

NI 4070/4072 Specifications

6½-Digit FlexDMM™ and 1.8 MS/s Isolated Digitizer



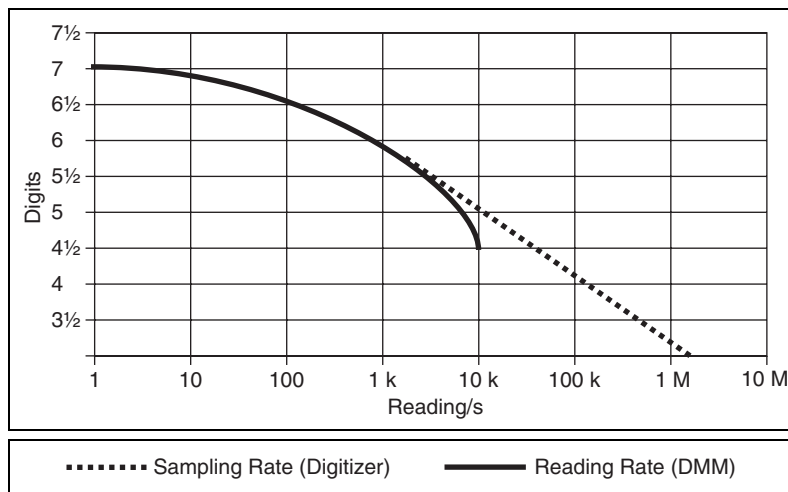
Note All specifications in this document are subject to change without notice.
For the most current specifications, visit ni.com/instruments.

DC Specifications

Digits	Bits	Max Sampling Rate* (Digitizer)	Reading Rate† (DMM)
7	23	5.0 S/s	5 S/s
6½	22	100.0 S/s	100 S/s
5½	18	5.0 kS/s	3 kS/s
4½	15	20.0 kS/s	10 kS/s
3	10	1.8 MS/s	N/A

* Maximum sampling rates refer to waveform acquisition in digitizer mode.
† Auto Zero disabled, except 7 digits, measured on a 10 V and 10 kΩ range.

DC Voltage Maximum Reading Rate



DC System Speeds

Range or function change 100/s

Auto Range time, DC V and DC I 5 ms

Auto Range time, resistance 50 ms

Trigger latency 2 μ s

Maximum trigger rate 6 kHz

DC Accuracy Specifications



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

DC Voltage \pm (ppm* of reading + ppm of range)

Range	Resolution	Input Resistance	24 Hr [†] 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 mV**	100 nV	>10 G Ω , 10 M Ω	10 + 10	30 + 20	40 + 20	4 + 5	0.3 + 0.3
1 V	1 μ V	>10 G Ω , 10 M Ω	6 + 2	20 + 6	25 + 6	2 + 1	0.3 + 0.3
10 V	10 μ V	>10 G Ω , 10 M Ω	4 + 2	20 + 6	25 + 6	1 + 1	0.3 + 0.3
100 V	100 μ V	10 M Ω	6 + 2	30 + 6	35 + 6	4 + 1	0.3 + 0.3
300 V	1 mV	10 M Ω	6 + 6	30 + 20	35 + 20	4 + 3	0.3 + 0.3

* 1 ppm (part per million) = 0.0001%.
[†] Relative to external calibration source.
[‡] Using internal self-calibration; specifications valid over the entire operating temperature range.
 ** With offset nulling and 100 ms aperture.
 T_{cal} = temperature at which last self-calibration or external calibration was performed.
 Tempco = temperature coefficient.

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 + 75	8 + 1
200 mA	100 nA	< 200 mV	3	400 + 20	8 + 0.2
1 A	1 μ A	< 800 mV	3	500 + 20	8 + 0.4

* Typical 24 hour accuracy (23 °C \pm 1 °C) is \pm (50 ppm of reading + 5 ppm of range).
 Tempco = temperature coefficient.

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

Range	Resolution	Test Current [†]	Max Test Voltage	24 Hr [‡] 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 Ω ^{††}	100 μΩ	1 mA	100 mV	15 + 10	50 + 10	80 + 10	8 + 1	0.8 + 1
1 kΩ ^{††}	1 mΩ	1 mA	1 V	12 + 2	50 + 3	80 + 3	8 + 0.1	0.8 + 0.1
10 kΩ ^{††}	10 mΩ	100 μA	1 V	12 + 2	50 + 3	80 + 3	8 + 0.1	0.8 + 0.1
100 kΩ	100 mΩ	10 μA	1 V	15 + 2	50 + 6	80 + 6	8 + 0.5	0.8 + 0.5
1 MΩ	1 Ω	10 μA	10 V	20 + 2	60 + 10	90 + 10	8 + 1	0.8 + 1
10 MΩ	10 Ω	1 μA	10 V	100 + 2	200 + 10	400 + 10	30 + 3	30 + 3
100 MΩ ^{‡‡}	100 Ω	1 μA 10 MΩ	10 V	900 + 20	1,800 + 40	2,000 + 40	200 + 10	200 + 10

