
PCI-4070

Specifications

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These specifications apply to the PCI-4070, a 6½-Digit, ± 300 V, 1.8 MS/s Isolated Digitizer Included, PCI Digital Multimeter Device.

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.

T_{cal} is the device temperature at last self-calibration or external calibration.

Conditions

Specifications are valid under the following conditions unless otherwise noted.

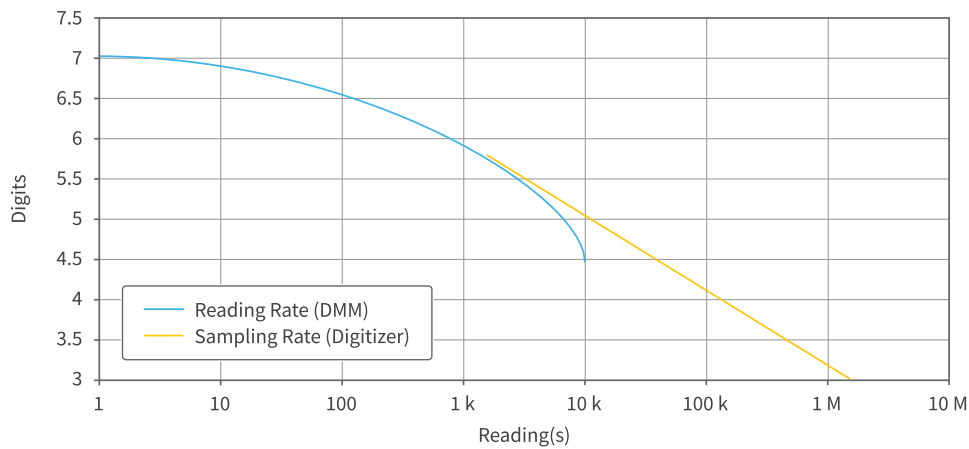
- Calibration interval of 2 years
- Warm-up time of 1 hour
- Resolution set to 6.5 digits for specifications requiring an aperture greater than or equal to 100 ms

DC Specifications

Table 1. PCI-4070 DC Speeds, Nominal

| Digits | Bits | Max sampling rate ¹ (Digitizer) | Reading rate ² (DMM) |
|--------|------|---|---------------------------------|
| 7 | 23 | 5 S/s | 5 S/s |
| 6½ | 22 | 100 S/s | 100 S/s |
| 5½ | 18 | 5 kS/s | 3 kS/s |
| 4½ | 15 | 20 kS/s | 7 kS/s |
| 3 | 10 | 1.8 MS/s | N/A |

Figure 1. DC Voltage Maximum Reading Rate, Nominal



DC System Speeds

| | |
|-----------------------------|-------|
| Range or function change | 100/s |
| Auto range time, DC V | 5 ms |
| Auto range time, DC I | 5 ms |
| Auto range time, resistance | 50 ms |
| Trigger latency | 2 µs |
| Maximum trigger rate | 6 kHz |

1. Maximum sampling rates refer to waveform acquisition in digitizer mode.

2. Auto Zero disabled, except 7 digits, measured on a 10 V and 10 kΩ range.

DC Accuracy Specifications

All DC accuracy specifications apply to 6½-digit resolution (≥ 1 PLC), Auto Zero and ADC calibration enabled.

Table 2. DC Voltage \pm (ppm of reading + ppm of range)

| Range | Resolution | Input resistance | 24 hour ³ $T_{cal} \pm 1^\circ\text{C}$ | 90 day ⁴ $T_{cal} \pm 5^\circ\text{C}$ | 2 year ⁵ $T_{cal} \pm 5^\circ\text{C}$ | Tempco/ $^\circ\text{C}$ (0 $^\circ\text{C}$ to 55 $^\circ\text{C}$) | |
|---------------------|-------------------|---|---|--|--|---|---------------|
| | | | | | | Without Self-cal | With Self-cal |
| 100 mV ⁶ | 100 nV | <ul style="list-style-type: none"> >10 GΩ 10 MΩ, nominal | 10 + 10 | 30 + 20 | 40 + 20 | 4 + 5 | 0.3 + 0.3 |
| 1 V | 1 μV | <ul style="list-style-type: none"> >10 GΩ 10 MΩ, nominal | 6 + 2 | 20 + 6 | 25 + 6 | 2 + 1 | 0.3 + 0.3 |
| 10 V | 10 μV | <ul style="list-style-type: none"> >10 GΩ 10 MΩ, nominal | 4 + 2 | 20 + 6 | 25 + 6 | 1 + 1 | 0.3 + 0.3 |
| 100 V | 100 μV | 10 M Ω , nominal | 6 + 2 | 30 + 6 | 35 + 6 | 4 + 1 | 0.3 + 0.3 |
| 300 V | 1 mV | 10 M Ω , nominal | 6 + 6 | 30 + 20 | 35 + 20 | 4 + 3 | 0.3 + 0.3 |

