5½ Digit Multimeters

NI 4050, NI 4060

- 5½-digits
- 5 measurement modes
- ±300 VDC/V_{rms} maximum
- 200 MΩ maximum (2 and 4-wire)
- 60 readings/s maximum

Models

- NI PCMCIA-4050
- NI PCI-4060
- NI PXI-4060

Operating Systems

- Windows 2000/NT/XP/Me/9x

Recommended Software

- LabVIEW
- LabWindows/CVI
- Measurement Studio for Visual C++

Other Compatible Software

- Visual Basic
- C/C++

Driver Software (included)

- NI-DMM

Calibration Certificate Included

See page 21.

Overview

The NI 4050 and NI 4060 devices are full-featured digital multimeters (DMMs). They feature accurate 5½ digit DC voltage and current, True-rms AC voltage and current, and resistance measurements. The PCMCIA-4050, with its size, weight, and low-power consumption, is ideal for portable measurements and data logging with handheld and notebook computers. The NI 4060 DMMs are perfectly suited for use in automated production test, portable field test, and benchtop electronic test. Using the NI 4060 DMMs with National Instruments switching modules, such as PXI-2501, PXI-2503, SCXI-1127, SCXI-1128, or SCXI-1129, you can measure thousands of channels, consisting of voltages, thermocouples, RTDs, thermistors, and current loops, and keep a firm control on the cost of your system.

Hardware

Reading Rates

NI 4050 and NI 4060 DMMs offer multiple reading rates determined by your resolution, function, range selections, and powerline rejection. The maximum reading rate is 60 reading/s, once the initial setup time affecting the first reading is passed. Please contact your National Instruments local sales representative for more information regarding measurement performance in your specific application.

Measuring Voltages

The NI 4050 and NI 4060 DMMs have five input ranges available for measuring DC voltages: 20 mV, 200 mV, 2 V, 25 V, and 250 V. Five input ranges are available for measuring AC voltages: 20 mV_{rms}, 200 mV_{rms}, 2 V_{rms}, 25 V_{rms}, and 250 V_{rms}. The NI 4060 DMMs measure AC voltages to the specified accuracy as long as the voltage is within 10 percent of the selected input range. In AC voltage ranges, the NI 4050 and NI 4060 DMMs measure the AC-coupled True-rms value of a signal.

INFO CODES

For more information, or to order products online visit *ni.com/info* and enter:

pxi4060
pci4060
pcmcia4050

BUY ONLINE!

Measuring Resistance

The NI 4050 and NI 4060 DMMs have five basic input ranges for both 2-wire and 4-wire (NI 4060 only) resistance measurements, and an extended range for 2-wire measurements. The basic ranges are 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, and 2 MΩ. With extended range, measurements up to 200 MΩ are possible. The NI 4050 and NI 4060 DMMs use a common technique to measure resistance. The method involves sending a current through the test resistor and measuring the voltage drop across the resistor. In the extended ohms range, a 1 MΩ resistor is added in parallel with the test resistor.

Family	Bus	Accuracy	SCXI Control	Autozero	Triggering for Scanners	4-Wire Resistance Measurement
NI 4050	PCMCIA	5½ digit	–	–	–	–
NI 4060	PCI, PXI	5½ digit	✓	✓	✓	✓

Table 1. NI 4050 and NI 4060 Channel, Speed, and Resolution Specifications

Measuring Current

For the PCMCIA-4050, use the optional CSM Series current shunt accessories

5½ Digit Multimeters

to measure both AC and DC current. The CSM accessories include a precision resistor that converts the current through the shunt into a voltage measurable by the PCMCIA-4050. For measuring currents up to 200 mA or 10 A, use the CSM-200mA or the CSM-10A, respectively.

The NI 4060 DMMs have built-in current measurement capability. Two input ranges exist for DC and True-rms AC current measurements – 20 mA and 200 mA. For measuring currents between 200 mA and 10 A, use the CSM-10A accessory.

Diode Testing

The NI 4050 and NI 4060 DMMs measure the forward drop (up to 2 V) across a diode. The diode is biased with 100 µA current, and the resulting voltage drop is measured. Diode measurements are made with a fixed range of 2 V.

