MODEL 9000-16-SM FEATURES

- **12 Strain gage channels**, sensors supported:
  - Strain gage (quarter-, half-, and full-bridges)
  - Strain-gage-based transducer
- **4 Plug-in card slots**, available to support:
  - High-level voltage signal
  - Thermocouples
  - Piezoelectric transducers (charge mode and voltage mode)
- **Sampling rates**: 50,000, 25,000, 10,000 and 5,000 samples/second. Analog-to-digital converters (ADCs) oversample data at 128 times the selected sample rate, and Finite Impulse Response (FIR) filters provide filtering. All ADCs are sampled simultaneously.
- **Expansion to a 48-channel system**: Up to three 9000s can be combined to provide 48 channels of fully synchronized data acquisition (36 strain gage plus 12 configurable).
- **On-board Data Recording**: Supports manual-, time-, and limits-based recording. Pre- and post-trigger data are available for limits-based recording and manually-triggered recording.
- **Self-Calibrating (Optional)**: An NIST-traceable MM Part No. A123 voltage calibration card is available as an accessory. This calibration card provides a high-accuracy voltage source that may be used to calibrate the gain and offset of each channel. MM Part No. A123 is removable and interchangeable and it only needs to be present in the Model 9000 during the self-calibration process.
- **Optional analog outputs (Model 9000-16-SM-AO)**: Provide an analog output for each of the twelve strain gage channels. Bandwidth DC to 19.8 kHz.

DESCRIPTION

System 9000 from Micro-Measurements is a versatile, precision data acquisition instrument system intended for dynamic test and measurement applications.

The system includes a scanner with 12 channels of strain-gage-based input and 4 optional input slots (thermocouple, high level and piezoelectric). The scanners may be used separately or up to 3 scanners can be used concurrently for a maximum of 48 fully synchronized channels.

Strain gage channels accept full-, half-, or quarter-bridge configurations and have the required bridge completion components for 120-, 350-, and 1000-ohm bridges. The data is processed in a modern 24-bit digital signal processor and filtering is performed using Finite Impulse Response (FIR), multi-stage filters. This provides excellent noise rejection and stability, and unsurpassed measurement accuracy.

The Model 9000-16-SM Scanner communicates with a host personal computer (PC) via a DHCP auto configured Ethernet connection (required router not included).

SUPPORTED SENSORS

- Strain gage (quarter-, half-, and full-bridges)
- Strain-gage-based transducer
- High-level voltage signal
- Thermocouples
- Piezoelectric (voltage and charge mode)

INPUT CONNECTIONS

Strain gage and high level inputs use eight RJ45 plugs. Shielded wires and shielded connectors are recommended. The thermocouple card accepts both 2- and 3-pin miniature plugs. The piezoelectric card connects through a BNC connector.

ETHERNET ARCHITECTURE

The Model 9000 communicates over an IEEE-802.3u 100Base-TX Network. Use of the Dynamic Host Configuration Protocol (DHCP) automates the IP address configuration.

DC OPERATION

The Model 9000 operates on 11-32 VDC power. Power can be sourced from the included power supply, a separate AC-to-DC converter, or a DC supply such as a battery.

DIGITAL I/O

A digital input and output are provided to interface with external hardware.

MOUNTING

The Model 9000 can be configured as a stand-alone desktop unit, stacked, or rack-mounted. A rack-mount kit is available from Micro-Measurements (9000-RM).
System 9000

StrainSmart® Data Acquisition System

SPECIFICATIONS

General
Environmental:
  Temperature: 0° to +50°C
  Humidity: Up to 90%, non-condensing
Enclosure:
  Material: A356-T6 aluminum casting
  Dimensions: 3.50 H (3.88 with feet) x 17.19 W x 11.50 D (12.97 including optional 9000-SM-VC card and input cards) inches (88.9 x 436.7 x 292.1 mm)
Configurations:
  Bench-top, stackable, rack-mountable
Weight:
  13.05 lbs (5.92 kg), without auxiliary plug in cards

Power
  Input: 11–32 VDC, 10 A max
  Fuse: 10 A Fast-acting blade terminal. (Littlefuse MINI® Blade fuse P/N 0297010 or equivalent)

Communication
  Ethernet interface: 100 Mbit
  Network protocol: DHCP

Data Recording
  Storage type: Internal SATA solid state drive
  Capacity: ≥16 GB, max file size is 2 GB

Synchronization
  Channel count: ≤48 channels (3 devices)
  Configuration: “Star” topology, max cable length ≤7 ft (~2 m)

