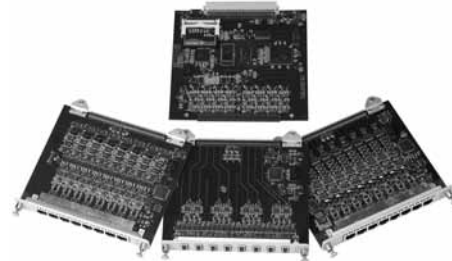


## StrainSmart® Data Acquisition System

### FEATURES

- Stable, accurate, low-noise signal conditioning
- Measurement accuracy  $\pm 0.05\%$
- 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  $\pm 0.05\%$  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.

### StrainSmart® Data Acquisition System

#### 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

**LCD DISPLAY**

64 x 128 white LED-backlit display

**LED PANEL**

32 individual red/green LEDs; one per channel

**KEYPAD**

Membrane. 20-key; 12-key numeric keypad, 5 key navigation keypad, and three 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 7.1 W x 13.5 D in (190 x 180 x 343 mm)

**WEIGHT**

10.1 lb (4.6 kg)

**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)

EXCITATION VOLTS	MEASURING RANGE Includes Full Scale Imbalance	
	µε @ GF=2	mV/V
0	48,000	24*
0.25	100,000	50
0.5	96,000	48
0.75	70,000	35
1	48,000	24
2	24,000	12
3	16,000	8
4	50,000	25
5	40,000	20
6	35,000	17.5
7	30,000	15
8	25,000	12.5
9	20,000	10
10	20,000	10

\*Based on 1 volt excitation

## StrainSmart® Data Acquisition System

**INPUT CONNECTOR**

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

**AMPLIFIER**

**Zero Temperature Stability:**  $\pm 1 \mu\text{V}/^\circ\text{C}$  RTI, after 60-minute warm-up

**DC Gain Accuracy and Stability:**  $\pm 0.05\%$ ;  $\pm 50 \text{ ppm}/^\circ\text{C}$  (1 year without periodic VCAL)

**Analog Input (Including Full-Scale Balance):**

Low Range:  $\pm 50 \text{ mV}$

High Range:  $\pm 220 \text{ mV}$

Linearity:  $\pm 0.02\%$  of Full Scale

Common-Mode Rejection:  $>90 \text{ dB}$  (DC to 60 Hz)

Common-Mode Voltage Range:  $\pm 12\text{V}$  typical

**BALANCE**

**Type:** Software (mathematical)

**Range:** Full ADC range

**EXCITATION**

**Selection:** Software controlled

**Resolution:** 1 mV

**Accuracy:**  $\pm 4 \text{ mV}$  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:**  $\pm 10 \text{ ppm}/^\circ\text{C}$

**QUARTER-BRIDGE COMPLETION**

**Selection:** Firmware controlled

**Accuracy and Drift:**

120 $\Omega$  and 350 $\Omega$ :  $\pm 0.01\%$ , 2.8 ppm/ $^\circ\text{C}$  max.

1 k $\Omega$ :  $\pm 0.01\%$ , 1.6 ppm/ $^\circ\text{C}$  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  $\mu\epsilon$  @ GF = 2.0

**Values:**

P- to D120: 5940 $\Omega$   $\pm 0.1\%$

P- to D350: 17,325 $\Omega$   $\pm 0.1\%$

P- to D1000: 49,500 $\Omega$   $\pm 0.1\%$

**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 M $\Omega$  nominal each input

**INPUT CONNECTORS**

Five-position connector with screw terminals

**AMPLIFIER**

**Zero Temperature Stability:**  $\pm 2 \mu\text{V}/^\circ\text{C}$  RTI,  $\pm 10 \mu\text{V}/^\circ\text{C}$  RTO, after 60-minute warm-up

**DC Gain Accuracy and Stability:**  $\pm 0.1\%$ ;  $\pm 30 \text{ ppm}/^\circ\text{C}$

**Linearity:**  $\pm 0.02\%$  of Full Scale

**Common Mode Rejection (DC to 60 Hz):**  $>90 \text{ dB}$

**Common Mode Voltage Range:**  $\pm 12\text{V}$  typical

StrainSmart® Data Acquisition System

**MEASUREMENT RANGE AND RESOLUTION**

Range:  $\pm 81.9$  mV  
Resolution: 1°C minimum

**ACCURACY**

$\pm 2^\circ\text{C}$

**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 ( $\pm 10\text{V}$ ) inputs.

**CHANNELS**

Eight per card

**INPUTS**

Differential

**Input Impedance:** 220 M $\Omega$  nominal each input

**Input Bias Current:**  $\pm 0.5$  nA typical ( $\pm 2$  nA max.)

**INPUT CONNECTOR**

Eight-pin RJ-45

**AMPLIFIER**

**Zero Temperature Stability:**  $\pm 2$   $\mu\text{V}/^\circ\text{C}$  RTI, typical,  $\pm 10$   $\mu\text{V}/^\circ\text{C}$  RTO, after 60-minute warm-up

**DC Gain Accuracy and Stability:**  $\pm 0.1\%$ ;  $\pm 30$  ppm/ $^\circ\text{C}$

**Linearity:**  $\pm 0.02\%$  of Full Scale

**Common-Mode Rejection (DC to 60 Hz):**  $>90$  dB

**Common-Mode Voltage Range:**  $\pm 12\text{V}$  typical

**MEASUREMENT RANGES AND RESOLUTION**

**Range:**  $\pm 10\text{V}$

**Resolution:** 100  $\mu\text{V}$  effective

**EXCITATION**

**Selection:** Software controlled

**Bipolar Range:** 0 to  $\pm 12$  VDC (24 VDC total)

**Unipolar Range:** 0 to +12 VDC

**Accuracy:**  $\pm 0.1\%$  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  $\pm 30$  ppm/ $^\circ\text{C}$

**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 M $\Omega$  nominal each input with 0.001  $\mu\text{F}$  parallel to both inputs

**Input Bias Current:**  $\pm 0.5$  nA typical ( $\pm 2$  nA max.)

**INPUT CONNECTOR**

Eight-pin RJ-45

**AMPLIFIER**

**Zero Temperature Stability:**  $\pm 2$   $\mu\text{V}/^\circ\text{C}$  RTI, typical,  $\pm 10$   $\mu\text{V}/^\circ\text{C}$  RTO, after 60-minute warm-up

**DC Gain Accuracy and Stability:**  $\pm 0.25\%$ ,  $\pm 30$  ppm/ $^\circ\text{C}$

**Common-Mode Rejection (DC to 60 Hz):**  $>90$  dB

**Common-Mode Voltage Range:**  $\pm 12\text{V}$  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:**  $\pm 5$  VRMS  
**Resolution:** 50  $\mu$ VRMS effective

#### EXCITATION

**Selection:** Software controlled  
**Frequency:** 2500, 5000, or 10000 Hz sine wave  
**Amplitude:** 3 VRMS  
**Accuracy:**  $\pm 0.5\%$  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  $\pm 0.05\%/^{\circ}\text{C}$

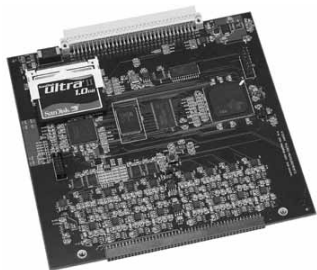
#### SIZE

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-2)  
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)

**StrainSmart® Data Acquisition System**

**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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