3. Relative to external calibration source.

4. Using internal self-calibration; specifications valid over the entire operating temperature range.

5. Using internal self-calibration; specifications valid over the entire operating temperature range.

6. With offset nulling and 100 ms aperture.

Table 3. DC Current \pm (ppm of reading + ppm of range)

| Range | Resolution | Burden voltage, typical | Noise (ppm of range RMS) | 2 year (0 °C to 55 °C) | Tempco/°C (0 °C to 55 °C) |
|--------|------------|-------------------------|--------------------------|------------------------|---------------------------|
| 20 mA | 10 nA | <20 mV | 20 | 400 + 150 | 8 + 1 |
| 200 mA | 100 nA | <200 mV | 3 | 400 + 20 | 8 + 0.2 |
| 1 A | 1 μ A | <800 mV | 3 | 500 + 50 | 8 + 0.4 |



Note For DC current, typical 24 hour accuracy (23 °C \pm 1 °C) is \pm (50 ppm of reading + 5 ppm of range).

Table 4. Resistance (4-Wire and 2-Wire) \pm (ppm of reading + ppm of range)

| Range | Test current ⁷ | Max test voltage ⁸ | Open circuit voltage ⁹ | 24 hour ¹⁰ T _{cal} \pm 1 °C | 90 day ¹¹ T _{cal} \pm 5 °C | 2 year ¹² T _{cal} \pm 5 °C | Tempco/°C (0 °C to 55 °C) | |
|------------------------------|------------------------------|-------------------------------|-----------------------------------|--|---|---|---------------------------|---------------|
| | | | | | | | Without Self-cal | With Self-cal |
| 100 Ω ¹³ | 1 mA | 100 mV | 11.5 | 15 + 10 | 50 + 10 | 80 + 10 | 8 + 1 | 0.8 + 1 |
| 1 k Ω ¹⁴ | 1 mA | 1 V | 11.5 | 12 + 2 | 50 + 3 | 80 + 3 | 8 + 0.1 | 0.8 + 0.1 |
| 10 k Ω ¹⁵ | 100 μ A | 1 V | 12.2 | 12 + 2 | 50 + 3 | 80 + 3 | 8 + 0.1 | 0.8 + 0.1 |
| 100 k Ω | 10 μ A | 1 V | 12.2 | 15 + 2 | 50 + 6 | 80 + 6 | 8 + 0.5 | 0.8 + 0.5 |
| 1 M Ω | 10 μ A | 10 V | 12.2 | 20 + 2 | 60 + 10 | 90 + 10 | 8 + 1 | 0.8 + 1 |
| 10 M Ω | 1 μ A | 10 V | 12.2 | 100 + 2 | 200 + 10 | 400 + 10 | 30 + 3 | 30 + 3 |
| 100 M Ω ¹⁶ | 1 μ A 10 M Ω | 10 V | 9.6 | 900 + 20 | 5,500 + 40 | 6,000 + 40 | 200 + 10 | 200 + 10 |

7. -10% to 0% tolerance.

8. Highest nominal voltage present with highest range resistance applied.

9. Nominal voltage present at output with no resistance load.

10. Relative to external calibration source.

11. Using internal self-calibration; specifications valid over the entire operating temperature range.

12. Using internal self-calibration; specifications valid over the entire operating temperature range.

13. With offset compensated ohms enabled.

14. With offset compensated ohms enabled.

15. With offset compensated ohms enabled.

16. 2-wire resistance measurement only. Typical accuracy is 5% between 105 M Ω and 1.05 G Ω . Use



Note For 2-wire resistance measurements, perform offset nulling or add 200 mΩ to reading.