ANALOG CHANNELS

Channels
  12 Differential inputs
  4 Configurable input slots

A/D Converter
  Architecture: Delta-Sigma (ΔΣ)
  Resolution: 24 bits
  Oversampling rate: 128 times the selected data rate
  Sampling mode: Simultaneous

Data Rates
  50,000, 25,000, 10,000 and 5,000 samples/second/channel

Analog Anti-Alias Filter
  Type: Low-pass
  Frequency: 20 kHz @ –3 dB
  Number of poles: One
  Topology: Lowpass RC

Digital Filters
  Type: Finite Impulse response (FIR), two selectable filters provided per sampling rate

<table>
<thead>
<tr>
<th>Table 1. Default Digital Filter Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f_{user}$ (Hz)</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>50,000</td>
</tr>
<tr>
<td>25,000</td>
</tr>
<tr>
<td>10,000</td>
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<tr>
<td>5,000</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2. Alternate Digital Filter Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f_{user}$ (Hz)</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>50,000</td>
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<tr>
<td>25,000</td>
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<tr>
<td>10,000</td>
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<tr>
<td>5,000</td>
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</tbody>
</table>

STRAIN GAGE INPUTS

Channels
  Quantity: 12

Inputs
  Software-selectable for S+/S–, Vcal+/Vcal–, or excitation

Strain gage:
  120 Ω, 350 Ω, 1000 Ω quarter-bridges;
  60 Ω to 5000 Ω half- and full-bridges

Input impedance:
  220 MΩ nominal each input

Source current:
  ±5 nA per volt excitation

Measurement Range and Resolution
  Range: Depends upon excitation setting (see Table 3)
  Resolution: 0.5 με @ GF=2 (0.25 μV/V)

<table>
<thead>
<tr>
<th>Table 3. Strain Gage Measurement Range and Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excitation Volts</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>0.25</td>
</tr>
<tr>
<td>0.5</td>
</tr>
<tr>
<td>0.75</td>
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<tr>
<td>1</td>
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<tr>
<td>2</td>
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<tr>
<td>3</td>
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<td>4</td>
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<td>5</td>
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<td>6</td>
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<td>7</td>
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<tr>
<td>8</td>
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<tr>
<td>9</td>
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<tr>
<td>10</td>
</tr>
</tbody>
</table>

* NOTE: Range calculations at zero volts excitation are based upon 1 volt excitation, and are typically used for the quantification of self-generating noise.
System 9000

StrainSmart® Data Acquisition System

Input Connector
8-pin shielded TIA/EIA RJ45 (MM Part No. A114)

Amplifier
Zero temperature stability:
±1 μV/°C RTI, after 60-minute warm-up
DC Gain accuracy and stability:
±0.05%; ±50 ppm/°C (1 year without periodic VCAL)
Analog input (including full-scale balance):
  Low range: ±38 mV
  High range: ±155 mV
Linearity: ±0.02% of full scale
Common-mode rejection: >90 dB (DC to 60 Hz)
Common-mode voltage range: ±12 V typical

Balance
Type: Software (mathematical)
Range:
Full ADC range (actual balance level shifts dynamic measurement range 1:1)

Excitation
Selection: Software controlled
Unipolar: 0 to +10 VDC
Resolution: 3 mV
Accuracy: ±10 mV typical
(Firmware measures excitation variations during arming process)
Current: 50 mA max per channel
Over-current limited
Over-current indication
Load regulation: <0.05% of full scale for 10% to 100% of full scale loads with remote sense
Temperature stability: ±10 ppm/°C

Quarter-Bridge Completion
Selection: Firmware controlled
Accuracy and drift:
  120 Ω and 350 Ω: ±0.01%, 5 ppm/°C max
  1 kΩ: ±0.01%, 4.5 ppm/°C max (socketed)

Shunt Calibration
Selection: Firmware controlled
Configuration:
Internal QB: P– to D120, P– to D350, P– to D1000
External: Switched shunt at input connector (Ra, Rb)
Standard factory installed resistor values:
Simulates 10000 με @ GF = 2.0
  5940 Ω ±0.1%: Shunts P– to D120
  17325 Ω ±0.1%: Shunts P– to D350
  49500 Ω ±0.1%: Shunts P– to D1000
  17325 Ω ±0.1%: External shunt Ra to Rb
Resistor sockets: Tin-plated

9000-TC THERMOCOUPLE INPUT CARD
(OPTIONAL)

