



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>*

Instruction Manual

Model 4675LV

Precision Water Level Monitor

No part of this instruction manual may be reproduced, by any means, without the written consent of Geokon, Inc.

The information contained herein is believed to be accurate and reliable. However, Geokon, Inc. assumes no responsibility for errors, omissions or misinterpretation. The information herein is subject to change without notification.

Copyright © 1991, 2004, 2006 by Geokon, Inc.

(Doc Rev E, 7/06)

Warranty Statement

Geokon, Inc. 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.

Geokon manufactures scientific instruments whose misuse is potentially dangerous. The instruments are intended to be installed and used only by qualified personnel. There are no warranties except as stated herein. There are no other warranties, expressed or implied, including but not limited to the implied warranties of merchantability and of fitness for a particular purpose. Geokon, Inc. is not responsible for any damages or losses caused to other equipment, whether direct, indirect, incidental, special or consequential which the purchaser may experience as a result of the installation or use of the product. The buyer's sole remedy for any breach of this agreement by Geokon, Inc. or any breach of any warranty by Geokon, Inc. shall not exceed the purchase price paid by the purchaser to Geokon, Inc. for the unit or units, or equipment directly affected by such breach. Under no circumstances will Geokon reimburse the claimant for loss incurred in removing and/or reinstalling equipment.

Every precaution for accuracy has been taken in the preparation of manuals and/or software, however, Geokon, Inc. neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damages or losses that result from the use of the products in accordance with the information contained in the manual or software.

Contents

SPECIFICATIONS	1
1. INTRODUCTION	2
2. INSTALLATION PROCEDURES	2
2.1. PRELIMINARY CHECKS	2
2.2. INSTALLATION	2
3. TAKING READINGS	4
3.1. OPERATION OF THE GK-401 READOUT BOX	4
3.2. OPERATION OF THE GK-403 READOUT BOX	4
3.3. OPERATION OF THE GK404 READOUT BOX	4
3.4. MEASURING TEMPERATURES	5
4. DATA REDUCTION	5
4.1 DETERMINATION OF WATER ELEVATION	5
4.2 CORRECTIONS FOR TEMPERATURE CHANGES	6
5. MAINTENANCE	7
5.1 MOISTURE TRAP	7
5.2 WEIGHT MAINTENANCE	7
5.3 SENSOR	7
6. TROUBLE SHOOTING	8

LIST of FIGURES, TABLES and EQUATIONS

FIGURE 1. STILLING -WELL SUPPORTS.....	3
FIGURE 1. DENSITY P OF PURE WATER AS A FUNCTION OF TEMPERATURE AND PRESSURE INTENSITY. BY PERMISSION FROM FLUID MECHANICS FOR HYDRAULIC ENGINEERS, BY HUNTER ROUSE, COPYRIGHT 1938, MCGRAW-HILL BOOK COMPANY, INC.	7

Specifications

Model No.	4675LV
Range Ft.¹	1, 2, 5 standard
Accuracy²	± 0.1% F.S.
Temperature Range³	-30° to +80° C
Frequency Range	1400-3500Hz
Materials:	<i>Sensor and weight:</i> Stainless steel <i>Stilling Well:</i> PVC standard, stainless steel (optional)
Cable	4-Conductor, 22 gage PVC jacket
Sensor	Diameter - 1.00" Length - 8.5"

¹Other ranges available on request

²Accuracy achieved by using a polynomial expression rather than a linear coefficient

³Using anti-freeze solution can extend the range below 0°C. The system requires calibration with the solution being used.

1. Introduction

The Geokon Model 4675LV Precision Water Level Monitor is designed for the measurement of water levels in streams, weirs and boreholes where accurate measurements of very small water level changes are required. The unit consists of a vibrating wire strain gage with a cylindrical weight attached to it whose specific gravity is slightly greater than 1.0. The strain gage works as a load cell monitoring the buoyant forces on the hanging weight as water levels change in relation to the fixed position of the weight. Level changes of as little as .001' can be measured. Ranges of up to 10' are available.

2. Installation Procedures

2.1. Preliminary Checks

Before installing the weight cylinder, remove the orange colored spacer from between the base of the sensor and the nut on the hook assembly. (This releases the tension in the sensor wire –put there as a safety precaution to protect the sensor from damage during shipment.)

The gage and weight assembly can now be checked out on site by connecting the sensor to the readout system and measuring the 'zero' output of the sensor with the weight hanging from it. The readings in position "B" should coincide within about 200 digits of the factory zero reading shown on the calibration sheet. Be sure that the sensor is held firmly and allow the system to stabilize (no swinging of the weight).

