The World Leader in Vibrating Wire Technology

48 Spencer Street
Lebanon, NH 03766, USA
Tel: 603•448•1562
Fax: 603•448•3216
E-mail: geokon@geokon.com
http://www.geokon.com

Installation Instructions

Model 6700

Geobeam

(Doc Rev C, 10/03)

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1. Introduction

The Geokon Model 6700 Geobeam comprises a rigid metal or composite material beam with a sensitive electrolytic tilt sensor attached to it. This beam is in-turn attached to the structure to be monitored and measured changes in angle are converted to displacements over the beam length. Series of these beams can be coupled together to create a deformation profile as in a tunnel or in the vertical mode along an excavation wall. The sensors are set up with a manual readout box that can also be used to take on going readings. The normal mode of readout, however, is with a data acquisition system that can provide nearly real time readout.

2. Installation

Horizontal Beam

The beam is normally mounted on threaded studs that are attached to the structure to be monitored by grout or epoxy or expansion anchors.

1. Mark the position of the studs on the structure using the beam itself as a template. The holes should be located at the mid-point of the mounting slots. Be sure that the beam is level before marking the holes. When installed the horizontal beam must be level both along the axis of the beam and perpendicular to it. When using grouted or epoxied studs drill the holes at least two inches deep. For expansion anchors 1.5 inches is usually sufficient. The required depth of these holes can vary considerably depending upon the material and the surface topography. Clean out the hole thoroughly after drilling.

2. Mix the epoxy or grout, place it in the hole and install the stud. Allow sufficient time for the grout to set up before installing the beam. In the case using expansion type anchor bolts the beam can be installed immediately.

3. If the anchor studs are not parallel and horizontal it may not be possible to properly level the beam. The studs can be bent to make them as close to level as possible. The mounting hardware allows for some adjustment and the sensor also has a considerable adjustment range along the measurement axis.

4. Mount the beam on the studs using the hardware supplied and according to Fig. 1. Be sure to place the plastic washers in the proper order as they are attached to the beam end connector.