Table 5. Diode Test

| Range | Resolution | Test current ¹⁷ | Accuracy |
|-------|------------|---|---|
| 10 V | 10 μV | 1 μA, 10 μA, 100 μA, 1 mA ¹⁸ | Add 20 ppm of reading to 10 VDC voltage specifications. |

Table 6. Additional Noise Errors for DC Voltage, Current, Resistance

| Resolution | Additional noise error |
|------------|------------------------|
| 5½ digits | 10 ppm of range |
| 5 digits | 30 ppm of range |
| 4½ digits | 100 ppm of range |

DC Functions General Specifications

| | |
|---|---|
| Effective CMRR (1 kΩ resistance in LO lead) | >140 dB (DC), 100 ms aperture; >170 dB (>46 Hz) with high-order DC noise rejection, 100 ms aperture |
| Maximum 4-wire lead resistance | Use the lesser of 10% of range or 1 kΩ |
| Overrange | 105% of range except 300 V and 1 A range |
| DC voltage input bias current | <30 pA at 23 °C, typical |

Table 7. Normal-Mode Rejection Ratio (NMRR)

| Readings/s | NMRR | Conditions |
|------------|-----------------------|--------------------------|
| 10 | >100 dB ¹⁹ | All noise sources >46 Hz |
| 50 (60) | >60 dB ²⁰ | 50 (60) Hz ±0.1% |

tempco outside 18 °C to 28 °C.

17. -10% to 0% tolerance.

18. Up to 4.5 V measurement for 1 mA test current.

19. With high-order DC noise rejection; 100 ms aperture.

AC Specifications

All AC speed specifications apply with Auto Zero disabled.

Table 8. PCI-4070 AC Bandwidth

| Digits | Reading rate | Bandwidth |
|--------|--------------|-------------------|
| 6½ | 0.25 S/s | 1 Hz to 300 kHz |
| 6½ | 2.5 S/s | 10 Hz to 300 kHz |
| 6½ | 25 S/s | 100 Hz to 300 kHz |
| 6½ | 100.0 S/s | 400 Hz to 300 kHz |
| 5½ | 1.0 kS/s | 20 kHz to 300 kHz |

AC System Speeds

| | |
|--------------------------------|--------|
| Range or function change | 10/s |
| Auto range time, AC V and AC I | 250 ms |
| Trigger latency | 2 µs |
| Maximum trigger rate | 1 kHz |

AC Accuracy Specifications

All AC accuracy specifications apply to 6½ digit resolution, signal amplitudes greater than 1% of range, and Auto Zero enabled. AC accuracy specifications also apply to measurement aperture greater than $4/f_L$, where f_L is the lowest frequency component of the signal being measured.

20. With normal DC noise rejection; 20 ms (16.67 ms) aperture.

Table 9. AC Voltage 2 Year \pm (% of reading + % of range), 23 °C \pm 10 °C

| Range (RMS) | Peak voltage | Resolution | 1 Hz to 40 Hz ²¹ | >40 Hz to 20 kHz | >20 kHz to 50 kHz | >50 kHz to 100 kHz ²² | >100 kHz to 300 kHz ²³ |
|---------------------------|--------------|-------------|-----------------------------|------------------|-------------------|----------------------------------|-----------------------------------|
| 50 mV ²⁴ | ± 105 mV | 100 nV | 0.1 + 0.04 | 0.05 + 0.04 | 0.09 + 0.04 | 0.5 + 0.08 | 3 + 0.1 |
| 500 mV | ± 1.05 V | 1 μ V | 0.1 + 0.01 | 0.05 + 0.02 | 0.09 + 0.02 | 0.5 + 0.02 | 3 + 0.05 |
| 5 V | ± 10.5 V | 10 μ V | | | | | |
| 50 V | ± 105 V | 100 μ V | | | | | |
| 300 V | ± 450 V | 1 mV | | | | | |
| Tempco/°C (0 °C to 55 °C) | | | 0.001 + 0.001 | 0.001 + 0.001 | 0.001 + 0.001 | 0.001 + 0.001 | 0.01 + 0.01 |



Note AC voltage specifications are after self-calibration.