2.2 Installation

If the 4675LV is used in a stream or a weir box, a stilling-well is required. The stilling-well is provided by Geokon, in the form of a slotted, 3 inch or 4 inch PVC pipe. This stilling well must be installed in a **vertically plumb** position in an area where there is little turbulence and positioned in such a way that the average water level coincides with the mid-point of the weight. It is important that the well be vertical, because any friction from the weight rubbing along the well will influence the sensor output

The installation is made by using two pipe-straps to hold the stilling well in place. Two spacer bars are provided to hold the stilling well away from the wall so that the stilling well cap can be removed and replaced as necessary. For concrete weir boxes 4 Rawl plugs are provided. Mark out the position for four bolt holes, (see Figure 1), and drill a ½ inch (12mm) diameter hole 2 inch (50mm) deep at each location. (The spacer bar can be used to help locate the hole spacing properly). A 3/8 Rawl plug (four provided) is installed in each hole, using the installation tool provided. The Rawl plug is first placed in the hole and tapped flush with the surface. Then place the installation tool inside the Rawl plug and set the anchor by means of several sharp hammer blows.

The PVC slotted tubing has a bottom plug at its lower end, which can now be cemented in place using PVC cement. (It is left loose in case the PVC pipe needs to be shortened a little due to space limitations). Use the four 3/8-16 bolts provided to bolt the stilling well to the wall of the weir box using the pipe-strap and spacer bars.

