Strain Gage Instrumentation

Databook

Stress Analysis Testing
Structural Testing
Materials Testing

micro-measurements.com

MICRO MEASUREMENTS
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Strain Gage Instrumentation

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Considerations for Instrument Selection

Considerations for Instrument Selection

STRAIN MEASUREMENT INSTRUMENTS

Basic instrumentation requirements call for stability, accuracy and high resolution when making measurements under static loading conditions, and particularly where measurements are to be taken over long periods of time. Micro-Measurements offer our P3 Strain Indicator and D4 Data Acquisition Conditioner to meet these demanding criteria. In addition, our MultiDAQ is a single-channel USB device suitable for less demanding applications.

The P3 Strain Indicator and Recorder is a portable, battery-operated instrument while our Model D4 Data Acquisition Conditioner is a USB-powered instrument that connects to a personal computer. Both are capable of simultaneously accepting four inputs from quarter, half, and full bridge strain gage circuits, including strain-gage-based transducers. The P3 has front-panel quick terminal blocks whereas the D4 uses RJ45 connectors. A highly stable measurement circuit, regulated bridge excitation supply, and precisely settable gage factor enable measurements of ±0.1% accuracy and 1 microstrain resolution. Whilst the P3 can be operated stand-alone via the membrane switch front panel or via USB, the D4 is exclusively USB powered and connects to a PC for operation. Both devices share a common software application enabling both P3s and D4s to be operated from a PC; up to six units can be operated concurrently.

The MultiDAQ is a unique and simple single-channel device. Whilst it does not have the advanced features of its multi-channel siblings, it enables quick measurements with a minimum of setup. Strain gage inputs (quarter, half and full bridge) can be connected via the RJ45 connector and set up with the supplied software. Measurements units can be microstrain or user-defined for load or displacement measurements, and up to twelve devices can be operated at the same time. The internal quarter bridge resistance is fixed; three versions are available for 120, 350 or 1000 Ω inputs.

	MultiDAQ/StudentDAQ	D4	P3
Measurement Range	±16,000 με @ GF=2.00	±31,000 με @ GF=2.00	±31,000 με @ GF=2.00
Connection	RJ45	RJ45	Terminal Block or TIO
Input Type	Strain Gage	Strain Gage	Strain Gage
Bridge Types	Quarter, half, and full bridge	Quarter, half, and full bridge	Quarter, half, and full bridge
Bridge Completion	120Ω, 350Ω, 1000Ω, internal HB 1KΩ	120Ω, 350Ω, 1000Ω, internal HB 1KΩ	120Ω, 350Ω, 1000Ω, internal HB 1KΩ
A/D Converter	24 bit Delta-Sigma	24 bit Delta-Sigma	24 bit Delta-Sigma
Max. Input	±8 mV/V @ GF=2.0	±15.5 mV/V @ GF=2.0	±15.5 mV/V@ GF=2.0
Resolution	1 με @ GF=2.00	1 με @ GF=2.00	1 με @ GF=2.00
Accuracy	1% of reading @GF=2.0	0.1% of reading ±3 counts	0.1% of reading ±3 counts
Excitation	2.5 Volts (nominal, fixed)	1.5 Volts (nominal, pulsed)	1.5 Volts (nominal, pulsed)
Power source	USB only	USB only	USB, battery, or DC Input
Data Rate (Samples / second / channel)	Up to 80	Up to 8	1
Max. Storage	PC dependent	PC dependent	2 GB card or PC
Max. Channels (multiple units)	12	24	24
Software	Windows based	Windows based	Windows based
Drivers	Labview, .NET interface	Labview, .NET interface	Labview, .NET interface

Considerations for Instrument Selection

CALIBRATORS

Calibration requires ultra-stable references with accuracy that exceeds the instrument under test. Micro-Measurements have two offerings, our 1550B and V/E-40.

The 1550B can mimic quarter, half and full bridge true Wheatstone bridge circuits in two resistances (120/350 or 350/1000 Ω), with decade buttons for +/-99000με in 100 microstrain steps and +/-49.5mV/V in 0.05mV/V steps.

The V/E40 is a high precision decade resistance box adjustable from 30.00 to 1111.10 Ω in 0.01 Ω steps and can therefore mimic any resistance of strain gage up to 1000 Ω in quarter bridge, as well as be used to calibrate RTDs and our Model 1300 Gage Installation Tester percentage scales.

	1550 Strain Indicator Calibrator	V/E-40 Strain Gage Simulator
Display	Analog	Analog
Operation	Manual, Direct-Reading	Manual, Direct-Reading
Remarks	Quarter, half, and full true Wheatstone bridge. Direct microstrain or mV/V.	Quarter bridge only. Precision resistance source

SIGNAL CONDITIONING AMPLIFIERS

When signals are produced by dynamically applied loads at frequencies above 0.1 Hz, or are transients, measuring instrumentation requires adequate frequency response, and a wide amplifier gain range for output to the appropriate recording or display device. Such an instrument consists of an amplifier and signal conditioner with a built-in or shared power supply. Individual units are normally required for each channel when simultaneous recording or multiple channels are needed. With the output sent to a suitable display device, signal conditioning amplifiers can be used for making long-term measurements under static loading conditions when maximum stability and accuracy are not primary considerations.

The 2100, 2200, and 2300 Systems accept low-level signals, and condition and amplify them into high-level outputs suitable for multiple channel, simultaneous, dynamic recording. All of these systems can be used in conjunction with a variety of recording devices. Progressively advanced features and frequency responses are offered.

2100 is a high performance but simple amplifier. Up to 10 channels in a rack share a common power supply. Setup is simple and intuitive, with front-panel manual controls for bridge excitation, user-definable shunt calibration, and a gain multiplier and Vernier adjustment from 1 to 2100.

2200 offers individual power supplies for improved channel-to-channel separation. It offers a wider gain range, high frequency response, automatic balance control and constant voltage or current excitation. It is ideal for harsh environment measurements, with a common-mode input of up to +/-350 volts, and a driven-guard shield connection for improved environmental noise rejection over conventional ground shield connection systems.

2300 is the choice for impact and other high-speed transient events such as split Hopkinson bar and explosive tests. Separate power supplies per channel, very high frequency response and ultra-wide gain and automatic balance, 4-step user-definable shunt calibration, user-definable filters as well as switchable AC coupling make this a versatile and high-performance amplifier.

	2100	2200	2300
Frequency Response	DC to 50 kHz (–3 dB)	DC to 50 kHz (–0.5 dB) DC to 100 kHz (–3 dB)	DC to 60 kHz (–0.5 dB) DC to 145 kHz (–3 dB)
Output (±)	10 V @ 100 mA	10 V @ 10 mA and 1 VRMS @ 10 mA	10 V
Amplifier Gain	Continuously Variable 1 – 2100	Continuously Variable 1 – 3300	Continuously Variable 1 – 11,000
Bridge Excitation	DC: 0.5-12 V	DC: 0.5-15 V or 0.5-30 mA	DC: 0.7-15 V (11 steps) 0.2-7 V Variable
Input Power	AC	AC	AC
Remarks	High Performance Amplifier for Simultaneous Dynamic Recording	High Performance for Demanding Environments	High-Frequency Response Multi-Feature Signal Conditioner

Considerations for Instrument Selection

DIGITAL DATA SYSTEMS

Depending on their design, digital data systems can be used for measurement of static, dynamic, or both kinds of signals. Micro-Measurements offer three digital data systems, each controlled with StrainSmart® software and other third-party software. They share some common features, including analogue and digital FIR anti-alias filters, software-switchable bridge completion for 120, 350 and 1000 Ω quarter bridges, user-selectable excitation and shunt calibration, and are connected to a PC via Ethernet. They all use modern 24-bit digital signal processors for excellent resolution, stability and noise control.

System 7100 can accept inputs from common strain gage inputs, thermocouples, high level signals and LVDTs in groups of 8 channels. Racks of 32 channels or 128 channels can be combined for thousands of channels of fully synchronous data capture at up to 2000 samples/second/channel. Each scanner has a built-in, removable calibration reference for in-field calibration.

System 8000 is a versatile and compact system with 8 programmable channels for strain gages, thermocouples and high level inputs. Up to 16 System 8000 scanners can be connected for up to 128 channels (asynchronous), with sample rates up to 1000 samples/second/channel. An optional plug-in calibration reference can be used for in-field calibration.

System 9000 offers 12 strain gage inputs and 4 user-definable channels for thermocouples, high level, and piezo inputs (charge and voltage mode) at up to 50,000 samples/second/channel. Up to three units can be connected to offer a maximum 48 channels (36 strain gage, 12 others) for fully-synchronous transient data capture. An optional plug-in calibration reference can be used for in-field calibration.

All of the above systems use our StrainSmart® software, a turn-key application enabling quick and easy configuration of sensor and recording parameters. Captured data can be quickly displayed, analysed and exported. PCBA analysis to IPC/JEDEC 9704A is integrated, just requiring a single click of the mouse to access.

	7100	8000	9000
Measurement Range	25,000 - 310,000 με @ GF = 2.00	25,000 - 310,000 με @ GF = 2.00	25,000 - 310,000 με @ GF = 2.00
Connection	RJ45	RJ45	RJ45
Input Type	Strain, High-level, LVDT, Thermocouple	Strain, High-level, Thermocouple	Strain, High-level, Piezoelectric,Thermocouple
Bridge Types	Quarter, half, and full bridge	Quarter, half, and full bridge	Quarter, half, and full bridge
Bridge Completion	120Ω, 350Ω, 1000Ω, internal HB 1 KΩ	120Ω, 350Ω, 1000Ω, internal HB 1 KΩ	120Ω, 350Ω, 1000Ω, internal HB 1 KΩ
A/D Converter	24 bit Delta-Sigma	24 bit Delta-Sigma	24 bit Delta-Sigma
Max. Input	±155 mV/V @ GF = 2.0	±155 mV/V @ GF = 2.0	±155 mV/V @ GF = 2.0
Resolution	0.5 με @ GF = 2.00	0.5 με @ GF = 2.00	0.5 με @ GF = 2.00
Excitation - Strain Gage	0 -10 VDC (SW Selectable)	0 -10 VDC (SW Selectable)	0 -10 VDC (SW Selectable)
Excitation - High Level	±0-12 VDC	0 - 11.997 VDC	0 - 11.997 VDC
Power source	11-32 VDC, 40 A max, or Mains power supply	11-32 VDC, 5 A max, or Mains power supply	11-32 VDC, 10 A max, or Mains power supply
Data Rate (Samples / second / channel)	up to 2000	up to 1000	5,000 - 50,000
Max. Storage	8 GB (2GB file max)	PC dependent	>16 GB (2 GB file max size)
Max. Channels (multiple units)	Unlimited (with the Sync cable length limit of 100 ft (30 m) between scanners)	128 (not synchronized)	48 (synchronized)
Software	StrainSmart 7100	Bundled, simple app or StrainSmart 8000	StrainSmart 9000
Drivers	Labview, .NET interface	Labview, .NET interface	Labview, .NET interface
Self-Calibrate	Yes – with integrated Vcal	Yes – with Vcal option	Yes – with Vcal option

Considerations for Instrument Selection

SPECIAL PURPOSE EQUIPMENT

For many measurement applications additional equipment may be required, for example quality control of a strain gage installation, applications in harsh environments, or other measurement requirement.

The Model 1300 Gage Installation Tester enables quick and simple qualitative measurements that indicate the quality of the installation. Potential damage or degradation can be quickly identified with just three tests - resistance (Ω), deviation (5% and 1%), and insulation (MΩ).

The Model 700 Portable Welder is used to install strain gages in harsh environment where the stringent surface preparation processes and adhesive cure schedule are difficult or impossible to achieve. Special strain gages are manufactured by bonding a conventional foil gage to a thin shim which can then be spot-welded to a structure. With a rechargeable battery, it can be used to install gages outside in cold, dirty or wet environments with ease. Additionally, our high temperature weldable gages enable fast installations on exhausts and manifolds for temperatures approaching 1000°C (1800°F).

Our RS-200 facilitates measurements of residual stresses which are present in many structures. The high speed drilling equipment is designed to enable precision drilling of a small hole using a dental turbine to minimise any detrimental effect on the measurement. In combination with a suitable strain gage and measuring instrument such as our P3, getting consistent strain values for analysis is made simple. The process follows ASTM E837.

	700 Spot Welder	1300 Gage Installation Tester	RS200
Display	Analog dial	Analog	Calibrated microscope graticle
Operation	Manual	Manual, Direct-Reading	Manual
Remarks	Battery-powered welder for weldable gauges, thermocouples and thin shim	Essential tool for quality control of strain gage installations	Precision drilling for residual stress measurement to ASTM E837

LEGACY AND OBSOLETE INSTRUMENTS

Micro-Measurements products have a long service life but eventually we are limited by spare parts availability. These products are included here because we can offer a limited capability to build, calibrate or repair some items.

A2 is a programmable signal conditioner amplifier. We can still manufacture individual sensor input cards and offer calibration and repairs. Additional control modules and rack extensions are no longer able to be manufactured due to parts availability.

System 5000 was our first StrainSmart® system and is still in use worldwide in thousands of channels after more than 25 years since first introduced. We can provide limited calibration and repair, but spare parts are no longer available.

System 6000 is a dynamic StrainSmart® system still in use after more than 20 years. We have limited repair and calibration capabilities for both the 6100 laboratory racks and 6200 portable enclosures, but spare parts are no longer available.

System 7000 is a legacy system and as such can still be manufactured. This is limited to current customers who wish to expand their existing systems. The performance is similar to System 7100, which replaces System 7000 for new customers and installations.

	5000	6000	7000	A2
Repair	Yes	Yes	Yes	Yes
Calibrate	Yes	Yes	Yes	Yes
Purchase	No	No	Yes	Limited
Remarks	Obsolete	Obsolete	Expansion for existing systems and customers. See 7100 for new applications.	Limited availability of boards.Master and expansion racks not available.

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Considerations for Instrument Selection

	5000	6000	6200
Operating mode	Stationary, online	Stationary, online	Remote, stand alone
Channels	5-1200	1-1200	1-1200
Data Rate (Samples / second / channel)	Up to 100	Up to 10,000	Up to 10,000
Bridge Excitation	0-10 V programmable	0-10 V programmable	0-10 V programmable
Input Power	AC	AC	DC (AC with mains power supply)
Remarks	5 Hz low pass filter	Programmable digital filters to 4 kHz	Programmable digital filters to 4 kHz

	A2
Frequency Response	DC to 100 kHz (-3 dB)
Output	+/- 10 V
Amplifier Gain	125-2500
Bridge Excitation	0 - 10 V
Input Power	DC (AC with mains power supply)
Remarks	General-Purpose Signal Conditioner with Digital Control

	7000
Measurement Range	16,000 - 100,000 με @ GF = 2.00
Connection	RJ45
Input Type	Strain, High-level, LVDT, Thermocouple
Bridge Types	Quarter, half, and full bridge
Bridge Completion	120 Ω, 350 Ω, 1000 Ω, internal HB 1 KΩ
A/D Converter	24 bit Delta-Sigma
Max. Input	±50 mV/V @ GF = 2.0
Resolution	0.5 με @ GF = 2.00
Excitation - Strain Gage	0 -10 VDC (SW Selectable)
Excitation - High Level	±0-12 VDC
Power source	11-32 VDC, 30A max, or Mains power supply
Data Rate (Samples / second / channel)	up to 2048
Max. Storage	CF card, (2GB file max)
Max. Channels (multiple units)	Unlimited (with the Sync cable length limit of 100 ft (30 m) between scanners)
Software	StrainSmart 7000
Drivers	Labview, .NET interface
Self-Calibrate	Yes – with integrated Vcal

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Strain Indicator and Recorder

FEATURES

- Four input channels
- Direct reading LCD display
- On-board data storage
- 0 to 2.5 VDC analog output
- Quarter, half, and full bridge circuits
- Built-in bridge completion and shunt calibration
- 120, 350, and 1000 Ω dummy gages
- Automatic zero-balancing
- Intuitive, menu-driven operations
- USB data link
- Operation from keypad or PC
- Portable, lightweight, and rugged
- Battery, USB, or line-voltage power

DESCRIPTION

The P3 Strain Indicator and Recorder is a portable, battery-operated instrument capable of simultaneously accepting four inputs from quarter, half, and full bridge strain-gage circuits, including strain-gage-based transducers. Water-resistant grommets in the hinged cover allow the lid to be closed with leadwires attached. Designed for use in a wide variety of physical test and measurement applications, the P3 functions as bridge amplifier, static strain indicator, and digital data logger.

The P3, utilizing an LCD display for readout of setup information and acquired data, incorporates many unique operating features that make it the most advanced instrument of its kind. An extensive, easy-to-use menu-driven user interface operates through a front-panel keypad to readily configure the P3 to meet your particular measurement requirements. Selections include active input and output channels, bridge configuration, measurement units, bridge balance, calibration method, and recording options, among others.

Standard sensor input connection is via eccentric-lever-release terminal blocks. They enable fast connection and disconnection as well as easy reconfiguration for fault finding.

Data, recorded at a user-selectable rate of up to 1 reading per channel per second, is stored on a removable flash card and is transferred by USB to a host computer for subsequent storage, reduction and presentation with the supplied software.

The P3 can also be configured and operated directly from your PC with a separate software application included with each instrument. Additionally, a full set of ActiveX components is provided for creating custom applications in any language supporting ActiveX.

A highly stable measurement circuit, regulated bridge excitation supply, and precisely settable gage factor enable measurements of ±0.1% accuracy and 1 microstrain resolution. Bridge completion resistors of 120, 350 and 1000 Ω are built in for quarter bridge operation. Also, input connections and switches are provided for remote shunt calibration of transducers and full bridge circuits.

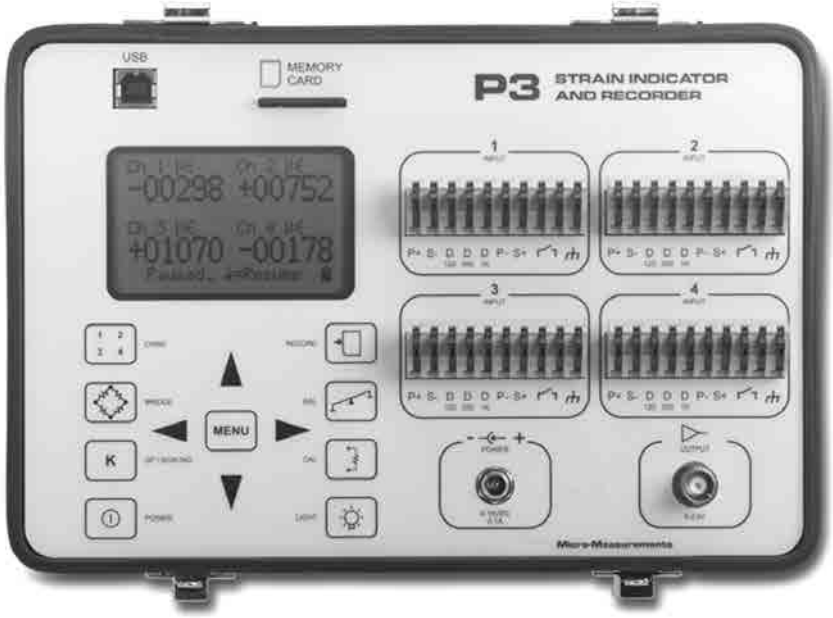
The P3 operates from two readily available D cells. Battery life depends upon mode of operation but ranges up to 600 hours of continuous use for a single channel. It can also be powered by connection to an external battery or power supply, a USB port on a PC or with an optional external line-voltage adapter, the P3-A105.

Strain Indicator and Recorder

SPECIFICATIONS

All specifications are nominal or typical at +73°F (+23°C) unless noted.

PARAMETER	SPECIFICATIONS
INPUT CONNECTORS	
P3 P3-TIO	Eccentric-lever-release terminal blocks accept up to four independent bridge inputs. Accommodates 16–28 AWG (1.3 to 0.35 mm diameter) wire. The Transducer Input Option (Model P3-TIO) includes four 10-pin bayonet locking circular connectors mounted on the side of the case and wired in parallel to the lever-release terminal blocks. The supplied mating connector has a 0.046 inch (1.17 mm) diameter solder well.
BRIDGE CONFIGURATIONS	Quarter, half, and full bridge circuits. Internal bridge completion provided for 120, 350 and 1000 Ω quarter bridges, 60 to 2000 Ω half or full bridges.
Bridge Excitation	1.5 VDC nominal. Readings are fully ratiometric, and not degraded by variation in excitation voltage.
Bridge Types	• Quarter bridge • Half bridge, adjacent arms, equal and opposite strains • Half bridge opposite arms equal strains • Shear bridge, 2 active arms • Poisson half bridge • Full bridge 4 fully active arms • Shear bridge, 4 active arms • Full bridge, Poisson gages in opposite arms • Full bridge, Poisson gages in adjacent arms • Undefined full bridge • Undefined half bridge/quarter bridge



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Strain Indicator and Recorder

PARAMETER	SPECIFICATIONS
Bridge Balance	Single key operation to initiate automatic software balance • Automatic • Manual offset adjust • Disabled (Raw offset)
DATA CONVERSION	High-resolution 24-bit sigma-delta converter. 50 or 60 Hz noise rejection. User selectable.
DYNAMIC RANGE	±31,000 με (±1 με resolution) at Gage Factor = 2.000
ACCURACY	±0.1% of reading ±3 counts. (Normal mode operation at Gage Factor = 2.000.)
GAGE FACTOR RANGE	0.500 to 9.900
SHUNT CALIBRATION	Shunt calibration across each dummy resistor to simulate 5000 με (±0.1%). Remote calibration supported via accessible switch contacts at input terminal block.
SCALING	Automatic scaling for microstrain, based upon gage factor, with nonlinearity correction based upon bridge type. Automatic calculation of mV/V Linear scaling for other engineering units
UNITS	με g rpm hp mV/V lbf m deg psi lb s rad ksi kg A oz GPa in N mV MPa mm V m/s2 Pa mil Ω ton
ANALOG OUTPUT	BNC connector. 0 to 2.5 V. Device impedance of 2000 Ω or greater. 480 updates/second output rate. 16-bit resolution
RECORDING	• Up to 64 data files • Automatic recording • 1 reading every 1 to 3600 seconds • Individually selectable per channel • Manual recording • Automatic date/time stamping
DATA STORAGE	
Media	Removable SD or Multimedia Card (32GB max).
Data Recording Rate	1 reading per second maximum.
DISPLAY	Full dot-matrix structure, 128 dots x 64 dots FSTN positive, grey transflective LCD with backlight. Display update rate is twice a second.
Backlight Control	Programmable on time while in run mode: 5, 15 or 60 sec. Manual off/on. If illuminated, backlight will remain illuminated while operating menus.
Contrast	Software Adjustable
OPERATING MODES	• Normal mode • Analog output (any one of four channels)
COMMUNICATION	USB 1.1 with type B connector. Used for device control, transferring stored data, and firmware updates.

