXI Express Hardware Specification Revision 1.0 ECN 1*.

<sup>33</sup> Input triggers can be re-exported.

# Protection

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## Output channel protection

|                            |  |
|----------------------------|--|
| Overcurrent or overvoltage | Automatic shutdown, output disconnect relay opens          |
| Sink overload protection   | Automatic shutdown, output disconnect relay opens          |
| Overtemperature            | Automatic shutdown, output disconnect relay opens          |
| Safety interlock           | Disable high voltage output, output disconnect relay opens |

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# Isolation

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**Caution** Do not connect to MAINS. Do not connect to signals or use for the measurements within CAT II, III, or IV.

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## Isolation voltage, channel-to-earth ground<sup>34</sup>

|            |                        |
|------------|------------------------|
| Continuous | 250 VDC, CAT I         |
| Withstand  | 1,000 V <sub>RMS</sub> |

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**Note** Measurement Categories CAT I and CAT O (Other) are equivalent. These test and measurement circuits are not intended for direct connection to the MAINS building installations of Measurement Categories CAT II, CAT III, or CAT IV.



**Hazardous Voltage** Take precautions to avoid electrical shock when operating this product at hazardous voltages.



**Caution** Isolation voltage ratings apply to the voltage measured between any channel pin and the chassis ground. When operating channels in series or floating on top of external voltage references, ensure that no terminal exceeds this rating.

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# Guard Output Characteristics

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## Cable guard

|                  |                        |
|------------------|------------------------|
| Output impedance | 3 k $\Omega$ , nominal |
| Offset voltage   | 1 mV, typical          |

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<sup>34</sup> Verified with a 5-second dielectric withstand test.

# Calibration Interval

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|                                  |        |
|----------------------------------|--------|
| Recommended calibration interval | 1 year |
|----------------------------------|--------|

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# Power Requirement

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**Caution** You can impair the protection provided by the PXIe-4135 if you use it in a manner not described in this document.

|                               |   |
|-------------------------------|---|
| PXI Express power requirement | 2.5 A from the 3.3 V rail<br>2.7 A from the 12 V rail |
|-------------------------------|---|

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# Physical

---

|                            |  |
|----------------------------|--|
| Dimensions                 | 3U, one-slot, PXI Express/CompactPCI Express module<br>2.0 cm × 13.0 cm × 21.6 cm<br>(0.8 in. × 5.1 in. × 8.5 in.) |
| Weight                     | 419 g (14.8 oz)  |
| Front panel connectors     | 2 × 3 lug triaxial connectors, 1 × 4.08 mm (3 position) combicon   |
| Safety interlock connector | 3.55 mm (4 position)   |

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# Environment

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

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

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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.) <sup>35</sup>  |

# Storage Environment

|                           |   |
|---------------------------|---|
| Ambient temperature range | -40 °C to 70 °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 <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.) |

# Compliance and Certifications



**Hazardous Voltage** This icon denotes a warning advising you to take precautions to avoid electrical shock.

<sup>35</sup> Accuracy specifications warranted for relative humidity between 10% and 70%, noncondensing up to 35 °C. Derate max relative humidity 3% per °C for ambient temperatures between 35 °C and 50 °C. From 50 °C to 55 °C, accuracy specifications warranted for relative humidity between 10% and 25%, noncondensing. See *Current* for humidity performance restrictions. When transitioning a device from a storage or operation environment with relative humidity outside of this range, device should be allowed to stabilize in the lower humidity environment for several hours before use.

## 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/](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](https://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）



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