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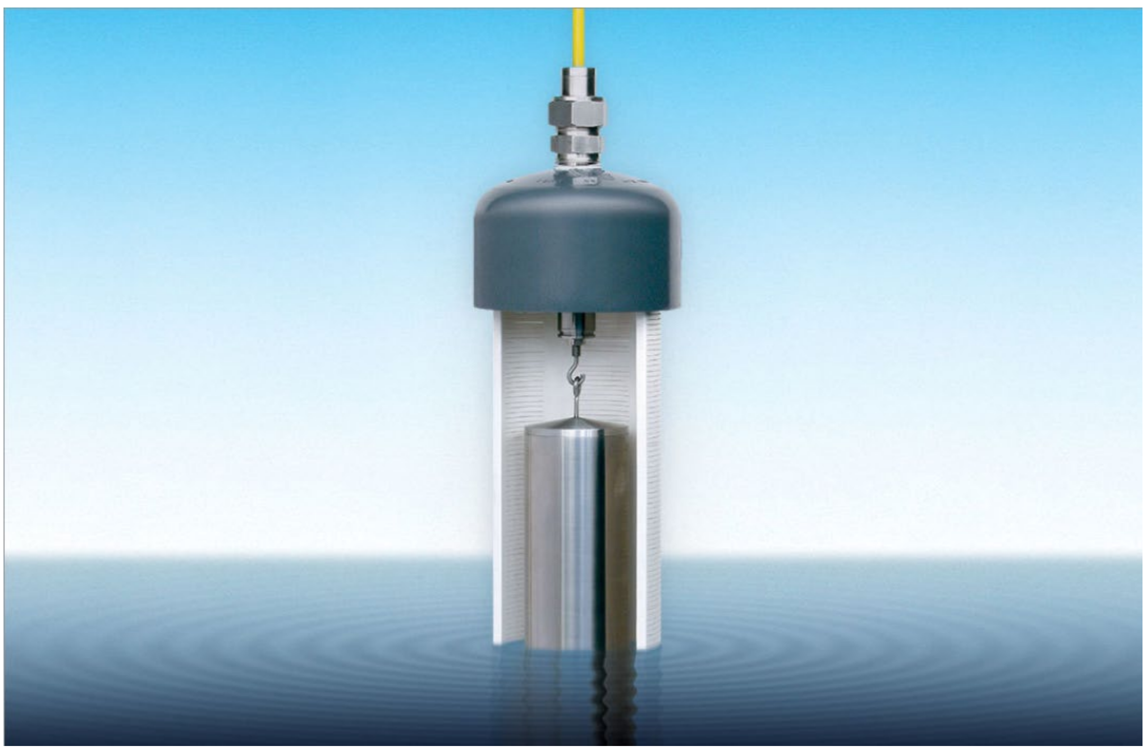
Instruction Manual

Model 4675LV

Weir Monitor



(Doc Rev K, 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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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

FIGURES

TABLES

EQUATIONS

1. INTRODUCTION

The Geokon Model 4675LV Weir Monitor is designed for the measurement of water levels in streams, weirs, flumes, etc., where accurate measurements of very small water level changes are required. The unit consists of a vibrating wire from which is suspended a hanging cylindrical weight partially submerged in the water. As the water level rises and falls, the buoyancy forces acting on the weight change causing changes in the tension and vibrational frequency in the vibrating wire. Level changes of as little as .001 inches can be measured. Ranges of up to 10 feet are available.

2. INSTALLATION PROCEDURES

2.1 Preliminary Checks

Before installing the weight cylinder, remove the orange colored spacer that lies 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 gauge and weight assembly can now be checked out on site by connecting the sensor to the readout system and measuring the output of the sensor with the weight hanging from it in air. The readings should coincide within about 200 digits of the factory reading in air shown on the calibration sheet. (See Section 3 for readout instructions. Be sure that the sensor is held firmly, and the system is allowed to stabilize (no swinging of the weight). Detach the weight after this preliminary check. **Always handle with great care to prevent breakage**.

2.2 Installation

If the 4675LV is used in a weir box, a Stilling Well is required. The Stilling Well is provided by Geokon, in the form of a slotted, three or four-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 bottom of the weight is slightly lower than the tip of the V notch.** 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, four Rawl plugs are provided. Mark out the position for four bolt holes, (see Figure 1) and drill a 1/2-inch (12 mm) diameter hole two inches (50 mm) 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.