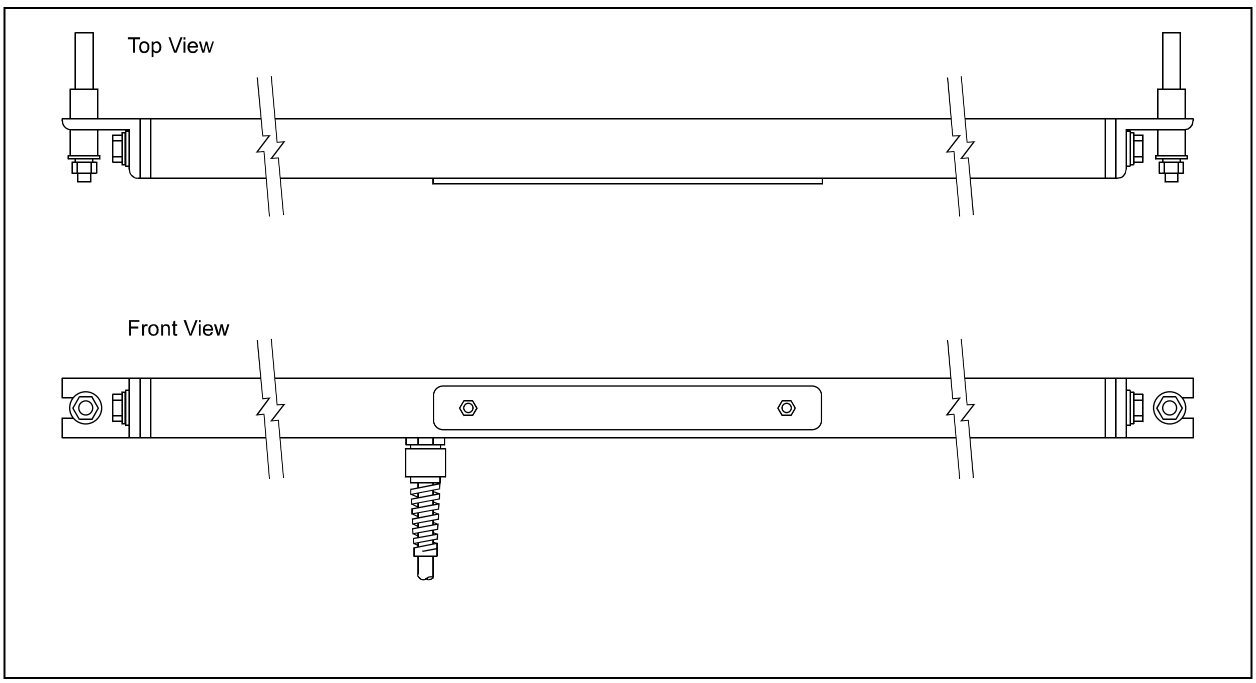


Figure 1 Horizontal Beam

Vertical Beam

The vertical beam is installed in the same manner as the horizontal beam, using the beam itself as a template. The bolts should be installed as close as possible to in-line vertically. Also the mounting studs must be long enough to allow the sensor box to clear the wall or rock surface when leveling and zeroing is performed. See Fig. 2 for details. Note that the figure shows the sensor mounted for measurements perpendicular to the mounting bolt orientation. To make measurements in the mounting bolt plane rotate the beam end brackets 90 degrees.

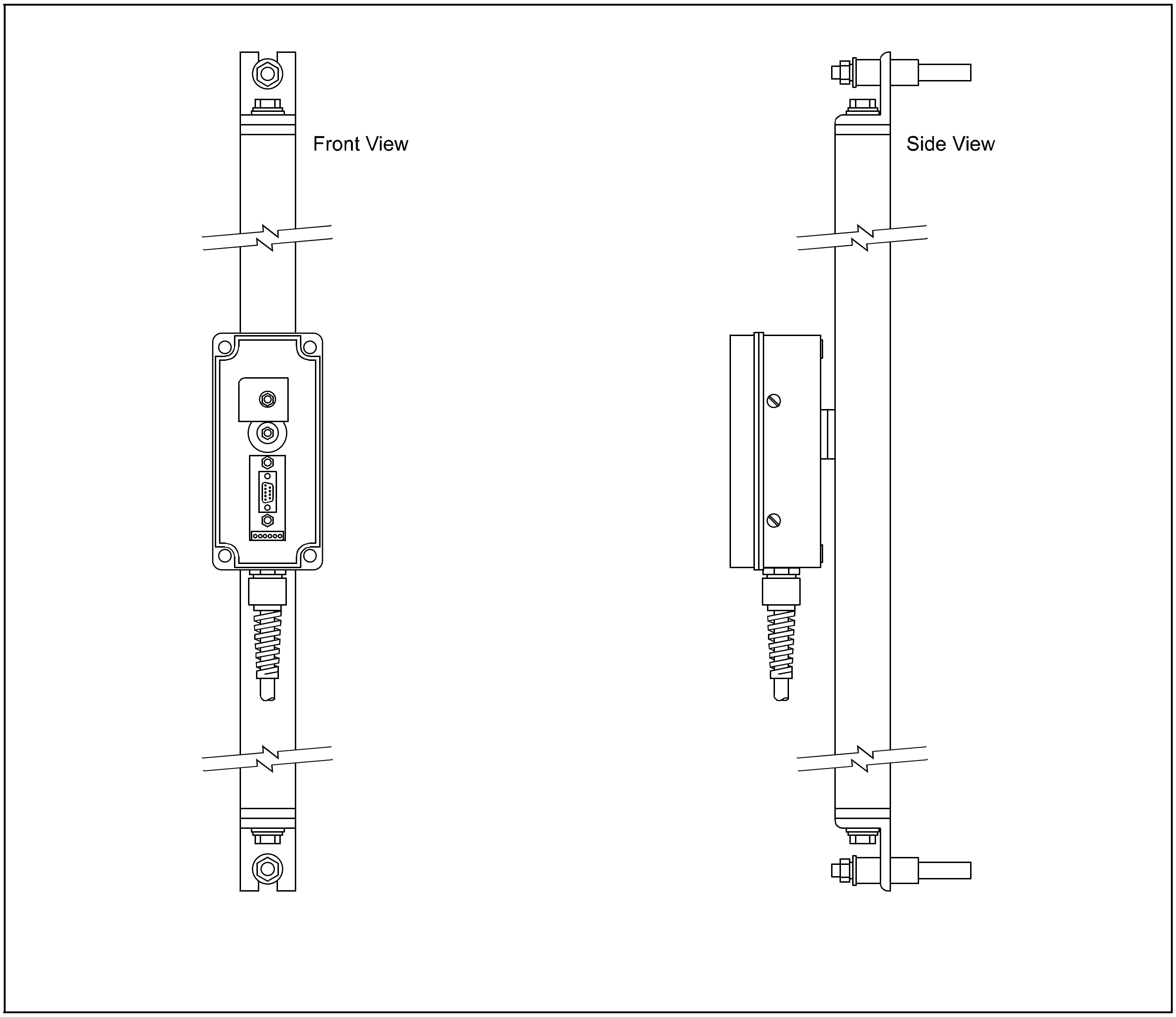


Figure 2 Vertical Beam

3. Taking Readings

The initial setup and zeroing of the Geobeam sensor is accomplished using the RB-201 readout box. A displayed output of 1.250 is equivalent to the null or zero position of the transducer. The readout jumper cable is connected to the D connector on the sensor circuit board or to the cable extending from the sensor.