Channels:
Quantity: 1 per card; 4 cards max

Inputs
Supported thermocouple types:
J, K, T, E, N, R, S, B
Cold-junction compensation, software-selectable
Open-sensor detection
Input impedance: 22 MΩ nominal each input

Input Connectors
Mini-TC with optional earth connection

Amplifier
Zero temperature stability:
±2 μV/°C RTI, ±10 μV/°C RTO, after 60-minute warm-up
DC Gain accuracy and stability:
±0.1%; ±30 ppm/°C
Zero accuracy and linearity: ±0.02% of full scale
Common mode rejection (DC to 60 Hz): >90 dB
Common mode voltage range: ±12 V typical

Measurement Range and Resolution
Range: ±77.5 mV
Resolution: 1°C min

Measurement Accuracy
±2°C (nominal)

9000-HL HIGH-LEVEL INPUT CARD
(OPTIONAL)

Channels
Quantity: 1 per card; 4 cards max

Inputs
Differential
Input impedance: 220 MΩ nominal each input
Input bias current: ±0.5 nA typical (±2 nA max)

Input Connector
8-pin shielded TIA/EIA RJ45 (MM Part No. A114)

Amplifier
Zero temperature stability:
±2 μV/°C RTI, typical, ±10 μV/°C RTO, after 60-minute warm-up
DC Gain accuracy and stability:
±0.1%; ±30 ppm/°C
Zero accuracy and linearity: ±0.02% of full scale
Common mode rejection (DC to 60 Hz): >90 dB
Common mode voltage range: ±12 V typical
System 9000

StrainSmart® Data Acquisition System

Measurement Ranges and Resolution

Range: ±10 V
Resolution: 100 μV effective

Excitation
Selection: Software controlled

Unipolar mode:
Range: 0 to +11.997 VDC
Accuracy: ±10 mV typical
Current: 50 mA max
Over-current/over-temperature protected

Load regulation:
<0.05% of full scale (unipolar mode) for a load variation of 10% to 100% of full scale loads (with remote sense)
Temperature stability: Better than ±30 ppm/°C

Bipolar mode:
Range: ±12 VDC (24 VDC total)
Accuracy: ±5% of full scale

9000-PZ PIEZOELECTRIC INPUT CARD
(OPTIONAL)

Channels
Quantity: 1 per card; 4 cards max

Inputs
VM or CM piezoelectric type transducers (switch-selectable)
Coupling:
CM type: Charge amplifier with software-selectable time constants of 0.5 and 5 seconds.
VM type: AC coupling to remove DC bias voltage with high-pass response of 0.1 Hz (–3 dB).

Input Connector
Female BNC

Amplifier
Gain Accuracy @1KHz: ±0.5%
Secondary stage DC gain accuracy and stability: ±0.1% at +23°C; ±25 ppm/°C

Measurement Ranges and Resolution
VM Type transducers range:
0.5 to 29.5 VDC input with measurement ranges of ±14.5 V, ±9.5 V, ±4.7 V, and ±2.3 V
Resolution: 1μV
Charge type transducers range:
±225,000 pC, ±66,000 pC, ±14, 000 pC, ±3,500 pC, and ±875 pC
Resolution: 0.1 pC

Excitation
Selection: Software controlled
Range: 0, 1, 2, 4, 5, 10 and 20 mA selections for VM type transducers
Accuracy: ±3% + (±30 μA) typical at 1 to 20 mA
Voltage compliance: 0 to 28 V
Temperature stability: ±100 ppm/°C

A123 VOLTAGE CALIBRATION CARD
(OPTIONAL)

Accuracy
±100 ppm repeatability, typical;
±250 ppm repeatability, max

Drift
1.9 ppm/°C ±0.6 μV/°C typical;
9.4 ppm/°C ±2.1 μV/°C max

Resolution
150 μV nominal

Instrument Calibration
Firmware controlled

Calibration voltage:
Supplied by the accessory item MM Part No. A123 voltage calibration card (interchangeable with System 8000)

Type: Multi-point, ≥100 samples per point

DIGITAL INPUT/OUTPUT

Quantity
1 input and 1 output

Configuration
5 V TTL
Isolated

ANALOG OUTPUTS
(MODEL 9000-16-SM-AO)

Channels
Quantity: 12 (one per strain gage input channel)

Output
Connectors: Female BNC Jack (50 Ω)
Range: ±10 V (min)
Load: 2000 Ω min
Bandwidth: DC to 19.8 KHz (~3 dB ±0.25 dB)
Gain accuracy: ±1%
Gain: Not selectable, depends upon excitation setting (see Table 4)