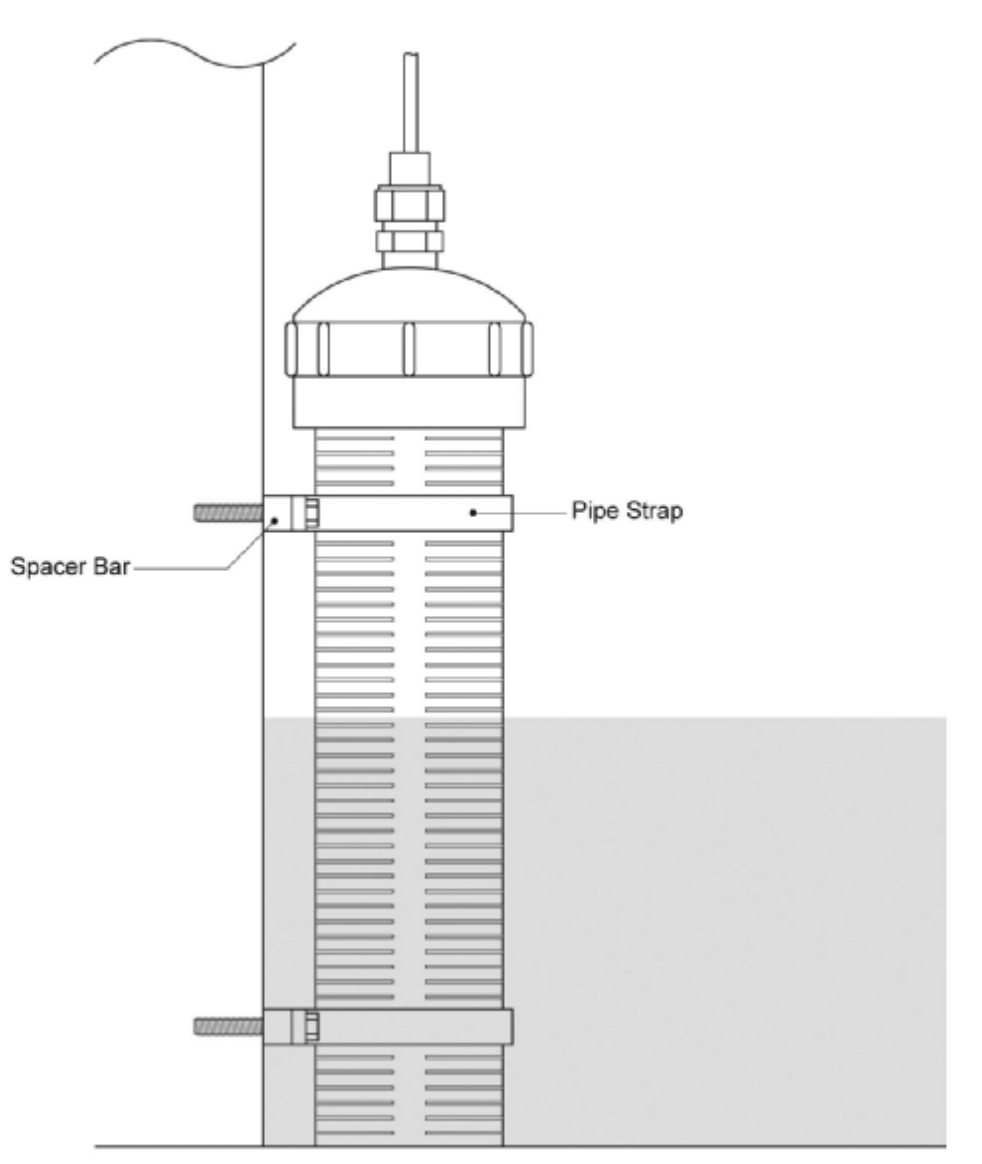


Figure 1. Stilling -Well Supports.

After checking the zero reading, push the sensor inside the Swagelok fitting in the pipe cap and tighten the Swagelok one full turn after finger tight. Leave about one inch of the sensor protruding from the Swagelok. Carefully attach the weight to the eyebolt on the base of the sensor and lower the assembly into the stilling well until the pipe cap sits firmly on top of the pipe.

The yellow vented readout cable can now be extended to a local readout location where an optional terminal box can be used to enclose the end of the yellow vented cable and the vent line moisture trap. If the readout location is remote from the weir location then a blue un-vented cable can be used between the terminal box containing the moisture trap and the readout location.

3. Taking Readings ---

3.1. Operation of the GK-401 Readout Box

The GK-401 is a basic readout for all vibrating wire instruments. Connect the Readout using the flying leads or in the case of a terminal station, with a connector. The red and black clips are for the vibrating wire transducer, the green or blue clip for the shield drain wire. The GK-401 cannot read the thermistor (see Section 3.4).

1. Turn on the Readout. Turn the display selector to position "B". Readout is in "digits"
2. Turn the unit on and a reading will appear in the front display window. The last digit may change one or two digits while reading. Record the value displayed. If zeros are displayed or the reading is unstable see section 5 for troubleshooting suggestions.
3. The unit will automatically turn its-self off after approximately 4 minutes to conserve power.

3.2. Operation of the GK-403 Readout Box

The GK-403 can store gage readings and also apply calibration factors to convert readings to engineering units, ie. inches or millimeters. Consult the GK-403 Instruction Manual for additional information on Mode "G" of the Readout. The following instructions will explain taking gage measurements using Mode "B".

Connect the Readout using the flying leads or in the case of a terminal station, with a connector. The red and black clips are for the vibrating wire transducer, the white and green clips are for the thermistor and the blue for the shield drain wire.

1. Turn on the Readout. Turn the display selector to position "B". Readout is in digits.
2. Turn the unit on and a reading will appear in the front display window. The last digit may change one or two digits while reading. Press the "Store" button to record the value displayed. If the no reading displays or the reading is unstable see section 5 for troubleshooting suggestions. The thermistor will be read and output directly in degrees centigrade.
3. The unit will automatically turn its-self off after approximately 2 minutes to conserve power.

3.3. Operation of the GK404 Readout Box

The GK-404 is a palm sized readout box which displays the Vibrating wire value and the temperature in degrees centigrade.

The GK-404 Vibrating Wire Readout arrives with a patch cord for connecting to the vibrating wire gages. One end will consist of a 5-pin plug for connecting to the respective socket on the bottom of the GK-404 enclosure. The other end will consist of 5 leads terminated with alligator clips. Note the colors of the alligator clips are red, black, green, white and blue. The colors represent the positive vibrating wire gage lead (red), negative vibrating wire gage lead (black), positive thermistor lead (green), negative thermistor lead (white) and transducer cable drain wire (blue). The clips should be connected to their respectively colored leads from the vibrating wire gage cable. Use the **POS** (Position) button to select position **B** and the **MODE** button to select **Dg** (digits).

Other functions can be selected as described in the GK404 Manual.

The GK-404 will continue to take measurements and display the readings until the OFF button is pushed, or if enabled, when the automatic Power-Off timer shuts the GK-404 off. The GK-404 continuously monitors the status of the (2) 1.5V AA cells, and when their combined voltage drops to 2V, the message **Batteries Low** is displayed on the screen. A fresh set of 1.5V AA batteries should be installed at this point.

