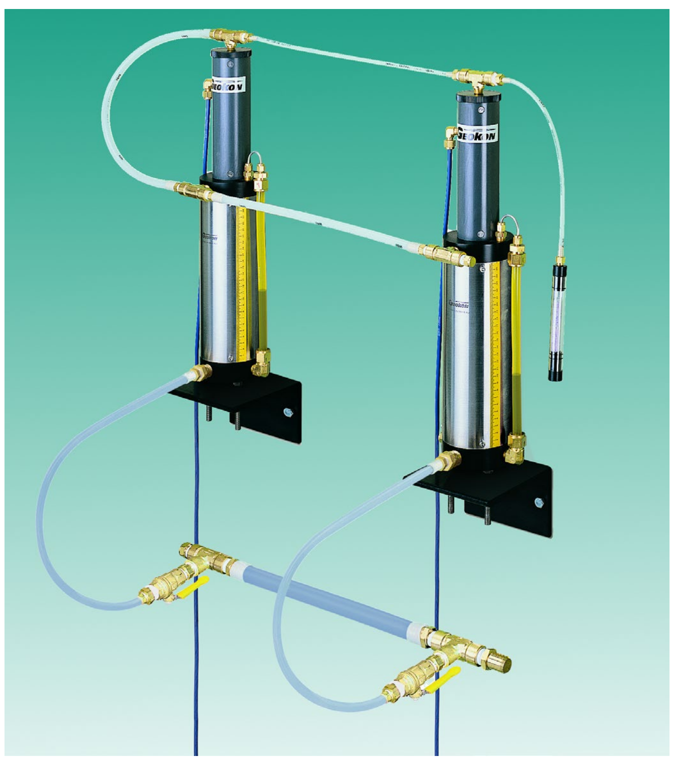
GEOKON®

48 Spencer Street
Lebanon, NH 03766, USA
Tel: 603·448·1562
Fax: 603·448·3216
Email: geokon@geokon.com
http://www.geokon.com

*Instruction Manual*

# Model 4675

## Liquid Level Sensor




(Doc Rev P.1, 05/08/23)

## 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.

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 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 or any breach of any warranty by GEOKON shall not exceed the purchase price paid by the purchaser to GEOKON 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 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.

# TABLE of CONTENTS

**1. THEORY OF OPERATION** .......... **1**

**2. INSTALLATION** .......... **2**

2.1 Install the Mounting Brackets .......... 2
2.2 Install the Chambers .......... 2
2.3 Connecting the Liquid Line .......... 2
2.4 Installing the Hanging Weights .......... 3
2.5 Connecting the Chamber and Transducer Vent Lines .......... 4
2.6 Filling the Liquid Line .......... 5
2.7 Filling the Chambers .......... 5
2.8 Connecting the Two Vent Lines .......... 6
2.9 Stringing the Transducer Signal Cables .......... 6

**3. CALIBRATION** .......... **6**

**4. TAKING READINGS** .......... **7**

4.1 GK-404 Readout Box .......... 7
*4.1.1 Operating the GK-404* .......... *7*
4.2 GK-405 Readout Box .......... 8
*4.2.1 Connecting Sensors with 10-pin Bulkhead* .......... *8*
*4.2.2 Connecting Sensors with Bare Leads* .......... *8*
*4.2.3 Operating the GK-405* .......... *8*
4.3 GK-403 Readout Box (Obsolete Model) .......... 9
*4.3.1 Connecting Sensors with 10-pin Bulkhead* .......... *9*
*4.3.2 Connecting Sensors with Bare Leads* .......... *9*
*4.3.3 Operating the GK-403* .......... *9*
4.4 Measuring Temperatures .......... 9

**5. DATA REDUCTION** .......... **10**

**6. CORRECTIONS FOR TEMPERATURE CHANGES** .......... **11**

**7. TROUBLESHOOTING** .......... **12**

**APPENDIX A. SPECIFICATIONS** .......... **14**

A.1 4675 Liquid Level Sensor .......... 14
A.2 Thermistor (see Appendix B also) .......... 14

**APPENDIX B. THERMISTOR TEMPERATURE DERIVATION** .......... **15**

**APPENDIX C. TYPICAL CALIBRATION SHEET** .......... **16**

**APPENDIX D. 4675 DIMENSIONS** .......... **17**

**APPENDIX E. SWAGELOK TUBE FITTING INSTRUCTIONS** .......... **18**

E.1 Installation .......... 18
E.2 Reassembly Instructions .......... 19

# FIGURES

FIGURE 1 - PRINCIPLE OF OPERATION ........ 1
FIGURE 2 - INSTALLATION DETAILS ........ 3
FIGURE 3 - LEMO CONNECTOR TO GK-404 ........ 7
FIGURE 4 - LIVE READINGS – RAW READINGS ........ 8
FIGURE 5 - DENSITY OF WATER AS A FUNCTION OF TEMPERATURE AND PRESSURE INTENSITY ........ 11
FIGURE 6 - TYPICAL 4675 CALIBRATION REPORT ........ 16
FIGURE 7 - TUBE INSERTION ........ 18
FIGURE 8 - MAKE A MARK AT SIX O'CLOCK ........ 18
FIGURE 9 - TIGHTEN ONE AND ONE-QUARTER TURNS ........ 18
FIGURE 10 - MARKS FOR REASSEMBLY ........ 19
FIGURE 11 - FERRULES SEATED AGAINST FITTING BODY ........ 19
FIGURE 12 - TIGHTEN NUT SLIGHTLY ........ 19

# TABLES

TABLE 1 - EXAMPLE READINGS ........ 10
TABLE 2 - SAMPLE RESISTANCE ........ 13
TABLE 3 - RESISTANCE WORK SHEET ........ 13
TABLE 4 - 4675 SPECIFICATIONS ........ 14
TABLE 5 - THERMISTOR RESISTANCE VERSUS TEMPERATURE ........ 15

# EQUATIONS

EQUATION 1 - CHANGE IN ELEVATION ........ 10
EQUATION 2 - TEMPERATURE/DENSITY CORRECTION ........ 11
EQUATION 3 - RESISTANCE TO TEMPERATURE ........ 15

# 1. THEORY OF OPERATION

The Model 4675 Liquid Level System is designed to detect and measure very small changes of elevation in situations which high accuracy and resolution are essential. It can be used to measure differential settlements along tunnels, deflections of bridges and bridge piers, the settlement of building columns or floor slabs, etc. A very high resolution/accuracy of 0.07 mm can be attained.

