

Special Use Sensors—Weldable Strain Gages

Micro-Measurements Standard Weldable Strain Gages and Temperature Sensors are specially designed for spot welding to structures and components. They are ideal for applications where test or environmental conditions preclude clamping and curing an adhesively bonded gage installation. These gages are equally advantageous when strain measurements must be made at an elevated temperature, but the nature of the test object does not permit the use of an elevated-temperature-curing adhesive.

Surface preparation requirements are minimal; only an appropriate solvent cleaning and abrasion of the test part surface with silicon-carbide paper or a small, hand-held grinder is needed. Spot welding is accomplished with a portable stored-energy hand-probe spot welder, such as the Model 700. Environmental protection is as easily applied to a welded gage installation as to an adhesively bonded gage.

Refer to Instruction Bulletin B-131 and MM Strain Gage Accessories Data Book for further information on installation and protective coatings. For specifications about the Model 700 Welding/Soldering Unit, please refer to the product datasheet.

DESCRIPTION AND PERFORMANCE

General—All sensors are laboratory-prebonded, with a high-performance adhesive, to thin [0.005 in (0.13 mm)] metal carriers. Sensor grids are fully encapsulated for protection against handling and installation damage. Standard weldable strain gages are offered in two series to meet differing performance requirements. Both series are available in either 06 or 09 self-temperature compensation. Strain gages with 06 S-T-C have Inconel carriers, while S-T-C 09 gages and temperature sensors are mounted on 300-series stainless steel.

CEA-Series Weldable Strain Gage—Polyimide-encapsulated constantan foil grid, with large, rugged,

copper-coated tabs. In most cases, the carrier can be contoured to a radius as small as 1/2 in (13 mm). The CEA Series is ideal for direct leadwire attachment, before or after installation.

Strain range is $\pm 5000 \mu\text{in/in}$ ($\pm 5000 \mu\text{m/m}$), and normal operating temperature range is -100° to $+200^\circ\text{F}$ (-75° to $+95^\circ\text{C}$). Short-term maximum temperature is $+300^\circ\text{F}$ ($+150^\circ\text{C}$).

LWK-Series Weldable Strain Gage—Nickel-chromium alloy grid, encapsulated in fiberglass-reinforced epoxy phenolic. The LWK gage is provided with a three-wire lead system with 10 in (250 mm) of Teflon®-insulated leadwire.

This construction simplifies leadwire temperature compensation and provides for easy connection of the lead system to the instrumentation cable. Minimum installation radius is generally limited to 2 in (50 mm).

Strain range is $\pm 5000 \mu\text{in/in}$ ($\pm 5000 \mu\text{m/m}$), and normal operating temperature range is -320° to $+500^\circ\text{F}$ (-195° to $+260^\circ\text{C}$). Short-term maximum temperature is $+550^\circ\text{F}$ ($+290^\circ\text{C}$).

WWT-Series Temperature Sensor—High-purity nickel foil grid encapsulated in fiberglass-reinforced epoxy-phenolic, and equipped with integral three-tab terminal to facilitate leadwire attachment. The temperature sensor is normally installed on a flat surface of the workpiece, but, in any case, should always be oriented with the gridlines in the direction of minimum strain to avoid strain-induced errors (see Micro-Measurements Tech Note TN-506, “Bondable Resistance Temperature Sensors and Associated Circuitry”). With an appropriate LST Matching Network, the temperature response characteristic of the nickel can be linearized and scaled for direct readout (in degrees) with any strain indicator.

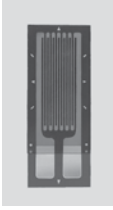
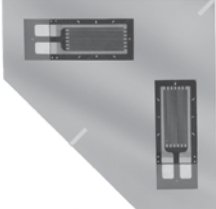

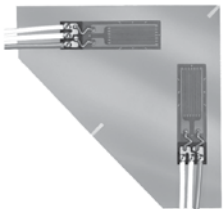
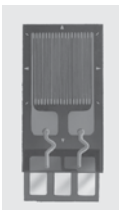
Teflon is a Registered Trademark of DuPont.

MEASUREMENT CONSIDERATIONS

It is important to note that operating characteristics of weldable strain gages (gage factor, transverse sensitivity, and thermal output) are specified for the basic strain gage itself—without the metal carrier. Thus, the properties are measured by bonding a conventional strain gage directly to an appropriate calibration specimen, following standard methods specified for all Micro-Measurements strain gages. This procedure assures the most accurate results, independent of the variables introduced by welding. In particular, the user should be aware that the gage factor specified on the engineering data sheet accompanying the gage applies only to the basic strain gage, without the shim. The effective gage factor of the weldable assembly

(after welding to the test member) is commonly 5 to 10% lower than this, due primarily to the stiffness of the shim. The reduction in gage factor is not subject to quantitative generalization, because it depends on the cross-sectional properties of the test specimen, and on the mode of loading (e.g., bending versus direct stress). It has been demonstrated, however, that for a group of like specimens, loaded in the same manner, the weldable gages exhibit very good repeatability and uniformity of response. Therefore, when test requirements dictate greatest accuracy, the weldable gages should be calibrated on a specimen of the same material and cross section as the test part, and under the same mode of loading.