Table 10. AC Current 2 Year \pm (% of reading + % of range), 0 °C \pm 55 °C

| Range (RMS) | Peak current | Resolution | Burden voltage (RMS), typical | 1 Hz to 20 kHz ²⁵ | Tempco/°C (0 °C to 55 °C) |
|---------------------|--------------|------------|-------------------------------|------------------------------|---------------------------|
| 10 mA ²⁶ | ± 20 mA | 10 nA | <10 mV | 0.04 + 0.02 | 0.001 + 0.0001 |
| 100 mA | ± 200 mA | 100 nA | <100 mV | 0.04 + 0.02 | 0.001 + 0.0001 |
| 1 A | ± 2 A | 1 μ A | <800 mV | 0.1 + 0.02 | 0.001 + 0.0001 |



Note No degradation in accuracy occurs due to crest factor for signals up to the rated peak voltage/current or bandwidth. For high crest factor signals, increase range. For example, for a 500 mVrms signal with a crest factor between 2 and 20, use the 5 V range.

21. Specification applies for DC coupling.

22. Above 150 V with V-Hz above 1.5×10 , specifications are typical.

23. Above 150 V with V-Hz above 1.5×10 , specifications are typical.

24. Applies to signals >2 mV.

25. Specification is typical for the 5 kHz to 20 kHz frequency range.

26. Applies to signals >200 μ A.

AC Functions General Specifications

| | |
|---|---|
| Input impedance | 1 M Ω in parallel with 150 pF, nominal |
| Input coupling | AC or DC coupling |
| Overrange | 105% of range except 300 V, 1 A range |
| Maximum Volt-Hertz product | $>8 \times 10^7$ V-Hz |
| Maximum DC voltage component | 250 V |
| CMRR (1 k Ω resistance in LO lead) | >70 dB (DC to 60 Hz) |

Frequency and Period

Table 11. PCI-4070 Frequency and Period

| Input range | Frequency range | Period range | Resolution | 2 year accuracy ²⁷ 0 °C to 55 °C \pm % of reading |
|----------------|-----------------|------------------|------------|--|
| 50 mV to 300 V | 1 Hz to 500 kHz | 1 s to 2 μ s | 6½ digits | 0.01 |



Note Frequency and period specifications have a 2 second gate time. The input signal must be $>10\%$ of AC voltage input range.

Temperature Accuracy Specifications (°C)



Note T_{cal} is the device temperature at last external calibration. For total measurement accuracy, add temperature probe error.

27. 0.00025% of reading, typical.

Table 12. Thermocouple Temperature Accuracy Specifications (°C)

| Type | Range | 2 year $T_{cal} \pm 5^\circ\text{C}$ | | Tempco/ $^\circ\text{C}^{28}$ | Resolution |
|------|--------------|--|-----------------------------|-------------------------------|------------|
| | | With Simulated Ref. Junction ²⁹ | With PXI-2527 ³⁰ | | |
| J | -150 to 1200 | 0.3 | 1.0 | 0.03 | 0.1 |
| | -210 to -150 | 0.4 | 1.2 | 0.03 | 0.1 |
| K | -100 to 1200 | 0.4 | 1.0 | 0.03 | 0.1 |
| | -200 to -100 | 0.4 | 1.5 | 0.03 | 0.1 |
| N | -100 to 1300 | 0.3 | 1.0 | 0.03 | 0.1 |
| | -200 to -100 | 0.6 | 1.5 | 0.03 | 0.1 |
| T | -100 to 400 | 0.3 | 1.0 | 0.03 | 0.1 |
| | -200 to -100 | 0.4 | 1.5 | 0.03 | 0.1 |
| E | -150 to 1000 | 0.2 | 1.0 | 0.03 | 0.1 |
| | -200 to -150 | 0.3 | 1.5 | 0.03 | 0.1 |
| R | 300 to 1760 | 0.6 | 1.8 | 0.06 | 0.1 |
| | -50 to 300 | 1.4 | 1.9 | 0.06 | 0.1 |
| S | 400 to 1760 | 0.7 | 1.8 | 0.06 | 0.1 |
| | -50 to 400 | 1.3 | 1.8 | 0.06 | 0.1 |
| B | 1100 to 1820 | 0.6 | 1.8 | 0.09 | 0.1 |
| | 400 to 1100 | 1.4 | 1.9 | 0.09 | 0.1 |

28. Tempco is the temperature coefficient, expressed in degrees of measurement uncertainty per degree change in DMM instrument operating temperature.