The 4675 consists of a series of chambers, which are hydraulically connected together at the bottom, by means of a water-filled tube. (See Figure 1.) The level of the water surface is the same inside each chamber. A vent line connects the air space inside each transducer to the air space above the liquid in the chamber. This minimizes the effect of changing temperatures and barometric fluctuations on the readings.

One reference chamber is located on stable ground, or at a point that can be surveyed. The other chambers are located at points where settlement or heave will be measured. Each chamber contains a cylindrical weight suspended from a vibrating wire transducer. The liquid inside each chamber partially submerges the hanging weight so that settlement or heave of any one chamber causes an apparent rise or fall of the water level in that chamber. This change in water level leads to a greater or lesser buoyancy force on the weight inside the chamber, and thus to a decrease or increase of tension and frequency of vibration in the attached vibrating wire.

Readout of the instruments is accomplished with portable readouts such as the GK-404, GK-405 or one of the GEOKON data acquisition systems such as the 8600 series dataloggers, or 8800 GeoNet wireless system.

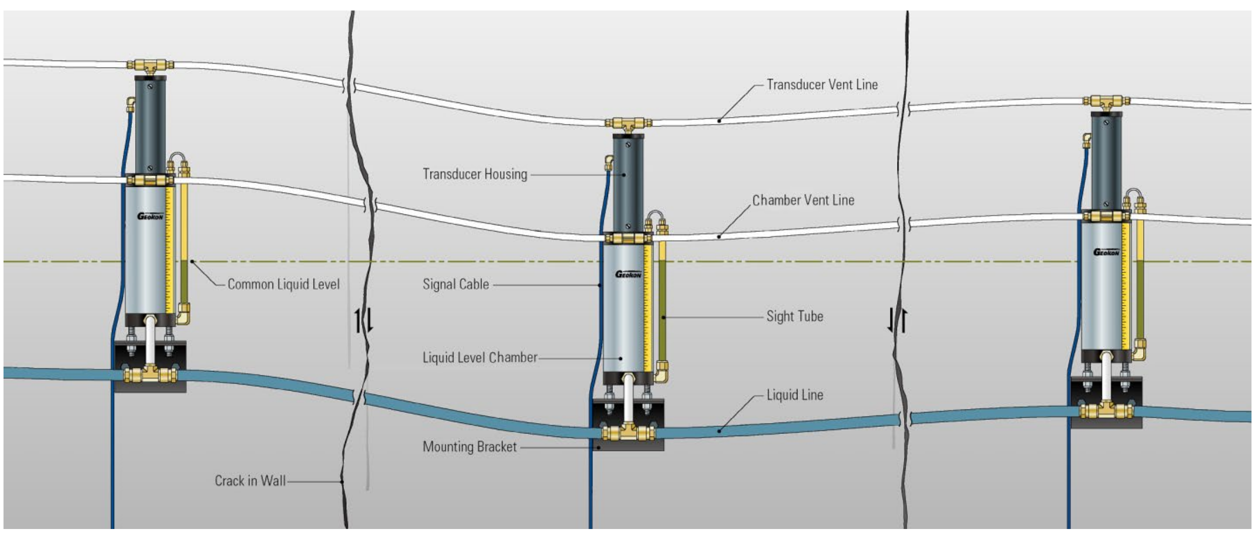



**Figure 1 - Principle of Operation**

# 2. INSTALLATION

The vibrating wire transducer is very sensitive and correspondingly fragile; it must be handled with great care. Before any attempt is made to install the sensors, the following directions must be read and understood.

## 2.1 Install the Mounting Brackets

Since the range of the transducers is limited and the amount of adjustment is small, it is important to **install all the chambers at about the same elevation, ±10 mm.** The chamber mounting brackets are designed to be bolted to a wall or a pedestal, and should be firmly attached with anchor bolts or epoxy grouted studs. (These can be supplied if requested.) When all brackets have been installed, the chambers should be attached.

## 2.2 Install the Chambers

1) Install the threaded rods into the holes in the base of the chamber assembly; tighten to finger tight.

2) Thread one jam nut onto each rod until it is tight up against the base.

3) Thread another jam nut onto each rod, approximately 1.5 inches.

4) Holding onto the chamber, insert the threaded rods through the holes of the mounting bracket.

5) Place a spirit level against the wall of the chamber cylinder.

6) Adjust the tilt of the chamber using the nuts on the threaded rods. The chambers must be within ±1.5 degrees of vertical for proper operation.

7) When the cylinder is level, thread the remaining jam nuts onto the threaded rods and tighten.

## 2.3 Connecting the Liquid Line

After the chambers have been mounted, the next step is to attach the liquid line. This is accomplished by connecting a half inch diameter plastic tube from the Swagelok fitting at the bottom of the chamber to the liquid line, which consists of a series of T-valve fittings and one inch plastic tubing.

The T-valve assemblies for the liquid line are shipped separately; **it is important to select the correct valve for each chamber.** As shown in Figure 2, the first chamber uses the T-valve fitting with one barb fitting and one filling valve, the intermediate chambers use T-valve assemblies equipped with two barb fittings, and the last chamber has one barb fitting and a pipe plug.

