

# Concrete Embedment Strain Gauges

## Applications

The Model 4200, 4202 and 4210 are designed to measure strains in or on...

- Foundations
- Piles
- Bridges
- Dams
- Containment vessels
- Tunnel liners
- Mass concrete with coarse aggregates
- Laboratories and/or where space limitations exist (Model 4202)



● Model 4200ER (5,000  $\mu$ strain) and 4200ER (10,000  $\mu$ strain) Strain Gauges.



● Model 4200L (low modulus) Strain Gauge.



● Model 4200HT-T High Temperature Strain Gauge.



● Model 4202 (front), Model 4200 (center) and Model 4210 (rear) Concrete Embedment Strain Gauges.

## Operating Principle

The Model 4200 Series Vibrating Wire Embedment Strain Gauges are designed for direct embedment in concrete. The Model 4200 (standard model) has a 153 mm gauge length and is commonly used for strain measurements in foundations, piles, bridges, dams, containment vessels, tunnel liners, etc. The Model 4210 has a 250 mm gauge length and is designed for use in mass concrete with coarse aggregates. It is extra rugged to resist bending and has large flanges to provide greater engagement area. The 4202 and 4204 (51 mm and 102 mm gauge lengths, respectively) are designed for laboratory use and/or where there are space limitations.

Strains are measured using the vibrating wire principle: a length of steel wire is tensioned between two end blocks that are embedded directly in concrete. Deformations (i.e. strain changes) of the concrete mass, will cause the two end blocks to move relative to one another, thus altering the tension in the steel wire. The tension is measured by plucking the wire and measuring its resonant frequency of vibration using an electromagnetic coil.

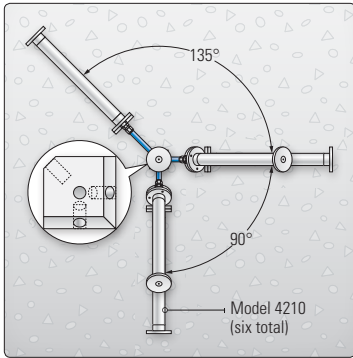
## Advantages and Limitations

The Model 4200 Series Strain Gauges enjoy all the advantages of vibrating wire sensors, which includes excellent long term stability, maximum resistance to the effects of water, and a frequency output suitable for transmission over very long cables.

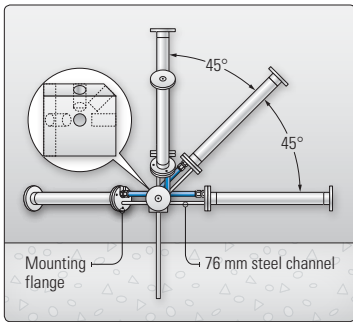
All components are made from stainless steel for corrosion protection and the gauges are fully waterproof. The Model 4210 is very rugged and designed to withstand the rigors of concrete placement.

Each gauge incorporates a thermistor so that the temperature can be read and displayed by the readout.

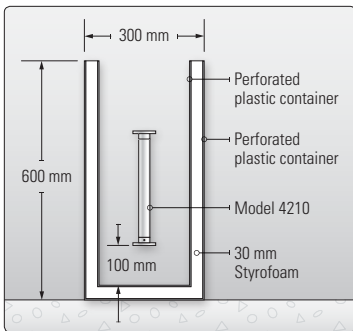
Extended range, low modulus and high temperature versions are also available. The Model 4200ER is designed for measuring large strains up to 10,000  $\mu$ strain. The Model 4200L (low modulus version) is particularly suitable for measuring curing strains in concrete. The Model 4200HT is designed for short-term use at temperatures up to 200 °C while the Model 4200HT-T is designed for long-term use at temperatures up to 220 °C, making it particularly suitable for installation in steam-cured spun concrete piles.



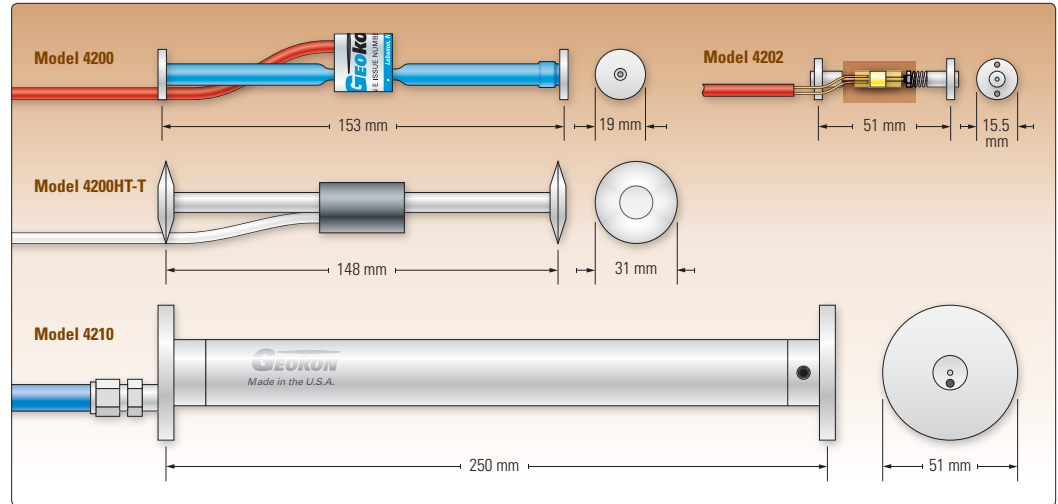
• Top view of a Model 4210 strain gauge rosette configuration. Inset shows rosette fixture (enlarged for detail).



