StrainSmart® Data Acquisition System

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) over-sample 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).

Micro-Measurements StrainSmart® software is optimal for configuring, controlling, and acquiring data from the System 9000.

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).**

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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 1. Default Digital Filter Specifications

f_{user} (Hz)	f_{pass} (Hz)	Passband Peak-Peak Ripple (dB)	Stopband Attenuation (dB)
50,000	12500	0.01	–80
25,000	6250	0.01	–80
10,000	2500	0.01	–80
5,000	1250	0.01	–80

Table 2. Alternate Digital Filter Specifications

f_{user} (Hz)	f_{pass} (Hz)	Passband Peak-Peak Ripple (dB)	Stopband Attenuation (dB)
50,000	6250	0.01	–80
25,000	3125	0.01	–80
10,000	1250	0.01	–80
5,000	625	0.01	–80

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 3.
Strain Gage Measurement Range and Resolution

Excitation Volts	Typical Measuring Range includes Imbalance	
	±με @ GF=2	±mV/V
0	77500*	19*
0.25	310000	155
0.5	155000	77
0.75	103000	51
1	77000	38
2	38000	19
3	25000	12
4	77000	38
5	62000	31
6	51000	25
7	44000	22
8	38000	19
9	34000	17
10	31000	15

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

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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 D_{120}, P– to D_{350}, P– to D_{1000}

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 D_{120}

17325 Ω ±0.1%: Shunts P– to D_{350}

49500 Ω ±0.1%: Shunts P– to D_{1000}

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

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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: 1uV

Charge type transducers range:
±225,000 pC, ±56,000 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

Voltage Range

±5 V

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

Excitation Selection (Volts)	Gain (Volts/Volt)
0–3	257.05
4–10	64.262

NOTE: Software gage factor settings or balance settings have no effect on Analog Output response.

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