StrainSmart® Data Acquisition System

FEATURES
- Stable, accurate, low-noise signal conditioning
- Measurement accuracy ±0.05%
- Measurement resolution 0.5 microstrain
- Individual input cards for strain gage and strain-gage based transducers, thermocouples, sensors with high-level voltage outputs, and LVDTs
- Electronically selectable, built-in bridge completion for 120-, 350-, and 1000-ohm strain gages
- Virtually unlimited number of channels in increments of 8 channels (contact Applications Engineering for details)
- Maximum scan rate of 2048 samples per second
- Self calibration traceable to NIST standard
- Simultaneous sampling with anti-aliasing filter and analog-to-digital conversion for each channel
- Selectable digital filtering of measurement signals
- High-speed Ethernet network interface
- Remote Utility includes capability for acquiring data without connection to a computer (field upgradable)

DESCRIPTION
Micro-Measurements System 7000 builds upon the years of experience gained since the introduction of Systems 4000, 5000, and 6000 by continuing to provide a complete hardware/software approach to data acquisition, reduction, and presentation for strain gages and related sensors for stress analysis testing.

System 7000 hardware is designed to incorporate all the features required for precision strain measurement in a high channel density enclosure. Strain gages, strain-gage-based transducers, thermocouples, LVDTs, and other sensors with high level voltage outputs can be intermixed in groups of eight (8) by choosing the appropriate sensor card for up to 128 channels in a 4U height, 19-inch rack-mountable scanner (7000-128-SM). A 32-channel scanner is also available (7000-32-SM). The Ethernet interface allows flexible positioning of scanners, and multiple scanners can easily be synchronized using a single sync cable (maximum length 100 meters). A system can be configured with virtually an unlimited number of sensors; please contact our Applications Engineering Department for configuration details.

System 7000 is a high performance data acquisition instrument with measurement accuracy of ±0.05% of full scale. Each sensor card employs a 24-bit analog-to-digital converter enabling 0.5 microstrain resolution. Scan rates up to 2048 samples per second are available for simultaneous reading of all sensor inputs. A combination of analog and flexible Finite Impulse Response (FIR) filters are available to provide adequate anti-alias filtering at all scanning rates. Each sensor card has high-capacity nonvolatile data storage capability. Electronically selectable bridge completion resistors allow the user to choose between 120-, 350-, and 1000-ohm strain gages through software selection.

Several design features are provided to reduce total cost of ownership. System 7000 is capable of self-calibration with a removable calibration reference (7000-SM-VC). Calibration can be performed anywhere and there is no need to return the entire system to the factory for calibration. Down-time while waiting for calibration is essentially eliminated. Input connectors are RJ-45 type and assembly time is fast using simple cable crimping tools. Sensor input cards all use common Analog Input Cards (Model 7003-8-A-I), which thereby allow users to interchange sensor input cards with analog input cards. Individual scanners can be separated and located near sensors to reduce sensor cabling costs.

A feature for acquiring data without a connection to a computer has been added. This Remote Utility Feature is field upgradable on units purchased prior to the introduction of this feature. With this feature, data can be collected then exported to other applications for analysis.
SCANNER SPECIFICATIONS
(128 CHANNEL VERSION)

The purpose of the Model 7000-128-SM Scanner is to house and retain the acquisition cards, regulate power to the cards, establish and maintain communication between the Ethernet interface and the input cards, synchronize the analog-to-digital converters in the system, and provide visual status information to the operator.

CAPACITY
Up to 16 Input Cards. 128 channels maximum

CONFIGURATIONS
Rack-mount (19-inch) or bench-top

LCD DISPLAY
64 x 128 white LED-backlit display

LED PANEL
128 individual red/green LEDs; one per channel

KEYPAD
Membrane. 20-key; 12-key numeric keypad, 5 key navigation keypad, and 3 soft-keys

INPUT POWER
11–32 VDC, 30A max

POWER INDICATION
Green LED (illuminated when power is on)

ETHERNET INTERFACE
IEEE 802.3, 802.3u 10Base-T, 100Base-TX, half- and full-duplex, auto-detect

COMPACT FLASH® CAPACITY
1 GB supplied (removable)

