PCI-4070 Specifications

Integration Partner

SYSTEM INTEGRATOR

Contents

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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.

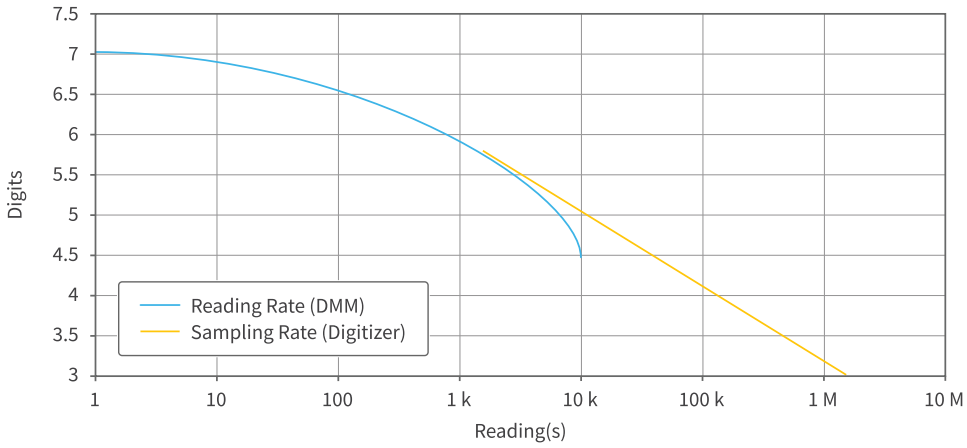
- Calibration interval of 2 years
- Warm-up time of 1 hour
- Resolution set to 6.5 digits for specifications requiring an aperture greater than or equal to 100 ms

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 ± (ppm of reading + ppm of range)

Range	Resolution	Input resistance	24 hour[3] T_{cal} ±1 °C	90 day[4] T_{cal}±5 °C	2 year[5] T_{cal}±5 °C	Tempco/°C (0 °C to 55 °C)	
						Without Self-cal	With Self-cal
100 mV [6]	100 nV	▪ >10 GΩ ▪ 10 MΩ, nominal	10 + 10	30 + 20	40 + 20	4 + 5	0.3 + 0.3
1 V	1 µV	▪ >10 GΩ ▪ 10 MΩ, nominal	6 + 2	20 + 6	25 + 6	2 + 1	0.3 + 0.3
10 V	10 µV	▪ >10 GΩ ▪ 10 MΩ, nominal	4 + 2	20 + 6	25 + 6	1 + 1	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.

Range	Resolution	Input resistance	24 hour T_{cal} ±1 °C	90 day T_{cal}±5 °C	2 year T_{cal}±5 °C	Tempco/°C (0 °C to 55 °C)	
						Without Self-cal	With Self-cal
100 V	100 µV	10 MΩ, nominal	6 + 2	30 + 6	35 + 6	4 + 1	0.3 + 0.3
300 V	1 mV	10 MΩ, nominal	6 + 6	30 + 20	35 + 20	4 + 3	0.3 + 0.3

Table 3. DC Current ± (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 µA	<800 mV	3	500 + 50	8 + 0.4

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

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

Range	Test current[7]	Max test voltage[8]	Open circuit voltage[9]	24 hour[10] T_{cal} ±1 °C	90 day[11] T_{cal}±5 °C	2 year[12] T_{cal}±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 kΩ[14]	1 mA	1 V	11.5	12 + 2	50 + 3	80 + 3	8 + 0.1	0.8 + 0.1
10 kΩ[15]	100 µA	1 V	12.2	12 + 2	50 + 3	80 + 3	8 + 0.1	0.8 + 0.1

[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.