Calibration

The NI 4050 and NI 4060 DMMs are shipped with a calibration certificate stating that the instrument was calibrated to NIST-traceable standards to the levels detailed in the specifications. These DMMs can be returned to National Instruments or a qualified metrology lab for calibration.

Cables and Probes

The NI 4060 DMMs have built-in shrouded banana jacks to prevent exposure to potentially hazardous voltages on the test probes. The DMM kits include the P-1 Probe Set – two 1 m test leads (red and black) with test probes.

The P-2 Probe Set, sold separately, includes two 1 m test leads (red and black) with shrouded banana plugs on one end and a variety of optional terminals on the other – two alligator clips (red and black) with boots, two spring hooks (red and black), and two spade connectors (red and black).

The banana-plug-to-bare-wire kit is a pair of banana to bare wire plugs (one red, one black) that permits you to connect your DMM to screw terminals for channel expansion via matrices or scanners. To connect your NI 4060 to SCXI scanners and matrices, special cable kits are available (SCXI-1357 and SCXI-1358). Refer to page 507 for more information on switch cabling.

The probe sets meet IEC 1010 safety requirements and permit direct probing of circuits and cables.

Triggering for Switches (NI 4060 only)

The NI 4060 DMMs work with external multiplexer/matrix switches. In particular, the NI 4060 devices have been designed to integrate seamlessly with National Instruments switch offerings for SCXI and PXI. Two signals, Voltmeter Complete Trigger Output and Trigger Input, control the switches. Access to the signals is through two BNC connectors on the auxiliary trigger cable. On PXI, you can access the triggers through the PXI trigger bus.

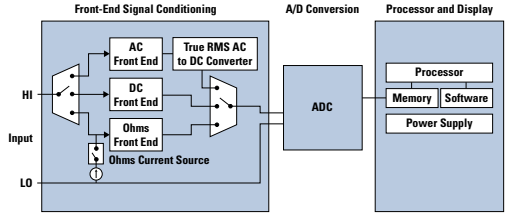

Figure 1. Fundamental DMM Architecture

Software

Driver Software

All National Instruments DMMs are shipped with NI-DMM driver software. NI-DMM is an IVI-compliant driver that exports the complete functionality of the DMMs through an easy-to-use application programming interface. You should use this driver if you want to build an automated test application or integrate the NI DMMs into your test software. NI-DMM works with LabVIEW, LabWindows/CVI, Measurement Studio for Visual C++, and Microsoft Visual Basic.

Interactive Control

Every NI DMM is shipped with the DMM Soft Front Panel (SFP). You can use the DMM SFP to quickly control the DMM without writing a program. The DMM SFP provides access to all hardware features except triggering and scanning.

Ordering Information

NI PCMCIA-4050 777186-01
Includes the PCMCIA-4050 card, P4-BJ2 Cable, P-1 Probe Set, NI-DMM, the DMM Soft Front Panel, carrying case, and calibration certificate.

NI PCI-4060 777559-01
NI PXI-4060 777554-01
Includes the NI 4060 hardware, P-1 probe set, NI-DMM, DMM Soft Front Panel, and calibration certificate.

For information on extended warranty and value added services, see page 20.

Cables and Accessories

Standard Probe, P-1 Probe Set 761000-01
Additional Probe, P-2 Probe Set 184698-01
Banana plug to bare wire, P-3 Probe Set
1 m, red and black (2 wires) 185692-01
Auxiliary trigger cable for use with external multiplexers 0.5 m 184931-0R5
10 A current shunt, CSM-10A 777488-02

Visit ni.com for a more complete list of cables and accessories.

Specifications – NI 4060

Specifications are guaranteed between 15 and 35 °C unless otherwise noted.

DC Voltage (Accuracy % of reading ± µV)

Range	24 Hour (25 °C ± 1 °C)	90 Day (25 °C ± 10 °C)	1 Year (25 °C ± 10 °C)	Temperature Coefficient (% of reading/°C + µV/°C)
250.000 V	0.0032% + 1.25 mV	0.021% + 1.25 mV	0.024% + 1.25 mV	0.0017%/°C + 480 µV/°C
25.0000 V	0.0032% + 1 mV	0.021% + 1 mV	0.024% + 1 mV	0.0017%/°C + 480 µV/°C
2.00000 V	0.0029% + 10 µV	0.014% + 10 µV	0.017% + 10 µV	0.0009%/°C + 5 µV/°C
200.000 mV	0.0029% + 6 µV	0.014% + 6 µV	0.017% + 6 µV	0.0009%/°C + 1 µV/°C
20.0000 mV	0.0029% + 6 µV	0.014% + 6 µV	0.017% + 6 µV	0.0009%/°C + 1 µV/°C

Accuracy numbers are for 5½ digits with autozero on and include the effects of full and zero-scale errors, temperature variation, linearity, and noise. Overrange capabilities to 300 V.