PROCESSOR
250 MHz floating point digital signal processor

MEMORY
64 MB SDRAM

INTERNAL COMMUNICATION
Asynchronous command bus, synchronous data bus

SYSTEM SYNCHRONIZATION
Connections: Sync In, Sync Out
Topology: Daisy-chain
Cable Connection: TIA/EIA RJ-45, Category 5
Max. Distance: 100m

SYSTEM CALIBRATION REFERENCE
Firmware-controlled
Drift: 1.9 ppm/°C ±0.6 μV/°C typical, 9.4 ppm/°C ±2.1 μV/°C maximum
Resolution: 150 μV nominal
Voltage Range: ±5V

DIMENSIONS
7.5 H x 17.5 W x 13.5 D in (190 x 445 x 343 mm)

WEIGHT
20 lb (9.1 kg)

SCANNER SPECIFICATIONS
(32-CHANNEL VERSION)

The purpose of the Model 7000-32-SM Scanner is to house and retain the acquisition cards, regulate power to the cards, establish and maintain communication between the Ethernet interface and the input cards, synchronize the analog-to-digital converters in the system, and provide visual status information to the operator.

CAPACITY
Up to 4 Input Cards. 32 channels maximum

CONFIGURATIONS
Bench-top
StrainSmart®

Acquisition System

STRAIN GAGE INPUT CARDS

A choice of two Strain Gage Input Cards (7003-8-SG or 7003-8-SG-A) are used in conjunction with the Model 7003-8-A-I Analog Input Card to perform bridge excitation, bridge completion, shunt calibration, and signal conditioning for eight quarter, half, and full bridges. Note that the 7003-8-SG-A Strain Gage Input Card with Analog Output has an analog output which provides an amplified representation of the input source.

CHANNELS
Eight per card

INPUTS
Software selectable for S+/S-, VCAL+/VCAL-, or excitation
Strain Gage: 120Ω, 350Ω, 1000Ω quarter-bridges; 60Ω to 5000Ω half- and full-bridges
Input Impedance: 220 MΩ nominal each input
Source Current: ±5 nA per volt excitation

ANALOG OUTPUT (MODEL 7003-8-SG-A ONLY)
Fixed Gain: 50.3 V/V ±1%
Output Range: ±10V min
Output Load: 2000Ω min
Bandwidth: DC to 4.2 kHz (-3 dB ±0.25 dB)

MEASUREMENT RANGE AND RESOLUTION
Total range depends on excitation setting (see table).
Resolution: 0.5 με (GF=2)

<table>
<thead>
<tr>
<th>EXCITATION VOLTS</th>
<th>MEASURING RANGE</th>
<th>MEASURING RANGE</th>
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<tr>
<td></td>
<td>mV/V</td>
<td>Includes Full Scale Imbalance</td>
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<tr>
<td>0</td>
<td>48,000</td>
<td>24*</td>
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<td>50</td>
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<td>50,000</td>
<td>25</td>
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<tr>
<td>9</td>
<td>20,000</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>20,000</td>
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</table>

*Based on 1 volt excitation

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Micro-Measurements

System 7000

StrainSmart® Data Acquisition System

INPUT CONNECTOR
Eight-pin TIA/EIA RJ-45 (Amp type 554739 or equivalent)

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: ±50 mV
  High Range: ±220 mV
  Linearity: ±0.02% of Full Scale
  Common-Mode Rejection: >90 dB (DC to 60 Hz)
  Common-Mode Voltage Range: ±12V typical

BALANCE
Type: Software (mathematical)
Range: Full ADC range

EXCITATION
Selection: Software controlled
Resolution: 1 mV
Accuracy: ±4 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 load with remote sense
Temperature Stability: ±10 ppm/°C

QUARTER-BRIDGE COMPLETION
Selection: Firmware controlled
Accuracy and Drift:
  120Ω and 350Ω: ±0.01%, 2.8 ppm/°C max.
  1 kΩ: ±0.01%, 1.6 ppm/°C max. (socketed)

SHUNT CALIBRATION
Selection: Firmware controlled
Configuration:
  Internal: P– to D120, P– to D350, P– to D1000
  Remote: RcalA to RcalB
Sockets: Tin-plated
Levels: Simulates 10,000 με; @ GF = 2.0
Values:
  P- to D120: 5940Ω ±0.1%
  P- to D350: 17,325Ω ±0.1%
  P- to D1000: 49,500Ω ±0.1%

SYSTEM CALIBRATION
Firmware controlled
Calibration voltage: Supplied by Model 7000-SM-VC voltage calibration card
Type: Ten point calibration

SIZE
6.5 L x 6.5 W x 0.9 H in (165 x 165 x 23 mm)
WEIGHT
0.45 lb (0.2 kg)

THERMOCOUPLE INPUT CARD

The Model 7003-8-TC Thermocouple Input Card is used in conjunction with the Model 7003-8-A-I Analog Input Card to perform signal conditioning and cold-junction compensation for thermocouple types J, K, T, E, N, R, S, and B.