Strain Indicator and Recorder

PARAMETER	SPECIFICATIONS
PC APPLICATION SUPPORT	Windows-based software provided for control and data storage. No device driver required (treated as an HID device).
FIRMWARE UPGRADEABLE	
REAL-TIME CLOCK	
SYSTEM CALIBRATION / VERIFICATION	Requires 1550B Strain Indicator Calibrator or other compatible calibrator. Calibration date stored in flash memory.
POWER	• Internal battery pack using two “D” cells. Battery life up to 600 hours (single channel, normal mode) • USB power • External 6 to 15 VDC • AC adapter (optional, P3-A105)
ENVIRONMENTAL	
Temperature	+32 to +122°F (0 to +50°C)
Humidity	Up to 90%, non-condensing
SIZE	9 x 6 x 6 in (228 x 152 x 152 mm)
WEIGHT	4.4 lb (2.0 kg), including batteries

View Showing
Optional Transducer
Input Connectors

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Data Acquisition Conditioner

FEATURES

- Four input channels with RJ45 connectors
- Quarter, half, and full bridge circuits
- Built-in bridge completion and shunt calibration
- 120, 350, and 1000 Ω dummy gages
- Automatic zero-balancing
- 8 Hz sampling rate
- Intuitive, user-friendly software communicates with up to six D4 units simultaneously
- Full control of all functions via USB Interface
- Portable, lightweight, and rugged design
- Powered via USB interface
- Programmable for custom applications

DESCRIPTION

The Model D4 Data Acquisition Conditioner is a portable, USB-powered precision instrument for use with resistive strain gages and strain gage-based transducers.

The Model D4 has four channels of data acquisition. Connection to each channel is via a RJ45 connector. Each channel of input accepts either quarter, half, or full bridge configuration. All required bridge completion components for 120, 350, and 1000 Ω bridges are supplied.

Operation of the Model D4 is performed with commands sent via the USB connection. User-friendly application software is provided to control the D4 with a MS Windows-based personal computer. The software connects with up to six D4 units to create a system of up to 24 channels. The D4 units can be connected directly to a computer through its USB ports or through a USB hub.

A Programmer's Reference Kit that includes a Programmer's Reference Manual, a NI LabVIEW instrument driver, and programming examples to simplify writing custom applications is also included. The D4 is also supplied with a calibration software utility that allows calibration of the D4 via the USB interface. The application software, Programmer's Reference Kit, and Instruction Manual are on a single CD included with the D4 unit.

The Model D4 uses modern digital signal processing technology to provide excellent noise rejection and stability. Proprietary scaling and linearization algorithms provide unsurpassed measurement accuracy for strain gage bridge measurements.

Front Panel

Back Panel

Data Acquisition Conditioner

SPECIFICATIONS

All specifications are nominal or typical at +73°F (+23°C) unless noted.

PARAMETER	SPECIFICATIONS
INPUT CONNECTIONS	
Type	RJ45
Quantity	4
BRIDGE CONFIGURATIONS	Quarter, half, and full bridge circuits. Internal bridge completion provided for 120, 350 and 1000 Ω quarter bridges, 60 to 2000 Ω half or full bridges.
DATA CONVERSION	
A/D Converter:	Delta-sigma with integral chopper-stabilized programmable gain instrumentation amplifier
Resolution:	24 bits. Noise-free resolution: 18 bits typ.
Filter:	Integrated linear phase FIR Sinc5 filter followed by a Sinc3 filter with a programmable decimation rate. Software selectable output rate provides >120 dB rejection of 50 or 60 Hz and higher level harmonics
MEASUREMENT RANGE/RESOLUTION	
Strain Range:	±31,000 με at GF = 2.000. (±15.5 mV/V)
Resolution:	±1 με at GF = 2.000 (±0.0005 mV/V)
MEASUREMENT ACCURACY	±0.1% of reading ±3 counts (Instrument Gage Factor = 2.000)
GAGE FACTOR CONTROL RANGE	0.500 to 9.900
BALANCE CONTROL	
Type:	Software
Control:	Manual or automatic
BRIDGE EXCITATION	
Value:	1.5 VDC nominal
Control:	Software enable/disable
Ratiometric measurement	Not degraded by variations in excitation voltage
SHUNT CALIBRATION	Shunt calibration across each dummy resistor to simulate 5000 με (±0.1%)
COMMUNICATION INTERFACE	USB 2.0. Cable included
POWER	USB, 5V 100 mA
ENVIRONMENTAL	
Temperature:	+32° to 122°F (0° to +50°C)
Humidity:	Up to 90%, non-condensing
CASE	
Material:	Aluminum
Size:	4.3 W x 1.4 H x 5.7 L inches (110 x 36 x 145 mm)
Weight:	0.8 lb. (0.36 kg)

Strain Gage Data Acquisition Device

FEATURES

- Single-channel strain gage data acquisition
- Hardware and software support for quarter, half, and full bridge
- Built-in bridge completion
- 3-wire strain gage connection
- 80 samples per second
- Fixed excitation of 2.5 V
- Input range of ±16,000 με
- Powered via the USB interface
- Intuitive, user-friendly software
- No calibration is needed
- Units: με, mV/V, and engineering units (user defined)
- Time stamped recorded data

Model	3-Wire Quarter Bridge
MM01-120	120 Ω
MM01-350	350 Ω
MM01-1K	1000 Ω

DESCRIPTION

The Multi Data Acquisition Device is a single-channel, USB-powered measurement device for use with resistive strain gages. Internal bridge completion supports quarter, half, and full bridge configurations.

This device is designed for use in applications where a convenient, low-cost, easy-to-use strain gage measurement is required. It is ideal for classroom environments or gage installation verification.

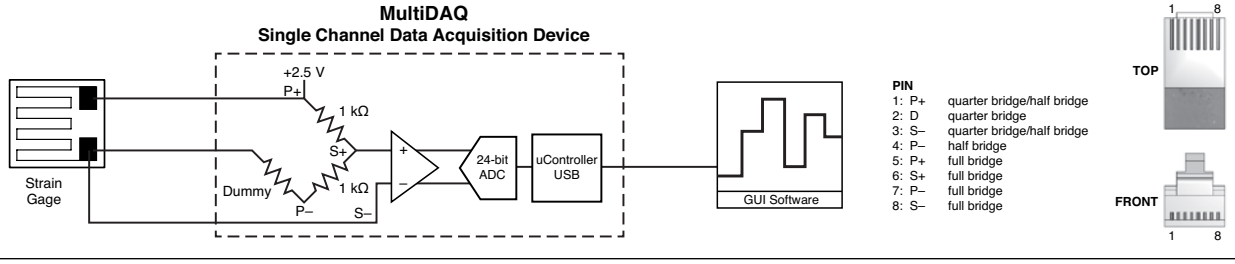
Operation of the MultitDAQ is performed with commands sent via a USB connection. User-friendly application software is provided to control the MultiDAQ with a Windows-based personal computer. Complete source code, written in National Instruments® LabVIEW® is provided. A .NET interface is also included.

SPECIFICATIONS

All specifications are nominal or typical at +73°F (+23°C) unless noted.

PARAMETER	VALUE
INPUT CONNECTIONS	
Type:	RJ45
Quantity:	1
BRIDGE CONFIGURATIONS	
Types:	Quarter, half, and full bridges
Internal bridge completion:	
Quarter bridge:	120, 350, or 1000 Ω
Half bridge:	1000 Ω
DATA CONVERSION	
A/D converter:	24-bit delta-sigma
MEASUREMENT RANGE	
Strain range:	±16,000 με at GF=2.000
Resolution:	1 με (@GF = 2.000)
Accuracy:	1% of reading (@ GF = 2.000)
BALANCE CONTROL	
Type:	Software
Control:	Manual
BRIDGE EXCITATION	
Value:	2.5 VDC nominal
Control:	Fixed
COMMUNICATION INTERFACE	Universal serial bus (USB)
CASE MATERIAL	Plastic
SIZE	1.0 W x 1.0 H x 3.5 L in (25.4 x 25.4 x 88.9 mm)
WEIGHT	0.05 lb (0.023 kg)

Block Diagram



Calibrators

MICRO MEASUREMENTS
A VPG Brand

Strain Indicator Calibrator

FEATURES

- True Wheatstone bridge circuitry
- Simulates quarter, half, and full bridge both 120/350 Ω or 350/1000 Ω (-S1 version)
- Three decades of push buttons
- Strain range direct reading: ±99 900 με in increments of 100 με
- Transducer range: ±49.95 mV/V in increments of 0.05 mV/V
- Reversing switch for plus and minus calibration
- High precision resistors used throughout to ensure excellent stability
- Accuracy 0.025 % traceable to the U.S. National Institute of Standards and Technology

A laboratory standard for verifying the calibration of strain and transducer indicators.

DESCRIPTION

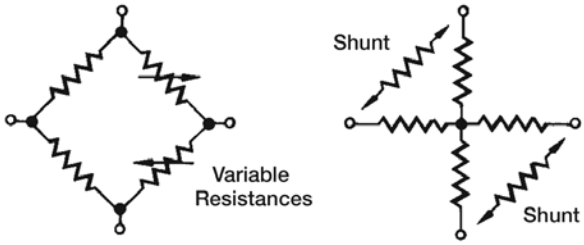
Sound engineering and laboratory practices require that the instrumentation used to make critical strain measurements be periodically calibrated to verify that it is within the manufacturer's original specifications. Additionally, each type of strain indicator exhibits some degree of nonlinearity, especially for large strains during quarter-bridge operation. Since this is the most common stress analysis application of strain gages, it is important that the strain indicator be calibrated in this mode. Instrumentation span should also be checked at a number of points before each important test to avoid inaccurate data.

The 1550B calibrator is a Wheatstone bridge and generates a true change of resistance in one or two arms of the bridge. It simulates the actual behaviour of a strain gage in both positive and negative strain.

The 'star network' used in certain other commercial calibrators provides a substantially lower cost instrument design, because component specifications are less critical, and fewer components are required. However, the 'star network' cannot simulate quarter-bridge strain gage behaviour, and cannot simulate positive strain. Another serious problem with this circuit is that the bridge input and output resistances change in an abnormal manner, leading to inaccuracies in calibration under some conditions.

A calibrator based on the Wheatstone bridge principle requires stable components. A total of 66 ultra-stable precision resistors are used in the 1550B calibrator to provide the stability, repeatability, accuracy and incremental steps required in a laboratory standards instrument.

WHEATSTONE BRIDGE / STAR NETWORK



SPECIFICATIONS

All specifications are nominal or typical at +73°F (+23°C) unless noted.

PARAMETER	SPECIFICATIONS
ACCURACY	0.025% of setting ±1 με (0.0005 mV/V), maximum, traceable to NIST.
REPEATABILITY	±1 με (0.0005 mV/V), maximum
STABILITY	(0.001% of setting ±1 με)/°C, maximum
THERMAL EMF	0.5 μV/V of excitation, maximum

Strain Indicator Calibrator

PARAMETER	SPECIFICATIONS
BRIDGE RESISTANCES	
1550B	120/350 Ω
1550B-S1	350/1000 Ω
INPUT RESISTANCE CHANGE	±0.05%, maximum, from nominal at all output settings
OUTPUT RESISTANCE CHANGE	±0.05%, maximum, from nominal at “000” με to ±0.25% at ±99 900 με
CIRCUIT	True ±ΔR in two adjacent arms (opposite signs), plus two fixed arms for bridge completion
SIMULATION	• Quarter bridge, one active arm • Half bridge, one or two active arms • Full bridge, two active arms
RANGE	
Two Active Arms:	• 0 to ±99,900 με in steps of 100 με @ GF = 2.00 • 0 to ±49.95 mV/V in steps of 0.05 mV/V
One Active Arm:	0 to ±49,950 με in steps of 50 με @ GF = 2.00
EXCITATION	
Recommended:	• 120 Ω: up to 10 VDC • 350 Ω: up to 15 VDC • 1000 Ω: up to 25VDC
Absolute maximum:	• 120 Ω: 25 VAC or VDC • 350 Ω: 25 VAC or VDC • 1000 Ω: 25 VAC or VDC
OUTPUT @ 000	50 με (0.025 mV/V), maximum in full-bridge mode
ENVIRONMENTAL	
Temperature:	+50°F to +100°F (+10°C to +38°C)
Humidity:	Up to 70%, non-condensing
CASE	Separable lid
Material:	Aluminum case
Size:	5-3/4 H x 8-1/4 W x 7-3/4 D in (145 x 210 x 195 mm)
WEIGHT	4.8 lb (2.2 kg)

A certificate of calibration is provided with each Model 1550B Calibrator

MICRO MEASUREMENTS
A VPG Brand

Strain Gage Simulator

FEATURES

- 5 Decade selector switches
- Resistance range: 30.00 to 1111.10 Ω in 0.01 Ω steps
- High precision resistors used throughout to ensure excellent stability
- Accuracy 0.02% of setting
- Simulates tension and compression strain for most widely used strain gage resistance values
- Simulates a broad range of RTDs for instrumentation setup and calibration
- A precision decade resistor for accurately simulating the behaviour of strain gages and RTDs

A precision decade resistor for accurately simulating the behavior of strain gages and RTDs

DESCRIPTION

The V/E-40 Strain Gage Simulator is an accurate, stable, compact, five-decade resistor specially designed to simulate the behaviour of strain gages and RTDs, and for use in a broad range of measurement and calibration applications.

As a precision strain gage simulator, the V/E-40 can be used to measure nonlinearity of the instrumentation in quarter bridge operation, or to verify instrument calibration over the anticipated measurement range. It is also well suited to measuring desensitization of the strain gage circuit due to the finite resistance of the strain gage leadwire system.

In a similar manner, the V/E-40 can be temporarily substituted for an RTD over a resistance range of 30.00 to 1111.10 Ω to verify calibration of temperature measurement instrumentation.

The V/E-40 can also be used in conjunction with a conventional Wheatstone bridge strain indicator to measure arbitrary resistances between 30.00 and 1111.10 Ω or to eliminate Wheatstone bridge nonlinearity effects when measuring high post-yield strains in quarter-bridge operation. In this mode, the resistance or strain gage to be measured is connected as one arm of a Wheatstone bridge, the V/E-40 is used as a decade resistor in an adjacent arm, and the strain measuring instrument as a null detector.

Other applications include use as an investigative tool to troubleshoot faulty strain gage installations, or as a precision decade resistor.

SPECIFICATIONS

All specifications are nominal or typical @ +23°C unless noted.

PARAMETER	SPECIFICATION
ACCURACY	0.02% of reading
STABILITY	±3 ppm/°C maximum
RESISTANCE RANGE	30.00 to 1111.10 Ω in 0.01 Ω steps
MAXIMUM CURRENT (to meet accuracy and repeatability specifications)	• 120 Ω: 65 mA • 350 Ω: 55 mA • 1000 Ω: 25 mA
ENVIRONMENTAL	
Temperature:	+0°F to +120°F (-18°C to +49°C)
Humidity:	Up to 70%, non-condensing
CASE	
Material:	Aluminum case
Size:	3-7/8 H x 9-1/8 W x 3-1/8 D in (98 x 232 x 89 mm)
WEIGHT	1.9 lb (0.85 kg)

MICRO MEASUREMENTS
A VPG Brand

Signal Conditioning Amplifiers

MICRO MEASUREMENTS
A VPG Brand

Signal Conditioning Amplifier System

FEATURES

- Accepts quarter, half, or full bridge; all bridge-completion gages built in, including 120/1000 and 350 Ω dummies
- Fully adjustable and regulated bridge excitation on each channel; up to 12 VDC by front-panel control
- Continuously variable amplifier gain up to 2100 by front-panel control
- Separate bridge power switch
- Output 10 VDC at 100 mA, short-circuit-proof and current limiting standard
- LED null indicators provided on each channel to indicate amplifier and bridge-balance condition
- High stability with temperature and time
- Frequency response up to 50 kHz

DESCRIPTION

The demands of today's measurement applications are more exacting than ever before. An instrumentation system must provide durability and versatility, reliability with ease of operation, and economy with no sacrifice of accuracy.

The 2100 System was engineered with all of these requirements in mind, and to provide a durable, multi-channel signal conditioner/amplifier system capable of performing equally well in a wide variety of test applications and environments, and the 2100 System has proven itself through applications ranging from measurements on the ocean floor to testing of rocket motors.

The 2100 System accepts low-level signals, and conditions and amplifies them into high-level outputs suitable for multiple-channel simultaneous dynamic recording. The 2100 System is compatible with all types of external data recorders requiring voltage-level inputs.

Strain gage, load/pressure transducer and nickel temperature sensor inputs can be handled by the 2100 System without any rewiring.

All operational controls are located on the front panel for maximum setup efficiency. Frequently used controls are finger-operated, while initial setup adjustments are made through the front panel with a screwdriver.

Continuously variable amplifier gain is achieved via a locking ten-turn concentric-dial counting knob, which permits resetting to a predetermined value for repeating routine tests.

ADDITIONAL DETAILS

A separate bridge power switch removes bridge excitation, enabling the operator to detect unwanted signals due to electrical interference and/or noise, thermocouple effects, and shifts of the instrument zero during a long-term test. This feature is an absolute must for dynamic testing, and for validating test results.

An adjustable bridge excitation control on each channel permits excitation to be set as specified by the strain gage or transducer manufacturer. It also allows for any special consideration which may be dictated by the test material; for example, the poor thermal conductivity normally associated with plastics.

In addition to adjustable bridge excitation, each channel has its own regulator circuit. This prevents interaction of adjacent channels during setup or operation.

Each channel has a continuously variable gain control. In combination with recommended excitation, the independent gain control can provide a large output signal so that small signals can be resolved without overpowering the strain gage or transducer.

An LED display for each channel gives positive indication of amplifier and resistive balance. This capability accelerates setup and verifies tension/compression loading.

Easily read reference marks on the setup meter indicate acceptable line voltage and proper operation of internal power supplies.

A switch contained in the Model 2110B Power Supply allows adjustment when the line voltage is too high or too low.

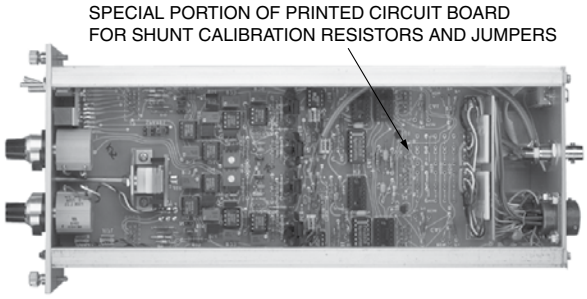
The 2100 System provides true quarter bridge, three-leadwire capability, including internal dummies and sufficient plug connections for remote shunt calibration.

A convenient network in the Model 2120B Strain Gage Conditioner/Amplifier allows the operator to change the factory-supplied shunt values, as well as shunt any arm of the bridge, as required.

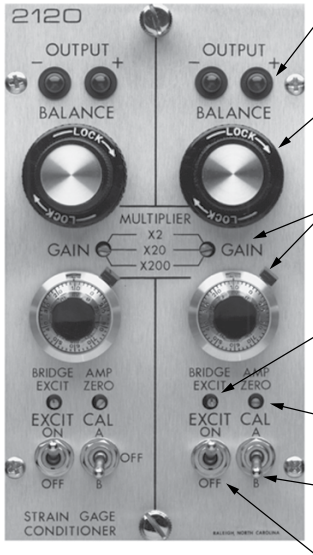
Signal Conditioning Amplifier System

MODEL 2120B
STRAIN GAGE CONDITIONER AMPLIFIER

A two-channel plug-in amplifier module that includes bridge completion, bridge balance, amplifier balance, bridge excitation regulator, and shunt calibration.