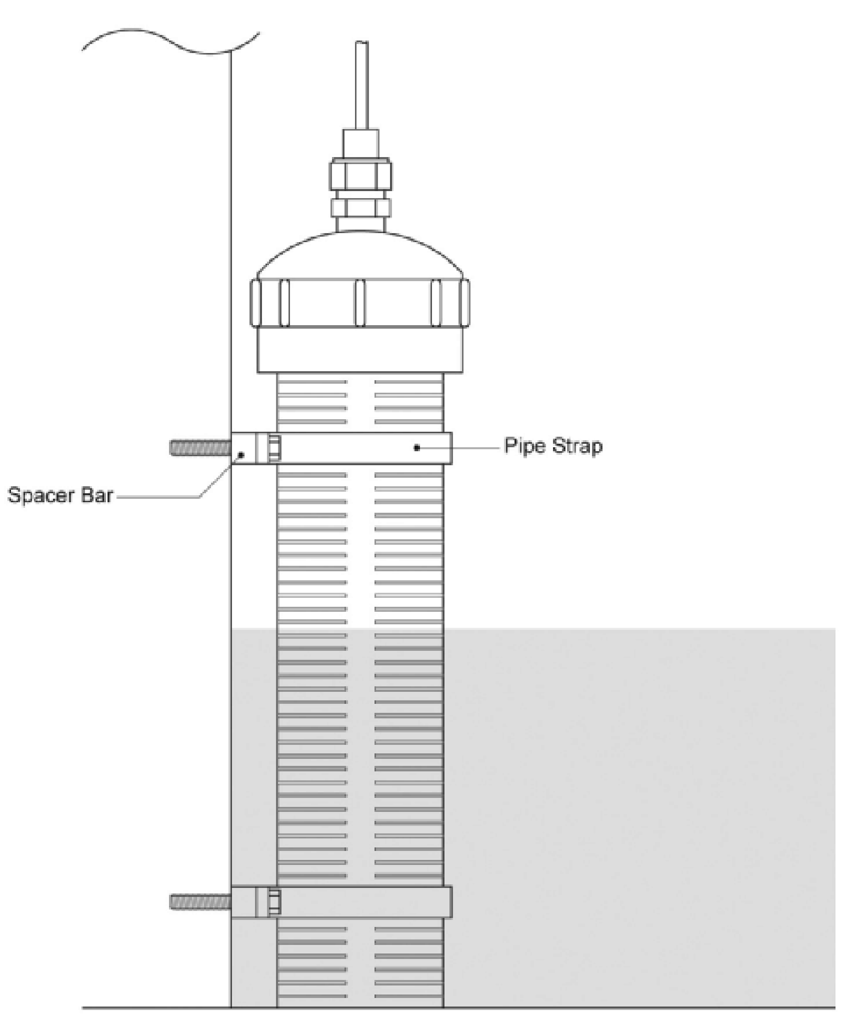

Figure 1 - Stilling Well Supports

Check that the sensor is reading then push it inside the Swagelok fitting in the pipe cap and tighten the According to the instructions in Appendix C. 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, as well as the vent line moisture trap. If the readout location is remote from the weir location, then a blue unvented cable can be used between the terminal box containing the moisture trap and the readout location. **The seal screw on the bottom of the desiccant chamber must be kept open while the Weir Monitor is in operation.** The proper color for the desiccant is blue. If the color is pink, then fresh desiccant is required.

3. TAKING READINGS

3.1 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.

3.1.1 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 2). Insert the Lemo connector into the GK-404 until it locks into place.

Figure 2 - 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, consult the GK-404 manual.

3.2 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.

3.2.1 Connecting Sensors

Sensors with 10-pin Bulkhead Connectors Attached:
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.

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).

3.2.2 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 3 shows a typical vibrating wire output in digits and thermistor output in degrees Celsius.

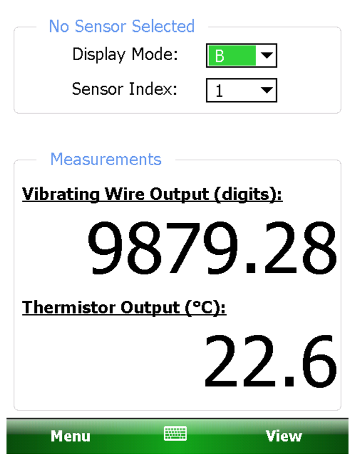

Figure 3 - Live Readings – Raw Readings

For further information, consult the GK-405 Instruction Manual.