CHANNELS
Eight per card

INPUTS
Supported Thermocouple Types: J, K, T, E, N, R, S, B
Cold-junction compensation, software-selectable
Open-sensor detection
Input Impedance: 220 MΩ nominal each input

INPUT CONNECTORS
Five-position connector with screw terminals

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
Linearity: ±0.02% of Full Scale
Common Mode Rejection (DC to 60 Hz): >90 dB
Common Mode Voltage Range: ±12V typical
StrainSmart® Data Acquisition System

MEASUREMENT RANGE AND RESOLUTION
Range: ±81.9 mV
Resolution: 1°C minimum

ACCURACY
±2°C

SIZE
6.5 L x 6.5 W x 0.9 H in (165 x 165 x 23 mm)

WEIGHT
0.45 lb (0.2 kg)

HIGH LEVEL INPUT CARD

The Model 7003-8-HL High Level Input Card is used in conjunction with the Model 7003-8-A-I Analog Input Card to perform signal conditioning and excitation for high level (±10V) inputs.

CHANNELS
Eight per card

INPUTS
Differential
Input Impedance: 220 MΩ nominal each input
Input Bias Current: ±0.5 nA typical (±2 nA max.)

INPUT CONNECTOR
Eight-pin RJ-45

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
Linearity: ±0.02% of Full Scale
Common-Mode Rejection (DC to 60 Hz): >90 dB
Common-Mode Voltage Range: ±12V typical

MEASUREMENT RANGES AND RESOLUTION
Range: ±10V
Resolution: 100 μV effective

EXCITATION
Selection: Software controlled
Bipolar Range: 0 to ±12 VDC (24 VDC total)
Unipolar Range: 0 to +12 VDC
Accuracy: ±0.1% of full scale using remote sense
Current: 50 mA max. Over-current/over-temperature protected
Load Regulation: <0.05% of full scale (bipolar mode) for a load variation of 10% to 100% of full scale load (with remote sense)
Temperature Stability: Better than ±30 ppm/°C

DIMENSIONS
6.5 L x 6.5 W x 0.9 H in (165 x 165 x 23 mm)

WEIGHT
0.45 lb (0.2 kg)

LVDT CARD

The Model 7003-8-LVDT is used in conjunction with the Model 7003-8-A-I Analog Input Card to perform signal conditioning, polarity demodulation and AC excitation for transformer type transducers.

CHANNELS
Eight per card

INPUTS
Six-, five-, four- and three-wire transducers
Input Impedance: 220 MΩ nominal each input with 0.001 μF parallel to both inputs
Input Bias Current: ±0.5 nA typical (±2 nA max.)

INPUT CONNECTOR
Eight-pin RJ-45

AMPLIFIER
Zero Temperature Stability: ±2 μV/°C RTI, typical, ±10 μV/°C RTO, after 60-minute warm-up
DC Gain Accuracy and Stability: ±0.25%, ±30 ppm/°C
Common-Mode Rejection (DC to 60 Hz): >90 dB
Common-Mode Voltage Range: ±12V typical
StrainSmart® Data Acquisition System

**POST DEMODULAR FILTER**
- **Type:** Low-Pass
- **Frequency:** 1.0 kHz @ –3 dB
- **Number of Poles:** Six
- **Topology:** Butterworth

**MEASUREMENT RANGE AND RESOLUTION**
- **Range:** ±5 VRMS
- **Resolution:** 50 μVRMS effective

**EXCITATION**
- **Selection:** Software controlled
- **Frequency:** 2500, 5000, or 10000 Hz sine wave
- **Amplitude:** 3 VRMS
- **Accuracy:** ±0.5% of full scale typical
- **Current:** 50 mA max. Over-current/over-temperature protected

**Load Regulation:** <0.1% of full scale for a load variation of 10% to 100% of full scale load
**Temperature Stability:** Better than ±0.05%/°C

**SIZE**
- 6.5 L x 6.5 W x 0.9 H in (165 x 165 x 23 mm)

**WEIGHT**
- 0.45 lb (0.2 kg)

**ANALOG INPUT CARD**

The Model 7003-8-A-I Analog Input Card performs the analog anti-alias filtering, analog-to-digital conversion and data storage for the System. The Model 7003-8-A-I is used in conjunction with a Sensor Input Card, which performs the sensor-specific analog conditioning.