The one-inch tubing used to connect the T-valve assemblies is supplied in a coil and should be cut to the proper lengths and then attached to the barbed fittings of the T-valve assemblies. Support the tubing and T-valve assemble below the chambers. If possible, the tubing should be slightly inclined so that the tubing below the first chamber is lowest, with the liquid line inclined upwards to the last chamber. A slope of approximately 1/4” per foot (20 mm per meter) is recommended. If site conditions or length of the tubing precludes this, then whatever slope is possible should be applied to help prevent bubble formation in the line while filling. The lowest end of the line should have a valve for draining and filling. Try to keep the liquid line as straight as possible and avoid loops. There must be no siphons at all.

To connect the liquid line to the bottom of the chambers, cut the correct lengths of the half-inch tubing needed to connect the Swagelok fitting at the base of the chambers to the hose barbs on the T-valve fittings of the liquid line.

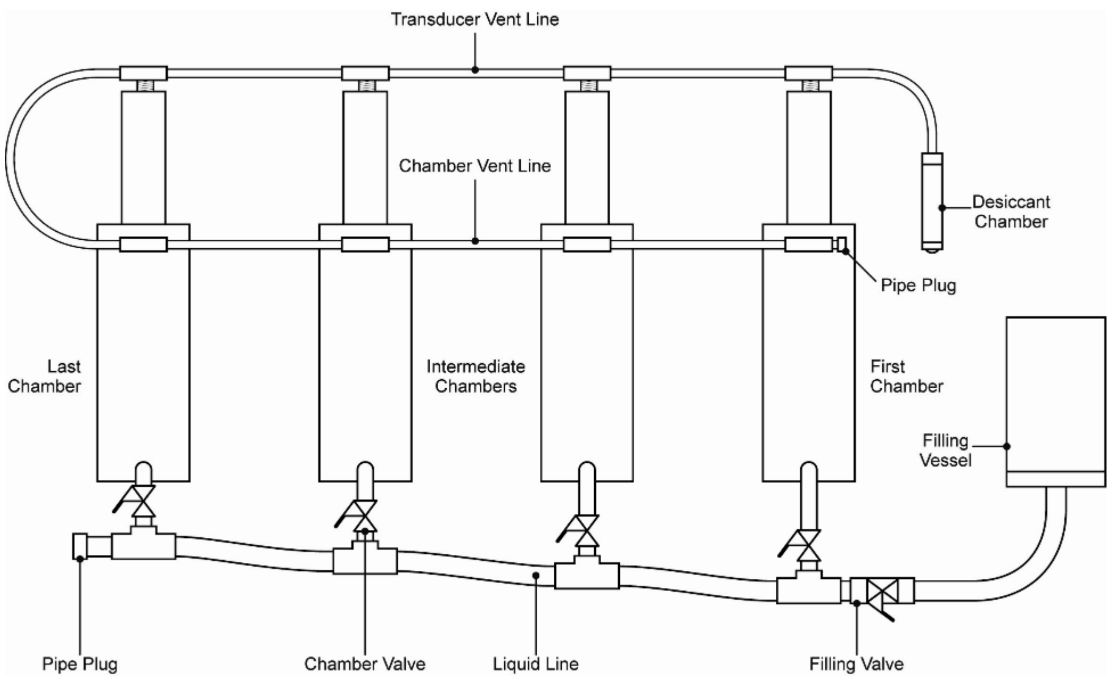



**Figure 2 - Installation Details**

## 2.4 Installing the Hanging Weights

**WARNING! THIS OPERATION IS VERY CRITICAL AND SHOULD BE PERFORMED WITH EXTREME CARE.**

A spring and a stop protect the sensor from overrange; however, severe dynamic shocks could destroy the vibrating wire element.

The chambers are shipped fully assembled minus the hanging weights. To install the hanging weights, complete the following:

1) Undo the Swagelok fitting that connects the stainless steel tube to the top of the yellow sight tube.

2) Remove the three cap screws at the top of bottom of the transducer housing.

3) Gently pull the transducer housing upward, until the transducer is out of the chamber.

4) Remove the orange colored shipping spacer from the transducer.

5) Hanging weights and transducers are matched pairs. Make sure to select the cylindrical weight that has the serial number matching that of the transducer.

6) The large o-ring, supplied separately should be placed into the groove on transducer housing. A light application of o-ring grease will help with the installation.

7) Holding the transducer housing **with both hands**, connect the hook on the top of the weight to the hook on the bottom of the transducer.

8) Gently lift the weight while keeping the transducer housing vertical.

9) Lower the cylindrical weight into the chamber and hold the transducer housing just above the chamber.

10) Line up the holes in the chamber with the screw holes in the cap.

11) Gently lower the transducer housing into the chamber being careful not to jar it as the O-ring contacts the tube.

12) Force the housing down into the chamber being careful not to cut the O-ring as it passes the screw holes.

13) When the cap is all the way in place, put the three screws in and tighten them. Do not overtighten.

14) Tighten the Swagelok connector at the top of the sight tube on to the stainless steel tubing per the instructions in Appendix E.

15) Repeat the above procedure for all the chambers.

## 2.5 Connecting the Chamber and Transducer Vent Lines

The purpose of the 1/2 inch chamber vent line is to allow the air pressure above the fluid in all the chambers to equilibrate. A separate 1/4 inch transducer vent line for the transducer prevents any chamber liquid from accidentally getting into the transducer. The vent lines are supplied in a coil. Cut off the correct lengths and connect them to the barb fitting on the chambers.

## 2.6 Filling the Liquid Line

The filling operation should be done very carefully to exclude air bubbles from the lines. The liquid can be either water or antifreeze solution. If using an antifreeze solution, it is important to measure the specific gravity of the fluid and apply a correction to the gauge factors for the sensors. **If water is used a small amount of ethylene glycol antifreeze should be added to prevent the growth of algae**. **(Do not use bleach as this will corrode the brass fittings).**

The first step is to fill the liquid line from one end to the other, while **keeping the chamber valves closed.** Before starting, disconnect all of the liquid lines from the chambers by loosening the Swagelok fitting on the base of each chamber. The purpose of this is to allow manipulating the main line to remove air bubbles. Remove the pipe plug from the chamber valve below the last chamber. See Figure 2.