Range	Test current	Max test voltage	Open circuit voltage	24 hour T_{cal} ±1 °C	90 day T_{cal}±5 °C	2 year T_{cal}±5 °C	Tempco/°C (0 °C to 55 °C)	
							Without Self-cal	With Self-cal
100 kΩ	10 µA	1 V	12.2	15 + 2	50 + 6	80 + 6	8 + 0.5	0.8 + 0.5
1 MΩ	10 µA	10 V	12.2	20 + 2	60 + 10	90 + 10	8 + 1	0.8 + 1
10 MΩ	1 µA	10 V	12.2	100 + 2	200 + 10	400 + 10	30 + 3	30 + 3
100 MΩ [16]	1 µA|| 10 MΩ	10 V	9.6	900 + 20	5,500 + 40	6,000 + 40	200 +10	200 + 10

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

[16] 2-wire resistance measurement only. Typical accuracy is 5% between 105 MΩ and 1.05 GΩ. Use tempco outside 18 °C to 28 °C.

[17] -10% to 0% tolerance.

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

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%

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

[19] With high-order DC noise rejection; 100 ms aperture.
[20] With normal DC noise rejection; 20 ms (16.67 ms) aperture.

to measurement aperture greater than $4/f_L$, where f_L is the lowest frequency component of the signal being measured.

Table 9. AC Voltage 2 Year ± (% of reading + % of range), 23 °C ± 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 µV	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 µV					
50 V	±105 V	100 µV					
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 ± (% of reading + % of range), 0 °C ± 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 µA	<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 µA.

AC Functions General Specifications

Input impedance	1 MΩ 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 kΩ 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 ± % of reading
50 mV to 300 V	1 Hz to 500 kHz	1 s to 2 µs	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} ±5 °C		Tempco/°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

Table 13. RTD Temperature Accuracy Specifications (°C)

Range	2 year T_{cal} ±5 °C [31]	Tempco/°C [32]	Resolution
-200 to 600	0.14	0.011	0.01

[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 µV 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.

[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.

Note Based on RTD with R_O = 100 Ω 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} ±5 °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 GΩ, 1 MΩ	-0.03 dB	300 kHz	-104 dB	-78 dB
1 V	>10 GΩ, 1 MΩ	-0.03 dB	300 kHz	-109 dB	-83 dB
10 V	>10 GΩ, 1 MΩ	-0.03 dB	300 kHz	-96 dB	-70 dB
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

[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.

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	$r = \frac{1.8\ MS/s}{y}$, where y = 1, 2, 3,...1.8×10^5
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

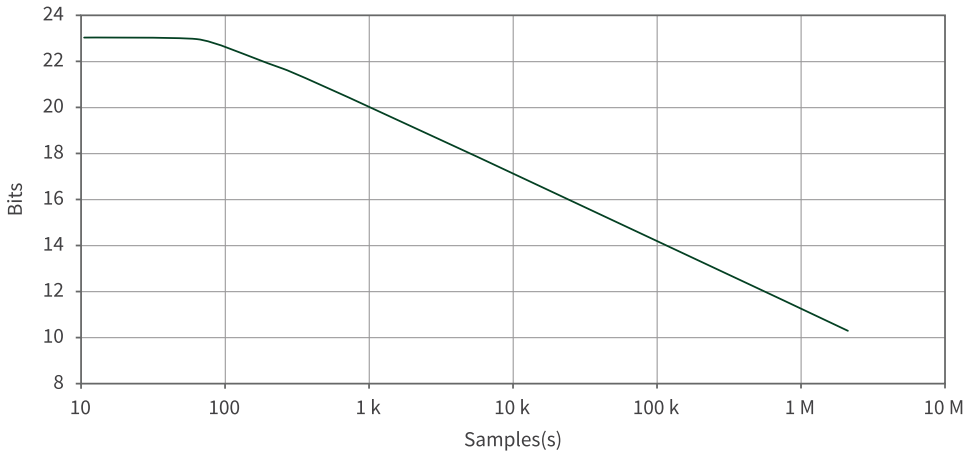
Table 18. Input Trigger

Latency[37]	1.8 µs
Jitter	<600 ns

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

[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 trigger delay.

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	
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 µs
Input trigger pulse width	1 µs, 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 LVTTL/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