3.3 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”.

3.3.1 Connecting Sensors to the GK-403

Connecting Sensors with 10-pin Bulkhead Connectors Attached:
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.

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).

3.3.2 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.

3.4 Measuring Temperatures

All 4675LV transducers 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. The GK-403, GK-404, and GK-405 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 transducer. (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 14.7 ohms per one thousand feet. Multiply this factor by two to account for both directions.)
2) Look up the temperature for the measured resistance in Appendix B, Table 1.

4. DATA REDUCTION

4.1 Determination of Water Elevation

Each type of weir, depending on its type, shape, and size has an equation relating the volume of fluid passing over it to the height of water, H, passing over the weir.
The change in height of the water is directly proportioned to the change in output of the transducer. The following formula applies for the determination of the change in water height:

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

Equation 1 - Change in Water Height

Where;
H is the height of water above the tip of the weir.
$\mathbf{R_0}$ is the initial reading.
$\mathbf{R_1}$ is the subsequent reading.
G is the calibration factor in the height units /digit shown on the calibration sheet. (See Figure 4 for an example of a typical calibration sheet.)

At the time that the initial reading (R_0) is taken, it is necessary to measure accurately as possible the difference in elevation between the surface of the water in the weir box and the tip of the weir. If the weir plate is graduated, simply record the initial water level as indicated, call this difference in elevation $\mathbf{\Delta_E}$.

Then;
$H = (R_1 - R_0)\,G + \Delta_E$ inches or mm

Alternatively, from the initial reading ($\mathbf{R_I}$) taken when the measured water height is $\mathbf{\Delta_E}$ inches, it is possible, using the gauge factor (**G**), to calculate the reading equivalent to the water level at the tip of the V notch ($\mathbf{R_o}$).

For instance:

If;
$R_I = 6500$
$\Delta_E = 5.2$ inches
G= - 0.001981 inches

Then;
$R_o = 6500 + 5.2/0.001981 = 9125$ and $H = G(R_I - 9125)$

Another method, if possible, is to adjust the height of water so that water just trickles over the V notch tip, and then take the R_o reading.

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

Model 4675LV Weir Monitor Calibration Report

Model Number: 4675LV-1-300 mm

Temperature: 23.6 °C

Serial Number: 1317899

Calibration Date: July 24, 2013

Calibration Instruction: CI-4675

Technician: KWBellavance

Applied Load L (lbs)	Equivalent inches H_2O	Reading 1st Cycle	Reading 2nd Cycle	Average Reading (R)	Change	Linearity (%FS)	Polynomial Fit % (FS)
1.462	6.858	4598	4598	4598			
2.136	10.017	6247	6247	6247	1649	0.38	0.03
2.806	13.161	7868	7868	7868	1621	0.46	0.00
3.477	16.306	9476	9476	9476	1608	0.32	-0.03
4.146	19.443	11070	11070	11070	1594	0.03	0.01

Factory reading with the cylindrical weight hanging in air = 9985

Mid-range reading = 6900

Cylinder Dimensions (inches):

Weight Range: 12 inches

	1	2	3
Top	2.751	2.746	2.749
Middle	2.749	2.747	2.748
Bottom	2.751	2.744	2.755

Manufacturing Number: HW-13-249

Average Diameter (D): 2.749

Volume Factor (K): 4.690 inches / lb)

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

Equivalent inches of $H_2O = L \times K$

Calibration Factor (G): -0.04941 (mm / digit) or -0.001945 (inches / digit)

Change in Water Height = $G(R_1-R_0)$

Polynomial Gage Factors: **A: 1.357E-07** **B: 0.0472816** **C: -46.1323**

Polynomial, $P = AR_1^2 + BR_1 + C$

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.
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Figure 4 - Typical Calibration Sheet

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 that the submerged sensor may or may not intersect. A temperature/density curve for water is shown in Figure 5. 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:

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

Equation 2 - Correction for Temperature/Density Changes

Where;
H is the height of water above the tip of the weir.
$\mathbf{R_0}$ is the initial reading.
$\mathbf{R_1}$ is the subsequent reading.
$\mathbf{T_0}$ is the initial water temperature in °C
$\mathbf{T_1}$ is the current water temperature in °C
G is the calibration factor in the height units /digit shown on the calibration sheet. (See Figure 4 for an example of a typical calibration sheet.)

