

# NI 4070/4072 Specifications

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

For the most current specifications, visit [ni.com/instruments](http://ni.com/instruments).



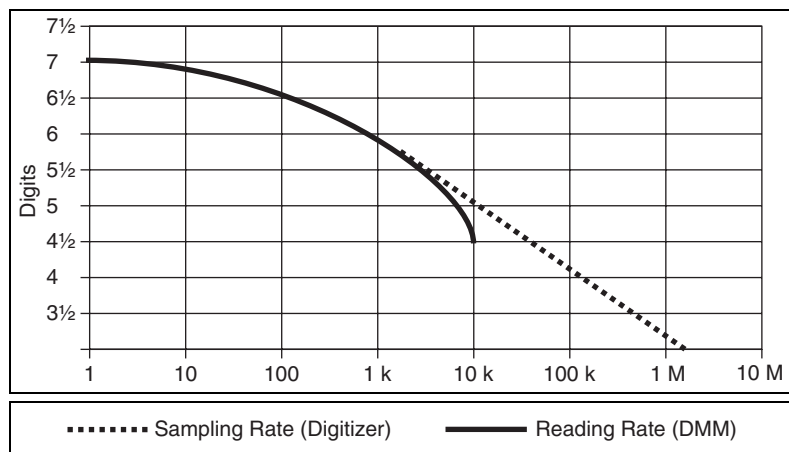
**Note** All specifications in this document are subject to change without notice.

### DC Specifications

Digits	Bits	Max Sampling Rate <sup>1</sup> (Digitizer)	Reading Rate <sup>2</sup> (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	10 kS/s
3	10	1.8 MS/s	N/A

<sup>1</sup> Maximum sampling rates refer to waveform acquisition in digitizer mode.  
<sup>2</sup> 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

Autorange time, DC V and DC I ..... 5 ms

Autorange time, resistance ..... 50 ms

Trigger latency ..... 2  $\mu$ s

Maximum trigger rate ..... 6 kHz

## DC Accuracy Specifications



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

### DC Voltage $\pm$ (ppm<sup>1</sup> of reading + ppm of range)

Range	Resolution	Input Resistance	24 Hr <sup>2</sup> T <sub>cal</sub> $\pm 1$ °C	90 Day <sup>3</sup> T <sub>cal</sub> $\pm 5$ °C	2 Year <sup>3</sup> T <sub>cal</sub> $\pm 5$ °C	Tempco/°C (0 °C to 55 °C)	
						Without Self-Cal	With Self-Cal
100 mV*	100 nV	>10 G $\Omega$ , 10 M $\Omega$	10 + 10	30 + 20	40 + 20	4 + 5	0.3 + 0.3
1 V	1 $\mu$ V	>10 G $\Omega$ , 10 M $\Omega$	6 + 2	20 + 6	25 + 6	2 + 1	0.3 + 0.3
10 V	10 $\mu$ V	>10 G $\Omega$ , 10 M $\Omega$	4 + 2	20 + 6	25 + 6	1 + 1	0.3 + 0.3
100 V	100 $\mu$ V	10 M $\Omega$	6 + 2	30 + 6	35 + 6	4 + 1	0.3 + 0.3
300 V	1 mV	10 M $\Omega$	6 + 6	30 + 20	35 + 20	4 + 3	0.3 + 0.3

<sup>1</sup> 1 ppm (part per million) = 0.0001%.

<sup>2</sup> Relative to external calibration source.

<sup>3</sup> Using internal self-calibration; specifications valid over the entire operating temperature range.

\* With offset nulling and 100 ms aperture.

T<sub>cal</sub> = temperature at which last self-calibration or external calibration was performed.

Tempco = temperature coefficient.

### DC Current<sup>1</sup> $\pm$ (ppm of reading + ppm of range)

Range	Resolution	Burden Voltage (typical)	Noise <sup>2</sup>	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 $\mu$ A	<800 mV	3	500 + 20	8 + 0.4

<sup>1</sup> Typical 24 hour accuracy (23 °C  $\pm$  1 °C) is  $\pm$  (50 ppm of reading + 5 ppm of range).