Front Panel



LED DISPLAY
Setup/Indicator for amplifier balance, bridge balance, tension/compression

BRIDGE BALANCE
Resistively balances the bridge; standard locking knob; digital locking knob ("K" option)

GAIN RANGE AND VERNIER
Varies amplifier gain between 1–2100

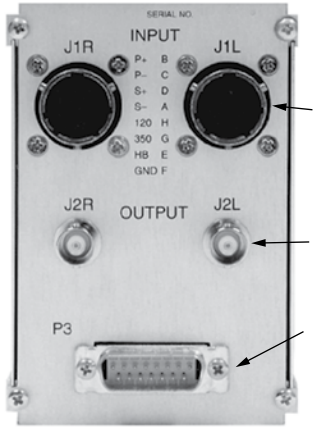
BRIDGE EXCITATION
Varies bridge excitation between 0.5–12 VDC

AMPLIFIER BALANCE
Adjusts amplifier offset

SHUNT CALIBRATION
(2 points)

BRIDGE EXCITATION (on/off)
Removes bridge excitation

Rear Panel



STRAIN GAGE/ TRANSDUCER INPUT
Quarter, half, and full bridge

OUTPUT
±10 VDC, ±100 mA

POWER RECEPTACLE

SPECIFICATIONS

All specifications are nominal or typical at +73°F (+23°C) unless noted.

PARAMETER	SPECIFICATIONS
INPUT BRIDGE TYPE	• Quarter (120/1000 Ω and 350 Ω) • Half and full bridge (50–1000 Ω) Quarter-bridge dummy gages provided
BRIDGE EXCITATION	
Voltage:	0.5 to 12 VDC (adjustable for each channel) with 120 Ω full-bridge load.
Short-circuit current: Under ripple, noise, and 10%	<40 mA
line change:	±2 mV max
Load regulation:	±0.2% no-load to 120 Ω load (10% line change)
BRIDGE BALANCE	±2000 με (quarter, half, or 350 Ω full bridge). Range can be changed by internal jumper to ±4000 με or ±6000 με

Signal Conditioning Amplifier System

PARAMETER	SPECIFICATIONS	
SHUNT CALIBRATION	Two-position (center off) toggle switch Standard factory-installed resistors (±0.1%) simulate ±1000 με at GF=2	
AMPLIFIER GAIN	1 to 2100 continuously adjustable ±1%	
BANDPASS		
Normal:	DC to 5 kHz (min): -0.5 dB (-5%) DC to 15 kHz: -3 dB	
Extended (using internal jumper):	DC to 17 kHz: -0.5 dB DC to 50 kHz: -3 dB	
AMPLIFIER INPUT		
Temperature coefficient of zero:	±1 µV/°C RTI* ±210 µV/°C RTO** (-10°C to +60°C, after 30 minute warm-up) *Referred to input **Referred to output	
Noise RTI (350Ω source impedance):	• 1 µVp-p at 0.1 Hz to 10 Hz • 2 µVRMS at 0.1 Hz to 50 kHz	
Noise RTO:	• 50 µV p-p at 0.1 Hz to 10 Hz • 80 µV p-p at 0.1 Hz to 100 Hz • 100 µVRMS at 0.1Hz to 15 kHz • 200 µVRMS at 0.1Hz to 50 kHz	
Input Impedance:	>100 MΩ (balance limit resistor disconnected)	
Common-Mode Rejection (DC to 60 Hz):	Gain Multiplier	CMR (dB)
	x2	67
	X20	87
	x200	100
Source Current:	±10 nA typical; ±40 nA max.	
OUTPUT	±10 V (min) at ±100 mA	
Current limit:	140 mA	
SIZE	5.25 H x 2.94 W x 10.97 D in (133 x 75 x 279 mm)	
WEIGHT	2.2 lb (1.0 kg)	

Signal Conditioning Amplifier System

MODEL 2110B - POWER SUPPLY

A plug-in module capable of powering up to ten channels (five Model 2120B modules) at a maximum rated voltage or current. Provides initial bridge and amplifier voltages. All supplies are current-limited against amplifier malfunction.

BRIDGE-VOLTS METER
Used to set up/monitor bridge excitation, also line and power supply levels

CHANNEL SELECTOR
AC monitors ac line input. DC monitors the power supplies. Positions 1–10 select and display bridge excitation for each channel

PILOT LAMP
Indicates main power

POWER SWITCH
Main power on-off

EXTERNAL METER
Used with an external digital voltmeter to precisely adjust bridge excitation

SPECIFICATIONS

All specifications are nominal or typical at +73°F (+23°C) unless noted.

PARAMETER	SPECIFICATIONS
INPUT VOLTAGE	107, 115, 214, 230 VAC ±10% 50/60 Hz (selected internally)
Power:	40 W typical, 100 W max.
OUTPUTS VOLTAGES	• ±15 V at 1.2 A • +17.5 V at 1.1 A; All regulators current-limited against overload
METER	• 0 to 12 VDC (with switch) to read bridge excitation. • AC input and DC output go/no-go monitor
SIZE	5.25 H x 2.44 W x 12.34 D in (133 x 62 x 313 mm)
WEIGHT	6.7 lb (3.1 kg)

Signal Conditioning Amplifier System

MODEL 2150 - RACK ADAPTER

A prewired rack adapter which accepts one Model 2110B and up to five Model 2120B Strain Gage Conditioner Amplifiers. It has its own fuse and power cord and can be housed in any standard 19-in (483-mm) electronic equipment rack.

MODEL 2150 FRONT

MODEL 2150 REAR

PARAMETER	SPECIFICATIONS
POWER CABLE	2-ft (0.6-m) 3-wire line cord; 10-ft (3-m) extension available Receptacle to accept line cord from adjacent 2150 Rack Adapter
SIZE	5.25 H x 19 W x 14.17 D in (133 x 483 x 360 mm)
WEIGHT	6.6 lb (3.0 kg)

MODEL 2160B PORTABLE FOUR-CHANNEL ENCLOSURE

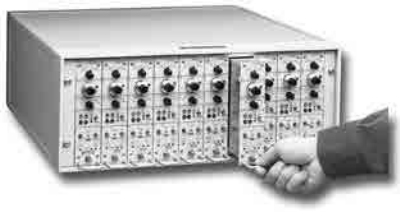
A prewired, fused enclosure which houses up to three (3) modules. A carrying handle ensures maximum portability. An additional snap-down bail support on the bottom can be used to elevate the 2160 for excellent work efficiency during bench-top operation. The Model 2160 would be substituted for the Model 2150 when two or four channels and maximum portability are required.

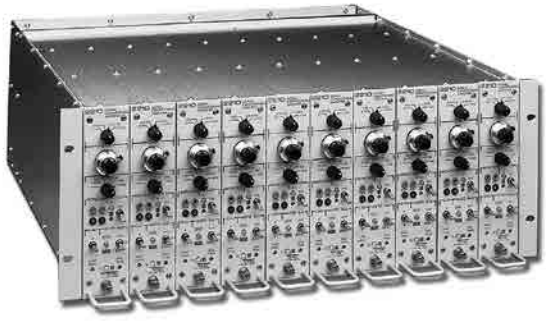
PARAMETER	SPECIFICATIONS
SIZE	5.55 H x 8.75 W x 13.80 D in (141 x 222 x 350 mm)
WEIGHT	5.2 lb (2.4 kg)

Signal Conditioning Amplifier

FEATURES

- Plug-in amplifier design; amplifiers are removable from the front panel without rear access
- Selectable constant-voltage or constant-current excitation: 0.5 to 15 V or 0.5 to 30 mA; selectable by single internal switch
- Calibrated gain from 1 to 3300; adjustable front-panel gain switch and calibrated front-panel ten turn potentiometer
- Front-panel monitoring of: ±10 V output; excitation; automatic balance status; and amplifier balance
- Automatic wide-range bridge balance with battery backup to retain balance in power-off condition
- Input coupling: selectable AC or DC by internal jumpers
- Fully grounded input amplifier: ±350 VDC or peak AC common-mode operating voltage
- Full-power bandwidth of 100 kHz at all gain settings; slew rate of 6.3 V/µs
- Built-in four-pole Bessel low-pass filter with cutoff frequencies of 1 Hz, 10 Hz, 100 Hz, 1 kHz and 10 kHz; front-panel frequency selection switch
- Two simultaneous buffered outputs: ±10 V and tape 1.0 VRMS; will drive up to 0.15 µF without instability
- Stable, proprietary bridge completion module for quarter and half bridge 120 and 350 Ω strain gage and transducer circuits
- 120 Ω dummy easily configured for 1000 Ω completion
- Built-in shunt calibration circuits; internal user-selectable configurations to provide two-point shunting of any bridge component or two-point double shunt calibration of transducers
- Optically isolated shunt calibration relays provided as standard; built-in power supply for relay operation is provided in ten-channel rack adapter and four-channel enclosure





DESCRIPTION

The 2200 Signal Conditioning System incorporates, as standard, all the features necessary for precise conditioning of strain gage and transducer inputs in the most severe operating environments.

The 2210B Amplifiers plug in from the front of the ten-channel 2250A Rack Adapter or four-channel 2260B Portable Enclosure without removing the rear-panel input connections.

Among the features of the 2210B Amplifier are isolated constant-voltage/constant-current excitation, guarded input structure with ±350 V common-mode capability, ±10 V and tape outputs, automatic wide-range bridge balance and four-pole Bessel low-pass filter.

Operating controls of the 2210B Amplifier are conveniently arranged and clearly marked to minimize the possibility of operator error. Constant-voltage or constant-current excitation, calibration configuration, and other optional operating modes are selected by easily accessible internal switches or jumpers.

ADDITIONAL DETAILS

A floating, guarded input environment maximizes the rejection of common-mode voltages up to ±350 V (operating). The input amplifier can also be AC-coupled for situations where only dynamic signals are of interest.

The independent, isolated bridge excitation system provides either constant-voltage or constant-current excitation. A front-panel LED serves as a supervisory indicator, and a front-panel switch removes bridge excitation to assist in evaluation of circuit integrity.

An automatic balance circuit is used to provide wide balance range and electronic injection of balance voltage. This feature eliminates transducer loading and assures

sufficient balance capability for practically all input configurations. The automatic balance circuit can be disabled from the front panel to allow measurement of initial unbalance, input noise, thermal offsets or zero shifts.

The four-pole Bessel low-pass filter provides five selectable bandwidths from 1 Hz to 10 kHz. The 1 Hz or 10 Hz positions can be used for quasi-static data with excellent rejection of line frequency (60 Hz) noise. The output of the low-pass filter can be routed to either the standard or tape output, or either output can be wideband.

Wide bandwidth and high slew rate at all gain settings and at full output (±10 V). This characteristic ensures that integrity of the system's performance is not compromised when higher gain settings are required.

A standard (±10 V) and a tape (1.0 VRMS) output are provided for each channel. The outputs are isolated from the guarded input and from chassis (system) ground. This feature gives the user complete independence to establish a high-quality instrumentation ground system at the recording or data acquisition site. Both outputs can drive long (high capacitance) coaxial cables without instability.

The system provides optically isolated shunt calibration circuits on each channel. Any desired calibration configuration can be selected by internal switches. External contact closures are also accessible via the input connector to facilitate double-shunt (two-level) transducer calibration. Calibration resistors can easily be changed to any special values. No soldering is required.

Individual amplifiers are removable from the front panel without disconnecting the input or output wiring. This gives the user the option of dedicated rack or enclosure wiring, sharing of amplifiers, and ease of amplifier replacement under emergency conditions.

SPECIFICATIONS

All specifications are nominal or typical at +73°F (+23°C) unless noted.

MODEL 2210B - SIGNAL CONDITIONING AMPLIFIER

PARAMETER	SPECIFICATION
INPUT	
Input Impedance: DC-coupled: AC-coupled: Low frequency cutoff (3 dB): Source Current:	 22 MΩ shunted by 250 pF 1.1 µF in series with 20 kΩ 8 Hz norm. ±10 nA typical; ±20 nA maximum
Input configuration:	2 to 10 wire plus guard shield accepts quarter, half, or full bridge strain gage or transducer inputs. Internal half bridge, dummy 120 Ω and 350 Ω completion resistors, remote sense and four-wire calibration capability provided. 1000 Ω completion capability also provided. Accepts inputs from ground-referenced or isolated devices.
Maximum Differential Input:	±50 VDC or peak AC
Maximum Common-Mode Input:	±350 VDC or peak AC
Guard Impedance:	Greater than 250 kΩ to output common; Greater than 1000 MΩ to power and rack ground
AMPLIFIER	
Gain:	1 to 3300; continuously variable; direct reading. Gain steps X1, X10, X100, X300; With 10-turn counting knob, X1 to X11. Accuracy ±0.5%
Linearity:	±0.01% of full scale at DC
Frequency Response: DC to 100 kHz: DC to 50 kHz:	 3±0.2 dB at all gain settings and full output 0.5 dB max at all gain settings and full output

Signal Conditioning Amplifier

PARAMETER	SPECIFICATION		
Gain Step vs Frequency Response (3 dB):	X300	100 kHz X 10	135 kHz
	X100	120 kHz X 1	240 kHz
Slew Rate:	6.3 V/µsec min at all gain settings		
Noise (350 Ω source impedance, DC-coupled): Referred-to-Input (RTI): Referred-to-Output (RTO):	 1 µV 0.1 Hz to 10 Hz p-p; 2 µV 0.1 Hz to 100 Hz p-p 3 µV 0.1 Hz to 100 kHz RMS Output related noise is a function of the setting of the gain multiplier potentiometer		
Zero Stability:	±2 µV RTI, ±200 µV RTO at constant temperature		
Temperature Coefficient of Zero:	±1 µV/°C RTI, ±100 µV/°C RTO; –10°C to 60°C		
Common-Mode Rejection	Gain	CMR (dB)	
	X1	82	
	X10	102	
	X100	122	
	X300	135	
Maximum Operating Common Mode Voltage	±350 VDC or peak AC		
Standard Output:	±10 V @ 10 mA max		
Tape Output	1.0 VRMS @ 10 mA max, or		
Output AC-coupled	±10 V @ 10 mA max (7 Hz, 3 dB)		
Output Monitor	±10 V standard monitored via front-panel jacks		
Output Isolation	>1000 MΩ from power and rack ground		
Output Protection	Protected against continuous short		
Capacitive Loading	Up to 0.15 µF		
Low Pass Filter	Four-pole Bessel low-pass filter with selectable 3 dB bandwidths of 1 Hz, 10 Hz, 100 Hz, 1 kHz and 10 kHz		
CONSTANT VOLTAGE EXCITATION			
Range :	0.50 to 15.0 VDC @ 85 mA max.		
Noise :	100 µV +0.002% of excitation p-p max DC to 20 kHz		
Line Regulation:	200 µV +0.01% of excitation max for line voltage change of 10% from nominal		
Load Regulation:	200 µV +0.01% of excitation max for load variation of 10% of 90% of full load		
Stability:	±0.01%/°C or 100 µV/°C, whichever is greater		
Remote Sense:	Error <0.0005%/Ω of lead resistance		
Monitoring:	Front-panel monitoring jacks		
Isolation:	Isolated from power ground and output common; floats with guard		

MICRO MEASUREMENTS
A VPG Brand

Signal Conditioning Amplifier

PARAMETER	SPECIFICATION		
CONSTANT CURRENT EXCITATION			
Range :	0.50 to 15.0 mA DC or 1.00 to 30.0 mA DC Compliance voltage: 0.50 to 16.0 V		
Noise :	(1 µA + 10 µV) p-p; DC to 20 kHz		
Line Regulation:	±1 µA ±0.01% max for line voltage change of ±10% from nominal		
Load Regulation:	±1 µA ±0.01% max for 100% load change		
Stability:	±0.01%/°C or 1 µA/°C, whichever is greater		
Monitoring:	Front-panel monitoring jacks; 10 mV/mA Isolation Isolated from power ground and output common; floats with guard		
BALANCE			
Method:	Electronically injected automatic balance		
Range:	±15,000 µε (7.5 mV/V) RTI (X2 with internal jumper)		
Resolution:	0.50 µε RTI (X2 with internal jumper)		
Balance time:	4 seconds typical, 8 seconds max.		
Accuracy:	±2 mV RTO; ±2 µε RTI		
Balance trim:	±375 µε (188 µV/V) RTI		
Storage:	Digital with battery backup. Battery life 3-5 years.		
Activation:	Activated by front-panel switch or by optically isolated remote switch or low TTL level		
SHUNT CALIBRATION	Four internal shunt calibration resistors, ±0.1% tolerance		
	174.8 K	1000 µε (0.50 mV/V)	350 Ω bridge
	874.8 K	200 µε (0.10 mV/V)	350 Ω bridge
	59.94 K	1000 µε (0.50 mV/V)	120 Ω bridge
Activation:	Activated by front-panel switch, or by optically isolated remote contact closure or low TTL level. Internal selector switches for selection of two-point unipolar, bipolar, or two-point double shunt calibration circuits Calibration resistors plug into fixed terminals (no soldering)		
SIZE	7 H x 1.71 W x 17.88 D in (178 x 43 x 454 mm)		
WEIGHT	3.7 lb (1.67 kg)		

Signal Conditioning Amplifier

MODEL 2250A - RACK ADAPTER

A prewired rack adapter which accepts up to ten Model 2210B plug-in amplifier modules. The Model 2250A also fits standard 19-in (483-mm) mainframe electronic equipment racks so that multi-channel system configurations can be conveniently housed. The Model 2250A contains all built-in wiring for connecting one rack adapter to another.

PARAMETER	SPECIFICATION
INPUT	Input plugs are provided for up to ten channels; Bendix PT06A-14-15 (SR)
OUTPUT	Standard ±10 V, BNC receptacle (10 ea) Tape 1.0 VRMS, BNC receptacle (10 ea)
REMOTE	Provides access to remote calibration and remote balance functions of 2210B Amplifiers. The required +5 V power supply is an integral part of the 2250A Rack Adapter.
POWER	115/230 VAC, 50-60 Hz, 120 W max.
SIZE	7 H x 19 W x 18.87 D in (178 x 483 x 479 mm)
WEIGHT	13.8 lb (6.25 kg)

MODEL 2260B - PORTABLE ENCLOSURE

A self-contained prewired rack/enclosure which accepts up to four 2210B Amplifiers. All input/output connectors are provided on the rear panel of the enclosure. A carrying handle allows convenient portability, and a snap-down bail support on the bottom is used to elevate the 2260B for work efficiency during bench-top operation.

PARAMETER	SPECIFICATION
INPUT	Input plugs are provided for up to four channels; Bendix PT06A-14-15 (SR)
OUTPUT	Standard ±10 V, BNC receptacle (4 ea) Tape 1.0 VRMS, BNC receptacle (4 ea)
REMOTE	Provides access to remote calibration and remote balance functions of 2210B Amplifiers. The required +5 V power supply is an integral part of the 2260A Portable Enclosure.
POWER	115/230 VAC, 50-60 Hz, 50 W max.
SIZE	7.31 H x 7.20 W x 20.16 D in (186 x 183 x 512 mm)
WEIGHT	8.1 lb (3.67 kg)

Signal Conditioning Amplifier

FEATURES

- Accepts all strain gage inputs (foil and piezoresistive), potentiometers, DCDTs, etc.
- Selectable bridge excitation, 0.7 to 15 VDC (11 steps), plus 0.2 to 7 VDC continuously variable
- Fully adjustable calibrated gain from 1 to 11,000
- Dual-range (±5000 με and ±25,000 με) automatic bridge balance, with battery backup to retain balance in power-off condition
- All bridge completion built in, including 120 or 1000 and 350 Ω dummies
- Dual polarity two-step double shunt calibration
- Bandpass:
  - o 55 kHz (–0.5 dB)
  - o 125 kHz (–3 dB)
- Switchable active filter—a 6-pole Butterworth is standard
- Two simultaneous buffered outputs
- Playback mode to filter and observe or re-record previously recorded low-level data
- Input impedance above 100 MΩ

DESCRIPTION

The 2300 System conditions and amplifies low-level signals to high-level outputs for multiple-channel simultaneous dynamic recording and display on external devices. Among its features, each 2310B Module includes a built-in power supply, active filtering, two simultaneous outputs, playback mode, wide frequency response, and voltage injection bridge balance.

Up to ten 2310B Modules can be mounted in a Model 2350 Rack Adapter; or up to four modules in a Model 2360B Portable Enclosure.

The 2310B Modules may be interchanged between the 2350 Rack Adapter and the 2360B Portable Enclosure to best satisfy testing requirements.

ADDITIONAL DETAILS

The 2310B Conditioner/Amplifier Modules accept inputs from strain gages, load/pressure/DC displacement transducers, potentiometers, RTDs and nickel temperature sensors, without any internal modification. Controls on the 2310B are arranged in sections, permitting easy setup. Clearly marked push-button and single-purpose switches minimize the possibility of operator error during use. With the exception of the playback switch, all operational and monitor controls are on the front panel. Switches for selecting remote sense and specific shunt calibration configurations are located on the printed circuit board inside the unit.

Calibration: Momentary two-position switches, ±A and ±B, control shunt calibration levels; 4 point

LED Display: Set up indicator for amplifier balance, bridge balance and for monitoring the output polarity

FRONT PANEL

REAR PANEL

Filter Section: Push-button controls for activating appropriate low- and high-pass active filters

Electronic Bridge Balance Section: Three-position switch—OFF, ON, RESET—for electronic bridge balance; auto ranging up to ±25 000 με with non-volatile zero storage; yellow light indicates high-range operation or over range condition

Vernier trim control is used to refine bridge balance when desired

AC IN: Capacitive coupling in the amplifier; eliminates static component of the signal

Signal Conditioning Amplifier

Bridge Excitation: ON-OFF switch for removing bridge excitation from the strain gage or transducer for noise documentation

Amplifier Balance: Adjusts amplifier offset

Excitation Level: Twelve-position switch; values arranged for doubling power with each step, with one 0.2 to 7 VDC continuously variable

Amplifier Gain Section: Continuously variable potentiometer (1.00 to 11.00) plus push-button course gain multipliers control amplifier gain; direct-reading

Battery Test: Momentary push button determines battery level for bridge zero storage

Main Power: Turns unit on/off; LED pilot light

Pin Jacks: Monitoring of Excitation, Unamplified Input, Amplified Output

AC Line Switch: Selects nominal 115 or 230 VAC operation

Playback Section: Slide switch activates playback operating mode. Connects the input to the filter circuits and post amplifiers. BNC input connector

Low-Level Output: Full-scale ±1.4V level available at this BNC connector for driving various recording devices and low-level analog-to-digital converters

High-Level Output: Full-scale ±10V level available at this BNC connector for driving an oscilloscope, digital voltmeter, analog-to-digital converter, etc.