Horizontal Beam

Loosen the transducer bracket hex nut, item 12, so that the bracket can be rotated on the shaft. Turn on the RB-201 readout, and while observing the readout display adjust the sensor position until the display is as close as possible to 1.250. Press the ON/OFF/READ button on the readout as often as required in order adjust to 1.250, and then re-tighten the hex nut. This may require a little practice because the sensor may tend to rotate as the nut is tightened. Place the cover over the sensor and run the cable to the readout location.

Vertical Beam

First level the sensor housing by loosening the large hex socket cap screw in the center of the transducer enclosure. Using a spirit level, rotate the housing until it is level. The transducer must now be leveled perpendicular to its sensitive axis before zeroing. This is accomplished by placing a small spirit level under or against the angle bracket that the sensor is mounted on and loosening the cap screw that secures it (the left hand screw when facing the sensor). Rotate the bracket until it is level and retighten the screw. Now connect the RB-201 readout to the transducer. Loosen the smaller cap screw holding the transducer bracket and rotate the bracket until the transducer output is as close as possible to 1.250. Press the ON/OFF/READ button on the readout as often as required in order adjust to 1.250. Retighten the cap screw, replace the housing cover, and run the cable to the readout location.

Cable Connections

Geobeams can be read out with the RB-201, the Micro-10 datalogger or other compatible readout devices. The usual method of readout is with the Micro -10 which can be set up to read many sensors remotely at pre-selected intervals. A cable with at least five conductors is required to read the tilt sensor and its accompanying thermistor. See Fig. 3 for the sensor wiring and the Micro-10 manual for multiplexer and datalogger connections. Be sure to remove the mylar shields and drain wires at the sensor end of the cable.

Data Reduction, RB-201

Calibrations for the Geobeams are provided in the form of linear and polynomial equations covering a standard range of +3 degrees to –3 degrees (other ranges are available). The change in angle is measured and converted to displacement by the following:

Linear:

Calculated change in angle **($\Delta\theta$) = (R1-R0) M**

Where: $\Delta\theta$ is the change in angle in degrees.

R1 and **R0** are the current and initial RB-201 readings.

M is the gage factor in degrees per digit (volt).

The displacement, over the beam length, **D=sinθ(L)** where **L** is the beam length.

$$D = (R_1 - R_0) \times G$$

Polynomial:

First, determine the in-situ coefficient C by applying the following equation with the supplied A and B coefficients:

AR✧ + BR + C = 0

Use the new C coefficient for all subsequent measurements of change in angle:

$\Delta\theta$ = AR✧ + BR + C

Determine displacement as above, **D=sinθL**

Data Reduction, Micro-10 (CR-10)

Instruction P5 AC Half Bridge

2500mv Excitation, 2500mv fast input Range, Multiplier 2.5, Offset = 0
Gage Factor, M, Degrees/volt

Change in angle, $\Delta \theta = (R_1 - R_0) \times M$

Where R_1 and R_0 are the CR-10 outputs

Displacement = $\sin\theta \times L$,
Where **L** = beam length in mm

Sign Convention

When viewing the beam installation the change in output sign is positive (> 1.250) when the tilt is down to the left. *(This polarity can be reversed by changing the sensor wiring).*

Temperature

The thermal coefficient of the electrolytic sensor itself is on the order of 0.3 to 0.5 arc seconds /degree C. The installed assembly, however, can have a coefficient of as much as 100 times this depending on the installation apparatus. In varying temperature environments, aluminum beams, mounted rigidly to concrete or masonry constructions can undergo deformations that are unrelated to structural deformations due to the different coefficients of thermal expansion of the various components. Some effort is made to allow the beams to expand freely but this can be difficult to accomplish with confidence.

The most accurate and meaningful data will be obtained when the temperature is constant and all components and the structure are at the same temperature. Readings taken in the early morning hours have been shown to yield the most reliable data. Readings taken on the outside of buildings during the heat of the day, on the other hand, have often proven to be of little value. In all cases instruments located outdoors should be covered and insulated to minimize transient effects.

