

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 $\pm 0.1\%$ 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	$\pm 16,000 \mu\epsilon$ @ GF=2.00	$\pm 31,000 \mu\epsilon$ @ GF=2.00	$\pm 31,000 \mu\epsilon$ @ 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	120 Ω , 350 Ω , 1000 Ω , internal HB 1K Ω	120 Ω , 350 Ω , 1000 Ω , internal HB 1K Ω	120 Ω , 350 Ω , 1000 Ω , internal HB 1K Ω
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 $\mu\epsilon$ @ GF=2.00	1 $\mu\epsilon$ @ GF=2.00	1 $\mu\epsilon$ @ 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

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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 $\pm 99000\mu\epsilon$ in 100 microstrain steps and $\pm 49.5mV/V$ 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 50 kHz (-3 dB)	DC 50 kHz (-0.5 dB) DC 100 kHz (-3 dB)	DC 60 kHz (-0.5 dB) DC 145 kHz (-3 dB)
Output (\pm)	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

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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

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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 ($M\Omega$).

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 graticule
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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	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 $\mu\epsilon$ @ 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 K Ω
A/D Converter	24 bit Delta-Sigma
Max. Input	± 50 mV/V @ GF = 2.0
Resolution	0.5 $\mu\epsilon$ @ GF = 2.00
Excitation - Strain Gage	0 - 10 VDC (SW Selectable)
Excitation - High Level	$\pm 0-12$ 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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