Input Receptacle: All sensor inputs made through a 15-pin quarter-turn connector. Pin selection determines mode of operation (mating plug included)

Power Connector: Main power input from the rack adapter, portable enclosure or individual line plug. Additional pins for optional remote operation of shunt calibration, bridge excitation (ON/OFF), and electronic bridge balance

SPECIFICATIONS

All specifications are nominal or typical at +23°C unless noted.

MODEL 2310B - SIGNAL CONDITIONING AMPLIFIER

PARAMETER	SPECIFICATIONS
INPUT	
Strain Gages	Quarter, half or full bridge (50 Ω to 1000 Ω); Built-in 120 and 350 Ω dummy gages; 1000 Ω dummy capability. Foil or piezoresistive strain gage types.
Transducers	
DCDT displacement transducers	
Potentiometers	
EXCITATION	
Fixed Settings:	11 positions: 0.7, 1, 1.4, 2, 2.7, 3.5, 5, 7, 10, 12 and 15 VDC, 1% max.
Variable Setting:	0.2 to 7 VDC
Current:	0–100 mA, min, limited at 175 mA, max.
Regulation (0–100 mA ±10% line change):	±0.5 mV; ±0.04%, max measured at remote sense points. (Local sense: –5 mV, typical, @ 100 mA, measured at plug)
Remote Sense Error:	0.0005% per Ω of lead resistance (350 Ω load)
Noise and Ripple:	0.05% p-p, max (DC to 10 kHz)
Stability:	±0.02%/°C
Level:	Normally symmetrical about ground; either side may be grounded with no effect on performance
BRIDGE BALANCE	
Method	Counter-emf injection at pre-amp; automatic electronic; dual range; can be disabled on front panel

Signal Conditioning Amplifier

PARAMETER	SPECIFICATIONS		
Ranges (auto ranging):	• ±5000 με (±1% bridge unbalance or ±2.5 mV/V), resolution 2.5 με (0.0012 mV/V); • ±25,000 με (±5% bridge unbalance or ±12.5 mV/V), resolution 12.5 με (0.006 mV/V)		
Balance Time:	2 seconds, typical		
Manual Vernier Balance Range:	100 με (0.050 mV/V)		
Interaction:	Essentially independent of excitation and amplifier gain		
Storage:	Non-volatile digital storage without line power for up to two years		
SHUNT CALIBRATION			
Circuit (two-level, dual polarity)	• Single-shunt (for stress analysis) across any bridge arm, including dummy gage • Double-shunt (for transducers) across opposite bridge arms • Provision for four dedicated leads to shunt external arms • CAL circuit selected by switches on PC board		
Fixed Settings:	• ±200 and ±1000 με @ GF=2 across dummy half bridge; • ±1000 με @ GF=2 across dummy gage (120 Ω and 350 Ω). • ±1 mV/V (double shunt) for 350 Ω transducer.		
Remote-Operation Relays (**Option Y**)	Four relays (plus remote-reset relay for bridge balance and relay for excitation on/off). Each relay requires 10 mA @ 5 VDC except excitation on/off 25 mA		
AMPLIFIER			
Gain:	1 to 11, 000 continuously variable. Direct reading, ±1% max. 10-turn counting knob (X1 to X11) plus decade multiplier (X1 to X1000)		
Frequency Response, All Gains Full Output	**DC coupled:** DC to 125 kHz, -3 dB max. DC to 55 kHz, -0.5 dB max. **AC coupled:** 1.7 Hz typ. to 125 kHz, -3 dB max.		
Frequency Response Versus Gain, Full Output:	Gain	-0.5 dB	-3 dB
	1-11	120 kHz	300 kHz
	10-110	90 kHz	230 kHz
	100-1100	70 kHz	150 kHz
	1000-11000	55 kHz	125 kHz
Slew Rate:	7.8 V/μs typical		
Input Impedance:	100 MΩ, min, differential or common-mode, including bridge balance circuit		

Signal Conditioning Amplifier

PARAMETER	SPECIFICATIONS
Bias Current:	±40 nA, typical max., each input
Source impedance:	0 to 1000 Ω each input
Common-Mode Voltage:	±10 V
Common-Mode Rejection (gain over X100):	• Shorted input: 100 dB, min, at DC to 60 Hz; 90 dB, min, DC to 1 kHz; • 350 Ω balanced input: 90 dB, typical, DC to 1 kHz
Stability (gain over X100):	±2 µV/°C, max, RTI (referred to input)
Noise (gain over X100, all outputs)	• 0.01 to 10 Hz: 1 µV p-p RTI • 0.5 to 125 kHz: 6µ VRMS, max, RTI
FILTER	
Characteristic:	Low-pass active six-pole Butterworth standard
Frequencies (–3 ±1 dB):	10, 100, 1000 and 10,000 Hz and wide-band
Outputs Filtered:	Either one or both (switch-selected on printed circuit board)
AMPLIFIER OUTPUTS	
Standard Output:	±10 V @ 5 mA, min.
Slew Rate:	7.8 V/µs (typical)
Low-Level Output:	±1.414 V (1 VRMS) @ 5 mA, min.
Linearity @ DC:	±0.02%
Either output can be short-circuited with no effect on the other	
PLAYBACK	
Input:	±1.414 V full scale; input impedance 20 kΩ
Gain:	X1 to low-level output; X7.07 to standard output
Filter Selection:	As specified above
Outputs:	Both as specified above
ENVIRONMENTAL	
Temperature:	32°to 122°F (0°C to +50°C)
Humidity:	10% to 90%, non-condensing
POWER	105 V to 125 V or 210 V to 250 V (switch-selected), 50/60 Hz, 10 watts, max
Keep-alive supply (for bridge balance)	Lithium 3.6 V, 1/2 AA or equal; Shelf life approximately two years
SIZE	
Panel:	8.75 H x 1.706 W in (222.2 x 43.3 mm)
Case Depth Behind Panel:	15.9 in (404 mm)
WEIGHT	6 lb (2.7 kg)

Signal Conditioning Amplifier

MODEL 2350 - RACK ADAPTER

A prewired rack adapter which accepts up to ten Model 2310B plug-in amplifier modules. The Model 2350 also fits standard 19-in (483-mm) mainframe electronic equipment racks so that multi-channel system configurations can be conveniently housed.

PARAMETER	SPECIFICATIONS
APPLICATION	• Fits standard 19-in (483-mm) electronic equipment rack • Accepts up to ten 2310B Amplifiers • AC line completely wired • Wiring for remote calibration with Option Y
POWER	115 or 230 VAC switch selected in amplifiers, 50/60 Hz, 100 Watts max.
SIZE	8.75 H x 19 W x 19.06 D overall (222 x 483 x 484 mm)
WEIGHT	13.5 lb (6.1 kg)

MODEL 2360B - 4-CHANNEL ENCLOSURE

Model 2360B Portable Enclosure includes all AC wiring. Accepts up to four amplifier modules.

PARAMETER	SPECIFICATIONS
APPLICATION	• Accepts up to four 2310B Amplifiers • AC line completely wired • Wiring for remote calibration with Option Y
POWER	115 or 230 VAC switch selected in amplifiers, 50/60 Hz, 100 Watts max.
SIZE	9.06 H x 7.20 W x 18.90 D in (229 x 183 x 480 mm)
WEIGHT	6.75 lb (3.1 kg)

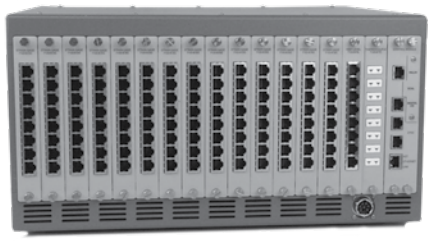
MICRO MEASUREMENTS
A VPG Brand

Digital Data Acquisition Systems

System 7100 – Data Acquisition System

FEATURES

- Stable, accurate, low-noise signal conditioning
- 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
- Scalable synchronized system (using multiple scanners)
- Maximum scan rate of 2000 samples per second (Radix-10).
- 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 with DHCP addressing



DESCRIPTION

Micro-Measurements System 7100 builds upon the years of experience gained since the introduction of Systems 4000, 5000, 6000 and 7000 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.

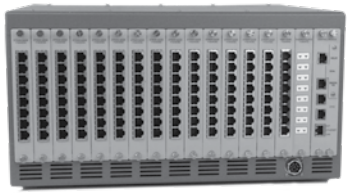
System 7100 hardware is designed to incorporate all the features required for precision strain measurement in a high channel density enclosure. Strain gages, strain-gage based transducers, thermocouples, LVDTs, and other sensors with high level voltage outputs can be intermixed in groups of eight (8) by choosing the appropriate sensor card for up to 128 channels in a 5U height, 19-inch rack mountable scanner (7100-128-SM). A 32-channel scanner is also available (7100-32-SM). The Ethernet interface with DHCP addressing allows flexible positioning of scanners, and multiple scanners can easily be synchronized using a single sync cable (maximum length 100 feet (30m)).

System 7100 is a high performance data acquisition. Each sensor channel employs a 24-bit analog-to-digital converter. Scan rates up to 2000 updates 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 scanner module has high-capacity non-volatile 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 (7100-SM-VC). Calibration can be performed anywhere and there is no need to return the entire system to the factory for calibration. Downtime while waiting for calibration is essentially eliminated. Input connectors are RJ45 type (except for the TC card) and assembly time is fast using simple cable crimping tools. Individual scanners can be separated and located near sensors to reduce sensor signal loss and cabling costs.

System 7100 – Data Acquisition System

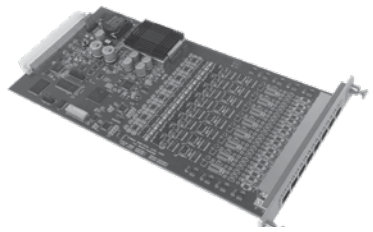
MODEL 7100-128-SM - 128-CHANNELS SCANNER SPECIFICATIONS	
	Model 7100-128-SM Scanner houses and retains up to 16 input cards, regulates power to the cards, establishes and maintains communication between the Ethernet interface and the input cards, synchronizes the analog-to-digital converters in the system, and provides visual status information to the operator.
Parameter	**Value**
Capacity	Up to 16 Input Cards, 8 channels each, maximum 128 channels per scanner
Installation	Rack-mount (19-inch) or bench-top
Front panel	Incorporates power switch and four status LEDs
Input Power	11-32 VDC, 40A max.
Power Indication	Green LED (illuminated when power is on)
Ethernet Interface	802.3z Gigabit Ethernet
Processor	Cortex-A8, 32 bit, RISC
Memory	512MB DDR3
System Synchronization	
Connections	Sync In, Sync Out
Topology	Daisy-chain
Cable Connection	RJ45, Category 5
Max. Distance	100 ft (30m) between scanners
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	9.25 H x 17.3 W x 13.8 D inches (235 x 440 x 351 mm)
Weight	18.2 lb (8.25 kg)

System 7100 – Data Acquisition System

MODEL 7100-32-SM - 32-CHANNELS SCANNER SPECIFICATIONS	
	Model 7100-32-SM Scanner houses and retains up to 4 input cards, regulates power to the cards, establishes and maintains communication between the Ethernet interface and the input cards, synchronizes the analog-to-digital converters in the system, and provides visual status information to the operator.
Parameter	**Value**
Capacity	Up to 4 Input Cards, 8 channels each, maximum 32 channels per scanner
Installation	Bench-top
Front panel	Incorporates power switch and four status LEDs
Input Power	11–32 VDC, 12A max
Power Indication	Green LED (illuminated when power is on)
Ethernet Interface	802.3z Gigabit Ethernet
Processor	Cortex-A8, 32 bit, RISC
Memory	512MB DDR3
System Synchronization	
Connections	Sync In, Sync Out
Topology	Daisy-chain
Cable Connection	RJ45, Category 5
Max. Distance	100 ft (30m) between scanners
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	9.1 H x 5.9 W x 13.9 D inches (231 x 150 x 352 mm)
Weight	10.1 lb (4.6 kg)

System 7100 – Data Acquisition System

MODEL 7100-8-SG - STRAIN GAGE INPUT CARDS



Model 7100-8-SG Strain Gage Input Cards accomplish bridge excitation, bridge completion, shunt calibration, and signal conditioning for eight quarter, half, and full bridges.

Parameter	Value
Channels	Eight per card
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
Sample rate	2000, 1000, 500, 200, 100, and 10 samples/ second
Input Impedance	220 MΩ nominal each input
Source Current	±5 nA per volt excitation
Measurement Range and Resolution	
Resolution	0.5 με (GF=2)
Range	Total range depends on excitation setting (see table):

Excitation (Volts)	Measuring Range	
	με @ GF=2	mV/V
0	77,500*	19*
0.25	310,000	155
0.5	155,000	77
0.75	103,000	51
1	77,000	38
2	38,000	19
3	25,000	12
4	77,000	38
5	62,000	31
6	51,000	25
7	44,000	22
8	38,000	19
9	34,000	17
10	31,000	15

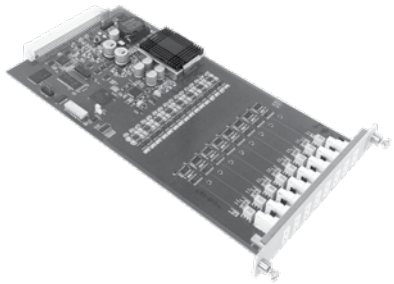
Input Connector	RJ45
Amplifier	
Zero Temperature Stability	±1 µV/°C RTI, after 60-minute warm-up
DC Gain Accuracy and Stability	±0.1%; ±50 ppm/°C (1 year without periodic VCAL)
Analog Input (Including Full-Scale Balance)	
Low Range	±38 mV
High Range	±155 mV
Linearity	±0.02% of Full Scale
Common-Mode Rejection	>90 dB (DC to 60 Hz)
Common-Mode Voltage Range	±12V typical

*Based on 1 volt excitation

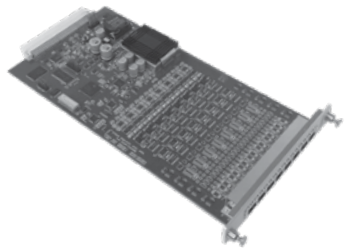
System 7100 – Data Acquisition System

MODEL 7100-8-SG - STRAIN GAGE INPUT CARDS (cont.)	
Parameter	**Value**
Balance	
Type	Software (mathematical)
Range	Full ADC range
Excitation	
Selection	Firmware controlled per channel
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 load with remote sense
Temperature Stability	±10 ppm/°C
Quarter-Bridge Completion	
Selection	Firmware controlled
Accuracy and Drift 120Ω and 350Ω: 1 kΩ:	 ±0.01%, 5 ppm/°C max. ±0.01%, 4.5 ppm/°C max. (socketed)
Shunt Calibration	
Selection	Firmware controlled
Configuration Internal QB: External:	 P- to D120, P- to D350, P- to D1000 Switched shunt at Input Connector (Ra, Rb)
Standard Factory Installed resistors values (Simulates 10,000 με@GF=2.0)	5,940 Ω ± 0.1%: shunts P- to D120 17,325 Ω ± 0.1%: shunts P- to D350 49,500 Ω ± 0.1%: shunts P- to D1000 17,325 Ω ± 0.1%: external shunt Ra to Rb
Sockets	Tin-plated
System Calibration	Firmware controlled
Calibration voltage	Supplied by Model 7100-SM-VC voltage calibration card
Type	Ten point calibration, 100 samples per point
Size	6.5 H x 1.0 W x 12.5 D in (165 x 25.4 x 318 mm)
Weight	0.9 lb (0.4 kg)

System 7100 – Data Acquisition System

MODEL 7100-8-TC - THERMOCOUPLE INPUT CARD	
	Model 7100-8-TC Thermocouple Input Card is to perform signal conditioning and cold-junction compensation.
Parameter	**Value**
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	mini-TC
Sample rate	2000, 1000, 500, 200, 100, and 10 samples/second
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
Measurement Range and Resolution Range: Resolution:	 ±77.5 mV 1°C minimum
Accuracy	±2°C
Size	6.5 H x 1.0 W x 12.5 D in (165 x 25.4 x 318 mm)
Weight:	0.9 lb (0.4 kg)

System 7100 – Data Acquisition System

MODEL 7100-8-HL - HIGH LEVEL INPUT CARD	
	Model 7100-8-HL High Level Input Card is used to perform signal conditioning and excitation for high level (±10V) inputs.
Parameter	**Value**
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	RJ45
Sample rate	2000, 1000, 500, 200, 100, and 10 samples/second
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	±12 V typical
Measurement Ranges and Resolution Range: Resolution:	 ±10 V 100 µV effective
Excitation	**Firmware controlled settable per channel**
Unipolar Mode	
Range	0 to +11.997 VDC
Accuracy	±10mV 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
Size	6.5 H x 1.0 W x 12.5 D in (165 x 25.4 x 318 mm)
Weight:	0.9 lb (0.4 kg)

System 7100 – Data Acquisition System

MODEL 7100-8-LVDT - LVDT CARD	
	Model 7100-8-LVDT is used to perform signal conditioning, polarity demodulation and AC excitation for Transformer-type transducers.
Parameter	**Value**
Channels	Eight per card
Inputs	**Six-, five-, four- and three-wire transducers**
Input Impedance	220 MΩ nominal each input with0.001 µF parallel to both inputs
Input Bias Current	±0.5 nA typical (±2 nA max.)
Input Connector	RJ45
Sample rate	2000, 1000, 500, 200, 100, and 10 samples/second
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)	>80 dB
Common-Mode Voltage Range	±12 V typical
Post Demodulator Filter	1.0 kHz @ –3 dB
Measurement Range and Resolution Range: Resolution:	 ±5 VRMS 50 µVRMS effective
Excitation	Firmware controlled per card
Frequency	2500, 5000, or 10000 Hz sine wave
Amplitude	3 VRMS
Accuracy	±0.5% of full scale typical @ 2500 Hz; ±1.0% @ 5000 or 10000 Hz
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
Dimensions	6.5 H x 1.0 W x 12.5 D in (165 x 25.4 x 318 mm)
Weight	0.9 lb (0.4 kg)

Model 8000 – Data Acquisition System

FEATURES

- Eight software-selectable input channels
- Up to 16 scanners can be used concurrently
- Supported inputs include:
  - o Strain gage (quarter, half, and full bridges)
  - o Strain-gage-based transducer
  - o High-level voltage signal
  - o Thermocouples
- RJ45 input connectors for each input channel
- Scanning rates are 1000, 500, 200, 100, and 10 samples/second
- Compact size and ruggedized enclosure
- Ethernet network architecture
- Optional self-calibration functionality available

DESCRIPTION

System 8000 from Micro-Measurements is a versatile, precision data acquisition instrument system intended for static and dynamic test and measurement applications.

The system includes a scanner with 8 channels of data acquisition. A 10-ft crossover Ethernet cable is also included. The scanners may be used separately or up to 16 scanners can be used concurrently for a maximum of 128 channels.

Each channel can be configured, via software, to accept signals from strain gages or strain-gage-based transducers, thermocouples, or high level voltage sensors. Strain gage channels accept quarter, half, or full bridge configurations and have the required bridge completion components for 120, 350, and 1000 Ω bridges. Each scanner operates independently; multiple scanners are not synchronized.

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 8000-8-SM Scanner communicates with a host personal computer (PC) via an Ethernet connection. Micro-Measurements StrainSmart® software is optimal for configuring, controlling, and acquiring data from the System 8000. A Programmer's Reference Kit provides documentation, programming examples, and instrument drivers to assist with custom software development.

SUPPORTED SENSORS

Each channel can be defined, via software, to be one of the following sensor types:

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

SAMPLING

All channels in each scanner are sampled simultaneously. Each channel's 24-bit analog-to-digital converter over-samples data at a rate of 128k samples/second, and provides high quality, low noise data (without the need for signal averaging) at rates up to 1000 samples/second/channel.

SCANNING RATES

The system provides numerous scan rates and Finite Impulse Response (FIR) filters are automatically selected to provide suitable filtering at each rate to avoid aliasing. Sampling rates for the Model 8000-8-SM are 1000, 500, 200, 100, and 10 samples/second.

COMPACT, RUGGEDIZED ENCLOSURE

The Model 8000-8-SM has 8 channels in a 1U (1.72 inch) height aluminium-alloy enclosure for durability. A rack mount kit is also available.

RJ45 INPUT CONNECTORS

Each channel input connector is RJ45.

RELAY OUTPUT

A relay output is provided to control external hardware.

ETHERNET NETWORK ARCHITECTURE

The system communicates over an IEEE-802.3u 100Base-TX or an IEEE-802.3 10Base-T Ethernet Network. The firmware uses separate command and data ports and employs a reliable TCP-based protocol to prevent data loss.

DC OPERATION

Model 8000 operates on 11-32 VDC power. This can be from the included power supply or by using a separate AC-to-DC converter or DC supply such as a battery.

