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Instruction Manual

Model RB-500

MEMS Sensor Readout Box

(Doc Rev J, 05/01/19)

Warranty Statement

Geokon warrants its products to be free of defects in materials and workmanship, under normal use and service for a period of 13 months from date of purchase. If the unit should malfunction, it must be returned to the factory for evaluation, freight prepaid. Upon examination by Geokon, if the unit is found to be defective, it will be repaired or replaced at no charge. However, the WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion or current, heat, moisture or vibration, improper specification, misapplication, misuse or other operating conditions outside of Geokon's control. Components which wear or which are damaged by misuse are not warranted. This includes fuses and batteries.

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1. INTRODUCTION

The Geokon Model RB-500 MEMS (Micro Electro Mechanical Structure) Sensor Readout Box is a portable battery powered instrument for reading the voltage output from the Geokon 6150 and 6155 MEMS In Place Inclinometers, the Geokon 6160 MEMS tilt sensors, and the Model 6101 Portable Tiltmeter.

The Readout Box incorporates a 12 volt, 1.2 Ahr Lead acid battery, a 4½ digit liquid crystal display (LCD), a power on/off switch, an A/B selector switch, a battery charger circuit, an AC adaptor connector, and a 10-pin Bendix connector and a terminal strip.

The RB-500 instrument supplies +12V power to the MEMS sensor and displays the output in Volts which is proportional to the sine of the angle of inclination.

2. INCLINATION MEASUREMENT

Complete the following steps:

1) Connect the MEMS Sensor to the readout box by means of the 10-pin plug or, if bare leads, by means of the terminal strip on the face panel following the printed color code on the panel.

Wire Color	Description
RED	+12V Power
RED'S BLACK	GROUND
WHITE	Channel A +Voltage Output
WHITE'S BLACK	Channel A –Voltage Output
SHIELD	Cable overall shield
GREEN	Uniaxial sensors: Thermistor +
	Biaxial sensors: Channel B +Voltage Output
GREEN'S BLACK	Uniaxial sensors: Thermistor –
	Biaxial sensors: Channel B –Voltage Output
BLUE	Biaxial sensors: Thermistor +
BLUE'S BLACK	Biaxial sensors: Thermistor –

Table 1 - Wiring Chart

Warning! Do not allow the RED and RED'S BLACK leads to touch each other, if the leads do touch each other it will blow the internal 0.6A Slo-Blo fuse. Additional fuses are supplied with the readout box.

2) Switch the power switch to the "ON" position.

3) Switch the selector switch to the "A" position.

4) Read the display and record the reading.

5) If a Biaxial sensor is connected, switch the selector switch to the "B" position.

6) Read the display and record the reading.

7) Power the unit off with the "OFF" switch.

2.1 Data Interpretation

The calculated Tilt is derived from the equation:

$$Tilt = (R_1 - R_0)G$$

Equation 1 - Tilt Calculation

Where;
G = The gauge factor, (sin θ/volt) **or** (degrees/volt) from the calibration report provided with the sensor. (A sample calibration report is provided in Appendix C.)
R_0 = The initial reading in volts as displayed on the RB-500
R_1 = The current readings in volts as displayed on the RB-500.

2.2 Reading Temperature

The RB-500 does not read temperatures.

The thermistor built into the sensor gives a varying resistance output as the temperature changes. To read the thermistor using an ohmmeter, complete the following:

1) Connect the ohmmeter to the two thermistor leads (refer to Table 1). Since the resistance changes with temperature are large, the effect of cable resistance is usually insignificant. For long cables a correction can be applied, equal to approximately 14.7Ω for every 1000 ft., or 48.5Ω per km at 20 °C. Multiply these factors by two to account for both directions.

2) Look up the temperature for the measured resistance in Table 3 in Appendix B

3. MAINTENANCE

3.1 General Maintenance

Keep the following points in mind when using the RB-500 MEMS Sensor Readout to maximize reliability and accuracy of the unit.

- The readout box is splash proof, but it will not withstand complete immersion in water.
- The face plate should be kept clean and dry and the box should be stored in a warm dry area when not in use.
- The transducer connector is waterproof.
- The battery charger connector is not waterproof.
- In very wet or humid conditions, the connector should be kept sealed using the plug provided.
- **Do not spray oil or WD40 into the connections.** If they become wet, they must be dried prior to use or errors will likely result. Clean the connections with soap and water and dry thoroughly before use.