Noise Rejection

NMRR ..... 80 dB (10 Hz filter setting, 50/60 Hz powerline frequency ±1%)
DC ECMRR ..... 140 dB (with a 1 kΩ imbalance in HI lead)
AC ECMR (50/60 Hz) ..... 150 dB (with a 1 kΩ imbalance in HI lead)

Input Characteristics

Input bias current ..... 1 nA maximum
Input resistance ..... >1 GΩ (2 V, 200 mV, 20 mV ranges); 1 MΩ (250 V, 25 V)

DC Current (Accuracy % of reading ± µA)

Range	24 Hour (25 °C ± 1 °C)	90 Day (25 °C ± 10 °C)	1 Year (25 °C ± 10 °C)	Temperature Coefficient (% of reading/°C + µA/°C)
20.0000 mA	0.015% + 10 µA	0.039% + 10 µA	0.042% + 10 µA	0.0035%/°C + 1 µA/°C
200.000 mA	0.015% + 10 µA	0.039% + 10 µA	0.042% + 10 µA	0.0035%/°C + 1 µA/°C
10.0000 A*	0.02% + 1 mA	0.035% + 2 mA	0.035% + 2 mA	0.007%/°C + 0.1 mA/°C

*Requires 10 A shunt, CSM-10A
Accuracy numbers are for 5½ digits with autozero on and include the effects of full and zero-scale errors, temperature variation, linearity, and noise.

Input Characteristics

Input protection ..... Fuse F1 500 mA/250 V fast-fusing
Shunt resistor ..... 1 Ω
Burden voltage ..... <400 mV at 200 mA DC

AC Voltage (Accuracy % of reading ± mV)

Range	24 Hour (25 °C ± 1 °C)	90 Day (25 °C ± 10° C)	1 Year (25 °C ± 10 °C)	Temperature Coefficient (% of reading/°C + mV/°C)
250.000 V	0.6% + 250 mV	0.62% + 680 mV	0.62% + 680 mV	0.007%/°C + 20 mV/°C
25.0000 V	0.16% + 30 mV	0.18% + 210 mV	0.18% + 210 mV	0.007%/°C + 20 mV/°C
2.00000 V	0.28% + 3 mV	0.30% + 21 mV	0.30% + 21 mV	0.019%/°C + 2 mV/°C
200.000 mV	0.16% + 0.22 mV	0.18% + 1.20 mV	0.18% + 1.20 mV	0.007%/°C + 0.110 mV/°C
20.0000 mV	0.28% + 100 µV	0.30% + 170 µV	0.30% + 170 µV	0.019%/°C + 12 µV/°C

Accuracy numbers are for 5½ digits and include the effects of full and zero-scale errors, temperature variation, linearity, and noise. Applies for sine waves ≥ 10% of input range. Accuracy may be affected by source impedance, cable capacitances, dielectric absorption, or slew rate. Overrange capabilities to 300 V.

Noise Rejection

AC CMRR (50/60 Hz) ..... >80 dB (with a 1 kΩ imbalance in HI lead)

Input Characteristics

Input resistance ..... 1 MΩ
Bandwidth ..... 20 Hz - 25 kHz

Additional AC Errors

Frequency dependent errors

Input Frequency	Additional Error (% of reading)
20 Hz - 50 Hz	2.5%
50 Hz - 100 Hz	0%
100 Hz - 20 kHz	1%
20 Hz - 25 kHz	2.5%

AC Current (Accuracy % of reading ± mA)

Range	24 Hour (25 °C ± 1 °C)	90 Day (25 °C ± 10 °C)	1 Year (25 °C ± 10 °C)	Temperature Coefficient (% of reading/°C ± mA/°C)
20.0000 mA	0.30% + 100 µA	0.32% + 170 µA	0.32% + 170 µA	0.022%/°C + 12 µA/°C
200.000 mA	0.18% + 0.22 mA	0.20% + 1.2 mA	0.20% + 1.2 mA	0.009%/°C + 0.110 mA/°C
10.0000 A*	0.3% + 22 mA	0.32% + 120 mA	0.32% + 120 mA	0.026%/°C + 11 mA/°C

*Requires 10 A shunt, CSM-10A
Accuracy numbers are for 5½ digits and include the effects of full and zero-scale errors, temperature variation, linearity, and noise.