MODEL 8000-8-SM POWER SOURCE

The Model 8000 is a DC-powered instrument. The system accommodates DC input voltages from 11 to 32 volts. The included power supply provides the required AC-to-DC conversion and up to 26 watts of power to the system. An alternate DC power source can be used provided that it

Model 8000 – Data Acquisition System

supplies enough power to meet the system and excitation power requirements. The total system power requirements are highly dependent upon the power requirements of the bridge excitation circuitry. At a minimum, the instrument requires approximately 17 watts of power. A fully loaded instrument employing the maximum excitation current requires up to 26 watts of power.

ENCLOSURE

The Model 8000-8-SM enclosure is constructed of aluminum alloy. The enclosure is designed to provide strength, durability, and to minimize RF emissions and susceptibility.

A123 SYSTEM VOLTAGE CALIBRATION CARD (OPTIONAL)

The Micro-Measurements A123 System Voltage Calibration (VCAL) Card is available as an accessory and provides the ability to perform a system-level calibration of the entire measurement circuit without the need to return the system to the manufacturer or metrology lab. The gain and offset of each channel can be calibrated. The A123 is calibrated at the factory to NIST-traceable standards and does not need to be present in the system during normal operation. A benefit of on-board system calibration is the ability to calibrate the system under the actual operating conditions, thereby minimizing errors due to environmental conditions.

SPECIFICATIONS

All specifications are nominal or typical at +23°C unless noted.

MODEL 8000-8-SM – SCANNER

For CE compliance, Micro-Measurements recommends that all cables be limited to 30 meters in length.

PARAMETER	SPECIFICATION
GENERAL	
ENVIRONMENTAL	
Temperature:	0° to +50°C
Humidity:	Up to 90%, non-condensing
ENCLOSURE	
Material:	A356-T6 aluminum casting
CONFIGURATIONS:	Bench-top, stackable, rack-mountable
POWER	
Input:	10-32 VDC, 5A max.
Power Switch:	Rocker switch with green LED to indicate power on
RELAY	
Configuration	One NO and NC, 500 mA relay contact
COMMUNICATION	IEEE 802.3 10Base-T, 802.3u 100Base-TX, half- and full-duplex, auto-detect.
SIZE	1.72 H (1.96 with feet) x 11.0 W x 10.18 D (10.55 including power connector) inches (43.68 (49.78 with feet) x 279.4 x 258.66 mm)
WEIGHT	3.85 lbs (1.75 kg)

Model 8000 – Data Acquisition System

PARAMETER	SPECIFICATION
ANALOG CHANNELS	Eight, differential inputs
A/D CONVERTER	Eight (one per channel)
Architecture:	Delta-Sigma (ΔΣ)
Resolution:	24 bits
Oversampling Rate:	128k samples/second/channel (max)
DATA RATES	1000, 500, 200, 100, or 10 samples/second/channel
ANALOG ANTI-ALIAS FILTER	
Type:	Low-pass
Cutoff Frequency:	500 Hz @ –3 dB
Number of Poles:	One
Topology:	Low pass RC
DIGITAL FILTERS	
Type	Two-stage Finite Impulse Response (FIR)

*f*user (Hz)	*F*pass (Hz)	Passband Peak-Peak Ripple (dB)	Stopband Attenuation (dB)
1000	360	0.01	-70
500	200	0.01	-80
200	80	0.01	-80
100	35	0.01	-70
10	3.5	0.01	-66

PROCESSOR	
Type	32-bit floating point Digital Signal Processor, 300 MHz
RAM	
Type:	SDRAM
Capacity:	32 MB
FLASH Memory	
Type:	Serial NOR
Capacity:	1MB (user)
SYSTEM CALIBRATION	Firmware-controlled. Calibration Voltage Supplied by Model A123 voltage calibration card.
Type:	Multi-point, ≥100 samples per point
STRAIN GAGE INPUTS	Up to 8 per scanner
INPUTS	Software selectable for S+/S-, Vcal+/Vcal-, or excitation
Strain Gage:	120, 350, 1000 Ω quarter-bridges; 60 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	
Resolution:	0.5 με @ GF=2 (0.25 μV/V)
Range:	Depends upon excitation setting

Model 8000 – Data Acquisition System

PARAMETER	SPECIFICATION		
	Excitation (V)	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	3800	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		
INPUT CONNECTOR	RJ45		
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		

Model 8000 – Data Acquisition System

PARAMETER	SPECIFICATION
Temperature Stability:	±10 ppm/°C
QUARTER-BRIDGE COMPLETION	
Selection:	Firmware-controlled
Accuracy and drift:	120 Ω and 350 Ω: ±0.01%, 2.8 ppm/°C max. 1 kΩ: ±0.01%, 1.6 ppm/°C max. (Socketed)
SHUNT CALIBRATION	
Selection:	Firmware-controlled
Configuration:	Shunt calibration across each dummy resistor to simulate 10000 με (±0.1%).
Sockets:	Tin-plated
Levels:	Simulates 10000 με @ GF = 2.0
Values:	P- to D120: 59400 ±0.1% P- to D350: 173250 ±0.1% P- to D1000: 495000 ±0.1%
THERMOCOUPLE INPUTS	Up to 8 per scanner
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	RJ45
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:	±12 V typical
MEASUREMENT RANGE AND RESOLUTION	
Range:	±77.5 mV
Resolution:	1°C minimum
ACCURACY	±2°C (nominal)
HIGH-LEVEL INPUTS	Up to 8 per scanner
INPUTS	Differential
Input Impedance:	220 MΩ nominal each input
Input Bias Current:	±0.5 nA typical (±2 nA max.)
INPUT CONNECTOR	RJ45
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:	±12 V typical

Model 8000 – Data Acquisition System

PARAMETER	SPECIFICATION
MEASUREMENT RANGE 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
ACCURACY	±100 ppm repeatability, typical ±250 ppm repeatability, maximum
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	±5 V

Model 9000 – High-Speed Data Acquisition System

FEATURES

- 12 Strain gage channels, supporting quarter, half, and full bridge strain gages and strain-gage-based transducers.
- 4 Plug-in card slots, available to support:
  - o High-level voltage signal
  - o Thermocouples
  - o Piezoelectric transducers (charge mode and voltage mode)
- Sampling rates: 50,000, 25,000, 10,000 and 5,000 samples/second.
- Synchronized sampling of all channels.
- Expansion to a 48-channel system: Up to three scanners can be combined to provide 48 fully synchronized channels (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) using NIST-traceable voltage calibration card (Model A123).
  - o Provides a high-accuracy voltage source used to calibrate the gain and offset of each channel. 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 quarter, half, or bridge configurations and have the required bridge completion components for 120, 350, and 1000 Ω bridges. The data is processed in a 24-bit digital signal processor (DSP) and filtering is performed using Finite Impulse Response (FIR), multi-stage filters. This provides excellent noise rejection and stability.

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 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).

Model 9000 – High-Speed Data Acquisition System

SPECIFICATIONS

All specifications are nominal or typical at +23°C unless noted.

PARAMETER	SPECIFICATION
MODEL 9000-16-SM	
Environmental	
Temperature:	0° to +50°C
Humidity:	Up to 90%, non-condensing
CONFIGURATIONS	Bench-top, stackable, rack-mountable
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)
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:	Low-pass RC
DIGITAL FILTERS	
Type:	Finite Impulse response (FIR), two selectable filters provided per sampling rate)

*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

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

POWER Input:	11-32 VDC, 10 A max

Model 9000 – High-Speed Data Acquisition System

PARAMETER	SPECIFICATION
ENCLOSURE	
Material:	A356-T6 aluminum casting
SIZE	3.50 x 17.19 x 11.5 inch (88.9 x 436.7 x 292.1 mm) (H x W x D) Feet add 0.33” (9.35 mm) to the height. A123 VCAL module adds 1.47” (37.4 mm) to the depth
WEIGHT	13.05 lbs (5.92 kg), without auxiliary plug in cards
STRAIN GAGE INPUTS	
Quantity:	12
INPUTS	Software-selectable for S+/S–, Vcal+/Vcal–, or excitation
Supported Strain gage resistance	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	
Resolution:	0.5 με @ GF=2 (0.25 μV/V)
Range:	Depends upon excitation setting

Excitation (V)	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	3800	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.

Input connector	RJ45
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

Model 9000 – High-Speed Data Acquisition System

PARAMETER	SPECIFICATION
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:	Shunt calibration across each dummy resistor to simulate 10000 με (±0.1%).
External:	Switched shunt at input connector (Ra, Rb)
Resistor sockets:	Tin-plated
DIGITAL INPUT/OUTPUT	
Quantity:	1 input and 1 output
Configuration:	5 V TTL, Isolated
ANALOG OUTPUTS	(MODEL 9000-16-SM-AO)
Quantity:	12 (one per strain gage input channel)
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

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.

MODULE 9000-TC	**THERMOCOUPLE INPUT CARD (OPTIONAL)**
CHANNELS:	1 channel per card; 4 cards max

Model 9000 – High-Speed Data Acquisition System

PARAMETER	SPECIFICATION
INPUTS	
Supported 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
Common-mode Voltage range:	±12 V typical
MEASUREMENT RANGE AND RESOLUTION	
Range:	±77.5 mV
Resolution:	1°C min.
Measurement Accuracy:	±2°C (nominal)
MODULE 9000-HL	**HIGH-LEVEL INPUT CARD (OPTIONAL)**
CHANNELS:	1 channel 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:	RJ45
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
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

Model 9000 – High-Speed Data Acquisition System

PARAMETER	SPECIFICATION
Bipolar mode:	
Range:	±12 VDC (24 VDC total)
Accuracy:	±5% of full scale
MODEL 9000-PE	**PIEZOELECTRIC INPUT CARD (OPTIONAL)**
CHANNELS:	1 channel 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, ±875 pC
Resolution:	0.1 pC
EXCITATION	
Selection:	Software controlled
Range:	0, 1, 2, 4, 5, 10 and 20 mA 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 optional A123 voltage calibration card
Type:	Multi-point, ≥100 samples per point

A123 Voltage Calibration Card
(Optional)

Model 9000 – High-Speed Data Acquisition System

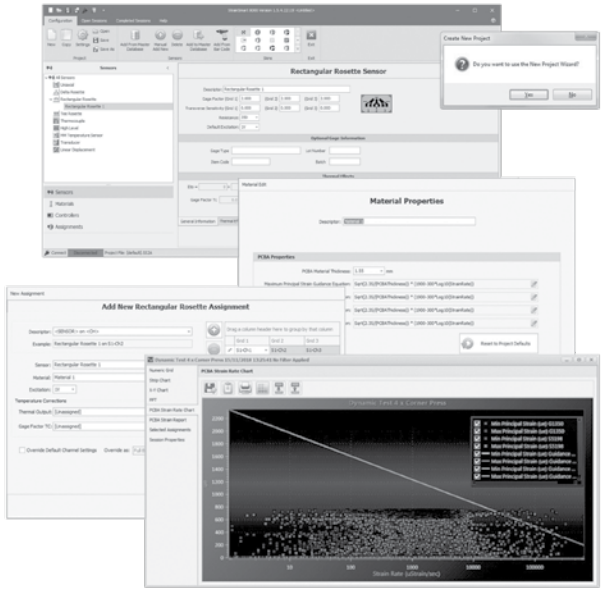
SYSTEM 9000 OPTIONAL ACCESSORIES		
MM Part Number	**Item Description**	**Notes**
COMMUNICATION		
MM120-001623	MMA128 Ethernet router (with cable)	Required for communication between your PC and the 9000 (1)
MM120-001624	MMA129 7', Cat6, shielded, straight-through Ethernet cable	Used for synchronization cabling between multiple instruments. May also be used for Ethernet communication.
MM120-001625	MMA131 2', Cat6, shielded, straight-through Ethernet cable	Used for synchronization cabling between multiple instruments. May also be used for Ethernet communication.
MM120-001580	10', Cat5e, unshielded, straight-through Ethernet cable	Used for Ethernet communication (1) (should not be used for synchronization cabling)
OPTION MODULES		
MM120-001608	9000-HL High Level Input Card	High-level voltage signals ±10 VDC
MM120-001609	9000-TC Thermocouple Input Card	Supported J, K, T, E, N, R, S, B types
MM120-001610	9000-PZ Piezoelectric Input Card	Charge and voltage mode capable
MM120-001579	A123 Calibration (VCAL) card	Required for on-site calibration
MM120-001606	Rack-mount kit	Brackets for mounting into an instrumentation rack
INPUT CONNECTION		
MM120-001620	MMA114 - RJ45(8) modular plug, shielded	Recommended connector for strain gage and high level inputs. May be used for digital I/O.
MM120-001581	MMA106 RJ45(8) modular plug, unshielded	Connector for digital input/output
MM120-001622	MMA115 RJ45(8), shielded modular plug crimping	Tool used to crimp wires to connector MMA114
MM120-001582	MMA108 RJ45(8), unshielded modular plug crimping	Tool used to crimp wires to connector MMA106
MM120-001627	MMA134 2-Pin miniature plug for type J	No shield present
MM12X300830	MMA135 3-Pin miniature plug for type J	Shield present
MM120-001629	MMA136 2-Pin miniature plug for type	No shield present
MM120-001630	MMA137 3-Pin miniature plug for type K	Shield present
MM120-001626	MMA141 Wire Clamp Bracket For Mini TC Plug	

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).

StrainSmart® Data Acquisition Software

StrainSmart® is a ready-to-use, Windows-based software package for acquiring, reducing, presenting, and storing measurement data from strain gages, strain-gage-based transducers, thermocouples, temperature sensors, LVDTs, potentiometers, piezoelectric sensors, and other commonly used transducers.

And, it is designed to function seamlessly with our StrainSmart® hardware, System 7100, System 8000, and System 9000 as well as our legacy System 7000.



FEATURES

- Complete Windows-based software designed for the experimental stress analyst
- Easy-to-use StrainSmart® Wizards for fast test setup and for data acquisition, reduction, and presentation
- Sensor-specific assignment of inputs (strain gages, thermocouples, etc.), as well as user-defined assignments for mathematical manipulation of measurement data
- One-touch auto-balance
- Shunt calibration of strain-gage inputs
- Test setup and commonly used parameters available for saving and reuse for subsequent testing
- Data reduction for delta, rectangular, and tee rosettes, including the conversion of principal strains to stresses
- Calculation of equivalent stresses for common failure mode criteria
- Online monitoring of key channels and/or rosettes in fully reduced and corrected numeric and graphic formats
- Offline presentation of all reduced data in numeric and graphical formats
- FFT analysis
- PCBA graphing and reporting according to IPC/JEDEC 9704A
- Thermal output compensation
- Correction for temperature coefficient of gage factor
- Wheatstone bridge nonlinearity correction
- Transverse sensitivity correction
- Thermocouple linearization
- Scaling for number of active bridge arms
- Record on limits or user-defined time intervals
- Automatic project log file
- Barcode input of strain gage datasheet information
- Through StrainSmart® software, the appropriate setup information is entered—gage factor, materials properties, transducer sensitivities, etc. Using these parameters, StrainSmart® automatically outputs the results of test data in engineering units.

DESCRIPTION

Ready-to-use StrainSmart® software makes test setup fast and easy for strain gages, strain-gage-based transducers, thermocouples, temperature sensors, LVDTs, potentiometers, piezoelectric sensors, and other commonly used transducers. Using the parameters input for sensors, materials, and instrumentation hardware, StrainSmart® automatically outputs the results of the test data in engineering units. Test setups and measurement data can also be permanently stored for offline display or for use in databases, word processors, and spreadsheets.

StrainSmart® has the capability to reduce data in both the time and frequency domains. FFT analysis may be elected for data acquired at scanning rates greater than 100 samples per second.

Accurate strain measurements require attention to the unique characteristics of the strain gage and measurement system—thermal output, temperature coefficient of gage factor, and transverse sensitivity of strain gages, as well as nonlinearity errors inherent in the Wheatstone bridge. StrainSmart® software takes these into account automatically.

All strain-gage bridges are scaled for the number of active bridge arms. Data from measurements with delta, rectangular, and tee rosettes can be reduced to principal strains and stresses, as well as the equivalent stresses for common failure mode criteria.

PCBA reporting to IPC/JEDEC 9704A is integrated into StrainSmart®, with user-definable strain guidance as a formula or fixed microstrain value. Data can be viewed as a strain rate graph or pass/fail report.

Fully reduced and corrected measurement data can be monitored online, and recorded at predetermined limits or at user-defined intervals.

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MICRO MEASUREMENTS
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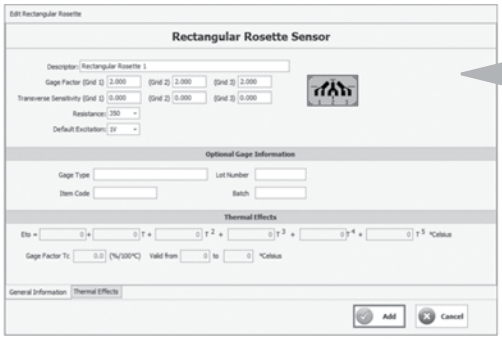
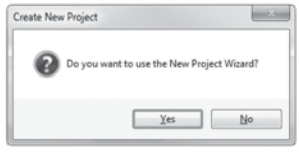
Software for Stress Analysis Testing

THE STRAINSMART® ADVANTAGE

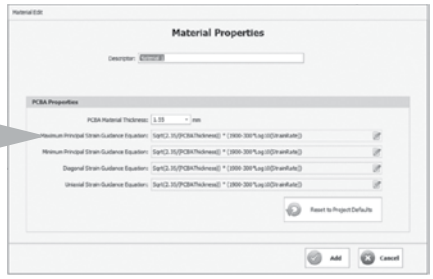
Strain gage technology is the stress/strain measurement technique most widely used around the world. Over the years, we have developed the tools necessary for accurate acquisition and understanding of strain gage measurements. The primary factors affecting strain gage and instrument performance are incorporated into our extensive selection of Tech Notes, Application Notes, Instruction Bulletins, and other technical publications that are recognized and used as the authoritative references for strain gage measurement by practitioners throughout the world. StrainSmart® software automatically applies the techniques and corrections covered by these publications to your test measurements.



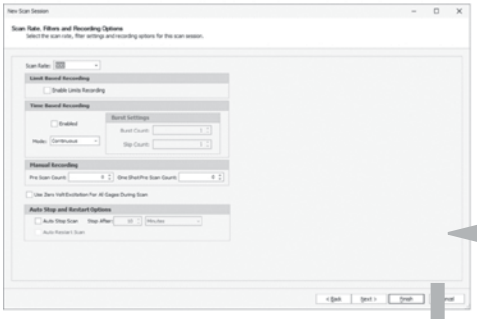


Create Project

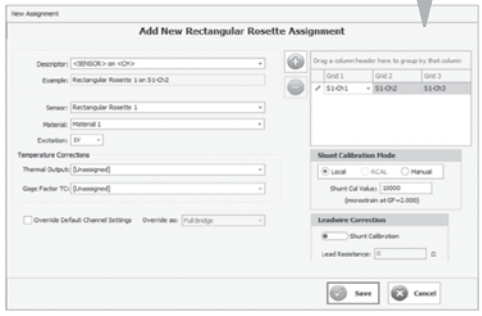
Enter Materials Properties



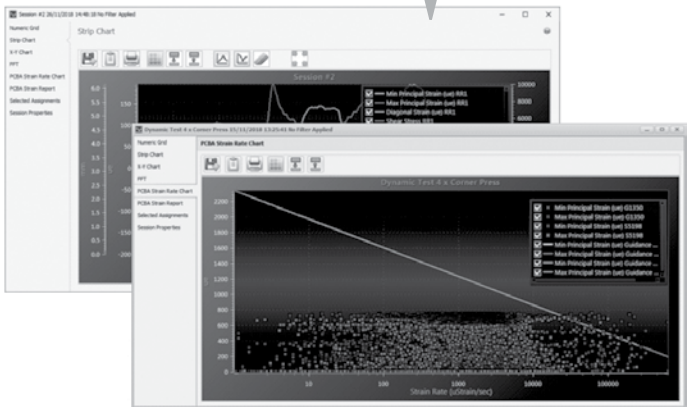
Enter Sensor Information



Create Assignments of Sensors, Materials and Channels



Select recording parameters



Scan and Display Fully Corrected Test Data

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Special Use Equipment

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Portable Strain Gage Welding and Soldering Unit

FEATURES

- Separate visual and audible indicators monitor welder status.
- Weld energy is continuously adjustable from 3 to 50 joules, making the Model 700 an excellent choice for installing weldable strain gages and temperature sensors, as well as small thermocouples and light-gage metal.
- Supplied with a lightweight soldering pencil. A front-panel control adjusts soldering tip temperature for a wide range of soldering applications in the field or in the laboratory.
- "Low-battery" light to warn the user when the internal, sealed lead-acid battery requires charging. A battery charger is included to provide for full battery charge with no danger of overcharging. Indicator lights monitor battery charge rate.
- Convenient storage space for cables, battery charger and instruction manual

SPECIFICATIONS

All specifications are nominal or typical at +23°C unless noted.