The filling vessel should be of sufficient size to hold enough liquid to fill the main line and all of the chambers to about the half-full position. The supply tank should be above the chambers to maintain a positive flow. A carboy makes a good supply vessel. Using the supplied flexible tubing, a siphon should be started, and then connect the tube to the valve barb at the end of the liquid line. Raise the liquid line ahead of the first valve and allow the liquid to flow, chase the air ahead of the liquid by manually controlling the elevation of the liquid line as the liquid flows. Make a bit of a ∩ in the line as it is installed. When the liquid line is full, the plug at far end of the liquid line can be replaced. Make sure there are no air bubbles in the liquid line and that the filling vessel has enough liquid left in it to allow filling of the chambers.

## 2.7 Filling the Chambers

Before connecting each chamber line to its chamber open the shutoff valve and let the liquid flow from the line clearing any bubbles out. It is a good idea to rotate and tap the tee a bit in order to push out any entrapped air. Reconnect the line to the chamber and open the valve to fill the chamber up to the midpoint mark on the chamber. Close the shutoff valve. Go to the next chamber in line and repeat this operation.

When all the chambers have been filled to this level and closed off, close the filling valve. Next, open all of the chamber shutoff valves and allow the liquid level to equilibrate in all the chambers. If any chamber is seen to be too high or too low, it should be adjusted now, using the threaded rod mounts if possible. If this is not possible, the mounting bracket may need to be moved. The system liquid level can be adjusted by adding or removing liquid through the filling valve. When the proper level is achieved, the filling valve is closed, and the filling vessel can be disconnected. **To prevent tampering with the liquid level the handle should be removed from the filling valve**. The plug on the end of the chamber vent line at the first chamber can now be replaced. The chamber vent line can be connected to the transducer vent line and the desiccant chamber can be attached to the open end of the transducer vent line. (See Figure 2).

### 2.8 Connecting the Two Vent Lines

The two vent lines should be connected together at the last chamber using the 1/2 inch tubing. (See Figure 2). **Only do this after the chambers have been filled**. (This is a precaution to avoid any water entering the transducer vent line and flooding the transducer during the filling operation). The pipe plug on the chamber vent line at the first chamber should be removed and left open until the filling process is completed**.**

### 2.9 Stringing the Transducer Signal Cables

The transducer cables can now be uncoiled and supported, at intervals on their passage to the readout location.

The sensor operation can be checked by taking readings on all sensors and, by reference to the calibration sheet supplied confirm that the readings are in the midrange position. A rough in-situ calibration check can be made by adding or subtracting liquid and comparing the change in water level – as shown by the sight tube – with the change in level calculated using the calibrating gauge factors.

## 3. CALIBRATION

Laboratory calibrations are performed on each individual sensor using a system of calibrated weights. Gauge factors are presented for pure water applications. If mixtures other than this are used, the gauge factor should be adjusted for the specific gravity of the fluid used. A typical calibration sheet is shown in Appendix C.

# 4. TAKING READINGS

## 4.1 GK-404 Readout Box

The Model GK-404 Vibrating Wire Readout is a portable, low-power, handheld unit that can run continuously for more than 20 hours on two AA batteries. It is designed for the readout of all GEOKON vibrating wire gauges and transducers; and is capable of displaying the reading in either digits, frequency (Hz), period (μs), or microstrain (με). The GK-404 also displays the temperature of the transducer (embedded thermistor) with a resolution of 0.1 °C.

### 4.1.1 Operating the GK-404

Before use, attach the flying leads to the GK-404 by aligning the red circle on the silver "Lemo" connector of the flying leads with the red line on the top of the GK-404 (Figure 3). Insert the Lemo connector into the GK-404 until it locks into place.

**Figure 3 - Lemo Connector to GK-404**

Connect each of the clips on the leads to the matching colors of the sensor conductors, with blue representing the shield (bare).

To turn the GK-404 on, press the "ON/OFF" button on the front panel of the unit. The initial startup screen will be displayed. After approximately one second, the GK-404 will start taking readings and display them based on the settings of the POS and MODE buttons.

The unit display (from left to right) of the GK-404 is as follows:

- The current Position: Set by the **POS** button, displayed as a letter A through F.
- The current Reading: Set by the **MODE** button, displayed as a numeric value followed by the unit of measure.
- Temperature reading of the attached gauge in degrees Celsius.

Use the **POS** button to select position **B** and the **MODE** button to select **Dg** (digits). (Other functions can be selected as described in the GK-404 Manual.)

The GK-404 will continue to take measurements and display readings until the unit is turned off, either manually, or if enabled, by the Auto-Off timer. For further information please see the GK-404 manual.

## 4.2 GK-405 Readout Box

The GK-405 Vibrating Wire Readout is made up of two components: The Readout Unit, consisting of a Windows Mobile handheld PC running the GK-405 Vibrating Wire Readout Application; and the GK-405 Remote Module, which is housed in a weatherproof enclosure and connects via a cable to the vibrating wire gauge to be measured. The two components communicate wirelessly. The Readout Unit can operate from the cradle of the Remote Module, or, if more convenient, can be removed and operated up to 20 meters from the Remote Module.

### 4.2.1 Connecting Sensors with 10-pin Bulkhead

Align the grooves on the sensor connector (male), with the appropriate connector on the readout (female connector labeled senor or load cell). Push the connector into place, and then twist the outer ring of the male connector until it locks into place.

### 4.2.2 Connecting Sensors with Bare Leads

Attach the GK-403-2 flying leads to the bare leads of a GEOKON vibrating wire sensor by connecting each of the clips on the leads to the matching colors of the sensor conductors, with blue representing the shield (bare).