29. Using simulated reference junction.

30. Includes PXI-2527 with TB-2627 with a typical 0.5°C CJC error and a typical thermal EMF offset of $2.5\ \mu\text{V}$ for CJC temperatures between 15°C and 35°C . Add an additional 0.5°C uncertainty when CJC is in the range 0 - 15°C or 35 - 50°C .

Table 13. RTD Temperature Accuracy Specifications (°C)

| Range | 2 year $T_{cal} \pm 5^\circ\text{C}$ ³¹ | Tempco/°C ³² | Resolution |
|-------------|--|-------------------------|------------|
| -200 to 600 | 0.14 | 0.011 | 0.01 |



Note Based on RTD with $R_0 = 100\ \Omega$ Pt3851 RTD in a 4-wire configuration, using lowest possible resistance range for each temperature. For total measurement accuracy, add temperature probe error.

Table 14. Thermistor Temperature Accuracy Specifications (°C)

| Range | 2 year $T_{cal} \pm 5^\circ\text{C}$ ³³ | Tempco/°C ³⁴ | Resolution |
|------------|--|-------------------------|------------|
| -80 to 150 | 0.08 | 0.002 | 0.01 |

Isolated Digitizer Specifications



Note All digitizer accuracy specifications apply to Auto Zero enabled, DC coupling, after self-calibration, and 1.8 MS/s sampling rate. For basic DC accuracy, refer to the DC voltage specifications and DC current specifications in the DC Specifications section.

Table 15. Voltage Mode

| Range | Input impedance, ³⁵ nominal | Flatness error 20 kHz, typical | Bandwidth (-3 dB), Typical ³⁶ | THD 1 kHz signal, -1 dBfs, typical | THD 20 kHz signal, -1 dBfs, typical |
|--------|---|-----------------------------------|--|--|---|
| 100 mV | >10 G Ω , 1 M Ω | -0.03 dB | 300 kHz | -104 dB | -78 dB |
| 1 V | >10 G Ω , 1 M Ω | -0.03 dB | 300 kHz | -109 dB | -83 dB |
| 10 V | >10 G Ω , 1 M Ω | -0.03 dB | 300 kHz | -96 dB | -70 dB |

31. Using simulated reference junction.

32. Tempco is the temperature coefficient, expressed in degrees of measurement uncertainty per degree change in DMM instrument operating temperature.

33. Using simulated reference junction.

34. Tempco is the temperature coefficient, expressed in degrees of measurement uncertainty per degree change in DMM instrument operating temperature.

35. In parallel with 150 pF.

36. The AC coupling low frequency (-3 dB) point is 0.8 Hz.

| Range | Input impedance, nominal | Flatness error 20 kHz, typical | Bandwidth (-3 dB), Typical | THD 1 kHz signal, -1 dBfs, typical | THD 20 kHz signal, -1 dBfs, typical |
|-------|--------------------------|--------------------------------|----------------------------|------------------------------------|-------------------------------------|
| 100 V | 1 MΩ | -0.03 dB | 300 kHz | -96 dB | -70 dB |
| 300 V | 1 MΩ | -0.03 dB | 300 kHz | -98 dB | -72 dB |

Table 16. Current Mode

| Range | Resolution | Burden voltage, typical | Flatness error 20 kHz, typical | Bandwidth (-3 dB), typical |
|--------|------------|-------------------------|--------------------------------|----------------------------|
| 20 mA | 10 nA | <20 mV | ±0.01 dB | 430 kHz |
| 200 mA | 100 nA | <200 mV | ±0.01 dB | 430 kHz |
| 1 A | 1 μA | <800 mV | ±0.01 dB | 400 kHz |

Acquisition System

Table 17. Sampling Rate and Record Duration


| | |
|--------------------------|---|
| Available sampling rates | $r = \frac{1.8 \text{ MS/s}}{y}$, where $y = 1, 2, 3, \dots, 1.8 \times 10^5$ |
| Minimum record duration | 8.89 μs |
| Maximum record duration | 149 s |
| Record duration | n/r , where n = number of samples, r = sampling rate |
| Variable resolution | 10-23 bits; refer to Digitizer Maximum Sampling Rate graph |
| Available functions | Voltage and current |
| Voltage ranges | ±100 mV to ±300 V (DC or AC coupled) |
| Current ranges | ±20 mA to ±1 A |
| Timebase accuracy | 25 ppm |

