

# Guide to Structural Health Monitoring

Bulletin 320



[micro-measurements.com](http://micro-measurements.com)

**MICRO**  
**MEASUREMENTS**  
A VPG Brand





Micro-Measurements has been a leader in providing the products and technology for stress/strain measurements for over 50 years. This brochure describes an assortment of strain gages, installation accessories, and instrumentation that is specifically suited to the demands of Structural Health Monitoring. Whether the task is revitalizing an existing structure or designing a new one, your success is our goal.

## Strain Gages and Sensors

Representing over five decades of design, development, and manufacturing experience, Micro-Measurements offers a broad range of electrical resistance strain gages and other resistive sensors that can be used for structural testing.

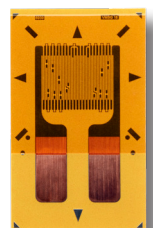
**Right image:** Bridge  
**Left image:** Concrete



## Bondable Strain Gages

For stress analysis applications, Micro-Measurements CEA-Series strain gages are the most widely used. They simplify the installations by enabling the direct attachment of leadwire to large, rugged, copper-coated solder tabs, and their encapsulated construction enhances long-term stability. Also available from Micro-Measurements are sensors for crack detection and propagation measurement, residual or dead-load stress determination, composites testing and temperature sensing.

For more details about these and the full range of Micro-Measurements strain gage and sensors, please visit our Website at [www.micro-measurements.com](http://www.micro-measurements.com)



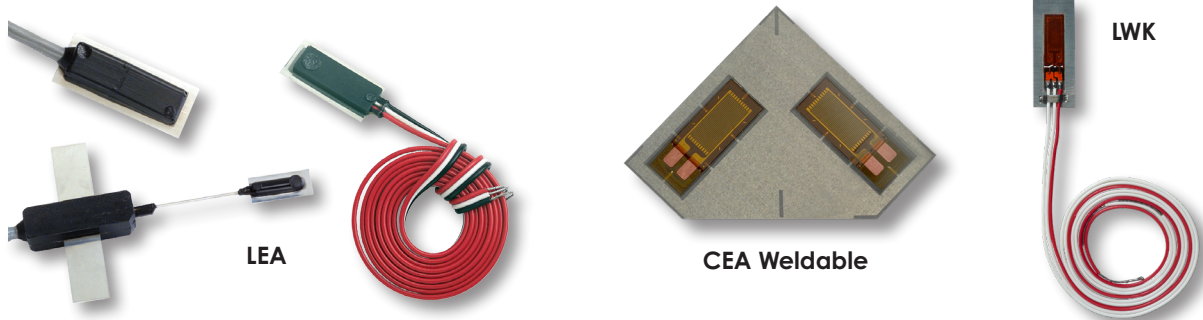
## Cabled Strain Gages

C4A-Series strain gages are designed specifically for civil engineering applications, these Micro-Measurements strain gages save time in making gage installations by eliminating the need to attach leadwires to solder terminals or tabs. Each is supplied with a preattached 10-ft (3.1 m) cable ready for connection.



## Weldable Strain Gages

Weldable strain gages and temperature sensors are ideal for applications where testing or environmental conditions preclude an adhesively bonded strain gage installation. Surface preparation requirements are minimal. These sensors, with grids attached to thin metal shims, are specifically designed for spot welding to steel structures and components. The CEA-Series weldables will require soldering the leads to the tabs whereas the LWK Series have 10 inches of Teflon leadwire that can be directly spliced to the instrumentation cable. The LEA Series weldables simplify the installation as the leadwires and protective coating are already in place on the strain gages- clean the area and weld the gages in place!



## Embedment Strain Gages

Micro-Measurements embedment strain gages simplify the measurement of internal strains in concrete. These sturdy gages are designed with a rugged 5.118" [130mm] outer body of proprietary polymer concrete that resists mechanical damage during pouring, minimizes reinforcement of the structure, and provides protection from moisture and corrosive attack. The grid, cast within the polymer concrete to ensure maximum strain sensitivity, is self-temperature-compensated to minimize thermal output when installed in concrete structures. Each gage incorporates a heavy-duty 10 ft [3 m] cable with 22-AWG [0.643 mm dia.] lead wires. While traditionally constructed as a 120 or 350 ohm quarter bridge, we have recently added a 5000 ohm full bridge version to allow the embedment strain gages to be connected to a much broader range of instrumentation including general purpose data acquisition systems. The increased resistance also reduces energy consumption.