3.4. Measuring Temperatures

Each Vibrating Wire Convergence Meter is equipped with a thermistor for reading temperature. The thermistor gives a varying resistance output as the temperature changes. Usually the white and green leads are connected to the internal thermistor. The Gk 401 readout box does not read temperatures – a digital ohmmeter is required.

1. Connect the ohmmeter to the two thermistor leads coming from the convergence meter. (Since the resistance changes with temperature are so large, the effect of cable resistance is usually insignificant.)
2. Look up the temperature for the measured resistance in Table B-1 (Appendix B). Alternately the temperature could be calculated using Equation B-1 (Appendix B). For example, a resistance of 3400 ohms equivalent to 22° C. When long cables are used the cable resistance may need to be taken into account. Standard 22 AWG stranded copper lead cable is approximately 14.7Ω/1000' or 48.5Ω/km, multiply by 2 for both directions.

Note: The GK-403 and GK-404 readout boxes will read the thermistor and display temperature in °C automatically.

4. Data Reduction

4.1 Determination of Water Elevation

At a given water temperature, the change in elevation of the water is directly proportioned to the change in output of the transducer. The following formula applies for the determination of water elevation relative to the sensor.

$$\Delta H = (R_0 - R_1) G$$

Where, ΔH is the change in elevation of the water,
 R_0 is the initial reading after installation
 R_1 is the subsequent reading
 G is the calibration factor in inches/digit

and the water elevation is determined by:

$$EL = \text{Ref EL} + \Delta H$$

Where the Ref EL is the elevation of the water at R_0

The elevation of the water at this initial reading, R_0 , must be established by measurement of the water level relative to the tip of the V-notch.

4.2 Corrections for Temperature Changes

The vibrating wire sensor itself is insensitive to temperature changes within the normal operating range. The system, however, is not entirely unaffected by changes in water temperature which influence the density and therefore, the buoyancy of the fluid. The influence is relatively minor and can be accounted for to some degree by measuring the water temperature and making density corrections. Alternatively, two sensors can be used, one of which is completely submerged at all times and whose output can be used to make corrections for the other sensor. This technique is not fool proof either since the water may have temperature gradients which the submerged sensor may or may not intersect. A temperature/density curve for water is shown in Figure 1. As can be seen from the data the density of the water changes very little in the normal operating range of the sensor. The following equation is used to correct for temperature/density changes:

$$\Delta H = (R_0) G / (1 - 0.0002T_0) - (R_1) G / (1 - 0.0002T_1)$$

Where T is the water temperature in ° C.

Density and Compressibility

Density is defined as the mass per unit volume, and it depends upon the temperature and pressure intensity. The density of pure water is given in Figure 1.