Table 18. Input Trigger

| | |
|-----------------------|--------|
| Latency ³⁷ | 1.8 μs |
|-----------------------|--------|

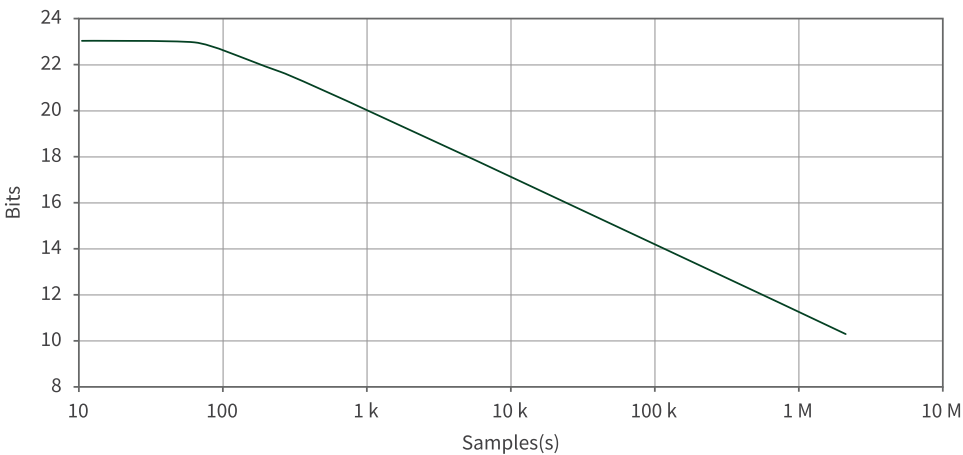
37. The latency specification value actually reflects negative latency due to sampling before the trigger. Can be reduced to near zero (with the jitter specification) or made positive in software by adding a

| | |
|--------|---------|
| Jitter | <600 ns |
|--------|---------|



Note Refer to *Trigger Specifications* for additional input trigger specifications.

Figure 2. Digitizer Maximum Sampling Rate, Nominal



General Specifications

| | |
|-------------------------------|--|
| Warm-up | 1 hour to rated accuracy |
| Self-calibration | Calibrates the FlexDMM relative to high-precision internal voltage and resistance standards. No external calibration equipment required. |
| External calibration interval | 2 year recommended |
| Measurement category | I (up to 300 V) and II (up to 250 VAC _{rms} , 220 VDC) |

Current Ratings

| |
|------------------|
| Input protection |
|------------------|

trigger delay.

| | | |
|----------------------------|--|-----|
| Current mode fuse | F 1.6 A H 300 V, fast-acting user-replaceable fuse | |
| Resistance, diode | Up to 300 VDC | |
| DC V, AC V | Up to 300 VDC, 300 VAC _{rms} , 450 VAC peak | |
| Maximum continuous current | | |
| HI SENSE to LO | | 1 A |

Trigger Specifications

| | |
|--|----------------------------|
| Measurement complete trigger pulse width | 3 μ s |
| Input trigger pulse width | 1 μ s, with <2 m cable |

Table 20. Trigger Voltage Levels

| | |
|-----------|-----------|
| Vin High | 2.0 V min |
| Vin Low | 0.8 V max |
| Vout High | 2.4 V min |
| Vout Low | 0.4 V max |

Table 20. Trigger Voltage Level Absolute Maximums

| | |
|----------|--------|
| Vin High | 5.5 V |
| Vin Low | -0.5 V |



Note Triggers are LVTTTL/TTL compatible.



Note The interdevice connector on the PCI-4070 is not isolated. This


connector is not referenced to the measurement circuit but is referenced to the ground of the computer. Do not operate the digital signal of this connector beyond -0.5 V to 5.5 V of the computer ground.

Power

| | |
|-------------------|---------------------|
| Power consumption | <12 W from PCI slot |
|-------------------|---------------------|

Physical Characteristics

| | |
|------------|---|
| Dimensions | One-slot PCI module 12.6 cm × 35.2 cm × 1.98 cm (4.95 in. × 13.86 in. × 0.78 in.) |
| Weight | 570 g (20 oz), nominal |

 **Note** If you need to clean the device, wipe it with a dry towel.

Environmental Characteristics

| Temperature | |
|-------------|-----------------|
| Operating | 0 °C to 40 °C |
| Storage | -40 °C to 70 °C |