PARAMETER	SPECIFICATION
General	
Power for recharging	115 VAC or 230 VAC, 50-60 Hz. Uses external AC transformer (provided)
Operating and Storage Temperature Range	0°F to +120°F (–20°C to +50°C)
Size	9 L x 9 W x 9-3/4 H in (230 x 230 x 250 mm)
Weight	21 lb (9.5 kg)
Welding Specifications	
Weld Energy Range	3 to 50 joules, continuously adjustable by front-panel control Maximum open-circuit voltage less than 25 VDC
Maximum Weld Repetition Rate	20 per minute at 30 joules, typical
Number of Welds per Battery Charge	Approximately 2000 at weld energy setting of 30 joules. This is equivalent to around 30 Micro-Measurements linear weldable gages.
Battery Charge Time: (from full discharge)	12 hours to 75% full charge; 18 hours to full charge
Battery	One sealed, rechargeable lead-acid (non-liquid) type, 12 volt, 5 ampere-hour
Welding Probe	Manually fired with trigger control and "steady-rest"
Welding Cables	Two 5 ft (1.5 m), fully flexible
Weld Energy Monitor	Calibrated front-panel control with READY and WAIT indicators; audible indication selectable

Portable Strain Gage Welding and Soldering Unit

PARAMETER	SPECIFICATION
Soldering Specifications	
Temperature Control	Continuously variable with bands indicating melting range of solders
Soldering Pencil	1.1 oz (31 gm), rated at 25 watts, 12 volt operation. Tip temperature adjustable from +200°F to +900°F (+90°C to +480°C).
Duration	4 hours using +361°F (+183°C) melting point solders (with initial full charge)
Accessory	Model 700-A103 Spot Welding Probe Set: Recommended for spot welding instrument leadwires to ZC Series high-temperature gages ribbons.

PANEL CONTROL FEATURES

PART NUMBER	DESCRIPTION
MM120-002225	700 WELDER COMPLETE UNIT
REPLACEMENT PARTS	
MM100-121073	700-A STRAIGHT PROBE TIP
MM100-121183	700-B BENT PROBE TIP
MM200-131524	700 HANDLE ASSEMBLY WITH CABLE
MM23X900002	700 REPLACEMENT BATTERY
MM100-123329	SOLDER PENCIL ASSEMBLY
MM100-122961	700 DESKTOP POWER SUPPLY

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Gage Installation Tester

FEATURES

- A compact, battery-powered instrument used to verify the electrical quality of a strain gage installation BEFORE it is placed in service as well as for fault finding AFTER an installation is put into service.
- Reads with the push of a button — no warm-up
- Reads insulation resistance (leakage) to 20,000 MΩ with 15 VDC
- Measures deviation of installed gage resistance from precise standards to a resolution of 0.02%
- Ohmmeter scale for troubleshooting questionable installations
- Verifies the complete gage circuit, including leadwires

DESCRIPTION

Two of the most important measurements used to verify the quality of a strain gage installation are insulation resistance (leakage to ground) and shift in gage resistance due to installation procedures. While these two measurements are not a complete guarantee of eventual proper strain gage performance, any installation that produces questionable values should not be relied upon where accuracy of results is necessary.

For example, a voltage difference between the specimen and strain gage frequently exists. A low insulation resistance will permit this voltage differential to introduce extraneous signals during strain measurement.

Several sources of variations in insulation resistance and shifts in gage resistance are:

- Insulation resistance in excess of 20,000 MΩ should be expected for foil strain gages when installed under laboratory conditions. A value of 10,000 MΩ should be considered minimum. A reading below this value generally indicates trapped foreign matter, moisture, residual flux or backing damage due to soldering, as well as incomplete solvent evaporation from an overcoating.
- Deterioration of the insulation resistance with time may be an indication of an improperly coated installation.
- At higher test temperatures, particularly above +300°F (+150°C), it is normal to expect lesser values. Ten MΩ is considered to be the lower allowable value.
- Shifts in gage resistance during installation should not normally exceed 0.5% when using room-temperature-curing adhesives. Resistance shifts greater than 0.5% generally indicate damage to the gage due to improper handling or clamping. However, strain gages installed using elevated-temperature-curing adhesives may exhibit greater shifts in resistance due to adhesive lock-up at elevated temperatures (difference in linear coefficient of thermal expansion between the strain gage and specimen). These shifts will vary depending upon the specific cure temperature and materials used. The shifts should never exceed 2% and should be uniform within 0.5%.

SPECIFICATIONS

All specifications are nominal or typical @ +23°C unless noted.

PARAMETER	SPECIFICATIONS
INPUT CIRCUITS	
Gages:	Three-wire quarter bridge (120 Ω and 350 Ω) and half bridge. Other value quarter bridges using customer's reference, at readily accessible panel terminals.
As ohmmeter:	Two ranges (500 Ω and 500 MΩ mid-scale)
INPUT LEADS	4-ft (1.2m) 4-conductor AWG #26 (0.4-mm diameter) twisted Teflon®-insulated cable supplied (with ground clip and three tinned leads)
METER	3.5-in size [3.00-in (76-mm) scale length] with mirror
Tracking accuracy:	±1% of full range

Gage Installation Tester

PARAMETER	SPECIFICATIONS
MODE SWITCH	Five momentary push buttons: • Battery check, • ±5% deviation, • ±1% deviation, • gage resistance (Ω), and • insulation resistance (MΩ)
DEVIATION MODE	Two ranges, ±1% and ±5%, of F.S. (50 graduations either side of zero)
Accuracy:	1% range: 0.04% ΔR (2 meter graduations) 5% range: 0.2% ΔR (2 meter graduations)l
Excitation:	1.0 VDC per gage
INSULATION RESISTANCE MODE	Graduated 5 MΩ to 20,000 MΩ (500 MΩ mid-scale)
Accuracy:	1 scale division
Test Voltage:	15 VDC open circuit
OHM MODE	Graduated 5 Ω to 20 kΩ (500 Ω mid-scale)
Accuracy:	1 scale division
Test Voltage:	2 VDC open circuit (0.4 VDC @ 120 Ω)
ENVIRONMENTAL	
Temperature:	+15°F to +125°F (–10°C to +50°C)
Humidity:	Up to 80%, non-condensing
POWER SUPPLY	Four 9 V PP3 (ANSI/NEDA 1604A, IEC 6LR61) batteries
Life:	Typically fully test 1000–5000 installations
Case	
Material:	Aluminum case (separable lid)
Size:	5 H x 7 W x 5 D in with lid (125 x 180 x 126 mm)
Weight	3.6 lb (1.6 kg) with batteries

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Milling Guide for Residual Stress Measurements

DESCRIPTION

A predominant factor contributing to the structural failure of machine parts, pressure vessels, framed structures, etc., may be the residual “locked-in” stresses that exist in the object prior to its being put into service. These residual stresses are usually introduced during manufacturing, and are caused by processes such as casting, welding, machining, heat treating, molding, etc.

Residual stress cannot be detected or evaluated by conventional surface measurement techniques, since the strain sensor (strain gage, photoelastic coating, etc.) can only respond to strain changes that occur after the sensor is installed.

The most widely used practical technique for measuring residual stresses is the hole-drilling strain gage method described in ASTM Standard E837. With this method, a specially configured electrical resistance strain gage rosette is bonded to the surface of the test object, and a small shallow hole is drilled through the center of the rosette. The local changes in strain due to introduction of the hole are measured, and the relaxed residual stresses are computed from these measurements. Micro-Measurements Tech Note TN-503, Measurement of Residual Stresses By The Hole-Drilling Strain Gage Method, presents a detailed discussion of the theory and application of this technique.

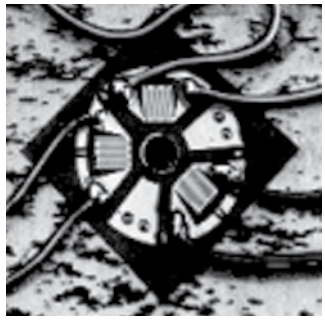
The hole-drilling method is generally considered semi-destructive, since the drilled hole may not noticeably impair the structural integrity of the part being tested. Depending on the type of rosette gage used, the drilled hole is typically 0.062 or 0.125 in (about 1.5 or 3.0 mm), both in diameter and depth. In many instances, the hole can also be plugged, if necessary, to return the part to service after the residual stresses have been determined.

The practicality and accuracy of this method is directly related to the precision with which the hole is drilled through the center of the strain gage rosette. The Micro-Measurements RS-200 milling guide provides a practical means to accomplish this task.

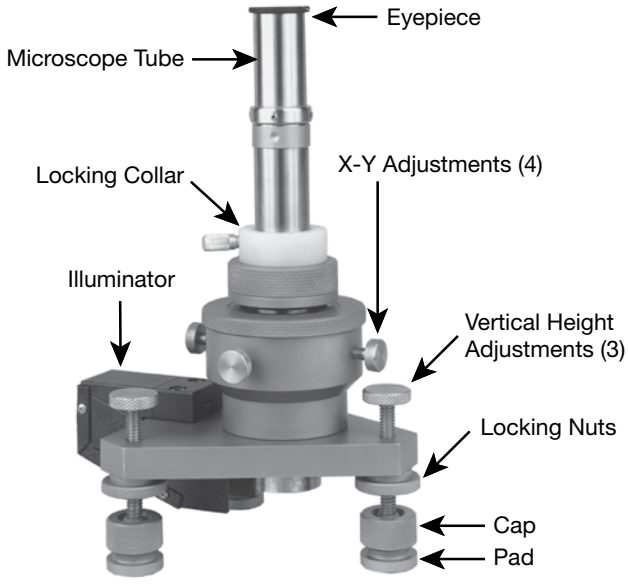
RS-200 MILLING GUIDE

The RS-200 Milling Guide is a precision fixture for accurate positioning and drilling of a hole through the center of a special strain gage rosette. Principal features and components of the milling guide assembly are shown in the photos herein. When installed on the workpiece, the guide is supported by three levelling screws footed with swivel mounting pads to facilitate attachment to uneven surfaces.

Alignment of the milling guide relative to the strain gage rosette is accomplished by inserting a special-purpose microscope into the guide’s centering journal, and then positioning the guide precisely over the center of the rosette by means of four X-Y adjusting screws.



The microscope assembly, consisting of a polished steel housing with eyepiece, reticle, and objective lens, permits alignment to within 0.0015 in (0.038 mm) of the gage center. The microscope is also used to measure the diameter of the hole after it is drilled. An illuminator attaches to the base of the guide to aid in the optical alignment procedure.



Alignment Setup

Milling Guide for Residual Stress Measurements

MILLING GUIDE FOR RESIDUAL STRESS MEASUREMENTS

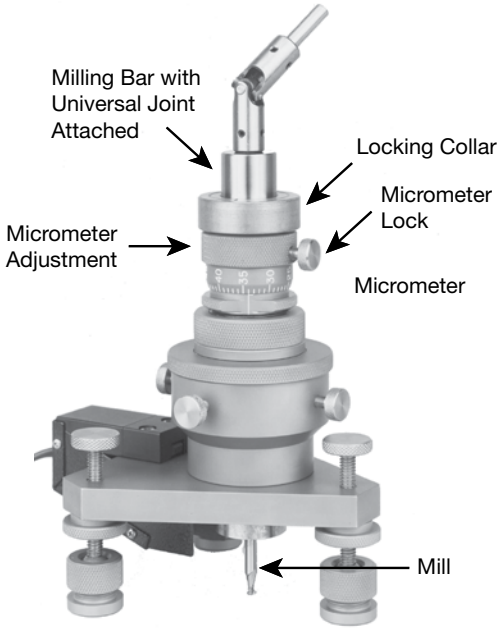
After alignment, the microscope is removed from the guide, and the milling bar or high-speed air turbine is inserted in its place. The milling bar is used for slow-speed drilling of the hole. Two standard milling cutters are supplied: 0.062 and 0.125 in (1.6 and 3.2 mm) diameter. The milling bar is equipped with a universal joint for flexible connection to a drill motor.

Conventional slow-speed milling may be satisfactory on some mild steels and aluminum alloys. But high-speed drilling is generally the most convenient and practical method for introducing the hole in all test materials. (When residual stresses are to be measured on materials such as stainless steels, nickel-based alloys, etc., ultra high-speed drilling techniques are preferred.) For this purpose, a high-speed air-turbine assembly, along with a supply of tungsten carbide-tipped cutters [ten each 0.031 in (0.8 mm) diameter and 0.062 in (1.6 mm) diameter], is supplied with the milling guide. A foot pedal control is included for operating the air turbine.

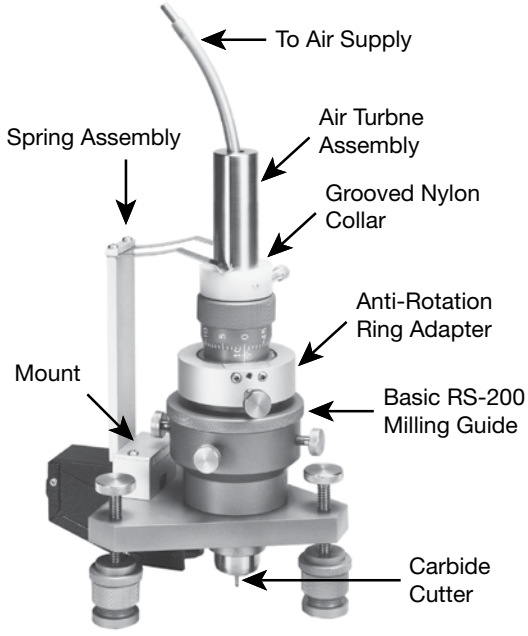
A micrometer depth set attachment, available in English or metric units, is provided with each milling guide assembly. This device is used for incremental drilling when information on the variation of residual-stress-with-depth is desired.

Other items supplied include a plastic template for the proper location of the milling guide foot pads on the test part and a special break-off tool used to remove the foot pads from the part after the test is completed. All components are housed in a sturdy carrying case. The guide is approximately 9 in (230 mm) high, and 4.5 in (114 mm) wide at the base.

A fast-setting-cement kit, used to firmly attach the guide to the test part, is available as an accessory item.



End-Mill Drilling Setup



High-Speed Drilling Setup

PART NUMBER	DESCRIPTION
MMP920-000265	RS-200 MILLING GUIDE- COMPLETE UNIT (GRIP ADHESIVE ORDERED SEPARATELY)
MMF336166	RS-200-CK2 GRIP ADHESIVE (5 PACK)
REPLACEMENT PARTS	
MMP920-000193	RS-200-FP REPLACEMENT FOOT PADS QTY 3 WITH TEMPLATE
MMP100-010569	RS-200 END MILL .062 QTY 1
MMP100-010573	RS-200 END MILL .125 QTY 1
MMP20X100033	RS-200-B1 REPLACEMENT BULB FOR LIGHTSOURCE
MMP27X300006	ATC-200-062 CARBIDE-TIPPED CUTTERS (10/PKG)
MMP27X300007	ATC-200-031 CARBIDE-TIPPED CUTTERS (10/PKG)

For technical questions, contact
mm@vpgsensors.com

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Accessories

Screw Terminal Adapter

DESCRIPTION

The RJ45-STA allows for an easy, reliable and reusable connection to all Micro-Measurements instruments that utilize the RJ45 connector. The RJ45-to-screw- terminal-block adapter has a 6-inch pigtail to allow manipulation and access to the screw terminal block, even when the RJ45 is connected to a data system. The screw terminal block accepts up to 22 AWG wire. Requires a 2 mm slotted screwdriver.

COMPATIBLE WITH:

- System 7000 StrainSmart® Data Acquisition System (strain gage, high level and LVDT inputs)
- System 7100 StrainSmart® Data Acquisition System (strain gage, high level and LVDT inputs)
- System 8000 StrainSmart® Data Acquisition System
- System 9000 StrainSmart® Data Acquisition System (strain gage and high level inputs)
- D4 Data Acquisition Conditioner
- MultiDAQ Strain Gage Data Acquisition Device

Crimping tools for RJ45 crimp connectors

DESCRIPTION

RJ45 crimp connectors are IDC (Insulation Displacement Contact) connectors. The terminals pierce the wire insulation and make gas-tight connections to the conductor for ultimate reliability. To achieve this a suitable crimping tool must be used. All 8 pins must be pushed fully home to ensure successful connection and to avoid damage to the mating input connector on the instrument; failure to achieve this can result in an expensive repair. Properly installed, RJ45 connectors are fast to install and offer excellent long-term reliability.

Plier-type crimping tools are unreliable because it is possible to release the tool before the terminals are fully pressed, and can cause RSI (repetitive strain injury) due to the amount of force required. Ratchet tools require low levels of force and release only when fully depressed. They are ideal when large numbers of connectors are required to be fitted. We offer two types of crimping tool:

MMA106, RJ45 Crimping Tool for Unshielded Modular Plugs – ideal for use with low-cost unshielded connectors where measurements are static or have low levels of environmental noise. For use with our MMA108 unshileded RJ45 connectors.

MMA115, RJ45 Crimping Tool for Shielded Modular Plugs – shielded connectors are essential for dynamic measurements where environmental electrical noise can affect the measured data. For use with our MMA115 shielded RJ45 Connectors.

COMPATIBLE WITH:

- System 7000 StrainSmart® Data Acquisition System (strain gage, high level and LVDT inputs)
- System 7100 StrainSmart® Data Acquisition System (strain gage, high level and LVDT inputs)
- System 8000 StrainSmart® Data Acquisition System
- System 9000 StrainSmart® Data Acquisition System (strain gage and high level inputs)
- D4 Data Acquisition Conditioner
- MultiDAQ Strain Gage Data Acquisition Device

For technical questions, contact
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Legacy and Obsolete Products

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Signal Conditioning Amplifier System

FEATURES

- Strain gage, transducer, and thermocouple inputs
- Frequency response to 110 kHz
- Analog output of ±10 VDC
- Operation with 12 to 15 VDC and 120/240 VAC power
- Scalable from 8 to 128 channels in high-density enclosures
- Digital control from both front panel and PC over Ethernet
- Remote channel-by-channel monitoring of signals by
- Ethernet

DESCRIPTION

The A2 is an analog signal conditioner and amplifier system for strain gages, strain-gage-based transducers, thermocouples and various other sensors with high-level signals. Scalable in multiples of eight channels to a maximum of 128 for each system, the A2 features digital control of the system instrumentation and monitoring of the analog outputs, both locally on the control panel and remotely by Ethernet from a PC. The Model A2 is an embedded web server. All system, card, and channel settings are accessible using simple HTTP (hypertext transfer protocol) commands or by using the graphical user interface provided by the system. Ordinary web browsers, such as Internet Explorer, can be used to control the system. The A2 is specially designed to function as the front-end for DAQ's and recorders accepting high-level analog signals.

Instrumentation hardware, available as individual eight-channel cards for strain gage, thermocouples, and high-level signals, features high stability with temperature and time. Strain-gage instrumentation accepts full-, half-, and quarter-bridge circuits and has built-in bridge completion resistors for 120-, 350- and 1000-ohm quarter bridges. Amplifiers gain, bridge excitation and balance, shunt calibration, and signal filtering are digitally controlled. Instrument design enables sensors to remain connected when cards are removed from the system for bridge configuration.

SPECIFICATIONS

General

All specifications are nominal or typical at +23°C unless noted. Performance may be degraded in the presence of high-level electromagnetic fields.

System Configuration

Each system consists of a Model A2-MC-8 Controller and at least one 8-channel instrumentation card. Stackable expansion cabinets are added when two or more instrumentation cards are used.

Physical Dimensions

Eight Channel Enclosure with Controller
17″ W x 12″ D x 8.5″ H
[43.2 cm W x 30.5 cm D x 21.6 cm H]

40 Channel Enclosure with Controller
17″ W x 12″ D x 17.5″ H
[43.2 cm W x 30.5 cm D x 44.6 cm H]

72 Channel Enclosure with Controller
17″ W x 12″ D x 26.5″ H
[43.2 cm W x 30.5 cm D x 67.3 cm H]

104 Channel Enclosure with Controller
17″ W x 12″ D x 35.5″ H
[43.2 cm W x 30.5 cm D x 90.2 cm H]

128 Channel Enclosure with Controller
17″ W x 12″ D x 44.5″ H
[43.2 cm W x 30.5 cm D x 113.0 cm H]

Input Power

115 or 230 VAC with optional external "line lump" power supply (15 VDC output). Will also work from a 12V battery with reduced specifications.

Controller with Model A2-EC Expansion Cabinet

Signal Conditioning Amplifier System

MODEL A2-MC-8 CONTROLLER

Supports hardware identification, setup and output data monitoring of each type of plug-in card via a local keyboard interface or remotely via an Ethernet Interface. Each controller supports 8 channels of signal conditioning and up to 128 channels of signal conditioning when expansion cabinets are added.

Front Panel User Interface
Membrane keypad with illuminated 128 x 64 pixel FSTN positive, gray transflective LCD

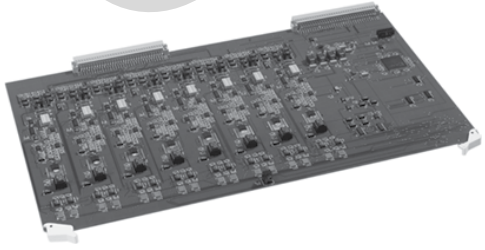
Communication Interface
Physical: 10/100 Base-T
Protocol: HTTP
IP Addressing: Static. Configurable by the front panel controls

Size
17″ W X 12″ D X 8.5″H
[43.2 cm W x 30.5 cm D x 21.6 cm H]

Weight
12.6 lbs [5.7 kg]

MODEL A2-SG-8-BX STRAIN GAGE CARD

(Specify **Model A2-SG-8-BW** (with Butterworth filter characteristics) or **Model A2-SG-8-BS** (with Bessel filter characteristics).



These specifications apply for each of eight independent channels of signal conditioning per removable card.

Amp Input

Inputs
Quarter (120 ohms, 350 ohms, and 1000 ohms), half and full bridge (50-1000 ohms)
Bridge completion resistors are provided for quarterbridge circuits

Input Impedance
>100 MΩ

Source Current
±5 nA typical; ±10 nA max.