Input Characteristics

Input protection ..... Fuse F1 500 mA/250 V fast-fusing
Shunt resistor ..... 1 Ω
Burden voltage ..... < 400 mV at 200 mA AC

Resistance (Accuracy % of reading ± Ω)

Range	24 Hour (25 °C ± 1 °C)	90 Day (25 °C ± 10 °C)	1 Year (25 °C ± 10 °C)	Temperature Coefficient (% of reading/°C + Ω/°C)
Extended ohm				
(> 2 MΩ)	0.1% + 6 kΩ	0.1% + 60 kΩ	0.1% + 60 kΩ	0.0072%/°C + 6 kΩ/°C
2.00000 MΩ*	0.012% + 9 Ω	0.077% + 27 Ω	0.080% + 27 Ω	0.0072%/°C + 2 Ω/°C
200.000 kΩ	0.012% + 5 Ω	0.077% + 22 Ω	0.080% + 22 Ω	0.0072%/°C + 2 Ω/°C
20.0000 kΩ	0.006% + 0.09 Ω	0.024% + 0.3 Ω	0.027% + 0.3 Ω	0.0020%/°C + 0.02 Ω/°C
2.00000 kΩ	0.006% + 0.05 Ω	0.024% + 0.2 Ω	0.027% + 0.2 Ω	0.0020%/°C + 0.02 Ω/°C
200.000 Ω	0.006% + 0.05 Ω	0.024% + 0.2 Ω	0.027% + 0.2 Ω	0.0020%/°C + 0.02 Ω/°C

*With autozero on, or while scanning, and when large resistance with capacitive loads is measured, additional delay time is required.
Accuracy numbers are for 4-wire resistance mode, 5½ digits with autozero on and include the effects of full and zero-scale errors, temperature variation, linearity, and noise.
Measurement modes
Ohms ..... 2 or 4-wire
Extended ohms ..... 2-wire only
Maximum lead resistance ..... 10 Ω (200 Ω range), 1 kΩ (all other ranges)
Additional error for 2-wire resistance ..... 0.6 Ω

Diode Testing (Accuracy % of reading ± µV)

Range	24 Hour (25 °C ± 1 °C)	90 Day (25 °C ± 10 °C)	1 Year (25 °C ± 10 °C)	Temperature Coefficient (% of reading/°C + µV/°C)
2 V	0.006% + 7 µV	0.024% + 22 µV	0.027% + 22 µV	0.0020%/°C + 2 µV/°C

Accuracy numbers are for 5½ digits with autozero on and include the effects of full and zero-scale errors, temperature variation, linearity, and noise.
Test current ..... 100 µA

General Specifications

Settling time ..... Affected by source impedance and input signal changes.
Warm-up time ..... 30 minutes for measurements accurate within specifications.
Altitude ..... Up to 2,000 m; at higher altitudes the installation category must be derated.
Working voltage ..... 300 V maximum between either input terminal and earth ground

Power Requirement

+5 VDC ..... 250 mA in operational mode

Physical

Dimensions
PCI ..... 10.8 by 17.5 cm (4.25 by 6.9 in.)
PXI ..... 10 by 16 cm (3.9 by 6.33 in.)