Table 4. Analog Output Gain

<table>
<thead>
<tr>
<th>Excitation Selection (Volts)</th>
<th>Gain (Volts/Volt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–3</td>
<td>257.05</td>
</tr>
<tr>
<td>4–10</td>
<td>64.262</td>
</tr>
</tbody>
</table>

NOTE: Software gage factor settings or balance settings have no effect on Analog Output response.
### System 9000 Optional Accessories

<table>
<thead>
<tr>
<th>MM Part Number</th>
<th>Item Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COMMUNICATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MMA128</td>
<td>Ethernet router (with cable)</td>
<td>Required for communication between your PC and the 9000&lt;sup&gt;(1)&lt;/sup&gt;</td>
</tr>
<tr>
<td>MMA129</td>
<td>7”, Cat6, shielded, straight-through Ethernet cable</td>
<td>Used for Ethernet communication or synchronization cabling</td>
</tr>
<tr>
<td>MMA90</td>
<td>10”, Cat5e, unshielded, straight-through Ethernet cable</td>
<td>Used for Ethernet communication&lt;sup&gt;(1)&lt;/sup&gt; (should not be used for synchronization cabling)</td>
</tr>
<tr>
<td><strong>OPTIONS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MMA138</td>
<td>9000-HL High Level Input Card</td>
<td>High-level voltage signals ±10 VDC</td>
</tr>
<tr>
<td>MMA139</td>
<td>9000-TC Thermocouple Input Card</td>
<td>Supported J, K, T, E, N, R, S, B types</td>
</tr>
<tr>
<td>MMA140</td>
<td>9000-PZ Piezoelectric Input Card</td>
<td>Charge and voltage mode capable</td>
</tr>
<tr>
<td>MMA123</td>
<td>Calibration (VCAL) card</td>
<td>Required for on-site calibration</td>
</tr>
<tr>
<td>MMA124</td>
<td>Rack-mount kit</td>
<td>Brackets for mounting into an instrumentation rack</td>
</tr>
<tr>
<td><strong>SYNCHRONIZATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MMA129</td>
<td>7”, Cat6, shielded, straight-through Ethernet cable</td>
<td>Used for synchronization cabling between multiple instruments. May also be used for Ethernet communication.</td>
</tr>
<tr>
<td>MMA131</td>
<td>2”, Cat6, shielded, straight-through Ethernet cable</td>
<td>Used for synchronization cabling between multiple instruments. May also be used for Ethernet communication.</td>
</tr>
<tr>
<td><strong>INPUT CONNECTION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MMA114</td>
<td>RJ45(8) modular plug, shielded</td>
<td>Recommended connector for strain gage and high level inputs. May be used for digital I/O.</td>
</tr>
<tr>
<td>MMA106</td>
<td>RJ45(8) modular plug, unshielded</td>
<td>Connector for digital input/output</td>
</tr>
<tr>
<td>MMA115</td>
<td>RJ45(8), shielded modular plug crimping tool</td>
<td>Tool used to crimp wires to connector MMA114</td>
</tr>
<tr>
<td>MMA108</td>
<td>RJ45(8), unshielded modular plug crimping tool</td>
<td>Tool used to crimp wires to connector MMA106</td>
</tr>
<tr>
<td>MMA134</td>
<td>2-Pin miniature plug for type J thermocouple</td>
<td>No shield present</td>
</tr>
<tr>
<td>MMA135</td>
<td>3-Pin miniature plug for type J thermocouple</td>
<td>Shield present</td>
</tr>
<tr>
<td>MMA136</td>
<td>2-Pin miniature plug for type K thermocouple</td>
<td>No shield present</td>
</tr>
<tr>
<td>MMA137</td>
<td>3-Pin miniature plug for type K thermocouple</td>
<td>Shield present</td>
</tr>
<tr>
<td>MMA141</td>
<td>Wire clamp for miniature thermocouple plug</td>
<td></td>
</tr>
<tr>
<td><strong>REPLACEMENT PARTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MMA123</td>
<td>Fuse, mini blade 32 V 10 A</td>
<td>Replacement item</td>
</tr>
<tr>
<td>MMA132</td>
<td>Power supply assembly</td>
<td>Replacement item</td>
</tr>
</tbody>
</table>

Note 1: The 9000 requires a DHCP-enabled router for communication with a PC. Part number MMA128 provides a router and a single cable which may be connected to your PC. Each 9000 instrument will require an additional Ethernet cable (MMA90, MMA129, or MMA131).
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