3.2 Calibration

The readout should be sent periodically (every 12 months) back to the manufacturer for inspection, cleaning, and calibration. A nominal fee will be charged for the service, but it is highly recommended.

3.3 Battery Charging

Battery charging is accomplished by plugging the AC adapter provided into the 3-pin connector on the readout box face plate and into the 120 VAC mains (230 VAC adaptor also available). The charger is automatic and can be left connected to the battery indefinitely. This will preserve the maximum charge condition with no danger to the battery.

CAUTION: Lead acid batteries are good in that they do not have the memory effect of Ni-Cad batteries. However, they do suffer from the disadvantage that they do not always recover from a deep discharge if the battery is allowed to go absolutely flat or dead. It is important, if the battery is not to be used for an extended period, that the charger be left plugged in. Also, avoid draining the battery completely.

4. TROUBLE SHOOTING

If the readout box fails to put out any power, it may be because the 12-volt power lead was inadvertently shorted to ground. To check, remove the face plate and replace the 6/10 Amp fuse to be found in the fuse holder. Additional fuses are included with a new readout box. If the readout box fails to power up it may be that the internal two-amp fuse has blown. This fuse protects the battery in case of major internal malfunction. Additional fuses are included with a new box.

APPENDIX A. SPECIFICATIONS

A.1 RB-500 Specifications

Range:	± 4.000 Volts input.
Resolution:	100µV
Accuracy:	±0.06%
Power Requirements:	12 VDC @ 50 mA
Battery Type:	Lead acid 12 volt, 1.2 Ahr
Operating Time:	≈24 hours
AC Adaptor:	120 VAC: 50-60 Hz, 18 VDC, 533 mA 230 VAC: 50-60 Hz, 15 VDC, 800 mA
Dimensions:	6.5 × 4 × 8.5", 165 × 102 × 216 mm
Weight:	5 lbs., 2.3 kg.
Materials:	Aluminum case and lid
Operating Temperature:	-20 to +120° F, -30 to +50° C
Display:	4½ digit LCD
Input connection:	Bulkhead: Bendix PTO2A-12-10S Mating: Bendix PY06A-12-10P(SR)
Fuse	Two 2A Slo-Blo (Geokon p/n ELC-412) One 0.6A Slo-Blo (Geokon p/n ELC-104)
Charger connection:	Bulkhead: Lemo EGG OK 303 CNL(N&W) Mating: Lemo FGG OK 303 CNA C/3.7

Table 2 - Specifications

A.2 Thermistor (Installed in MEMS Sensor)

(see Appendix B also)

Range: -80 to +150° C
Accuracy: ±0.5° C

APPENDIX B. THERMISTOR TEMPERATURE DERIVATION

Thermistor Type: YSI 44005, Dale #1C3001-B3, Alpha #13A3001-B3
Resistance to Temperature Equation:

$$T=\frac{1}{A+B(LnR)+C(LnR)^3}-273.15\ ^\circ C$$

Equation 2 - Resistance to Temperature

Where;
T = Temperature in °C.
LnR = Natural Log of Thermistor Resistance.
$A = 1.4051 \times 10^{-3}$ (coefficients calculated over the −50 to +150° C. span)
$B = 2.369 \times 10^{-4}$
$C = 1.019 \times 10^{-7}$

Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp
201.1K	-50	16.60K	-10	2417	+30	525.4	+70	153.2	+110
187.3K	-49	15.72K	-9	2317	31	507.8	71	149.0	111
174.5K	-48	14.90K	-8	2221	32	490.9	72	145.0	112
162.7K	-47	14.12K	-7	2130	33	474.7	73	141.1	113
151.7K	-46	13.39K	-6	2042	34	459.0	74	137.2	114
141.6K	-45	12.70K	-5	1959	35	444.0	75	133.6	115
132.2K	-44	12.05K	-4	1880	36	429.5	76	130.0	116
123.5K	-43	11.44K	-3	1805	37	415.6	77	126.5	117
115.4K	-42	10.86K	-2	1733	38	402.2	78	123.2	118
107.9K	-41	10.31K	-1	1664	39	389.3	79	119.9	119
101.0K	-40	9796	0	1598	40	376.9	80	116.8	120
94.48K	-39	9310	+1	1535	41	364.9	81	113.8	121
88.46K	-38	8851	2	1475	42	353.4	82	110.8	122
82.87K	-37	8417	3	1418	43	342.2	83	107.9	123
77.66K	-36	8006	4	1363	44	331.5	84	105.2	124
72.81K	-35	7618	5	1310	45	321.2	85	102.5	125
68.30K	-34	7252	6	1260	46	311.3	86	99.9	126
64.09K	-33	6905	7	1212	47	301.7	87	97.3	127
60.17K	-32	6576	8	1167	48	292.4	88	94.9	128
56.51K	-31	6265	9	1123	49	283.5	89	92.5	129
53.10K	-30	5971	10	1081	50	274.9	90	90.2	130
49.91K	-29	5692	11	1040	51	266.6	91	87.9	131
46.94K	-28	5427	12	1002	52	258.6	92	85.7	132
44.16K	-27	5177	13	965.0	53	250.9	93	83.6	133
41.56K	-26	4939	14	929.6	54	243.4	94	81.6	134
39.13K	-25	4714	15	895.8	55	236.2	95	79.6	135
36.86K	-24	4500	16	863.3	56	229.3	96	77.6	136
34.73K	-23	4297	17	832.2	57	222.6	97	75.8	137
32.74K	-22	4105	18	802.3	58	216.1	98	73.9	138
30.87K	-21	3922	19	773.7	59	209.8	99	72.2	139
29.13K	-20	3748	20	746.3	60	203.8	100	70.4	140
27.49K	-19	3583	21	719.9	61	197.9	101	68.8	141
25.95K	-18	3426	22	694.7	62	192.2	102	67.1	142
24.51K	-17	3277	23	670.4	63	186.8	103	65.5	143
23.16K	-16	3135	24	647.1	64	181.5	104	64.0	144
21.89K	-15	**3000**	**25**	624.7	65	176.4	105	62.5	145
20.70K	-14	2872	26	603.3	66	171.4	106	61.1	146
19.58K	-13	2750	27	582.6	67	166.7	107	59.6	147
18.52K	-12	2633	28	562.8	68	162.0	108	58.3	148
17.53K	-11	2523	29	543.7	69	157.6	109	56.8	149
								55.6	150

Table 3 - Thermistor Resistance versus Temperature

APPENDIX C. EXAMPLE CALIBRATION SHEET

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

MEMS Tilt Sensor Calibration

Model Number: MEMS Tilt Sensor

Calibration Date: February 06, 2008

Serial Number: Sensor A 08-542

Temperature: 25.5 °C

Technician:

Inclination (degrees)	Inclination (sinθ)	* Reading 1st Cycle (Volts)	* Reading 2nd Cycle (Volts)	* Average Reading (Volts)	Error in Calculated θ (%FS)	Error in Calculated sinθ (%FS)
10.00	0.1737	2.7616	2.7590	2.7603	-0.05	0.02
8.002	0.1392	2.2190	2.2165	2.2178	0.01	0.00
6.000	0.1045	1.6743	1.6727	1.6735	0.05	0.00
4.002	0.0698	1.1281	1.1280	1.1281	0.05	0.00
2.002	0.0349	0.5803	0.5802	0.5802	0.03	-0.01
0.000	0.0000	0.0322	0.0320	0.0321	0.00	0.00
-2.002	-0.0349	-0.5155	-0.5157	-0.5156	-0.02	0.02
-4.002	-0.0698	-1.0625	-1.0632	-1.0629	-0.03	0.02
-6.000	-0.1045	-1.6081	-1.6089	-1.6085	-0.03	0.02
-8.002	-0.1392	-2.1524	-2.1538	-2.1531	0.00	0.02
-10.00	-0.1737	-2.6947	-2.6958	-2.6953	0.07	0.00

6150 and 6155 In-Place Inclinometer Gage Factor (G): 0.06368 (sinθ/ Volt)

Temperature Correction Factor -0.0003 (T_1-T_0) Volts / °C

Deflection = GL(R_1-R_0) mm (inches)

6160 Tiltmeter Gage Factor (G): 3.6617 (degrees/ Volt)

Temperature Correction Factor -0.0003 (T_1-T_0) Volts / °C

Calculated Tilt = G(R_1 - R_0) degrees

Wiring Code: See manual for further information

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.

Figure 1 - Sample Calibration Sheet