* Perform offset nulling or add 200 mΩ to reading.
[†] -10% to 0% tolerance.
[‡] Relative to external calibration source.
^{**} Using internal self-calibration; specifications valid over the entire operating temperature range.
^{††} With offset compensated ohms enabled.
^{‡‡} 2-wire resistance measurement only. Typical accuracy is 5% between 105 MΩ and 1.05 GΩ. Use tempco outside 18 °C to 28 °C.
For ranges ≥1 MΩ and relative humidity >80%, add 100 ppm/MΩ.
T_{cal} = temperature at which last self-calibration or external calibration was performed.
Tempco = temperature coefficient.

Diode Test*

Range	Resolution	Test Current [†]	Accuracy
10 V	10 μV	1 μA, 10 μA, 100 μA, 1 mA [‡]	Add 20 ppm of reading to 10 V DC voltage specifications.

* Can be used to test p-n junctions, LEDs, or zener diodes up to 10 V.
[†] -10% to 0% tolerance.
[‡] Up to 4.5 V measurement for 1 mA test current.

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 Common-Mode Rejection Ratio (CMRR)
 (1 k Ω 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 k Ω

Overrange105% of range except
 300 V and 1 A range

DC voltage input bias current<30 pA at 23 °C (typical)

Normal-Mode Rejection Ratio (NMRR)

Readings/s	NMRR	Conditions
10	>100 dB*	All noise sources >46 Hz
50 (60)	> 60 dB [†]	50 (60) Hz \pm 0.1%
* With high-order DC noise rejection; 100 ms aperture. [†] With normal DC noise rejection; 20 ms (16.67 ms) aperture.		

AC Specifications



Note All AC speed specifications apply with Auto Zero disabled.

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 change10/s

Auto Range time, AC V and AC I.....250 ms

Trigger latency2 μ s

Maximum trigger rate1 kHz

AC Accuracy Specifications



Note All AC accuracy specifications apply to 6½ digit resolution, signal amplitudes greater than 1% of range, and Auto Zero enabled.

AC Voltage* 2 Year ± (% of reading + % of range), 23 °C ± 10 °C

Range (rms)	Peak Voltage	Resolution	1 Hz to 40 Hz [†]	40 Hz to 20 kHz	20 kHz to 50 kHz	50 kHz to 100 kHz	100 kHz to 300 kHz
50 mV [‡]	±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

* After self-calibration. Measurement aperture greater than $4/f_L$, where f_L is the lowest frequency component of the signal being measured.
[†] Specification applies for DC coupling.
[‡] Applies to signals >2 mV.
 Tempco = temperature coefficient.

AC Current* 2 Year ± (% of reading + % of range), 0 °C to 55 °C

Range (rms)	Peak Current	Resolution	Burden Voltage (rms)	1 Hz to 20 kHz [†]	Tempco/°C (0 °C to 55 °C)
10 mA [‡]	±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

* Measurement aperture greater than $4/f_L$, where f_L is the lowest frequency component of the signal being measured.
[†] Specification is typical for the 5 kHz to 20 kHz frequency range.
[‡] Applies to signals >200 µA.
 Tempco = temperature coefficient.



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

AC Functions General Specifications

Input impedance 1 M Ω in parallel with 150 pF

Input coupling AC or DC coupling

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)

Overrange 105% of range except
300 V, 1 A range

Frequency and Period*

Input Range	Frequency Range	Period Range	Resolution	2 Year Accuracy [†] 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
* 2 second gate time; input signal must be $>10\%$ of AC voltage input range. † 0.0025% of reading typical.				

Capacitance and Inductance Specifications (NI 4072 only)

Capacitance Accuracy Specifications

Capacitance \pm (% of reading + % of range), 23 °C \pm 10 °C

Range	Resolution	2 Year*	Tempco/°C (0 °C to 55 °C)	Effective Test Current†	Effective Frequency†	Default Model
300 pF	0.05 pF	0.15 + 0.5	0.01 + 0.025	160 nA	3 kHz	Parallel
1 nF	0.1 pF	0.15 + 0.1	0.01 + 0.003	330 nA	3 kHz	Parallel
10 nF	1 pF	0.15 + 0.1	0.01 + 0.001	330 nA	3 kHz	Parallel
100 nF	10 pF	0.15 + 0.1	0.01 + 0.001	3.3 μ A	3 kHz	Parallel
1 μ F	100 pF	0.18 + 0.1	0.01 + 0.001	100 μ A	1 kHz	Series
10 μ F	1 nF	0.18 + 0.1	0.01 + 0.001	1 mA	1 kHz	Series
100 μ F	10 nF	0.18 + 0.1	0.01 + 0.001	1 mA	91 Hz	Series
1,000 μ F	100 nF	0.18 + 0.1	0.01 + 0.001	1 mA	91 Hz	Series
10,000 μ F	1 μ F	0.18 + 0.1	0.01 + 0.001	1 mA	91 Hz	Series