By making simultaneous temperature measurements an indication of the magnitude of the thermal effect will be observed and, possibly, a correction algorithm can be formulated.

4. Operation Notes for GeoBeams and RB-201 Readout

Wiring:

The 3-pair violet cable should be attached via the flying leads to the RB-201 as shown below:

Geobeam Terminal Block Position	Violet Cable Wire Color	RB-201 Boot Color	RB-201 Faceplate Connector Pin	Function
1	Red			Remote Sense
2	Red's Black	Red	A	Excitation
3	White	White	C	Ground
4	White's Black	Black	B	Signal
5	Green			Thermistor
6	Green's Black			Thermistor
N/C	Shield	Blue	C	Cable Shield

Table 1 – RB-201 Wiring

Operation:

1. Press the ON/OFF/READ button on the RB-201 readout. The four L.C.D. digits will blink three times while the RB-201 powers up and self-calibrates.

2. As soon as self-calibration is complete, the RB-201 will take a reading on the sensor. If the sensor is within it's operating range (0.100 to 2.400), the readout will "beep" twice and display the reading.

3. Each time the ON/OFF/READ button is pressed, another reading of the sensor will be taken.

4. If the sensor is out of range high (> 2.400), the readout will display **H.HHH**.

5. If the sensor is out of range low (< 0.100), the readout will display **L.LLL**.

6. If the sensor is disconnected , the readout will display **–.– – –**.

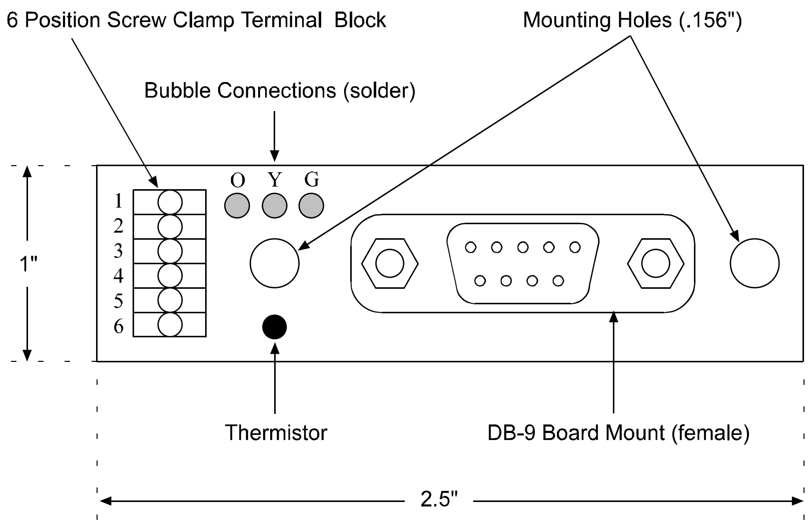
7. If the battery needs to be recharged, the colon (**:**) between the 2nd and 3rd digit will turn on.

8. To shut the RB-201 readout off, press and hold the ON/OFF/READ switch. After a short delay, the readout will "beep" three times and shut off.

9. To conserve battery power, the readout will automatically shut itself off after 10 minutes if no further readings are taken.

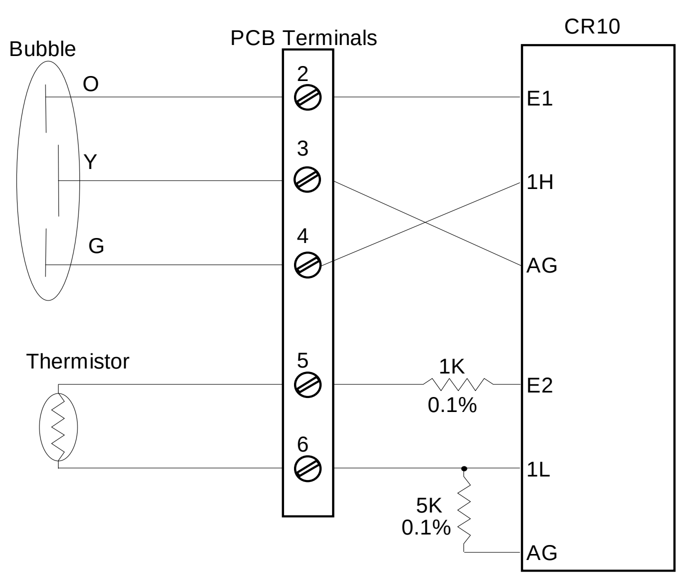
5. Electrolytic Bubble PCB Description, Wiring and Programming