Environment

Operating temperature ..... 0 to 55 °C
Storage temperature ..... -20 to 70 °C
Relative humidity ..... 10 to 90%, noncondensing

Certifications and Compliances

CE Mark Compliance CE

5½ Digit Multimeters

Specifications – PCMCIA-4050

DC Voltage (Accuracy = % of reading ± µV)

Range	24 Hour (25 °C ± 1 °C)	90 Day (25 °C ± 10 °C)	1 Year (25 °C ± 10 °C)	Temperature Coefficient (% of reading/°C + µV/°C)
250.000 V	0.0032% + 4.9 mV	0.021% + 49 mV	0.024% + 49 mV	0.0017%/°C + 4800 µV/°C
25.0000 V	0.0032% + 4.9 mV	0.021% + 49 mV	0.024% + 49 mV	0.0017%/°C + 4800 µV/°C
2.00000 V	0.0029% + 37 µV	0.014% + 260 µV	0.017% + 260 µV	0.0009%/°C + 25 µV/°C
200.000 mV	0.0029% + 27 µV	0.014% + 250 µV	0.017% + 250 µV	0.0009%/°C + 25 µV/°C
20.0000 mV	0.0029% + 27 µV	0.014% + 250 µV	0.017% + 250 µV	0.0009%/°C + 25 µV/°C

Accuracy numbers are for 5½ digits and include the effects of full and zero-scale errors, temperature variation, linearity, and noise.

Noise Rejection

NMRR ..... 80 dB (10 Hz reading rate, 50/60 Hz powerline frequency ±1%)
DC ECMRR ..... 140 dB (with a 1 kΩ imbalance in LO lead)
AC ECMR (50/60 Hz) ..... 150 dB (with a 1 kΩ imbalance in LO lead)

Input Characteristics

Input bias current ..... 1 nA maximum
Input resistance ..... >1 GΩ (2 V, 200 mV, 20 mV ranges); 1 MΩ (250 V, 25 V)

DC Current (Accuracy = % of reading ± µA)

Range	24 Hour (25 °C ± 1 °C)	90 Day (25 °C ± 10 °C)	1 Year (25 °C ± 10 °C)	Temperature Coefficient (% of reading/°C ± µA/°C)
20.0000 mA	0.1% + 27 µA	0.14% + 250 µA	0.15% + 250 µA	0.0035%/°C + 25 µA/°C
200.000 mA	0.1% + 27 µA	0.14% + 250 µA	0.15% + 250 µA	0.0035%/°C + 25 µA/°C
10.0000 A*	0.02% + 4 mA	0.035% + 26 mA	0.035% + 26 mA	0.007%/°C + 2.5 mA/°C

*Requires 10 A shunt, CSM-10A.
Accuracy numbers are for 5½ digits and include the effects of full and zero scale errors, temperature variation, linearity, and noise.

Input Characteristics

200 mA Shunt
- Input protection ..... Fuse F1 500 mA/250 V fast-fusing
- Shunt resistor ..... 1 Ω
- Burden voltage ..... <400 mV at 200 mA

10 A Shunt
- Input protection ..... Fuse F1 12.5 A/250 V fast-fusing
- Shunt resistor ..... 10 mΩ
- Burden voltage ..... <300 mV at 10 A

Range	24 Hour (25 °C ± 1 °C)	90 Day (25 °C ± 10 °C)	1 Year (25 °C ± 10 °C)	Temperature Coefficient (% of reading/°C ± mV/°C)
250.000 V	0.6% + 500 mV	0.62% + 680 mV	0.62% + 680 mV	0.007%/°C + 20 mV/°C
25.0000 V	0.3% + 30 mV	0.32% + 210 mV	0.32% + 210 mV	0.007%/°C + 20 mV/°C
2.00000 V	0.4% + 3 mV	0.42% + 21 mV	0.42% + 21 mV	0.019%/°C + 2 mV/°C
200.000 mV	0.3% + 0.22 mV	0.32% + 1.2 mV	0.32% + 1.2 mV	0.007%/°C + 0.110 mV/°C
20.0000 mV	0.4% + 100 µV	∫0.42% + 170 µV	0.42% + 170 µV	0.019%/°C + 12 µV/°C

AC Voltage (Accuracy = % of reading ± mV)

Accuracy numbers are for 5½ digits and include the effects of full and zero-scale errors, temperature variation, linearity, and noise.