* Relative to external calibration source. After lead compensation with <3 meters of coaxial or shielded twisted-pair cabling. Number of averages = 20. Specifications apply to >5% of range and <110% of range, except the 300 pF range which measures down to 0.05 pF.

† Correlated to single-tone test method.

Inductance Accuracy Specifications

Inductance \pm (% of reading + % of range), 23 °C \pm 10 °C

Range	Resolution	2 Year*	Tempco/°C (0 °C to 55 °C)	Effective Test Current†	Effective Frequency†	Default Model
10 μ H	1 nH	0.5 + 1	0.01 + 0.01	330 μ A	30 kHz	Series
100 μ H	10 nH	0.2 + 0.1	0.01 + 0.01	330 μ A	30 kHz	Series
1 mH	100 nH	0.2 + 0.1	0.01 + 0.001	330 μ A	3 kHz	Series
10 mH‡	1 μ H	0.15 + 0.1	0.005 + 0.001	3.3 μ A	3 kHz	Series
100 mH‡	10 μ H	0.15 + 0.1	0.005 + 0.001	33 μ A	273 Hz	Series
1 H‡	100 μ H	0.18 + 0.1	0.007 + 0.001	3.3 μ A	273 Hz	Series
5 H‡	1 mH	0.18 + 0.1	0.007 + 0.001	330 nA	273 Hz	Series

* Relative to external calibration source. After lead compensation with <3 meters of coaxial or shielded twisted-pair cabling. Number of averages = 20. Specifications apply to <110% of range.

† Correlated to single-tone test method.

‡ Specifications apply to >1% of range.

Capacitance and Inductance General Specifications

Range or function change 10/s

Mode	Ranges	Reading Rate
Capacitance	300 pF, 1 nF, 10 nF, 100 nF, 1 μF, 10 μF	20 S/s
	100 μF, 1,000 μF, 10,000 μF	3 S/s
Inductance	10 μH, 100 μH	40 S/s
	1 mH, 10 mH	20 S/s
	100 mH, 1 H, 5 H	3 S/s

Capacitance underrange 5% of range

Inductance overrange 110% of range

Excitation technique¹ Multi-tone, constant current

Measurement technique¹ Measures fundamental and third harmonic of voltage waveform, and calculates inductance or capacitance using FFT peak analysis

Lead compensation OPEN/SHORT

Measurement configuration 2-wire with lead compensation

DC bias (capacitance only) 0.46 V from HI to LO, user-selectable (OFF by default)

Isolated Digitizer Specifications

Acquisition System

Sampling rate and record duration

$$\text{Available sampling rates} \dots\dots\dots r = \frac{1.8 \text{ MS/s}}{y},$$

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

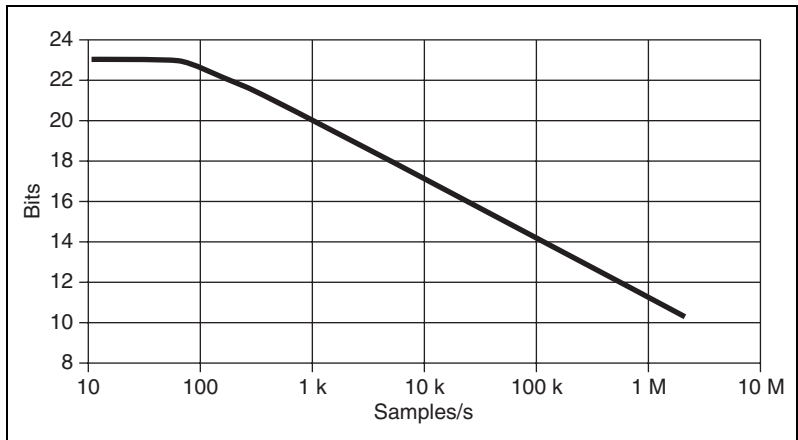
¹ Patents pending.

Variable resolution	10–23 bits; refer to the <i>Digitizer Maximum Sampling Rate</i> 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
Input trigger	
Latency ¹	1.8 μs
Jitter	<600 ns



Note Refer to *Triggers* under *General Specifications* for additional input trigger specifications.