### 4.2.3 Operating the GK-405

Press the button labeled “POWER ON”. A blue light will begin blinking, signifying that the Remote Module is waiting to connect to the handheld unit. Launch the GK-405 VWRA program by tapping on “Start” from the handheld PC’s main window, then “Programs” then the GK-405 VWRA icon. After a few seconds, the blue light on the Remote Module should stop flashing and remain lit. The Live Readings Window will be displayed on the handheld PC. Choose display mode “B”.

Figure 4 shows a typical vibrating wire output in digits and thermistor output in degrees Celsius. For further information, consult the GK-405 Instruction Manual.

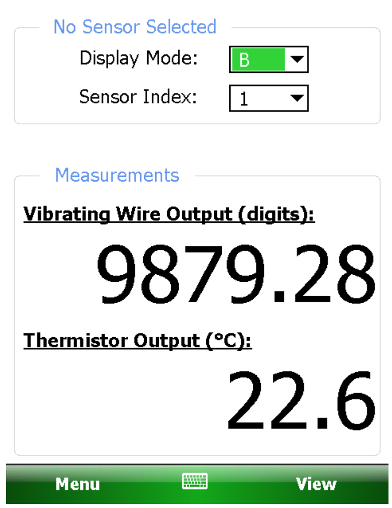



**Figure 4 - Live Readings – Raw Readings**

## 4.3 GK-403 Readout Box (Obsolete Model)

The GK-403 can store gauge readings and apply calibration factors to convert readings to engineering units. The following instructions explain taking gauge measurements using Mode "B".

### 4.3.1 Connecting Sensors with 10-pin Bulkhead

Align the grooves on the sensor connector (male), with the appropriate connector on the readout (female connector labeled senor or load cell). Push the connector into place, and then twist the outer ring of the male connector until it locks into place.

### 4.3.2 Connecting Sensors with Bare Leads

Attach the GK-403-2 flying leads to the bare leads of a GEOKON vibrating wire sensor by connecting each of the clips on the leads to the matching colors of the sensor conductors, with blue representing the shield (bare).

### 4.3.3 Operating the GK-403

1) Turn the display selector to position "B".
2) Turn the unit on.
3) The readout will display the vibrating wire output in digits. The last digit may change one or two digits while reading.
4) The thermistor reading will be displayed above the gauge reading in degrees centigrade.
5) Press the "Store" button to record the value displayed.

The unit will automatically turn off after approximately two minutes to conserve power. Consult the GK-403 Instruction Manual for additional information.

## 4.4 Measuring Temperatures

All liquid level sensors are equipped with a thermistor that gives a varying resistance output as the temperature changes. The white and green leads of the instrument cable are normally connected to the internal thermistor.

GEOKON readout boxes will read the thermistor and display the temperature in degrees C.

**To read temperatures using an ohmmeter:**

1) Connect an ohmmeter to the green and white thermistor leads coming from the strain gauge. 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/1000' or 48.5Ω/km. Multiply this factor by two to account for both directions.
2) Look up the temperature for the measured resistance in Appendix B, Table 5.

## 5. DATA REDUCTION

The change in elevation for any particular chamber in a system is determined as follows:

$$\Delta EL_x = (R1_x - R0_x)\, G_x - (R1_{Ref} - R0_{Ref})\, G_{Ref}$$

**Equation 1 - Change in Elevation**

Where;
$\Delta EL_x$ = Change in Elevation for Chamber x. Negative values of $\Delta EL_x$ indicate settlement. Positive values of $\Delta EL_x$ indicated heave.
$R1_x$ = Current Reading Chamber x
$R0_x$ = Initial Reading Chamber x
$G_x$ = Calibration Factor Chamber x
$R0_{Ref}$ = Initial Reading Reference Chamber
$R1_{Ref}$ = Current Reading Reference Chamber
$G_{Ref}$ = Calibration Factor Reference Chamber

Consider the following example, which shows the initial and subsequent readings on a four-chamber system (three active chambers and one reference chamber).

| Chamber | Initial Reading | Subsequent Reading | Calibration Factor |
|---|---|---|---|
| 1 (Reference) | 7163 | 7118 | 0.002852 |
| 2 | 7858 | 7813 | 0.002856 |
| 3 | 7967 | 8628 | 0.002808 |
| 4 | 8028 | 7637 | 0.002852 |

**Table 1 - Example Readings**

The calculations to determine the change in elevation of chambers two, three, and four are:
*Chamber No. 2:*
$\mathbf{\Delta EL_2 = (R1_2 - R0_2)\, G_2 - (R1_1 - R0_1)\, G_1}$
= (7813 – 7858) 0.002856 – (7118 – 7163) 0.002852
= – 0.1285 – (– 0.1283)
= – 0.0002″ (*No Movement)*

*Chamber No. 3:*
$\mathbf{\Delta EL_3 = (R1_3 - R0_3)\, G_3 - (R1_1 - R0_1)\, G_1}$
= (8628 – 7967) 0.002808 – (7118 – 7163) 0.002852
= 1.8561 – (– 0.1283)
= 1.9843″ (*Heave)*

*Chamber No. 4:*
$\mathbf{\Delta EL_4 = (R1_4 - R0_4)\, G_4 - (R1_1 - R0_1)\, G_1}$
= (7637 – 8028) 0.002852 – (7118 – 7163) 0.002852
= – 1.1151 – (– 0.1283)
= – 0.9868″ (*Settlement)*

## 6. CORRECTIONS FOR TEMPERATURE CHANGES

The vibrating wire sensor is insensitive to temperature changes within the normal operating range. Expansion and contraction of the liquid line, the liquid, and the chambers can cause the water level to fluctuate. However, these fluctuations are the same in all the chambers, and cancel out on data reduction. 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. A temperature/density curve for water is shown in Figure 5. As can be seen from the data, the density changes very little within the normal operating range of the sensor. The following equation is used to correct for temperature/density changes:

$$\Delta H = (R_1 - R_0)\, G / (SG)$$

**Equation 2 - Temperature/Density Correction**

Where;
SG = The specific gravity of the fluid (water) at the measurement temperature
$R_1$ = The current reading
$R_0$ = The initial zero reading
G = The calibration factor

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 5.