<sup>2</sup> In ppm of range rms.

Tempco = temperature coefficient.

### Resistance (4-Wire and 2-Wire<sup>1</sup>) ± (ppm of reading + ppm of range)

Range	Resolution	Test Current <sup>2</sup>	Max Test Voltage	24 Hr <sup>3</sup> T <sub>cal</sub> ±1 °C	90 Day <sup>4</sup> T <sub>cal</sub> ±5 °C	2 Year <sup>4</sup> T <sub>cal</sub> ±5 °C	Tempco/°C (0 °C to 55 °C)	
							Without Self-Cal	With Self-Cal
100 Ω <sup>†</sup>	100 μΩ	1 mA	100 mV	15 + 10	50 + 10	80 + 10	8 + 1	0.8 + 1
1 kΩ <sup>†</sup>	1 mΩ	1 mA	1 V	12 + 2	50 + 3	80 + 3	8 + 0.1	0.8 + 0.1
10 kΩ <sup>†</sup>	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 <sup>‡</sup>	100 Ω	1 μA  10 MΩ	10 V	900 + 20	1,800 + 40	2,000 + 40	200 + 10	200 + 10

<sup>1</sup> Perform offset nulling or add 200 mΩ to reading.  
<sup>2</sup> –10% to 0% tolerance.  
<sup>3</sup> Relative to external calibration source.  
<sup>4</sup> Using internal self-calibration; specifications valid over the entire operating temperature range.  
<sup>†</sup> With offset compensated ohms enabled.  
<sup>‡</sup> 2-wire resistance measurement only. Typical accuracy is 5% between 105 MΩ and 1.05 GΩ. Use tempco outside 18 °C to 28 °C.  
T<sub>cal</sub> = temperature at which last self-calibration or external calibration was performed.  
Tempco = temperature coefficient.

### Diode Test<sup>1</sup>

Range	Resolution	Test Current <sup>2</sup>	Accuracy
10 V	10 μV	1 μA, 10 μA, 100 μA, 1 mA <sup>†</sup>	Add 20 ppm of reading to 10 V DC voltage specifications.

<sup>1</sup> Can be used to test p-n junctions, LEDs, or zener diodes up to 10 V.  
<sup>2</sup> –10% to 0% tolerance.  
<sup>†</sup> 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 $\Omega$  resistance in LO lead).....>170 dB (DC, >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 $\Omega$

Overrange .....105% 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 <sup>†</sup>	All noise sources >46 Hz
50 (60)	>60 dB <sup>‡</sup>	50 (60) Hz $\pm$ 0.1%
<sup>†</sup> With high-order DC noise rejection; 100 ms aperture. <sup>‡</sup> 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 S/s	400 Hz to 300 kHz
5½	1 kS/s	20 kHz to 300 kHz

## AC System Speeds

Range or function change .....10/s

Autorange time, AC V and AC I .....250 ms

Trigger latency .....2  $\mu$ s

Maximum trigger rate .....1 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<sup>1</sup> 2 Year ± (% of reading + % of range), 23 °C ± 10 °C

Range (rms)	Peak Voltage	Resolution	1 Hz to 40 Hz <sup>2</sup>	40 Hz to 20 kHz	20 kHz to 50 kHz	50 kHz to 100 kHz	100 kHz to 300 kHz
50 mV <sup>†</sup>	±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

<sup>1</sup> After self-calibration. Measurement aperture greater than  $4/f_L$ , where  $f_L$  is the lowest frequency component of the signal being measured.  
<sup>2</sup> Specification applies for DC coupling.  
<sup>†</sup> Applies to signals >2 mV.  
 Tempco = temperature coefficient.

### AC Current<sup>1</sup> 2 Year ± (% of reading + % of range), 0 °C to 55 °C

Range (rms)	Peak Current	Resolution	Burden Voltage (rms)	1 Hz to 20 kHz <sup>2</sup>	Tempco/°C (0 °C to 55 °C)
10 mA <sup>†</sup>	±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

<sup>1</sup> Measurement aperture greater than  $4/f_L$ , where  $f_L$  is the lowest frequency component of the signal being measured.  
<sup>2</sup> Specification is typical for the 5 kHz to 20 kHz frequency range.  
<sup>†</sup> Applies to signals >200 µA.  
 Tempco = temperature coefficient.