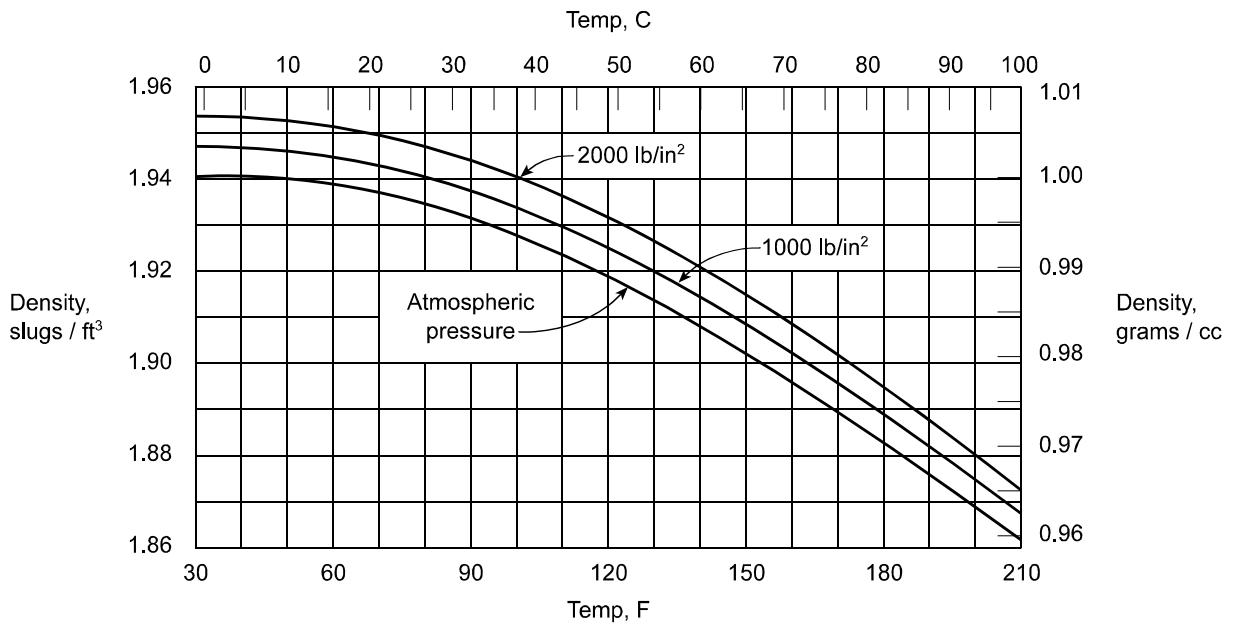


Figure 1. Density ρ of pure water as a function of temperature and pressure intensity. By permission from Fluid Mechanics for Hydraulic Engineers, by Hunter Rouse, copyright 1938, McGraw-Hill Book Company, Inc.

5. Maintenance

5.1 Moisture Trap

The vibrating wire sensor has a vent tube to prevent loading on the sensor due to changes in atmosphere pressure, and the moisture trap on the vent line requires periodic changing of the desiccant capsules. The frequency of this is dependent on weather conditions, but three to six months is a normal period.

5.2 Weight Maintenance

Since the weight is assumed to be of constant mass, it is important that it be kept clean and free of encrustation, algal growth, etc. Periodic observation should be made and this can coincide with the moisture trap maintenance.

5.3 Sensor

Maintenance of the sensor itself is confined to periodic checks of cable connections and maintenance of terminals. The transducers themselves can not be opened for inspection.

6. Trouble Shooting

If a unit fails to read, the following steps should be taken:

1. Check the coil resistance. Nominal coil resistance is $180 \Omega \pm 10$ plus cable resistance (22 gage copper = approximately 15Ω per 1000 feet).
 - a.) If the resistance is high or infinite, a cut cable must be suspected.
 - b.) If the resistance is low or near zero, a short must be suspected.
 - c.) If resistance's are within nominal and no readings are obtainable on any transducer, the readout is suspect and the factory should be consulted.
 - d.) If all resistance's are within nominal and no readings are obtainable on any transducer, the readout is suspect and the factory should be consulted.
2. If cuts or shorts are located, the cable may be spliced in accordance with recommended procedures.

Appendix 1 Thermistor Linearization using Steinhart and Hart Log Equation

Thermistor Type: YSI 44005, Dale #1C3001-B3, Alpha #13A3001-B3

Basic Equation:
$$T = \frac{1}{A + B(\ln R) + C(\ln R)^3} - 273.2 \text{ where:}$$

T = Temperature in °C

LnR = Natural Log of Thermistor Resistance

$$A = 1.4051 \times 10^{-3}$$

$$B = 2.369 \times 10^{-4}$$

$$C = 1.019 \times 10^{-7}$$

Note: Coefficients calculated over -50° to +150°C span.

Resistance versus Temperature Table

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



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

Vibrating Wire Liquid Level Sensor Calibration Report

Model Number: 4675LV-1-300 mmTemperature: 24.2 °CSerial Number: 06-10634Calibration Date: July 11, 2006Cal. Std. Control Number(s): 529, 405, 453, 500Calibration Instruction: CI-4675 Rev: ATechnician: *J. Sullitto*

Applied Load (lbs)	Reading 1st Cycle	Reading 2nd Cycle	Average Reading	Change	Linearity (%FS)
1.428	4654	4656	4655		
2.089	6318	6319	6319	1664	0.34
2.750	7965	7966	7966	1647	0.40
3.414	9604	9606	9605	1640	0.28
4.079	11240	11240	11240	1635	0.03

Calibration Factor (C): 0.0004026 (lbs/ digit), 1 digit = Hz²/1000

(inch) Calibration Factor (G): 0.001885 inches / digit

(mm) Calibration Factor (G): 0.04788 mm / digit

R0 = 10500

Weight

Cylinder Dimensions (mm): Length: 300

	1	2	3
Top	2.756	2.750	2.744

Manufacturing Number: HW-2006-090

Middle	2.753	2.748	2.749
--------	-------	-------	-------

Average Diameter(D): 2.750

Bottom	2.754	2.748	2.746
--------	-------	-------	-------

Volume Factor(K): 0.2144

Wiring Code:

Red and Black: Gage

White and Green: Thermister

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.

This report shall not be reproduced except in full without written permission of Geokon Inc.