Special Use Sensors—Weldable Strain Gages

GAGE PATTERN AND DESIGNATION Insert Desired S-T-C No. in Spaces Marked XX. See Note 1		RES. IN OHMS	DIMENSIONS							
			Legend: ES = Each Section						inch	
			CARRIER			ACTIVE GRID		MATRIX		millimeter
			Length	Width	Thick	Length	Width	Length	Width	
CEA-XX-W250A-120 CEA-XX-W250A-350		120 ± 0.4% 350 ± 0.4%	0.63	0.34	0.005	0.230	0.125	0.44	0.17	
			16.0	8.6	0.13	5.84	3.18	11.2	4.3	
			Most flexible and conformable pattern. Type 326-DFV and 330-DFV flat three-conductor cable typically used to solder directly to copper-coated tabs.							
CEA-XX-W250C-120 CEA-XX-W250C-350		120 ± 0.4% 350 ± 0.4%	0.90	0.90	0.005	0.230	0.125	0.44	0.17	
			22.9	22.9	0.13	5.84	3.18	11.2	4.3	
			Tee rosette, used in biaxial stress states where directions of principal stresses are known. See W250A pattern for typical leadwire recommendations.							
LWK-XX-W250B-350		350 ± 0.4%	0.88	0.32	0.005	0.250	0.125	0.62	0.17	
			22.4	8.1	0.13	6.35	3.18	15.7	4.3	
			Wide-temperature-range linear pattern with 10 in (250 mm) preattached leads. Teflon insulation is pretreated for best bond to protective coatings.							
LWK-XX-W250D-350		350 ± 0.4%	1.15	1.15	0.005	0.250	0.125	0.62	0.17	
			29.2	29.2	0.13	6.35	3.18	15.7	4.3	
			Tee rosette, used in biaxial stress states where directions of principal stresses are known and a wide operating temperature range is required.							
WWT-TG-W200B-050		50 ± 0.4% @ +75°F (+24°C)	0.71	0.43	0.005	0.200	0.200	0.52	0.26	
			18.0	10.9	0.13	5.08	5.08	13.1	6.6	
			Easy-to-use temperature sensor that can be welded or adhesively bonded to the test structure. For standard bondable temperature sensors, see Document Number 11522, "Temperature Sensors and LST Networks."							

Note 1: Products with designations and options shown in bold are not RoHS compliant.

Special Use Sensors – Weldable Strain Gages

Micro-Measurements Sealed Weldable Strain Gages are specially designed for spot welding to structures and components. They are ideally used for applications where test or environmental conditions preclude clamping and curing an adhesively bonded gage installation. These gages are equally advantageous when strain measurements must be made at elevated temperatures, but the nature of the test object does not permit the use of an elevated temperature-curing adhesive. Additionally, all Micro-Measurements Sealed Weldable Strain Gages come with a preinstalled protective coating providing both protection in moist environments and savings in the time and effort required for making the complete gage installation.

All sensors are fabricated with EA-Series strain gages, laboratory-prebonded with a high-performance adhesive to a thin [0.005 in (0.127 mm)] stainless steel carrier, and fully encapsulated for protection against moisture. They have a ± 5000 microinch/in strain range, and a normal operating temperature range of -40°F (-40°C) to $+180^{\circ}\text{F}$ ($+83^{\circ}\text{C}$). These gages can be used on surfaces with a radius of curvature of 3.0 in (76 mm) or greater.

The three leadwire-series of Micro-Measurements Sealed Weldable Strain Gages have physical constructions designed for various environmental exposures and installation constraints.



R-LEADWIRE-SERIES

These gages are designed for long-term out-of-doors use. Primarily used in applications such as railroad and civil structures, they can be exposed to oil and water splash and short-term submersion in water of shallow [24 in (60 cm)] depth. The metal carrier is processed to give good first cycle data, excellent fatigue resistance and a high strain range.