• Front view of a Model 4210 strain gauge rosette configuration. Inset shows rosette fixture (enlarged for detail).



• "No stress-strain" enclosure using the Model 4210.



• Dimensions of the 4200 Series Strain Gauges.

### System Components

The strain gauges are shipped ready for installation with the correct amount of cable attached. Installation is accomplished by attaching the strain gauge to any steel reinforcement bar, or, in mass concrete, to special rosette fixtures designed to hold multiple strain gauges in different orientations to allow the measurement of strain in three dimensions.

Also available are no stress-strain enclosures for use in concrete dams. These enclosures are double-wall,

plastic containers, lined with Styrofoam, designed to isolate one or more strain gauges from the stress field in the concrete, and to allow an estimate of, and correction for the effects of moisture, temperature, autogenous growth, etc.

All models are equipped with integral thermistors for the simultaneous measurement of temperature.

Readout is accomplished using the Model GK-404 or GK-405 Readouts, which can, when used with the Model 4200, display the strain directly in microstrain.

### Technical Specifications

	4200	4200ER	4200L	4200HT	4200HT-T	4202	4204	4210
Range <sup>1</sup>	3,000 $\mu\epsilon$	5,000 to 10,000 $\mu\epsilon$	3,000 $\mu\epsilon$	3,000 $\mu\epsilon$	3,000 $\mu\epsilon$	3,000 $\mu\epsilon$	3,000 $\mu\epsilon$	3,000 $\mu\epsilon$
Resolution	1.0 $\mu\epsilon$	2.0-5.0 $\mu\epsilon$	1.0 $\mu\epsilon$	1.0 $\mu\epsilon$	1.0 $\mu\epsilon$	0.4 $\mu\epsilon$	1 $\mu\epsilon$	0.4 $\mu\epsilon$
Accuracy <sup>2</sup>	$\pm 0.5\%$ F.S. <sup>3</sup>	$\pm 0.5\%$ F.S.	$\pm 0.5\%$ F.S. <sup>3</sup>	$\pm 0.5\%$ F.S. <sup>3</sup>	$\pm 0.5\%$ F.S.	$\pm 0.5\%$ F.S. <sup>3</sup>	$\pm 0.5\%$ F.S. <sup>3</sup>	$\pm 0.5\%$ F.S. <sup>3</sup>
Nonlinearity	< 0.5% F.S.	$\pm 2.5-4.0\%$ F.S.	< 0.5% F.S.	< 0.5% F.S.	< 0.5% F.S.	< 0.5% F.S.	< 0.5% F.S.	< 0.5% F.S.
Coil Resistance	180 $\Omega$	180 $\Omega$	180 $\Omega$	120 $\Omega$	50 $\Omega$	50 $\Omega$	180 $\Omega$	180 $\Omega$
Frequency Datum <sup>4</sup>	800 Hz	800 Hz	800 Hz	800 Hz	800 Hz	2600 Hz	1250 Hz	2600 Hz
Thermal Coefficient of Expansion	12.0 ppm/ $^{\circ}$ C	variable	12.0 ppm/ $^{\circ}$ C	12.0 ppm/ $^{\circ}$ C	12.0 ppm/ $^{\circ}$ C	12.0 ppm/ $^{\circ}$ C	12.0 ppm/ $^{\circ}$ C	12.0 ppm/ $^{\circ}$ C
Temperature Range	-20 $^{\circ}$ C to +80 $^{\circ}$ C <sup>1</sup>	-20 $^{\circ}$ C to +80 $^{\circ}$ C <sup>1</sup>	-20 $^{\circ}$ C to +80 $^{\circ}$ C <sup>1</sup>	-20 $^{\circ}$ C to +200 $^{\circ}$ C	-20 $^{\circ}$ C to +220 $^{\circ}$ C	-20 $^{\circ}$ C to +80 $^{\circ}$ C <sup>1</sup>	-20 $^{\circ}$ C to +80 $^{\circ}$ C <sup>1</sup>	-20 $^{\circ}$ C to +80 $^{\circ}$ C <sup>1</sup>
Cable Type	4-conductor, 2 twisted pairs, 22 AWG (for all models)							
Cable Jacket	Red PVC, 4.75 mm $\varnothing$	Red PVC, 4.75 mm $\varnothing$	Red PVC, 4.75 mm $\varnothing$	White Teflon <sup>®</sup> , 5.20 mm $\varnothing$	White Teflon <sup>®</sup> , 5.20 mm $\varnothing$	Red PVC, 4.75 mm $\varnothing$	Red PVC, 4.75 mm $\varnothing$	Blue PVC, 6.35 mm $\varnothing$
Active Gauge Length	153 mm	153 mm	153 mm	153 mm	148 mm	51 mm	102 mm	250 mm <sup>5</sup>

<sup>1</sup>Other ranges available on request. | <sup>2</sup>Transducer accuracy established under laboratory conditions:  $\pm 0.5\%$  F.S. with standard batch calibration. <sup>3</sup> $\pm 0.1\%$  F.S. with individual calibration. | <sup>4</sup>Typical. | <sup>5</sup>Other lengths available on request.