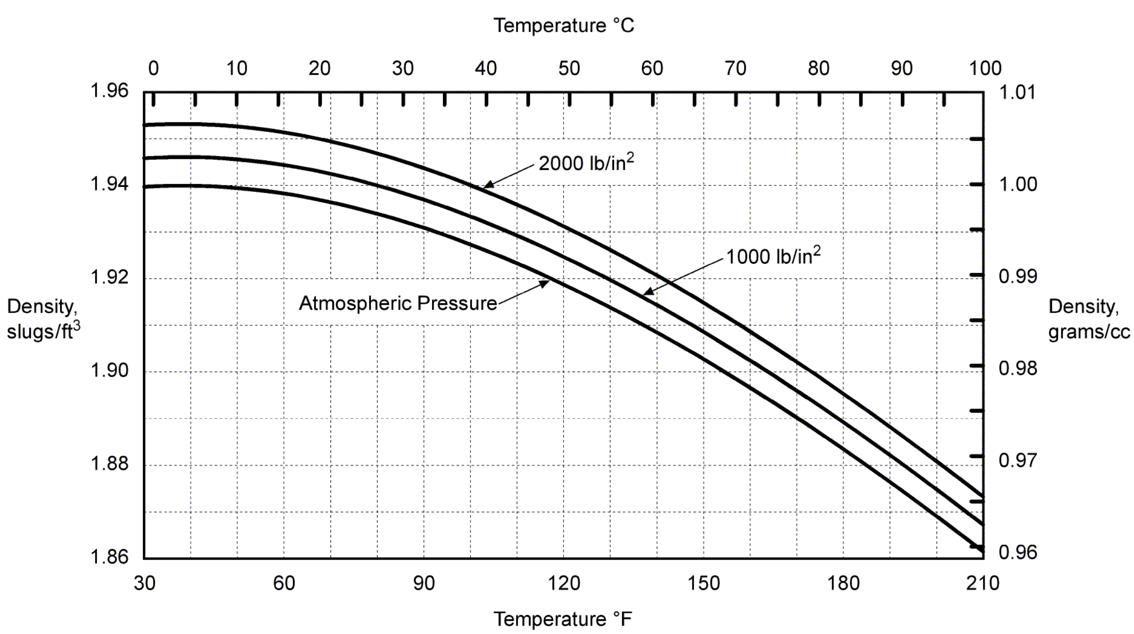


**Figure 5 - Density of Water as a Function of Temperature and Pressure Intensity**

(Figure 5 used with permission from *Fluid Mechanics for Hydraulic Engineers,* by Hunter Rouse, copyright 1938, McGraw-Hill Book Company, Inc.)

## 7. TROUBLESHOOTING

Should difficulties arise, consult the following list of problems and possible solutions. For additional troubleshooting and support, contact GEOKON.

***Symptom: Thermistor resistance is too high***

- ✓ Likely, there is an open circuit. Check all connections, terminals, and plugs. If a cut is located in the cable, splice according to recommended procedures.

***Symptom: Thermistor resistance is too low***

- ✓ A short is likely. Check all connections, terminals, and plugs. If a short is located in the cable, splice according to recommended procedures.
- ✓ Water may have penetrated the interior of the transducer. There is no remedial action.

***Symptom: Transducer reading unstable***

- ✓ Make sure the shield drain wire is connected to the blue clip on the flying leads. (Green for the GK-401.)
- ✓ Isolate the readout from the ground by placing it on a piece of wood or other insulator.
- ✓ Check for sources of nearby electrical noise such as motors, generators, antennas, or electrical cables. Move the transducer cable away from these sources if possible. Contact the factory for available filtering and shielding equipment.

***Symptom: Transducer fails to read***

- ✓ Check the coil resistance by connecting an ohmmeter to the sensor leads. Table 2 shows the expected resistance for the various wire combinations; Table 3 is provided for the customer to fill in the actual resistance found. Cable resistance is approximately 14.7Ω/1000' or 48.5Ω/km of 22 AWG wire. Multiply this factor by two to account for both directions.
  If the resistance is high or infinite, a cut cable must be suspected. If the resistance is low or near zero, a short must be suspected. If cuts or shorts are located, the cable may be splices in accordance with recommended procedures.
- ✓ Check the readout with another gauge to ensure it is functioning properly.

| Vibrating Wire Sensor Lead Grid - SAMPLE VALUES | | | | | |
|---|---|---|---|---|---|
| | Red | Black | White | Green | Shield |
| Red | N/A | **≅180Ω** | infinite | infinite | infinite |
| Black | **≅180Ω** | N/A | infinite | infinite | infinite |
| White | infinite | infinite | N/A | **3000Ω at 25°C** | infinite |
| Green | infinite | infinite | **3000Ω at 25°C** | N/A | infinite |
| Shield | infinite | infinite | infinite | infinite | N/A |

**Table 2 - Sample Resistance**

| Vibrating Wire Sensor Lead Grid - SENSOR NAME/## : | | | | | |
|---|---|---|---|---|---|
| | Red | Black | White | Green | Shield |
| Red | | | | | |
| Black | | | | | |
| White | | | | | |
| Green | | | | | |
| Shield | | | | | |

**Table 3 - Resistance Work Sheet**

# APPENDIX A. SPECIFICATIONS

## A.1 4675 Liquid Level Sensor

| | |
|---|---|
| **Standard Ranges**[1] | 100, 150, 300, 600 mm |
| **Resolution** | 0.025% F.S. |
| **System Accuracy**[2] | ±0.1% F.S. |
| **Temperature Range** | -20 ºC[3] to +80 ºC |
| **Frequency Range** | 1400 to 3500 Hz |

**Table 4 - 4675 Specifications**

Notes:
[1] Other ranges available on request.
[2] Laboratory accuracy. Total system accuracy is subject to site-specific variables.
[3] Using antifreeze solutions.