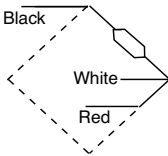
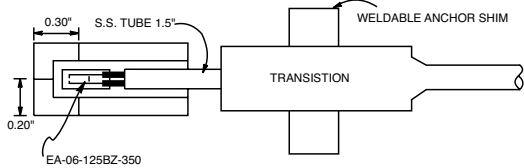
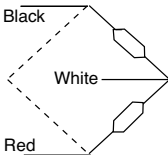
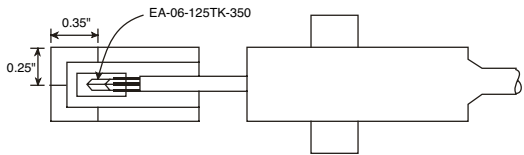
Exposure of the vinyl-insulated cable to strong solvents—especially MEK—should be avoided to prevent damage. Long-term exposure to sub-freezing temperatures requires careful handling to avoid cracking of the vinyl insulation.

DESIGNATION	NOMINAL RESISTANCE (Ohms)	NOMINAL GAGE FACTOR	GRID GEOMETRY	GAGE LENGTH (in)	LEADWIRE	SHIM LENGTH (in)	SHIM WIDTH (in)
LEA-06-W125E-350/3R	350	2.0	Axial	0.125	Vinyl	0.8	0.4
	<p>Bridge Circuit</p>		<p>Configuration</p>				
LEA-06-W125F-350/3R	350	2.0	Shear	0.125	Vinyl	1.0	0.5
	<p>Bridge Circuit</p>		<p>Configuration</p>				

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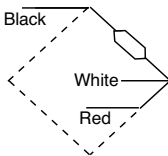
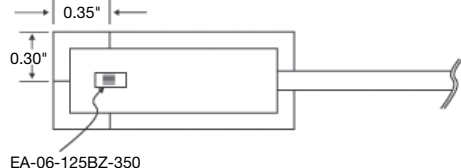
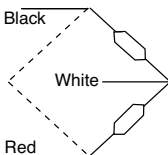
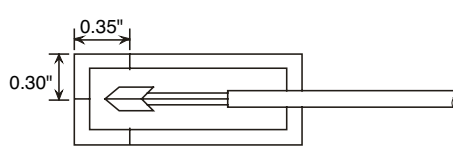
T-LEADWIRE-SERIES

This series is designed to withstand exposure to water pressures of up to 500 psi. They can also withstand short-term (up to 14 days) immersion in crude oil. A flexible stainless steel tube, providing wire routing from the strain gage to a cable transition, enables fine positioning of the sensor as well as providing strain relief. These sensors are typically used on larger civil structures, including bridges, dams, and buildings, or for exposures of up to a year in seawater.

DESIGNATION	NOMINAL RESISTANCE (Ohms)	NOMINAL GAGE FACTOR	GRID GEOMETRY	GAGE LENGTH (in)	LEADWIRE	SHIM LENGTH (in)	SHIM WIDTH (in)
LEA-06-W125E-350/10T	350	2.0	Axial	0.125	Shielded Vinyl	0.8	0.4
	 <p>Bridge Circuit</p>		 <p>Configuration</p>				
LEA-06-W125F-350/10T	350	2.0	Shear	0.125	Shielded Vinyl	1.0	0.5
	 <p>Bridge Circuit</p>		 <p>Configuration</p>				

L-LEADWIRE-SERIES

The L-Leadwire-Series sensors are designed to have a performance similar to the T-Leadwire-Series but without a cable transition. They can be used in similar applications when the sensor will be exposed to smaller strains, and care can be taken during installation to anchor the leadwire to provide for strain relief. The L-Leadwire-Series gages are particularly useful where space constraints preclude the use of the cable transition of T-Leadwire-Series gages.

DESIGNATION	NOMINAL RESISTANCE (Ohms)	NOMINAL GAGE FACTOR	GRID GEOMETRY	GAGE LENGTH (in)	LEADWIRE	SHIM LENGTH (in)	SHIM WIDTH (in)
LEA-06-W125E-350/10L	350	2.0	Axial	0.125	Shielded Vinyl	1.5	0.6
	 <p>Bridge Circuit</p>		 <p>Configuration</p>				
LEA-06-W125F-350/10L	350	2.0	Shear	0.125	Shielded Vinyl	1.5	0.6
	 <p>Bridge Circuit</p>		 <p>Configuration</p>				

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FEATURES

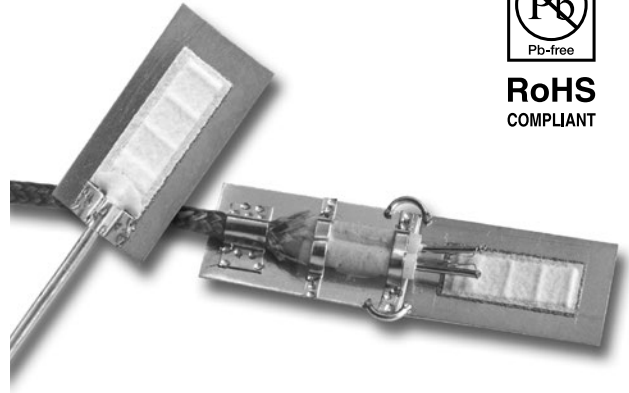
- High temperature installations using simple attachment techniques
- Ceramic bonded wire gage performance in a weldable gage
- Superior performance of bonded gages
- Improved fatigue life for dynamic applications