The Model 7003-8-A-I consists of eight dedicated 3-pole constant delay analog anti-alias filters, eight fully synchronized, 24 bit analog-to-digital converters operating at 40k samples/second/channel, a dedicated digital signal processor to perform scaling and digital filtering, a pretrigger buffer with a capacity of over one-half million samples per channel, and 1 GB of CompactFlash® memory for data storage.

**CHANNELS**
- Eight per card

**A/D CONVERTER**
- **Quantity:** Eight (one per channel)
- **Architecture:** Sigma-delta
- **Resolution:** 24 bits
- **Conversion Rate:**
  - Radix-10: 40k samples/second/channel
  - Radix-2: 40.96k samples/second/channel

**DATA RECORDING RATES**
- 2048, 1024, 512, 256, 128, or 64 samples/second/channel (radix-10)
- 2000, 1000, 500, 200, 100, or 10 samples/second/channel (radix-10)

**PRE-TRIGGER BUFFER**
- **Type:** SDRAM, firmware-controlled
- **Depth:** 645,276 samples/channel

**ANALOG ANTI-ALIAS FILTER**
- **Type:** Low-pass
- **Frequency:** 3.5 kHz @ –3 dB
- **Number of Poles:** Three
- **Topology:** GIC, constant delay

**PROCESSOR**
- **Type:** 32-bit floating point digital signal processor
- **250 MHz operating frequency**

**RAM**
- **Type:** SDRAM
- **Size:** 64 MB

**PROGRAM AND CALIBRATION DATA STORAGE**
- **Type:** Flash Memory
- **Size:** 1 MB

**DATA STORAGE**
- **Type:** Sandisk Ultra-Series II® CompactFlash
- **Quantity:** One per card
- **Capacity:** 1 GB supplied. Removable

**SIZE**
- 6.8 L x 6.5 W x 0.7 H in (173 x 165 x 18 mm)

**WEIGHT**
- 0.35 lb (0.16 kg)
CONFIGURATIONS
StrainSmart® Data Systems can be configured in a variety of ways to meet the specific requirements of each user. Each system consists of (1) software, (2) instrumentation hardware, and (3) personal computer.

SOFTWARE
It is strongly recommended that StrainSmart Software be installed on a Windows-based personal computer for data acquisition, reduction, display, and storage.

While the hardware for StrainSmart Data Systems may be used with third-party data acquisition software, total system operation becomes the user’s responsibility when third-party software is used.

INSTRUMENTATION HARDWARE
In addition to a one-time purchase of StrainSmart Software, the initial purchase for each system would normally include one of the following:

System 7000 with Ethernet Interface—At least one Model 7000-128-SM Scanner or Model 7000-32-SM Scanner, and at least one Model 7003-8-SG, 7003-8-SG-A, 7003-8-HL, or 7003-8-TC Input Card, each connected to a Model 7003-8-A-I Analog Input Card

PERSONAL COMPUTER REQUIREMENTS
In addition to StrainSmart Software and Hardware purchased from Micro-Measurements, the system requires access to a properly configured personal computer. The hardware requirements for StrainSmart are:

- Fast Intel Core-2 Duo or better
- 4 GB of memory or better
- 20 GB of available free space or better
- XGA (1024 x 768) or better

STRAINSMART SOFTWARE
StrainSmart Software is designed to function with all System 5000, 6000, and 7000 hardware. It contains everything needed to acquire, reduce, display, and store measurement data, including:

- StrainSmart Main Operating Program
- Offline Data Presentation Program
- Interactive Help System

All components are supplied on CD-ROM along with a utility for installing them.

An unlimited number of installations can be made within your facility with the one-time purchase of a single copy of StrainSmart.
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