## A.2 Thermistor (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:

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

**Equation 3 - Resistance to Temperature**

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 the −50 to +150 °C. span.

| 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 5 - Thermistor Resistance versus Temperature**

# APPENDIX C. TYPICAL CALIBRATION SHEET

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

## Vibrating Wire Liquid Level Sensor Calibration Report

Model Number: 4675-3-100 mm

Temperature: 23.4 °C

Serial Number: 1205830

Calibration Date: April 25, 2011

Calibration Instruction: CI-4675

Technician:

| Applied Load L (lbs) | Equivalent inches $H_2O$ | Reading 1st Cycle | Reading 2nd Cycle | Average Reading (R) |
|---|---|---|---|---|
| 1.430 | 5.647 | 3552 | 3552 | 3552 |
| 2.090 | 8.256 | 5132 | 5133 | 5133 |
| 2.752 | 10.868 | 6705 | 6705 | 6705 |
| 3.415 | 13.487 | 8271 | 8272 | 8272 |
| 4.080 | 16.113 | 9830 | 9830 | 9830 |

Factory reading with the cylindrical weight hanging in air = 10167

Mid-range reading = 8967

Cylinder Dimensions (inches): Weight Range: 4 inches

| | 1 | 2 | 3 |
|---|---|---|---|
| Top | 2.997 | 3.003 | 2.995 |
| Middle | 2.989 | 3.003 | 2.996 |
| Bottom | 2.994 | 2.997 | 2.997 |

Manufacturing Number: HW-12-075

Average Diameter (D): 2.997

Volume Factor (K): 3.950 (inches / lb)

$K = [1/(0.02836 \times D^2)]+0.02326$

Equivalent inches of $H_2O = L \times K$

**Calibration Factor (G): 0.001667 (inches / digit) or 0.04234 (mm / digit)**

Change in Sensor Elevation = $G(R_1-R_0)$

Wiring Code: Red and Black: Gage White and Green: Thermistor

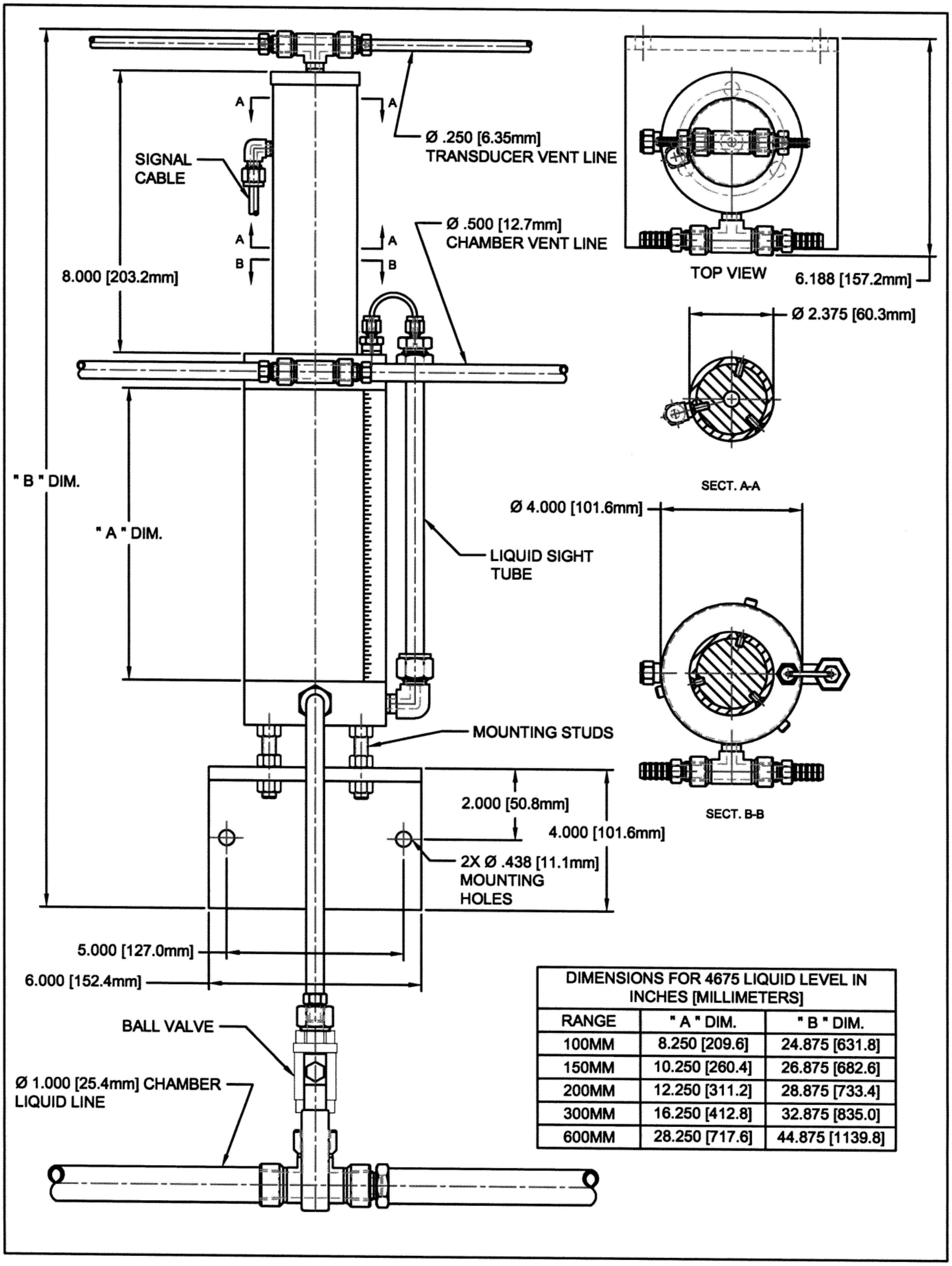
The above instrument was found to be In Tolerance in all operating ranges.