Micro-Measurements high-temperature weldable strain gages are free-filament wire strain gages pre-bonded to shim stock using flame sprayed alumina. The gages can be welded to the test structure using a capacitive discharge spot welder (such as Micro-Measurements Model 700), permitting easy installation in the field, especially on large structures. High-temperature weldable strain gages are excellent in applications where protection against moisture is not required. The fatigue resistance of this bonded wire strain gage makes it the best choice for dynamic, impact or vibratory strain measurements to 1800°F (980°C). Their use in measuring static strains should be avoided.

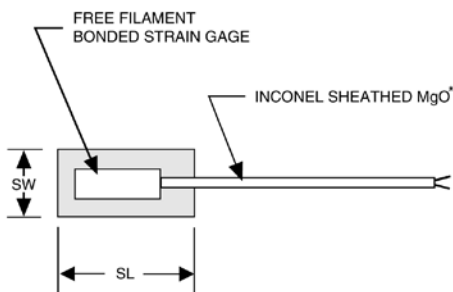
High-temperature weldable strain gages are available with grids of Nichrome V (N) or Pt8W (E) alloys. They can be ordered with either of two types of preattached high-temperature insulated cable.



RoHS
COMPLIANT

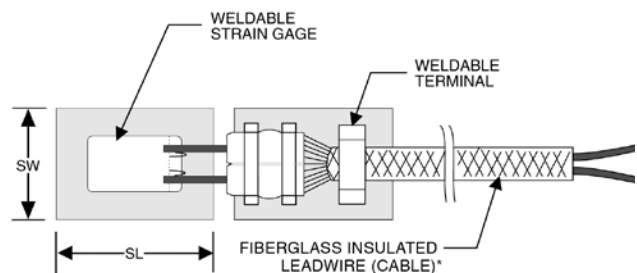


GAGES WITH M-SERIES LEADWIRES



Complete assembly consists of a free-filament gage bonded to a shim with an integral high-temperature cable with chromel/alumel wires. The mineral insulated, two-conductor cable with an Inconel metal jacket is rated to 1800°F (980°C) and offers excellent protection in harsh environments. While the ends are sealed to avoid moisture absorption during shipping or storage, care should be taken when using M-Series cables to ensure that the mineral insulation does not absorb moisture during handling and application.

GAGES WITH F-SERIES LEADWIRES



Complete assembly consists of a free-filament gage bonded to a shim, a weldable transition terminal and a high temperature cable with chromel/alumel wire. A fiberglass-insulated braided, two-conductor cable assembly is attached at the gage end through alumina insulators strap-welded to the terminal shim, providing a firm anchor for the cable at the gage end. The cable conductors are threaded through lengthwise holes in the alumina insulators and bonded to the insulators with high strength ceramic cement to prevent wire movement at the gage—cable weld junction. The fiberglass cable is rated to 1200°F (650°C) and is used where fraying due to vibration is not a concern. F-Series cables are more flexible than M-Series cables.

Special Use Sensors—Weldable Strain Gages

DESIGNATION	NOMINAL RESISTANCE	NOMINAL GAGE FACTOR	SENSOR ALLOY	SENSOR GAGE LENGTH	MAX. TEMP.	LEADWIRE	SHIM LENGTH (SL)	SHIM WIDTH (SW)	LEAD TERMINAL
LZN-NC-W250G-120/2F	120 Ω	2.0	NiChrome V	0.25 in (6.35 mm)	1200°F (649°C)	Chromel-Alumel	0.50 in (12.7 mm)	0.30 in (7.62 mm)	Yes
LZN-NC-W250G-120/2M					1600°F (871°C)				None
LZE-NC-W250G-120/2F	120 Ω	4.0	Pt8W	0.25 in (6.35 mm)	1200°F (649°C)	Chromel-Alumel	0.50 in (12.7 mm)	0.30 in (7.62 mm)	Yes
LZE-NC-W250G-120/2M					1600°F (871°C)				None

NOTE

The standard leadwire length is indicated, in feet, by the number to the left of the last letter of the gage designation. For example, /2F indicates 2 feet of fiberglass insulated leadwire. Gages with longer leadwires (up to 50 feet) are available on special order.