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 upgradeable)

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.
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® Data 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).
Resolutions: 0.5 με (GF=2)

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

*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:** ±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.

CHANNLES
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)
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.
Disclaimer

ALL PRODUCTS, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE.

Vishay Precision Group, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "VPG"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained herein or in any other disclosure relating to any product.

The product specifications do not expand or otherwise modify VPG’s terms and conditions of purchase, including but not limited to, the warranty expressed therein.

VPG makes no warranty, representation or guarantee other than as set forth in the terms and conditions of purchase. To the maximum extent permitted by applicable law, VPG disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Information provided in datasheets and/or specifications may vary from actual results in different applications and performance may vary over time. Statements regarding the suitability of products for certain types of applications are based on VPG’s knowledge of typical requirements that are often placed on VPG products. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. You should ensure you have the current version of the relevant information by contacting VPG prior to performing installation or use of the product, such as on our website at vpgsensors.com.

No license, express, implied, or otherwise, to any intellectual property rights is granted by this document, or by any conduct of VPG.

The products shown herein are not designed for use in life-saving or life-sustaining applications unless otherwise expressly indicated. Customers using or selling VPG products not expressly indicated for use in such applications do so entirely at their own risk and agree to fully indemnify VPG for any damages arising or resulting from such use or sale. Please contact authorized VPG personnel to obtain written terms and conditions regarding products designed for such applications.

Product names and markings noted herein may be trademarks of their respective owners.

Copyright Vishay Precision Group, Inc., 2014. All rights reserved.