Amplifier

Zero Temperature Stability
±1.7 µV/°C RTI*, ±100 µV/°C RTO**, after 30-minute warm-up

Input Range
4 to 80 mV full-scale input range (x2500 to x125)—adjustable by software control per channel

Output Range
±10V into 600Ω minimum load (When powered from 15 VDC)

DC Gain Accuracy and Stability
±0.10%; ±50 ppm/°C

Common-Mode Rejection (DC to 100 Hz)
105 dB typical

Common-Mode Voltage
±10V typical

Bandpass
Full Power Frequency response DC to 110 kHz; -3 dB. (Wideband operation)
Slew Rate: 7 V/µs

Dynamic Characteristics

Noise RTI
1 µV p-p at 0.1 Hz to 10 Hz
6 µVRMS at 0.1 Hz to 110 kHz

Total Harmonic Distortion
0.014% at 1 kHz

Filter

Type
Software-settable 5th order filter—DC to 40 kHz max: -3 dB. (Butterworth or Bessel characteristics)

Settings
Wideband, 40 kHz, 20 kHz, 10 kHz, 5 kHz, 1 kHz, 100 Hz, and 10 Hz
Software-programmable per channel.

Bridge Excitation

Type
Constant voltage

Settings
0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5 and 10.0 VDC
Software-programmable per channel

Accuracy
±3 mV typical

Current
50 mA max. Over-current protected

Load Regulation
<0.05% of full scale for a load variation of 10% to 100% of full load

Temperature Stability
Better than ±0.005%/°C

*Referred to input
**Referred to output

Signal Conditioning Amplifier System

Bridge Balance
99% of measurement range

Calibration
Standard factory-installed resistors (±0.1%) simulate 5000 microstrain at GF=2 for 120-, 350-, and 1000-ohm quarter bridge

8 Channel Strain Gage Card Size
15.13″ W x 9″ D [38.4 cm W x 22.9 cm D]

8 Channel Strain Gage Card Weight
0.80 lbs [0.36 kg]

MODEL A2-TC-8-BX THERMOCOUPLE CARD

(Specify **Model A2-TC-8-BW** (with Butterworth filter characteristics) or **Model A2-TC-8-BS** (with Bessel filter characteristics).

These specifications apply for each of eight independent channels of signal conditioning per removable card.

Amp Input

Inputs
Thermocouple types J, K, T, E, N, R, S, B.
Built-in electronic cold-junction compensation
Software-selectable

Input Impedance
10 MΩ differential, 100 KΩ common mode

Source Current
±5 nA typical; ±10 nA max.

Amplifier

Zero Temperature Stability
±1.7 µV/°C RTI*, ±100 µV/°C RTO**, after 30-minute warm-up

Input Range
4 to 80 mV full-scale input range (X2500 to X125)—adjustable by software control per channel

Output Range
±10V into 600Ω minimum load (when powered from 15 VDC)

DC Gain Accuracy and Stability
±0.05%; ±50 ppm/°C

Common-Mode Rejection (dc to 100 Hz)
105 dB typical

Common-Mode Voltage
±10V typical

Bandpass
Full Power Frequency response DC to 110 kHz; -3 dB (Filter not selected)
Slew Rate: 7 V/µs

Dynamic Characteristics

Noise RTI
1 µVolt p-p at 0.1 Hz to 10 Hz
6 µVRMS at 0.1 Hz to 110 kHz

Total Harmonic Distortion
0.014% at 1 kHz

Filter

Type
Software-settable 5th order filter—
DC to 40 kHz: -3 dB (Butterworth or Bessel characteristics)

Settings
Wideband, 40 kHz, 20 kHz, 10 kHz, 5 kHz, 1 kHz, 100 Hz, and 10 Hz
Software-programmable per channel

8 Channel Thermocouple Card Size
15.13″ W x 9″ D [38.4 cm W x 22.9 cm D]

8 Channel Thermocouple Card Weight
0.80 lbs [0.36 kg]

MODEL A2-HL-8-BX HIGH LEVEL CARD

(Specify **Model A2-HL-8-BW** (with Butterworth filter characteristics) or **Model A2-HL-8-BS** (with Bessel filter characteristics)

These specifications apply for each of eight independent channels of signal conditioning per removable card.

Amp Input

Inputs
DC voltage (differential)

Input Impedance
>100 MΩ

Source Current
±5 nA typical; ±10 nA max.

Amplifier

Zero Temperature Stability
±1.7 µV/°C RTI*, ±100 µV/°C RTO**, after 30-minute warm up

Input Range
1 to 10V full-scale input range—adjustable by software control per channel

Output Range
±10V into 600Ω minimum load (when powered from 15 VDC)

DC Gain Accuracy and Stability
±0.10%; ±50 ppm/°C

Common-Mode Rejection (dc to 100 Hz)
105 dB typical

Common-Mode Voltage
±10V typical

Bandpass
Full Power Frequency response DC to 110 kHz; -3 dB. (Filter not selected)
Slew Rate: 7 V/µs

Dynamic Characteristics

Total Harmonic Distortion
0.014% at 1 kHz

*Referred to input
**Referred to output

Signal Conditioning Amplifier System

Filter

Type
Software-settable 5th Order filte—DC to 40 kHz max: -3 dB. (Butterworth or Bessel characteristics)

Settings
Wideband, 40 kHz, 20 kHz, 10 kHz, 5 kHz, 1 kHz, 100 Hz, and 10 Hz
Software-programmable per channel

Bridge Excitation

Type
Constant voltage

Settings
0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5 and 10.0 VDC
Software-programmable per channel

Accuracy
±3 mV typical

Current
50 mA max. Over-current protected

Load Regulation
<0.05% of full scale for a load variation of 10% to 100% of full load

Temperature Stability
Better than ±0.005%/°C

8 Channel High Level Card Size
15.13″ W x 9″ D [38.4 cm W x 22.9 cm D]

8 Channel High Level Card Weight
0.80 lbs [0.36 kg]

Front View Back View

Controller with Model A2-EC Expansion Cabinet

Expansion Cabinets Size

Model A2-EC-8 Expansion Cabinet:
17″ W X 12″ D X 3.0″ H
[43.2 cm W x 30.5 cm D x 7.6 cm H]

Model A2-EC-16 Expansion Cabinet:
17″ W X 12″ D X 5.0″ H
[43.2 cm W 30.5 cm D x 12.7 cm H]

Model A2-EC-32 Expansion Cabinet:
17″ W X 12″ D X 9.5″ H
[43.2 cm W x 30.5 cm D x 24.1 cm H]

Expansion Cabinets Weight

Model A2-EC-8 Expansion Cabinet: 4.5 lbs [2.04 kg]
Model A2-EC-16 Expansion Cabinet: 6.8 lbs [3.08 kg]
Model A2-EC-32 Expansion Cabinet: 12.0 lbs [5.44 kg]

MODEL A2-EC-X EXPANSION CABINET

(Specify **Model A2-EC-8** (supports one additional instrumentation card) or **Model A2-EC-16** (supports two additional instrumentation cards) or **Model A2-EC-32** (supports four additional instrumentation cards).

Stackable expansion cabinets are added when two or more instrumentation cards are used. Up to 16 instrumentation cards (128 channels) can be used with one Model A2-MC Master Controller. Control and power are routed via the Model A2-MC-8 Controller.

MODEL A2 CONTROL AND MONITORING SOFTWARE

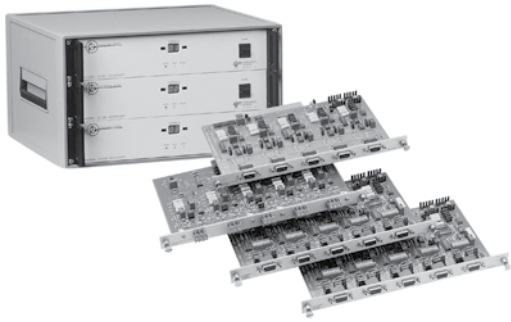
Recommended Browser (User Supplied): Internet Explorer version 6 or later, running under a Windows operating system (XP, Vista, and 7). A PC with Intel Pentium class, or better, processor (450 MHz or higher), 64 MB RAM and a 100 Base-T Ethernet interface is recommended.

MICRO MEASUREMENTS
A VPG Brand

StrainSmart® Data Acquisition System

FEATURES

- From 5 to 1200 input channels—can be configured as needed at any time
- Inputs accepted from strain gages and strain-gage-based transducers (Model 5110A), thermocouples (Model 5120A), sensors with high-level voltage output (Model 5130B), and LVDTs (Model 5140A)
- Built-in bridge completion for 120-, 350-, and 1000-ohm strain gages
- Scanning and recording intervals as short as 0.02 seconds for up to 1200 inputs
- Stable, accurate, low-noise signal conditioning
- Available with PCI and PCIe hardware Interface



DESCRIPTION

System 5000's Model 5100B Scanners acquire test data within 1 millisecond from up to 1200 channels at scan intervals as short as 0.02 seconds. This translates into more accurate test results, and the ability to capture data under static loading conditions immediately before failure.

Sensor connections are quickly made to the cards at the rear of each scanner in System 5000. Strain gage cards include built-in bridge completion for quarter and half bridges, and a constant voltage power supply for 0, 0.5, 1, 2, 5, and 10 VDC bridge excitation.

System 5000's instrumentation hardware is designed to incorporate all the features required for precision strain measurement under static loading conditions, while maintaining flexibility and ease of use. A system can be configured with as few as 5, and as many as 1200, sensors. Since each Model 5100B Scanner can function independently, your System 5000 components can easily be configured with StrainSmart software for each test requirement.

MODEL 5100B SCANNER SPECIFICATIONS

The Model 5100B Scanner is sized for standard 19-in (483-mm) instrumentation racks. Cabinets are available for various system configurations for bench-top or field use.

Since each Model 5100B Scanner can function independently, your System 5000 components can be easily configured for each test requirement. A 100-channel system, for example, can be used as five independent 20-channel systems simply by purchasing additional interface hardware installations.

INPUTS

Accepts up to four cards (five channels per card and up to 20 channels per scanner).

A/D CONVERTER

16-bit (15-bit plus sign) successive approximation converter. Usable resolution is typically 15 bits. 40 µs total conversion time per reading.

SCAN RATE

1 ms per scan. Fifty complete scans per second typical usage. Concurrent scanning for all scanners.

Input channels in each single scanner are scanned sequentially at 0.04-ms intervals and stored in random access memory within a 1-ms window.

DIGITAL OUTPUT

NO and NC relay contacts (500 mA at 30 VDC into a resistive load)

OPERATIONAL ENVIRONMENT

Temperature

–10° to +50°C

Humidity

Up to 90% RH, non-condensing

SIZE

3.5 H x 19 W x 16 D in (89 x 483 x 381 mm)

WEIGHT

16 lb (7.25 kg)

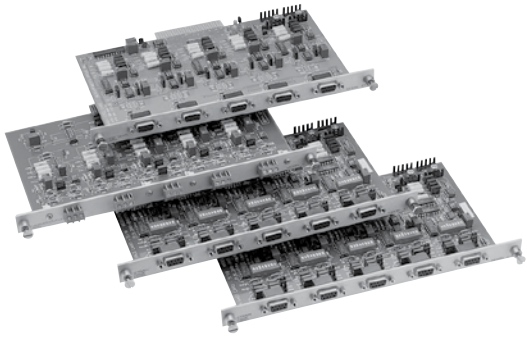
POWER

115 or 230 VAC user-selectable

±10% of setting; 50/60 Hz; 140W max

StrainSmart® Data Acquisition System

SENSOR CARD SPECIFICATIONS



Strain gages, strain-gage-based transducers, thermocouples, LVDTs, potentiometers and other transducers can be intermixed in multiples of 5 by choosing the appropriate sensor card.

MODEL 5110A STRAIN GAGE CARD

CHANNELS

Five per card

INPUTS

Strain Gages

120Ω, 350Ω,1000Ω quarter bridges; 60Ω to 5000Ω half and full bridges

Jumper-selectable completion resistors (0.02% ±3 ppm/°C typ)

Measurement Range

Normal range mode: ±16,380 με

High range mode: ±163,800 με

Low range mode: ±1638 με

Resolution

Normal range mode: 1 με

High range mode: 10 με

Low range mode: 0.1 με

Strain Gage Based Transducers

60Ω to 5000Ω impedance

Measurement Range

Normal range mode: ±8 mV/V

High range mode: ±80 mV/V

Low range mode: ±0.8 mV/V

Resolution

Normal range mode: 0.5 μV/V

High range mode: 5.0 μV/V

Low range mode: 0.05 μV/V

Input Impedance

220 MΩ each input

Input Protection

±40V

Source Current

±25 nA max.

Input Connector

Nine-pin D-sub style

AMPLIFIER

Zero Temperature Stability

±1.2 μV/°C RTI, ±100 μV/°C RTO, after 30-minute warm-up

Gain Accuracy and Stability

±0.1% at +23°C; ±100 ppm/°C

Common-Mode Voltage

±10V

Common-Mode Rejection (DC to 5 Hz)

100 dB typical

System Noise (Normal Mode Operation)

±2 με typical (±4 ADC counts)

System Coarse Balance Range

±100% of measurement range (typically ±16,383 με)

CALIBRATION

Two shunt calibration points are available on each channel

Switch-selectable

Calibration switches, A and B, are software selectable

EXCITATION

0.0, 0.5, 1.0, 2.0, 5.0, and 10.0 VDC

Software-programmable

Accuracy

±5 mV typical

Current

250 mA max. (50 mA per channel)

Over-current protected

Load Regulation

<0.05% of full scale for a load variation of 10% to 100% of full load

Temperature Stability

Better than ±0.005%/°C

FILTER

Type

Four-pole Butterworth

Cutoff Frequency (–3 dB)

5 Hz

StrainSmart® Data Acquisition System

MODEL 5120A THERMOCOUPLE CARD

CHANNELS
Five per card

INPUTS
Thermocouple types J, K, T, E, R, S, and B
Built-in electronic cold-junction compensation
Software-selectable

Open sensor detection:
Input Impedance: 22 MΩ each input
Input Protection: ±40V
Source Current: ±0.5 nA typical; ±5 nA max

Input Connector
Removable three-position screw terminal

AMPLIFIER

Zero Temperature Stability
±1.2 µV/°C RTI, ±100 µV/°C RTO, after 30-minute warm-up

Gain Accuracy and Stability
0.1% ±100 ppm/°C

Common-Mode Rejection (DC to 5 Hz)
100 dB typical

Common-Mode Voltage
±10V

System Noise (Normal Mode Operation)
±10 µV typical (±4 ADC counts)

MEASUREMENT RANGE
±81.9 mV

RESOLUTION
2.5 µV

FILTER

Type
Four-pole Butterworth

Cutoff Frequency (–3 dB)
5 Hz

MODEL 5130B HIGH-LEVEL INPUT CARD

CHANNELS
Five per card

INPUTS
DC volts (differential)

Input Impedance
22 MΩ each input

Input Protection
±40V

Source Current
±0.5 nA typical; ±5 nA max

Input Connector
Nine-pin D-sub style

AMPLIFIER

Zero Temperature Stability
±1.2 µV/°C RTI, ±100 µV/°C RTO, after 30-minute warm-up

Gain Accuracy and Stability
0.1% ±100 ppm/°C

Common-Mode Rejection (DC to 5 Hz)
100 dB typical

Common-Mode Voltage
±10V

System Noise (Normal Mode Operation)
± 4 ADC counts typical (0 to 15V excitation)
±10 ADC counts typical (20 to 30V excitation)

MEASUREMENT RANGES
±1, ±2, ±5, ±10 VDC

RESOLUTION
30.5, 61, 152.5, 305 µV

EXCITATION
0, 0.5, 1.0, 2.0, 5.0, 10.0, 15.0, 20.0, 25.0 and 30.0 VDC

Accuracy
±10 mV typical

Current
250 mA max (50 mA per channel) at 1 to 15V
200 mA max (40 mA per channel) at 20V
150 mA max (30 mA per channel) at 25 to 30V
Over-current protected
Max current limit selected by jumpers

Load Regulation
<0.05% of full scale for a load variation of 10% to 100% of full load

Temperature Stability
Better than ±0.005%/°C

FILTER

Type
Four-pole Butterworth

Cutoff Frequency (–3 dB)
5 Hz

StrainSmart® Data Acquisition System

MODEL 5140A LVDT INPUT CARD

CHANNELS

Five per card

INPUTS

Three- to six-wire transducers

Input Impedance

10 MΩ each input

Input Protection

±40V

Source Current

±0.5 nA typical; ±5 nA max

Input Connector

Nine-pin D-sub style

AMPLIFIER

Zero Temperature Stability

±1.2 µV/°C RTI, ±100 µV/°C RTO, after 30-minute warm-up

Gain Accuracy

0.25% typical

Common-Mode Rejection (DC to 5 Hz)

100 dB typical

Common-Mode Voltage

±10V

System Noise (Normal Mode Operation)

±4 ADC counts typical

Measurement Ranges

±0.5, ±1, ±2.5, ±5 VRMS

RESOLUTION

15.25, 30.5, 76.2, 152.5 µVRMS

CALIBRATION

Excitation sample

EXCITIATION

3.0 VRMS, 5000 Hz or 2500 Hz sine wave

Software-selectable

Accuracy

±5 mVRMS typical

Current

±250 mA max (±50 mA per channel)

Over-current protected

Load Regulation

<0.1% of full scale for a load variation of 10% to 100% of full load

Temperature Stability

Better than ±0.05%/°C

FILTER

Type

Four-pole Butterworth

Cutoff Frequency (–3 dB)

5 Hz

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 5000 with PCI or PCIe Interface:

Model 5101 PCI or PCIe Interface Card; one or more Model 5100 Scanners; and one or more Model 5110, 5120, 5130, or 5140 Input Cards

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.

MICRO MEASUREMENTS
A VPG Brand

StrainSmart® Data Acquisition System

FEATURES

- From 1 to 1200 input channels
- Individual input cards for strain gage and strain-gage-based transducers (Model 6010A), thermocouples (Model 6020), sensors with high-level voltage outputs (Model 6030A), LVDTs (Model 6040A), piezoelectric sensors (Model 6050), and digital tachometer (Model 6095)
- Built-in bridge completion for 120-, 350-, and 1000-ohm strain gages
- Maximum scan rate of 10,000 samples per second per channel; maximum throughput of 200,000 samples per second
- Simultaneous sampling with anti-aliasing filter and analog-to-digital conversion for each channel
- Stable, accurate, low-noise signal conditioning
- Selectable digital filtering of measurement signals
- High-speed PCI or PCIe hardware interface (Model 6100) and Ethernet network interface (Model 6200A)
- Digital I/O for triggering external events

DESCRIPTION

System 6000 features data acquisition rates of up to 10,000 samples per second per channel. The hardware is designed to incorporate all the features required for precision strain measurement under a variety of loading conditions, while maintaining flexibility and ease of use. A system can be configured with 1 to 1200 sensors. Strain gages, strain-gage-based transducers, thermocouples, LVDTs, potentiometers, accelerometers, piezoelectric sensors and other transducers can be intermixed by choosing the appropriate sensor card.

All System 6000 components can be easily configured for each test requirement. Both the Model 6100 Scanner (holding up to 20 input cards) and the Model 6200A Scanner (holding up to 16 input cards) function independently. Additionally, the smaller, lighter, portable Model 6200A can operate from a variety of DC power sources, and can be configured to remotely perform data acquisition and storage.

Utilizing the benefits of individual analog-to-digital conversion on each channel and simultaneous sampling data acquisition for all channels, System 6000's Model 6100 Scanners record test data at rates of up to 10,000 samples per second per channel of instrumentation hardware. The PCI or PCIe hardware interface between the scanners and a PC running Strain-Smart software in the Windows XP/Vista/7 environment enables a combined throughput of up to 200,000 samples per second for all channels (for example, 20 channels at 10,000 samples per second per channel or 40 channels at 5000 samples per second per channel).

Selectable, digital FIR low-pass filtering is incorporated into each instrumentation channel to meet a variety of testing requirements. Custom filters are also available.

MODEL 6100 SCANNER SPECIFICATIONS

- AC powered
- 19-in rack-mountable, 3.5-in high package
- Accepts up to 20 plug-in input cards
- Supports high-speed data transfer and setup of the plug-in cards
- Supports local diagnostics
- Supports software identification and setup of each type of plug-in card

OPERATION

Direct software control

INPUTS

Accepts up to 20 cards (one channel per card and up to 20 channels per unit)

SYNC

Automatic

DATA STORAGE

None

INTERFACE

Proprietary PCI or PCIe

StrainSmart® Data Acquisition System

SIZE

3.5 H x 19 W x 16 D in (89 x 483 x 381 mm)

WEIGHT

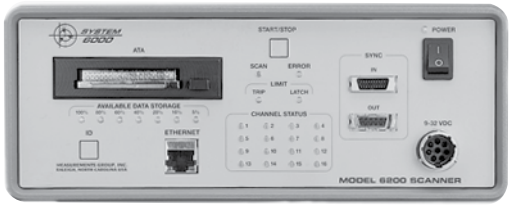
17 lb (7.7 kg) empty

19.5 lb (8.8 kg) loaded with 20 plug-in cards

POWER

115 or 230 VAC user-selectable; ±10% of setting; 50/60 Hz; 200W max.