Printed Circuit Board Description



Terminal	Description	Connection	DB-9
1	Remote Sense	O	1
2	Excitation	O	2
3	Ground	Y	3
4	Output	G	4
5	Thermistor	Thermistor	5
6	Thermistor	Thermistor	6

CR10 Wiring



Note: **The actual bubble wire colors may vary. See calibration data or cal sheet.**

CR10 Programming
For the included wiring example use the following CR10 program entries:

Electrolytic Bubble

Use CR10 Program Instruction 5 to apply an AC excitation voltage, delay, and read the output voltage. **DO NOT USE DC EXCITATION TO READ THE ELECTROLYTIC SENSOR!**

Parameter	Value	Description
Instruction:	5	AC excitation, half bridge measurement.
Repetitions:	1	1 Sensor will be read.
Range Code:	15	Fast integration, 2500 mV range.
Input Channel:	1	Single-ended input channel (1-12).
Excitation Channel:	1	Excitation channel (1-3).
Excitation Voltage:	2500	Excitation voltage.
Input Location:	1	CR10 input storage location.
Multiplier:	2.5 * M	Output Volts.* (M is the gage factor degrees per volt)
Offset:	0.0000	Leave at zero.

Thermistor

Use CR10 Program Instruction 4 to apply a DC excitation voltage, delay, and read the output voltage.

Parameter	Value	Description
Instruction:	4	DC excitation, half bridge measurement
Repetitions:	1	1 Sensor will be read.
Range Code:	15	Fast integration, 2500 mV input range.
Input Channel:	2	Single-ended input channel (1-12).
Excitation Channel:	2	Excitation channel (1-3).
Excitation Delay:	5	Delay (in 0.01s) before reading.
Excitation Voltage:	2500	Excitation voltage.
Input Location:	2	CR10 input storage location.
Multiplier:	0.001	Output volts.
Offset:	0.0000	Leave at zero.

Use CR10 Program Instruction 55 to convert the volt output of the P4 to degrees C.

Parameter	Value	Description
Instruction:	55	5th order polynomial.
Starting Location:	2	CR10 input location to apply polynomial.
Destination Location:	2	CR10 input location to place result.
C0:	-104.78	Polynomial coefficient C0.
C1:	378.11	Polynomial coefficient C1.
C2:	-611.59	Polynomial coefficient C2.
C3:	544.27	Polynomial coefficient C3.
C4:	-240.91	Polynomial coefficient C4.
C5:	43.089	Polynomial coefficient C5.

CR10 with Multilogger Software

See the Multilogger Manual under File-6700.ins Geokon Model 6700 Electrolytic Bubble.

6. Sample Calibration Sheet

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Electrolytic Tilt Sensor Calibration Report

Model Number: 6700-1X-V

Calibration Date: May 08, 2001

Serial Number: 158

Mfg. Number: 6196

Cust. I.D. #: n/a

Cal. Std. Control #(s): 133, 131, 159, 339

Customer:

Temperature: 23.4 °C

Job No.: 16829

Technician: JBM

Inclination (sin)	Inclination (degrees)	Reading 1st Cycle (Volts)	Reading 2nd Cycle (Volts)	Average Reading (Volts)	Error (%FS) Linear	Error (%FS) Polynomial
0.1000	5.7392	2.3915	2.3130	2.3523	-7.19	
0.0700	4.0140	2.2635	2.2600	2.2618	4.22	
0.0350	2.0058	1.8531	1.8513	1.8522	-0.28	0.15
0.0175	1.0027	1.5776	1.5758	1.5767	0.17	-0.21
0.0088	0.5013	1.4301	1.4305	1.4303	0.13	-0.14
0.0000	0.0000	1.2806	1.2813	1.2810	0.00	0.00
-0.0088	-0.5013	1.1308	1.1315	1.1312	-0.14	0.14
-0.0175	-1.0027	0.9832	0.9826	0.9829	-0.23	0.22
-0.0350	-2.0058	0.7014	0.7033	0.7024	0.06	-0.15
-0.0700	-4.0140	0.2592	0.2592	0.2592	-5.86	
-0.1000	-5.7392	0.1127	0.1143	0.1135	3.35	

Linear Gage Factor +2° to -2° (M): 3.4545 (Degrees/Volt)

Linear Gage Factor 2° to 6° (M) : 4.5870 (Degrees/Volt)

Polynomial Gage Factors: A: 3.738E-02 B: 3.364E+00 C: -4.370

Calculated Angle (degrees): Linear, $\theta = (R1 - R0)M$

Polynomial, $\theta = AR^2 + BR + C$

The above instrument was found to be in tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.