**Note** No degradation in accuracy due to crest factor for signals up to the rated peak voltage/current or bandwidth occurs. For high crest factor signals, increase range. For example, for a 500 mV<sub>rms</sub> signal with a crest factor between 2 and 10, use the 5 V range.

# AC Functions General Specifications

Input impedance ..... 1 M $\Omega$  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 $\Omega$  resistance in LO lead) ..... >70 dB (DC to 60 Hz)

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

## Frequency and Period<sup>1</sup>

Input Range	Frequency Range	Period Range	Resolution	2 Year Accuracy <sup>2</sup> 0 °C to 55 °C $\pm$ % of reading
50 mV to 300 V	1 Hz to 500 kHz	1 s to 2 $\mu$ s	6½ digits	0.01
<sup>1</sup> 2 second gate time; input signal must be >10% of AC voltage input range. <sup>2</sup> 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 <sup>1</sup>	Tempco/°C (0 °C to 55 °C)	Effective Test Current <sup>2</sup>	Effective Frequency <sup>2</sup>	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 $\mu$ A	3 kHz	Parallel
1 $\mu$ F	100 pF	0.18 + 0.1	0.01 + 0.001	100 $\mu$ A	1 kHz	Series
10 $\mu$ F	1 nF	0.18 + 0.1	0.01 + 0.001	1 mA	1 kHz	Series
100 $\mu$ F	10 nF	0.18 + 0.1	0.01 + 0.001	1 mA	91 Hz	Series
1,000 $\mu$ F	100 nF	0.18 + 0.1	0.01 + 0.001	1 mA	91 Hz	Series
10,000 $\mu$ F	1 $\mu$ F	0.18 + 0.1	0.01 + 0.001	1 mA	91 Hz	Series

<sup>1</sup> 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.

<sup>2</sup> Correlated to single-tone test method.

## Inductance Accuracy Specifications

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

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

<sup>1</sup> 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.

<sup>2</sup> Correlated to single-tone test method.

<sup>†</sup> 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, 1000 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 technique<sup>1</sup> ..... Multi-tone, constant current

Measurement technique<sup>1</sup> ..... 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

---

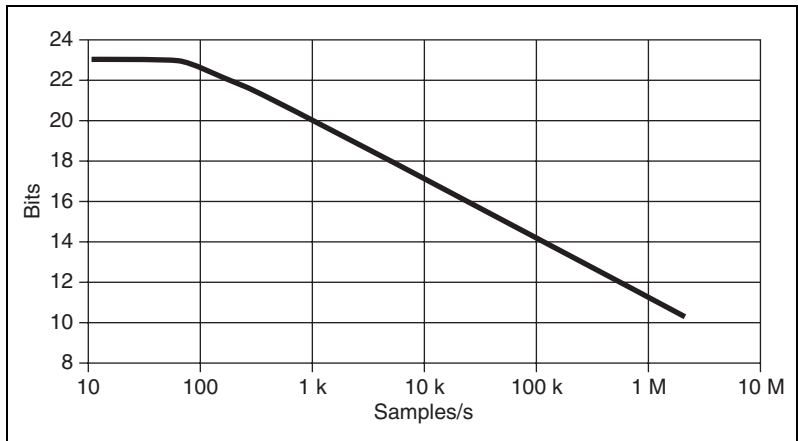
<sup>1</sup> Patents pending.