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.

**Figure 6 - Typical 4675 Calibration Report**

## APPENDIX D. 4675 DIMENSIONS




| DIMENSIONS FOR 4675 LIQUID LEVEL IN INCHES [MILLIMETERS] | | |
|---|---|---|
| RANGE | " A " DIM. | " B " DIM. |
| 100MM | 8.250 [209.6] | 24.875 [631.8] |
| 150MM | 10.250 [260.4] | 26.875 [682.6] |
| 200MM | 12.250 [311.2] | 28.875 [733.4] |
| 300MM | 16.250 [412.8] | 32.875 [835.0] |
| 600MM | 28.250 [717.6] | 44.875 [1139.8] |

## APPENDIX E. SWAGELOK TUBE FITTING INSTRUCTIONS

These instructions apply to one inch (25 mm) and smaller fittings.

### E.1 Installation

1) Fully insert the tube into the fitting until it bumps against the shoulder.

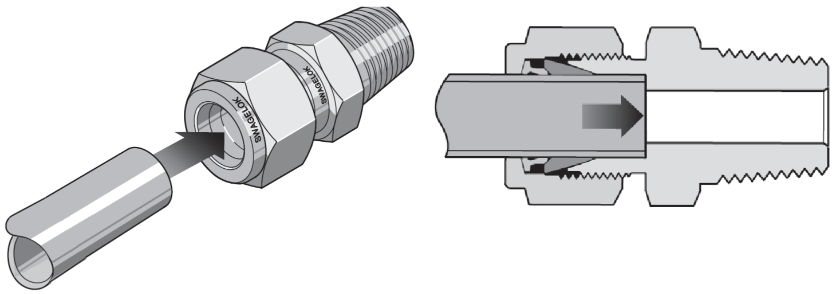


**Figure 7 - Tube Insertion**

2) Rotate the nut until it is finger-tight. (For high-pressure applications as well as high-safety-factor systems, further tighten the nut until the tube will not turn by hand or move axially in the fitting.)

3) Mark the nut at the six o'clock position.

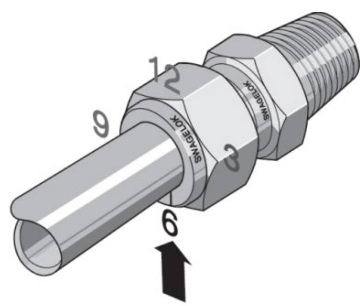



**Figure 8 - Make a Mark at Six O'clock**

4) While holding the fitting body steady, tighten the nut one and one-quarter turns until the mark is at the nine o'clock position. (Note: For 1/16", 1/8", 3/16", and 2, 3, and 4 mm fittings, tighten the nut three-quarters of a turn until the mark is at the three o'clock position.)

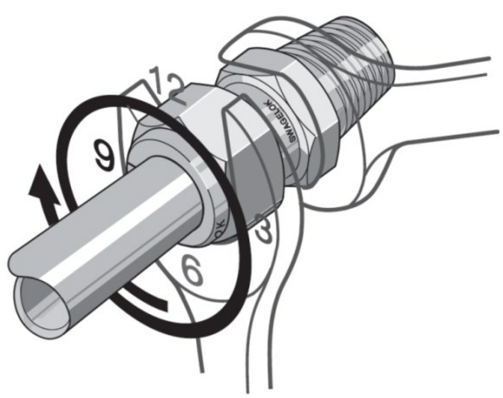



**Figure 9 - Tighten One and One-Quarter Turns**

## E.2 Reassembly Instructions

Swagelok tube fittings may be disassembled and reassembled many times.
**Warning! Always depressurize the system before disassembling a Swagelok tube fitting.**

1) Prior to disassembly, mark the tube at the back of the nut, then make a line along the nut and fitting body flats. *These marks will be used during reassembly to ensure the nut is returned to its current position.*

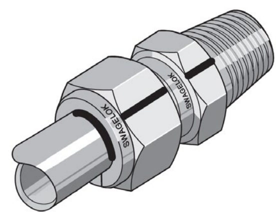


**Figure 10 - Marks for Reassembly**

2) Disassemble the fitting.

3) Inspect the ferrules for damage and replace if necessary. **If the ferrules are replaced the connector should be treated as a new assembly. Refer to the section above for installation instructions.**

4) Reassemble the fitting by inserting the tube with preswaged ferrules into the fitting until the front ferrule seats against the fitting body.

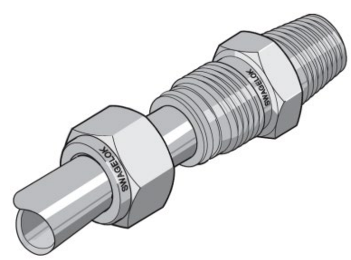


**Figure 11 - Ferrules Seated Against Fitting Body**

5) While holding the fitting body steady, rotate the nut with a wrench to the previous position as indicated by the marks on the tube and the connector. At this point, there will be a significant increase in resistance.

6) Tighten the nut slightly.

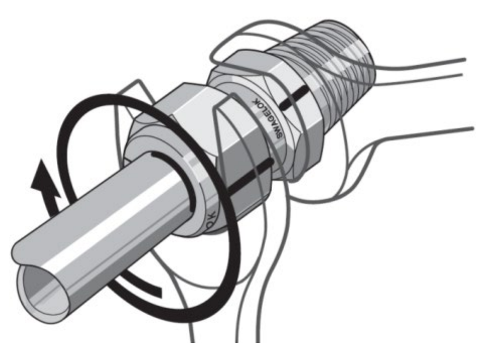


**Figure 12 - Tighten Nut Slightly**