Digitizer Maximum Sampling Rate



¹ Is actually negative latency. Can be reduced to near zero (within the jitter specification) or made positive in software.

Isolated Digitizer Accuracy Specifications



Note All digitizer accuracy specifications apply to Auto Zero enabled, DC coupling, after self-calibration, and 1.8 MS/s sampling rate.

Voltage

Range	Input Impedance*	Flatness Error† 20 kHz	Bandwidth†,‡ (-3 dB)	THD† 1 kHz signal, -1 dBfs	THD† 20 kHz signal, -1 dBfs
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

* In parallel with 150 pF.
† Typical specification.
‡ The AC coupling low frequency (-3 dB) point is 0.8 Hz.



Note For basic DC accuracy, refer to the DC voltage specifications in the [DC Specifications](#) section.

Current

Range	Resolution	Burden Voltage (typical)	Flatness Error* 20 kHz	Bandwidth* (-3 dB)
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

* Typical specification.



Note For basic DC accuracy, refer to the DC current specifications in the [DC Specifications](#) section.

General Specifications

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
Input protection	
Resistance, diode	Up to 300 V DC
DC V, AC V	Up to 300 V DC or AC _{rms} , 450 V AC peak
DC I and AC I	1.25 A, 250 V fast-acting user-replaceable fuse
Maximum common-mode voltage	300 V DC or AC _{rms}
Input terminals	Gold-plated low-thermal EMF solid copper
Triggers	
Measurement complete trigger pulse width	3 μs
Input trigger pulse width	1 μs, with <2 m cable



Note Refer to the *Isolated Digitizer Specifications* section for additional digitizer specifications.

Trigger Voltage Levels

Trigger Voltage	High	Low
V _{in}	2.4 V min	0.4 V max
V _{out}	2.0 V min	0.8 V max

Trigger Voltage Level Absolute Maximums

Trigger Voltage	High	Low
V _{in}	5.5 V	-0.5 V



Note Triggers are LVTTTL/TTL compatible.



Caution The AUX I/O connector on the NI 4070/4072 and the interdevice connector on the NI PCI-4070 are *not* isolated. These connectors are not referenced to your measurement circuit, but they are referenced to the ground of your PXI chassis or computer. The digital signals on these connectors should *not* operate beyond -0.5 to 5.5 V of your chassis or computer ground.

Power consumption

PXI devices.....<12 W from PXI backplane
 PCI devices.....<12 W from PCI slot

Warm-up.....1 hour to rated accuracy

Dimensions

PXI devices.....3U, one-slot, PXI/cPCI module;
 2.0 cm \times 13.0 cm \times 21.6 cm
 (0.8 in. \times 5.1 in. \times 8.5 in.)
 PCI devices.....One-slot PCI module;
 12.6 cm \times 35.2 cm
 (4.95 in. \times 13.86 in.)

Weight

NI PXI-4070340 g (12 oz)
 NI PCI-4070570 g (20 oz)
 NI PXI-4072370 g (13 oz)

Measurement Category.....II

Environment

Maximum altitude.....2000 m (at 25 °C ambient temperature)

Pollution Degree2

Indoor use only

Operating Environment

Ambient temperature range

PXI devices.....0 °C to 55 °C (Tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.)
 PCI devices.....0 °C to 40 °C

Relative humidity range.....Up to 95% at 40 °C

Storage Environment

Ambient temperature range.....	-40 °C to 70 °C (Tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.)
Relative humidity range	5% to 95% noncondensing (Tested in accordance with IEC-60068-2-56.)

Shock and Vibration (PXI only)

Operational Shock.....	30 g peak, half-sine, 11 ms pulse (Tested in accordance with IEC-60068-2-27. Test profile developed in accordance with MIL-PRF-28800F.)
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Random Vibration

Operating	5 Hz to 500 Hz, 0.3 g _{rms}
Nonoperating	5 Hz to 500 Hz, 2.4 g _{rms} (Tested in accordance with IEC-60068-2-64. Nonoperating test profile exceeds the requirements of MIL-PRF-28800F, Class 3.)

Safety

The NI 4070/4072 meets the requirements of the following standards of safety and electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1
- CAN/CSA-C22.2 No. 61010-1



Note For UL and other safety certifications, refer to the product label, or visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

Electromagnetic Compatibility

Emissions	EN 55011 Class A at 10 m FCC Part 15A above 1 GHz
Immunity	EN 61326:1997 + A2:2001, Table 1
EMC/EMI	CE, C-Tick, and FCC Part 15 (Class A) Compliant



Note For EMC compliance, operate this device with shielded cabling.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

Low-Voltage Directive (safety).....73/23/EEC

Electromagnetic Compatibility
Directive (EMC).....89/336/EEC



Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

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