MODEL 6200A SCANNER SPECIFICATIONS



- DC powered (AC optional)
- Compact package
- Accepts up to 16 plug-in input cards
- Supports network communication via a 100BASE-T Ethernet connection
- Multiple units can be linked together to provide common control and synchronous sampling
- Offers user-selectable decimal-based (radix 10) and binary-based (radix 2) scanning rates
- On-board program and data storage
- Supports local diagnostics
- Supports software identification and setup of each type of plug-in card

OPERATION

Stand-alone or direct software control

INPUTS

Accepts up to 16 cards (one channel per card and up to 16 channels per unit)

SYNC

Multiple scanners synchronized with synchronization cable links

DATA STORAGE

Can be configured:

Internal: 1 GB solid state

Removable: ATA form factor removable storage devices, solid state

INTERFACE

Type: Ethernet

Topology: 100Base-T

Protocol: TCP/IP (HTTP)

OPERATING VIBRATION

6G peak in all three axes, sweep to 10 Hz (solid state media)

OPERATING SHOCK

20G peak in all three axes, 5 shocks in each axis (solid state media)

SIZE

4 H x 10 W x 12.3 D in (102 x 254 x 312 mm)

WEIGHT

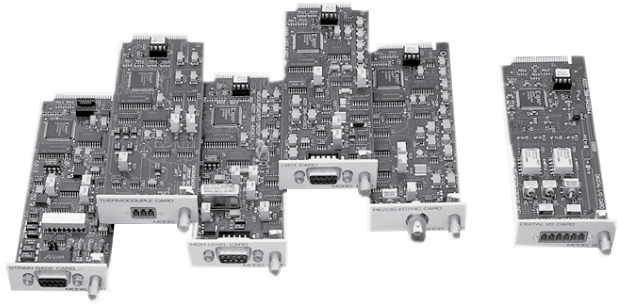
9.1 lb (4.1 kg) empty, 11.1 lb (5.0 kg) loaded with 16 plug-in cards

POWER

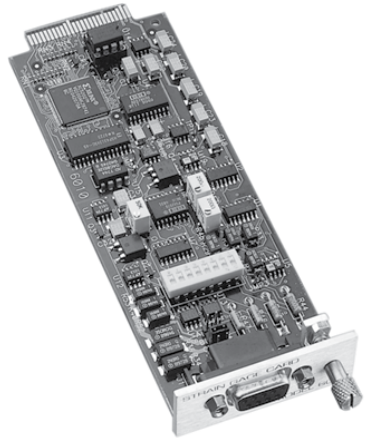
Designed for use with DC power; 9–32 VDC, 100W max

Optional power adapter (Model 6207); 120/240 VAC

SENSOR CARD SPECIFICATIONS



MODEL 6010A STRAIN GAGE CARD



MICRO MEASUREMENTS
A VPG Brand

StrainSmart® Data Acquisition System

- Supports software identification and setup of each type of plug-in card
- Complete strain gage signal conditioner with 16-bit analog-to-digital converter
- Programmable digital filter
- Programmable excitation supply per channel. The supply is settable to 0, 0.5, 1, 2, 5, and 10V. Up to 50 mA of excitation current is available on each channel. Remote sense is provided for full-bridge transducers.
- Programmable gain to complement the excitation steps of 1, 2, 5, and 10V. Full-scale input range will be ±16,383 με. An excitation setting of 0.5V will use the 1V gain range, but with one-half the resolution. Gain settings are independent per channel.
- Internal bridge completion resistors: 120Ω, 350Ω, and 1000Ω dummy resistors (jumper selectable); 1000 internal half bridge
- Programmable coarse balance range of ±16,300 με (4096 με steps)
- Fixed low-pass anti-aliasing filter (six-pole)
- Two programmable shunt calibration circuits
- Input connections to user's strain gage via nine-pin D-sub connector

CHANNELS

One per card

INPUTS

Strain Gages

120Ω, 350Ω,1000Ω quarter bridges; 60Ω to 5000Ω half and full bridges

Jumper-selectable completion resistors (0.01% ±2.5 ppm/°C typical)

Measurement Range

Normal range mode: ±16,380 με
High range mode: ±163,800 με
Low range mode: ±1638 με

Resolution

Normal range mode: 0.5 με
High range mode: 5 με
Low range mode: 0.05 με

Strain Gage Based Transducers

60Ω to 5000Ω impedance

Measurement Range

Normal range mode: ±8 mV/V
High range mode: ±80 mV/V
Low range mode: ±0.8 mV/V

Resolution

Normal range mode: 0.25 μV/V
High range mode: 2.5 μV/V
Low range mode: 0.025 μV/V

Input Impedance220 MΩ each input

Source Current

±25 nA max.

Input Connector

Nine-pin D-sub style

AMPLIFIER

Zero Temperature Stability

±1.5 μV/°C RTI, ±100 μV/°C RTO, after 30-minute warm-up

DC Gain Accuracy and Stability

(±0.1% at 23°C) ±50 ppm/°C

Common-Mode Rejection (DC to 60 Hz)

100 dB typical

Common-Mode Voltage

±6V typical

AC Accuracy (Typical)

Input Frequency/Bandwidth	500/3000	50/200
Spurious Free Dynamic Range	100 dB	110 dB
Signal to Noise	90 dB	95 dB
Signal to Distortion	100 dB	110 dB

Coarse Balance Range

±99% of measurement range (typically ±16 300 με)

CALIBRATION

Two shunt calibration points are available on each channel

Switch-selectable

Calibration switches, A and B, are software selectable

EXCITATION

0.0, 0.5, 1.0, 2.0, 5.0, and 10.0 VDC. Software programmable.

Accuracy

±3 mV typical

Current

50 mA max; over-current protected

Load Regulation

<0.05% of full scale for a load variation of 10% to 100% of full load

Temperature Stability

Better than ±0.005%/°C

Remote Sense

15Ω maximum lead resistance

StrainSmart® Data Acquisition System

A/D CONVERTER

Type

16-bit successive approximation with integrated sample and hold

Integral Linearity Error

±2 LSB

FILTERS

Linear phase, analog, 6-pole anti-aliasing filter, and 256-tap, programmable, FIR digital filter (lowpass)

Passband Frequency

User-selectable 1 Hz to 4 kHz

ANALOG OUTPUT (6010A Version Only)

Type

±5.00V max for typical full-scale input of ±16,380 με

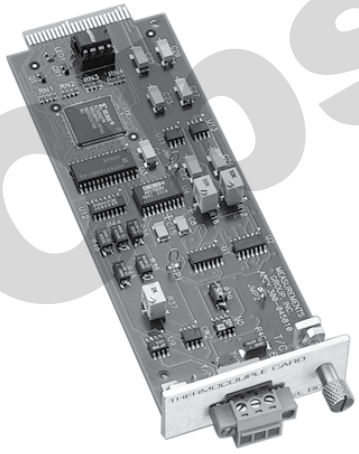
Output Load

2000Ω min

Bandwidth

DC to 15 kHz (–0.5 dB typical)

MODEL 6020 THERMOCOUPLE CARD



- Complete thermocouple signal conditioner with 16-bit analog-to-digital converter
- Programmable digital filter
- Programmable common cold-junction reference
- Compensation is provided for J, K, T, N, E, R, S, and B thermocouple types
- Fixed low-pass anti-aliasing filter (six-pole)
- Connections to user's thermocouple circuit via a removable three-terminal screw connector

CHANNELS

One per card

INPUTS

Thermocouple types J, K, T, E, N, R, S, B. Built-in electronic cold-junction compensation. Software-selectable.

Open sensor detection

Input Impedance

10 MΩ differential, 100 KΩ common mode

Source Current

±0.5 nA typical; ±5 nA max.

Input Connector

Three-position screw terminal

AMPLIFIER

Zero Temperature Stability

±1.5 μV/°C RTI, ±100 μV/°C RTO, after 30-minute warm-up

DC Gain Accuracy and Stability

0.05% at 23°C ± 50 ppm/°C

Common-Mode Rejection (DC to 60 Hz)

100 dB typical

Common-Mode Voltage

±6V typical

AC Accuracy (Typical)

Input Frequency/Bandwidth	500/3000 50/200
Spurious Free Dynamic Range	100 dB 110 dB
Signal to Noise	90 dB 95 dB
Signal to Distortion	100 dB 110 dB

MEASUREMENT RANGE

±81.9 mV

RESOLUTION

2.5 μV

A/D CONVERTER

Type

16-bit successive approximation with integrated sample and hold

Integral Linearity Error

±2 LSB

FILTERS

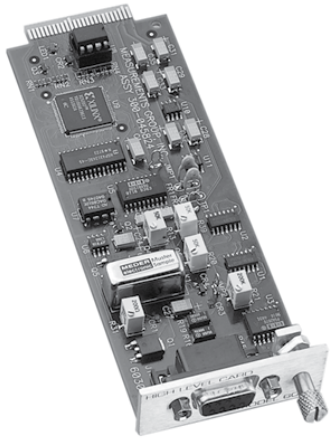
Linear phase, analog, 6-pole anti-aliasing filter, and 256-tap, programmable, FIR digital filter (lowpass)

Passband Frequency

User-selectable 1 Hz to 4 kHz

StrainSmart® Data Acquisition System

MODEL 6030A HIGH-LEVEL INPUT CARD



- Complete high-level signal conditioner with 16-bit analog-to-digital converter
- Programmable gain
- Programmable digital filter
- Programmable excitation supply. The supply is settable to 0, 0.5, 1, 2, 5, 10, 15, 20, 24, and 30V. Up to 50 mA of current is available on each channel
- Fixed low-pass anti-aliasing filter (six-pole)
- Input connections to user's voltage source via nine-pin D-sub connector
- Analog output

CHANNELS
One per card

INPUTS
DC volts (differential)

Input Impedance
22 MΩ each input

Source Current
±2 nA typical
±100 nA max

Input Connector
Nine-pin D-sub style

AMPLIFIER

Zero Temperature Stability
±2 µV/°C RTI, typical. ±100 µV/°C RTO, after 30-minute warm-up

DC Gain Accuracy and Stability
±0.05% at 23°C ± 20 ppm/°C

Common-Mode Rejection (DC to 60 Hz)
86 dB typical at X1 gain
94 dB typical at X10 gain

Common-Mode Voltage
±12V typical

AC Accuracy (Typical)

Input Frequency/Bandwidth	500/3000 50/200
Spurious Free Dynamic Range	100 dB 110 dB
Signal to Noise	90 dB 95 dB
Signal to Distortion	100 dB 110 dB

MEASUREMENT RANGES
±1, ±2, ±5, ±10 VDC

RESOLUTION
30.5, 61, 152.5, 305 µV

EXCITATION
0, 0.5, 1.0, 2.0, 5.0, 10.0, 15.0, 20.0, 24.0, 30.0 VDC

Accuracy
±10 mV typical at 0 to 24 VDC; ±5% at 30 VDC

Current
50 mA max. Over-current protected

Load Regulation
<±0.05% of full scale for a load variation of 10% to 100% of full load

Temperature Stability
Better than ±0.005%/°C

A/D CONVERTER

Type
16-bit successive approximation with integrated sample and hold

Integral Linearity Error
±2 LSB

FILTERS
Linear phase, analog, 6-pole anti-aliasing filter, and 256-tap, programmable, FIR digital filter (lowpass)

Passband Frequency
User-selectable 1 Hz to 4 kHz

ANALOG OUTPUT (6030A Version Only)

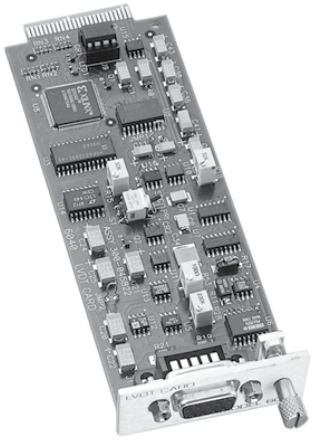
Type
±5.00V max for typical full-scale input of ±32,767 µε

Output Load
2000Ω min

Bandwidth
DC to 15 kHz (–0.5 dB typical)

StrainSmart® Data Acquisition System

MODEL 6040A LVDT CARD



- Complete LVDT signal conditioner with 16-bit analog-to-digital converter
- Programmable digital filter
- Independent AC excitation supply
- Programmable gain steps of 1, 2, 5, and 10
- Supports six-, five-, four-, and three-wire transducers
- Fixed low-pass anti-aliasing filter (six-pole)
- Excitation reference provided for calibration
- Input connections to user's transducer via nine-pin D-sub connector

CHANNELS
One per card

INPUTS
3- to 6-wire transducers

Input Impedance
10 MΩ each input

Source Current
±2 nA typical; ±100 nA max

Input Connector
Nine-pin D-sub style

AMPLIFIER

Zero Temperature Stability
±2 µV/°C RTI, typical. ±100 µV/°C RTO, after 30-minute warm-up

Gain Accuracy and Stability
±0.25% typical

Common-Mode Rejection (DC to 60 Hz)
86 dB typical at X1 gain
94 dB typical at X10 gain

Common-Mode Voltage
±12V typical

MEASUREMENT RANGES
±0.5, ±1, ±2.5, ±5 VRMS

RESOLUTION
15.25, 30.5, 76.2, 152.5 µVRMS

CALIBRATION
Excitation sample

EXCITATION
3.0 VRMS at 2500, 5000, or 10000 Hz sine wave
Software-selectable

Accuracy
±5 mVRMS typical

Current
±50 mA max. Over-current protected

Load Regulation
<±0.1% of full scale for a load variation of 10% to 100% of full load

Temperature Stability
Better than ±0.05%/°C

A/D COVERTER

Type
16-bit successive approximation with integrated sample and hold

Integral Linearity Error
±2 LSB

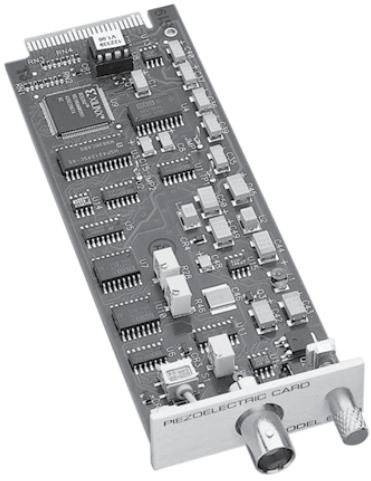
FILTERS
Butterworth, six-pole anti-aliasing analog filter, and 256-tap, programmable, FIR digital filter (lowpass)

Passband Frequency
User-selectable 1 Hz to 4 kHz

ANALOG OUTPUT (6040A Version Only)
Linear Output: ± 5.00V for typical full-scale input
Output Load: 2000Ω min
Bandwidth: DC to 1 kHz (–3 dB typical)

StrainSmart® Data Acquisition System

MODEL 6050 PIEZOELECTRIC CARD



- Complete piezoelectric signal conditioner with 16-bit analog-to-digital converter
- Supports both VM (voltage mode, low impedance) and CM (charge mode, high impedance) type piezoelectric transducers
- Programmable constant current excitation supply for VM transducers is software settable to 1, 2, 4, 5, 10 and 20 mA
- Programmable gain steps of 1, 2, 5, and 10 for VM transducers and steps of 1, 2, 5, 10, 20, 50 and 100 for CM transducers
- Programmable digital filter
- Fixed low-pass anti-aliasing filter (six-pole)
- Input connections to user's transducer via BNC connector

CHANNELS

One per card

INPUTS

Voltage mode (VM) or charge mode (CM) piezoelectric type transducers (type is 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

Zero Temperature Stability

±10 µV/°C RTI, typical, after 30-minute warm-up

Charge Amplifier Zero Stability

±1.2 pC/°C RTI typical at 0.5 second time constant

DC Gain Accuracy and Stability

±0.1% at +23°C; ±25 ppm/°C

AC Accuracy (Typical at X2 Gain Step)

Input Frequency/Bandwidth	500/3000	50/200
Spurious Free Dynamic Range	100 dB	110 dB
Signal to Noise	90 dB	95 dB
Signal to Distortion	100 dB	110 dB

MEASUREMENT RANGES

VM Type Transducers

±10.5V, ±5.25V, ±2.1V, and ±1.05V

CM Type Transducers

±200 000 pC, ±100 000 pC, ±40 000 pC, ±20 000 pC, ±10 000 pC, ±4000 pC, and ±2000 pC

RESOLUTION

0.0015% of range

CALIBRATION

Excitation sample

EXCITATION

0, 1, 2, 4, 5, 10 and 20 mA selections for VM type transducers

Accuracy

±1% + (±30 µA) typical at 1 to 20 mA

Voltage Compliance

0 to 28V

Temperature Stability

±50 ppm/°C

A/D CONVERTER

Type

16-bit successive approximation with integrated sample and hold

Integral Linearity Error

±2 LSB

FILTERS

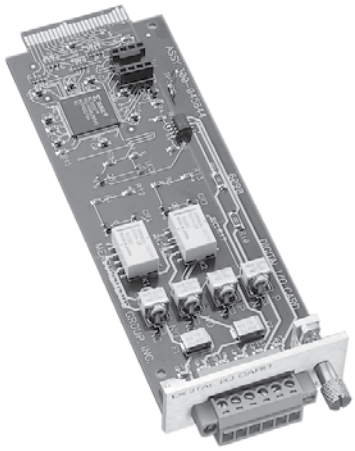
Linear phase, analog, 6-pole anti-aliasing filter, and 256-tap, programmable, FIR digital filter (lowpass)

Passband Frequency

User-selectable 1 Hz to 4 kHz

StrainSmart® Data Acquisition System

MODEL 6095 DIGITAL/TACHOMETER CARD



- Multi-function digital input card
- Relay output for control functions
- Compatible with all System 6000 hardware
- Supported by StrainSmart software

When used in conjunction with Micro-Measurements StrainSmart® Software, the Model 6095 Digital/ Tachometer Card enables the user to capture and reduce data in any one of five operating modes:

- Tachometer Mode
- Interval Mode
- Quadrature Mode
- Counter Mode
- Digital Input Mode

Depending upon the mode selected, data can be reduced as a digital input; counts; interval counts; pulses; rate; shaft angle; RPM; radians or degrees per second; elapsed time (milliseconds, seconds or minutes); or calculated values.

Multiple Model 6095 Cards can be used in each system, and each card in a system can be configured individually to any operating mode. However, the relay provides one distinct control function (on/off control for testing machines, etc.) per system when using a Model 6100 Scanner, or one per scanner when using multiple Model 6200 Scanners.

The Model 6095 is compatible with all Model 6100 and 6200 Scanners. It is supported by Version 3.0, and later, StrainSmart Software; no-charge upgrades are available upon request.

INPUT CONNECTOR

Nine-pin, D-sub style

RELAY OUTPUTS

Quantity

One

Configuration

NO and NC, 500 mA contact at 30 VAC or 30 VDC into resistive load

DIGITAL INPUTS

Quantity

Four

Configuration

Optically isolated. TTL Schmitt-trigger input thresholds accept up to 28 VDC without damage.

2.23Ω pull-up resistors can be selected for each input.

Impedance

50 kΩ

Data Rate

DC to 200 kHz

Accessory Supply

5 Volt ± 5%, 75 mA

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 6000 with PCI or PCIe Interface**—Model 6101PCI or Model 6101PCIe Interface Card, at least one Model 6100 Scanner, and at least one Model 6010, 6020, 6030, 6040, 6050, or 6095 Input Card
- **System 6000 with Ethernet Interface**—At least one Model 6200 Scanner and at least one Model 6010, 6020, 6030, 6040, 6050, or 6095 Input Card

StrainSmart® Data Acquisition System

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

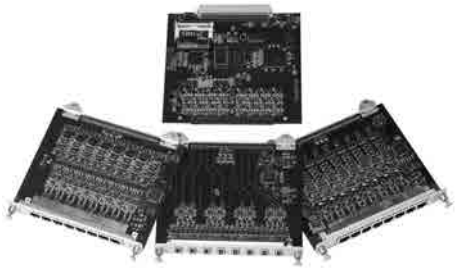
All components are supplied on CD-ROM along with a utility for installing them.

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

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 RJ45 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, 30 A 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 RJ45, Category 5
Max. Distance: 100 m

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: ±5 V

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, 30 A 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 RJ45, Category 5

Max. Distance: 100 m

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: ±5 V

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: 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

ANALOG OUTPUT (MODEL 7003-8-SG-A ONLY)

Fixed Gain: 50.3 V/V ±1%

Output Range: ±10 V 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 RJ45

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: ±12 V 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:

120 Ω and 350 Ω: ±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: 5940 Ω ±0.1%

P- to D350: 17,325 Ω ±0.1%

P- to D1000: 49,500 Ω ±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: ±12 V typical

StrainSmart® Data Acquisition System

MEASUREMENT RANGE AND RESOLUTION

Range: ±81.9 mV

Resolution: 1°C minimum

ACCURACY

±2°C

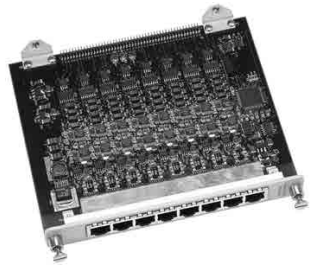
SIZE

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 (±10 V) 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 RJ45

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: ±12 V typical

MEASUREMENT RANGES AND RESOLUTION

Range: ±10 V

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 RJ45

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: ±12 V typical

MICRO MEASUREMENTS
A VPG Brand

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

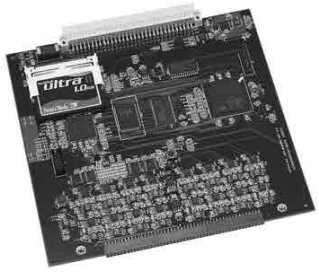
SIZE

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-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)

*CompactFlash® and ScanDisk® Ultra-Series II are registrered trademarks of ScanDisk Corporation in the United States.

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®.

*Windows® is a registrered trademarks of Microsoft.

Notes

For technical questions, contact
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