## Sister Bars

Micro-Measurements has recently added the Embedment Sister Bar Strain Gage to our line of products supporting Structural Health Monitoring. Embedment Sister Bar Strain Gages are used to monitor strain in steel-reinforced concrete structures. Typically positioned and tied to axially loaded rebar members before the concrete pour, Sister Bars provide a scaled output as the concrete structure is loaded. With a 3 foot long stainless steel rebar as base, the sensing element is a 1000 ohm full bridge robustly protected from moisture, corrosion and mechanical damage and wired with 25 feet of rugged cable designed for a variety of harsh field applications.





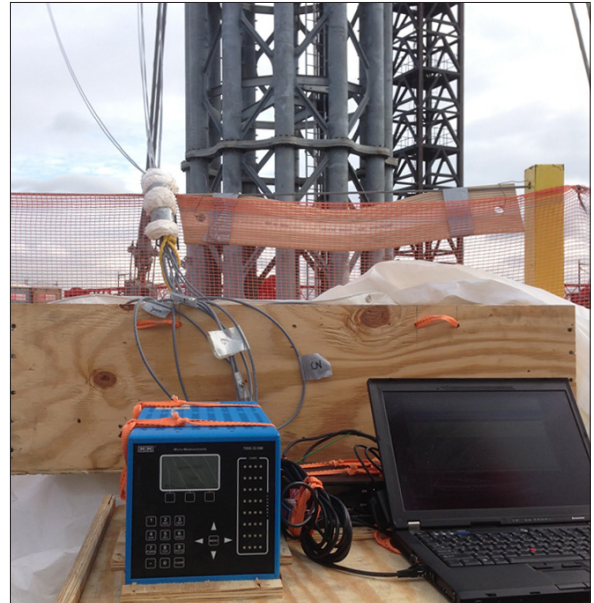
## Instruments

As specialists in the development and manufacture of strain gage instrumentation, Micro-Measurements provides a full range of instrumentation products ranging from strain indicators, signal conditioning amplifiers, and data acquisition systems for static and dynamic testing.



**Right image:**  
System 7000 in use at  
One World

**Left image:** System 7000



## Strain Indicator and Data Acquisition Conditioner

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.



**P3 Strain Indicator**

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  $\Omega$  bridges are supplied.



**Model D4**

## Signal Conditioning Amplifiers

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. 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.



**2200 System**

**2100 System**



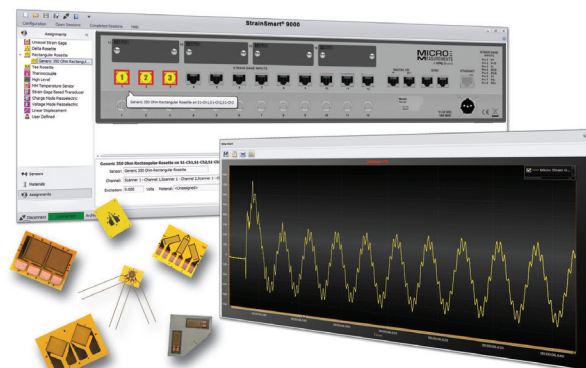
**2300 System**

## Digital Data Acquisition Systems

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)).



**32 channel 7100 System**



**StrainSmart**

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. 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  $\Omega$  bridges. Each scanner is DC powered and can operate independently or synchronized to multiply other scanners to build a larger system.



**8000 Scanner**



**9000 Scanner**

## Installation Tools

For ease, accuracy and reliability of measurements under just about any field conditions, a wide range of installation accessories is available from Micro-Measurements.

## Application Kits

It is often of greatest convenience for the strain gage installer to purchase all of the needed installation accessories and materials in a single package. The MAK-1 Master Strain Gage Application Kit includes all of the supplies and special tools necessary for a wide range of installations.

The GAK-2 Series Installation Kits provide specific selections of M-Line accessories for making basic strain gage installations with both quick-bonding cyanoacrylate and durable epoxy-based adhesive systems. The complete range of Micro-Measurements installation accessories can be found on Website at [www.micro-measurements.com](http://www.micro-measurements.com).