Variable resolution .....	10 bits to 23 bits; refer to the <i>Digitizer Maximum Sampling Rate</i> graph
Available functions .....	Voltage and current
Voltage ranges.....	$\pm 100$ mV to $\pm 300$ V (DC or AC coupled)
Current ranges.....	20 mA to 1 A
Timebase accuracy .....	25 ppm
Input trigger	
Latency.....	1.8 $\mu$ s
Jitter .....	<600 ns



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

### Digitizer Maximum Sampling Rate



# 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 ± (ppm of reading + ppm of range)

Range	Input Impedance <sup>1</sup>	2 Year T <sub>cal</sub> ±5 °C	Flatness Error <sup>2</sup> 20 kHz	Bandwidth <sup>2,3</sup> (-3 dB)	THD <sup>2</sup> 1 kHz signal, -1 dBfs	THD <sup>2</sup> 20 kHz signal, -1 dBfs	Tempco/°C (0 °C to 55 °C)
100 mV <sup>†</sup>	>10 GΩ 1 MΩ	45 + 30	-0.03 dB	300 kHz	-104 dB	-78 dB	4 + 6
1 V	>10 GΩ 1 MΩ	35 + 6	-0.03 dB	300 kHz	-109 dB	-83 dB	3 + 1
10 V	>10 GΩ 1 MΩ	30 + 6	-0.03 dB	300 kHz	-96 dB	-70 dB	3 + 1
100 V	1 MΩ	45 + 6	-0.03 dB	300 kHz	-96 dB	-70 dB	7 + 1
300 V	1 MΩ	45 + 30	-0.03 dB	300 kHz	-98 dB	-72 dB	7 + 3

<sup>1</sup> In parallel with 150 pF.  
<sup>2</sup> Typical specification.  
<sup>3</sup> The AC coupling low frequency (-3 dB) point is 0.8 Hz.  
<sup>†</sup> With offset nulling.  
T<sub>cal</sub> = temperature at which last self-calibration or external calibration was performed.  
Tempco = temperature coefficient.

## Current ± (ppm of reading + ppm of range)

Range	Resolution	Burden Voltage (typical)	2 Year (0 °C to 55 °C)	Flatness Error <sup>1</sup> 20 kHz	Bandwidth <sup>1</sup> (-3 dB)	Tempco/°C (0 °C to 55 °C)
20 mA	10 nA	<20 mV	400 + 75	±0.01 dB	430 kHz	8 + 1
200 mA	100 nA	<200 mV	400 + 20	±0.01 dB	430 kHz	8 + 0.2
1 A	1 μA	<800 mV	500 + 20	±0.01 dB	400 kHz	8 + 0.4

<sup>1</sup> Typical specification.  
Tempco = temperature coefficient.

# 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, 300 V AC <sub>rms</sub> , 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
Input terminals .....	Gold-plated low-thermal EMF solid copper
Triggers	
Measurement complete trigger pulse width .....	3 $\mu$ s
Input trigger pulse width .....	1 $\mu$ s, 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.

### Power consumption

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

### Operating environment

PXI devices.....0 °C to 55 °C,  
 up to 80% relative humidity  
 at 35 °C  
 PCI devices.....0 °C to 40 °C,  
 up to 80% relative humidity  
 at 35 °C

Storage environment.....-40 °C to 70 °C

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

### Dimensions

PXI devices.....10 cm × 16 cm  
 (3.9 in. × 6.33 in.)  
 PCI devices.....12.6 cm × 35.2 cm  
 (4.95 in. × 13.86 in.)

### Weight

PXI devices.....340 g (12 oz)  
 PCI devices.....570 g (20 oz)

Installation Category.....II

Pollution Degree.....2



**Caution** The AUX I/O connector 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 computer. The digital signals on these connectors should *not* operate beyond –0.5 to 5.5 V of your computer ground. The trigger signals are TTL-compatible.

## Safety

The NI 4070/4072 meets the requirements of the following standards for 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](http://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, you *must* 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](http://ni.com/certification), search by model number or product line, and click the appropriate link in the Certification column.

FlexDMM™, National Instruments™, NI™, and ni.com™ are trademarks of National Instruments Corporation. Product and company names mentioned herein are trademarks or trade names of their respective companies. For patents covering National Instruments products, refer to the appropriate location: **Help»Patents** in your software, the `patents.txt` file on your CD, or [ni.com/patents](http://ni.com/patents).  
© 2002–2004 National Instruments Corp. All rights reserved.



371304B-01

Aug04