Noise Rejection

AC CMRR (DC to 60 Hz) ..... >80 dB (with a 1 kΩ imbalance in LO lead)

Input Characteristics

Input resistance ..... 1 MΩ all ranges
Bandwidth ..... 20 Hz - 25 kHz

Additional AC Errors

Input Frequency	Additional Error (% of reading)
20 Hz - 50 Hz	2.5%
50 Hz - 100 Hz	1.0%
100 Hz - 5 kHz	0.0%
5 Hz - 10 kHz	1.0%
10 Hz - 25 kHz	2.5%

Frequency dependent errors

AC Current (Accuracy = % of reading ± mA)

Range	24 Hour (25 °C ± 1 °C)	90 Day (25 °C ± 10 °C)	1 Year (25 °C ± 10 °C)	Temperature Coefficient (% of reading/°C + mA/°C)
20.0000 mA	0.35% + 110 µA	0.37% + 170 µA	0.37% + 170 µA	0.019% /°C + 0.120 mA/°C
200.000 mA	0.45% + 0.22 mA	0.47% + 1.2 mA	0.47% + 1.2 mA	0.007%/°C + 12 µA/°C
10.0000 A*	0.3% + 22 mA	0.32% + 120 mA	0.32% + 120 mA	0.026%/°C + 11 mA/°C

*Requires 10 A shunt, CSM-10A.
Accuracy numbers are for 5½ digits and include the effects of full and zero scale errors, temperature variation, linearity, and noise.

Input Characteristics

200 mA Shunt
- Input protection ..... Fuse F1 500 mA/250 V fast-fusing
- Shunt resistor ..... 1 Ω
- Burden voltage ..... <400 mV at 200 mA

10 A Shunt
- Input protection ..... Fuse F1 12.5 A/250 V fast-fusing
- Shunt resistor ..... 10 mΩ
- Burden voltage ..... <300 mV at 10 A

Resistance (Accuracy = % of reading ± Ω)

Range	24 Hour (25 °C ± 1 °C)	90 Day (25 °C ± 10 °C)	1 Year (25 °C ± 10 °C)	Temperature Coefficient (% of reading/°C ± Ω/°C)
Extended ohm (> 2 MΩ)	0.1% + 6 kΩ	0.1% + 60 kΩ	0.1% + 60 kΩ	0.0072%/°C + 6 kΩ/°C
2.00000 MΩ	0.012% + 55 Ω	0.077% + 370 Ω	0.080% + 20 Ω	0.0072%/°C + 35 Ω/°C
200.000 kΩ	0.012% + 37 Ω	0.077% + 350 Ω	0.080% + 2 Ω	0.0072%/°C + 35 Ω/°C
20.0000 kΩ	0.006% + 0.5 Ω	0.024% + 4 Ω	0.027% + 4 Ω	0.0020%/°C + 0.40 Ω/°C
2.00000 kΩ	0.006% + 0.4 Ω	0.024% + 4 Ω	0.027% + 4 Ω	0.0020%/°C + 0.40 Ω/°C
200.000 Ω	0.006% + 0.4 Ω	0.024% + 4 Ω	0.027% + 4 Ω	0.0020%/°C + 0.40 Ω/°C

Accuracy numbers are for 5½ digits and include the effects of full and zero-scale errors, temperature variation, linearity and noise.
Measurement modes 2-wire

Diode Testing (Accuracy = % of reading ± µV)

Range	24 Hour (25 °C ± 1 °C)	90 Day (25 °C ± 10 °C)	1 Year (25 °C ± 10 °C)	Temperature Coefficient (% of reading/°C ± µV/°C)
2 V	0.006% + 60 µV	0.024% + 400 µV	0.027% + 400 µV	0.002%/°C + 40 µV/°C

Accuracy numbers are for 5½ digits and include the effects of full and zero-scale errors, temperature variation, linearity, and noise.
Test current ..... 100 µA

General Specifications

Settling time ..... Affected by source impedance and input signal changes
Warm-up time ..... 30 minutes for measurements accurate within specifications
Altitude ..... Up to 2,000 m; at higher altitudes the installation category must be derated
Working voltage ..... 250 V maximum between either input terminal and earth ground

Power Requirement

+5 VDC ..... 45 mA in operational mode

Environment

Operating temperature ..... 0 to 55 °C
Storage temperature ..... -20 to 70 °C
Relative humidity ..... 10 to 90%, noncondensing

Certifications and Compliances

CE Mark Compliance CE

The product meets applicable EU directives for CE Mark compliance as follows: Safety compliance IEC 1010-1 Certified, Designed for UL 3111, Low-Voltage Directive EN 61010-1, Installation Category II, Pollution Degree 2, Double Insulated, Indoor use.