**MAK-1 Kit**

**GAK Kit**

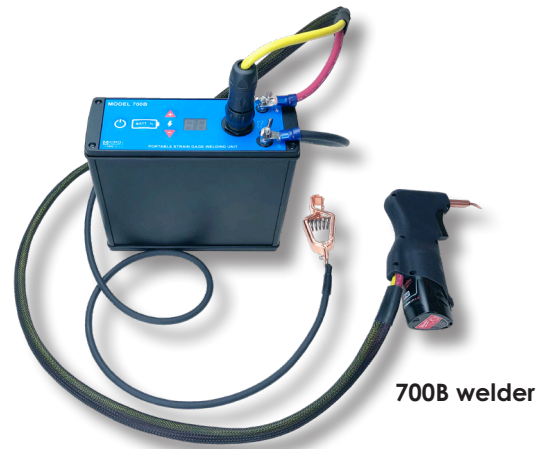




## Strain Gage Welding Unit

Model 700B is the next-generation of Micro-Measurements Model 700 Welder that has been used for decades for installing tens of thousands of strain gages world wide. It was developed based on this experience along with customers input and support, to provide more capability and flexibility, all the while being offered in a smaller, more portable package.

Designed for spot welding the Micro-Measurements line of CEA, LWK, LEA, LZN and LZE weldable strain gages, this new welder combines an extremely fast spot welding rate with enhance safety and portability features that you have come to expect from Micro-Measurements. The 700B is rugged, efficient and reliable in all types of adverse field conditions.



700B welder

## Technical Support

We offer a variety of comprehensive technical training programs from beginner to advanced levels in strain gage technology. Micro-Measurements regularly conducts workshops and technical seminars in our Technical Training Center in Wendell, North Carolina and at locations throughout the world.

An experienced and friendly Applications Engineering staff is always on duty at Micro-Measurements when you need assistance using our board range of products. Whether its strain gage installation questions or needing help with a new data acquisition systems, the Applications Engineers are available by phone or email to assist you as needed.

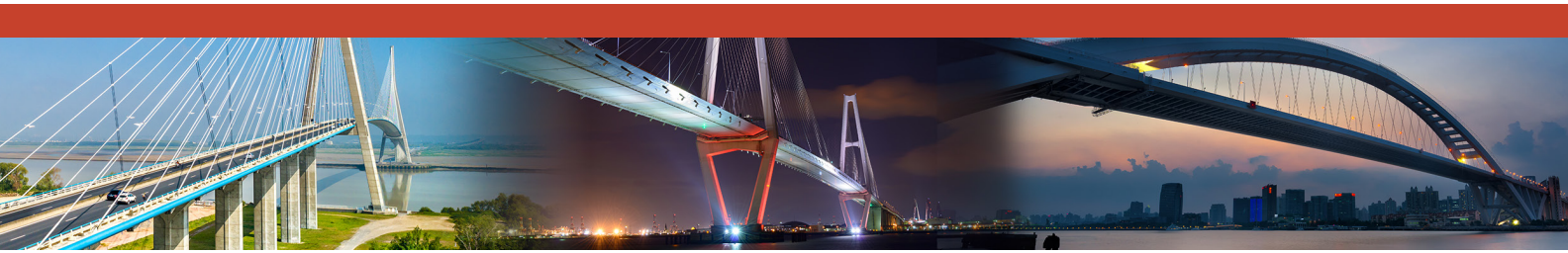


In addition, a comprehensive collection of Technical Notes and Technical Tips are available on our website at [www.micro-measurements.com](http://www.micro-measurements.com). The Technical Notes contain in-depth technical treatments of specific subjects having a bearing on the successful application of stress/strain measurement technology. The Technical Tips present practical strain gage application techniques for "out-of-the-ordinary" situations, and represent a practical "how-to" approach to strain gage installation.

The hostile environments encountered in Structural Health Monitoring often requires special techniques. Micro-Measurements is pleased to offer a series of Technical Tips on embedment gages, rebar installations, and surface measurements on concrete. A collection of videos related to Structural Health Monitoring are available on the Micro-Measurements YouTube channel as well.



Numerous organizations- large and small- have benefited from Micro-Measurements leadership in the field of stress/strain measurement technology. We welcome an opportunity to serve you by providing solutions to your special measurement needs in Structural Health Monitoring. For more details about the complete range of products and services, contact our Applications Engineering Department or visit the Micro-Measurements website at [www.micro-measurements.com](http://www.micro-measurements.com). At Micro-Measurements, your success is our goal.



## Sales Contact

mm@vpgsensors.com



strainblog.com



@strainblog



www.linkedin.com/in/strainblog



http://youtube.micro-measurements.com

micro-measurements.com