4.3 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 5 below.

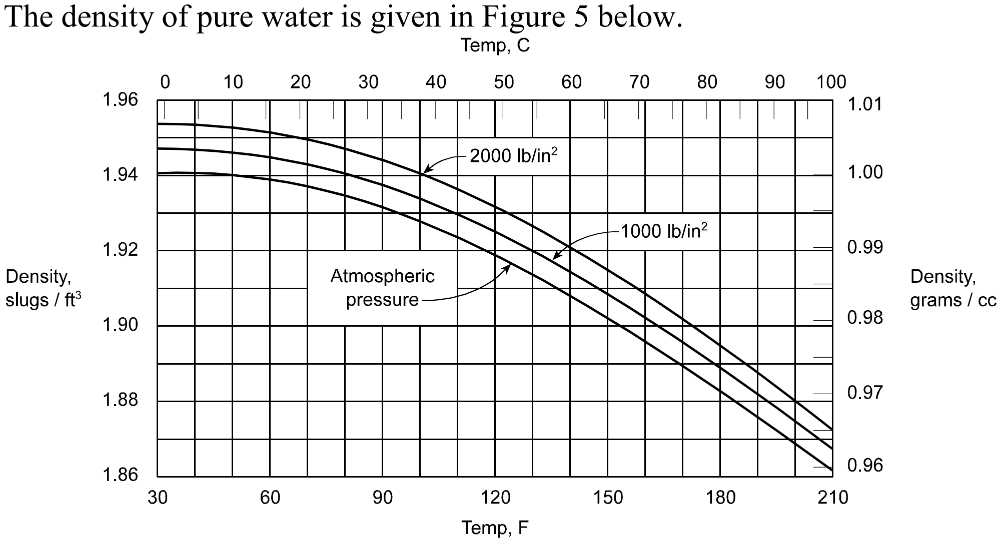

Figure 5 - Density of water as a function of temperature and pressure intensity

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

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. The seal screw on the moisture trap must be left open when the weir monitor is in operation.

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 cannot be opened for inspection.

6. TROUBLE SHOOTING

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 another 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.

APPENDIX A. SPECIFICATIONS

Model No.	4675LV
Standard Ranges[1]	150, 300, 600, 1500 mm
Accuracy[2]	±0.1% F.S.
Temperature Range[3]	-30 to +80 °C
Frequency Range	1400-3500 Hz
Materials:	*Sensor and Weight:* Stainless steel *Sitting Well:* PVC standard, stainless steel (optional)
Cable	Four Conductor, 22-gauge PVC jacket
Sensor	Diameter: 1.00” Length: 8.5”

[1] Other ranges available on request
[2] Accuracy achieved by using a polynomial expression rather than a linear coefficient
[3] Using antifreeze solution can extend the range below 0 °C. The system requires calibration with the solution being used.

APPENDIX B. THERMISTOR TEMPERATURE DERIVATION

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

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

Equation 3 - Resistance to Temperature

Where;
T = Temperature in °C.
LnR = Natural Log of Thermistor Resistance
A = 1.4051×10^{-3}
B = 2.369×10^{-4}
C = 1.019×10^{-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 1 - Thermistor Resistance versus Temperature

APPENDIX C. SWAGELOK TUBE FITTING INSTRUCTIONS

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

C.1 Installation

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

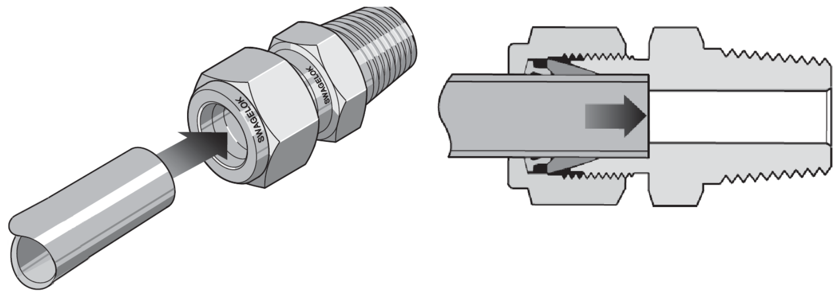

Figure 6 - Tube Insertion

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.

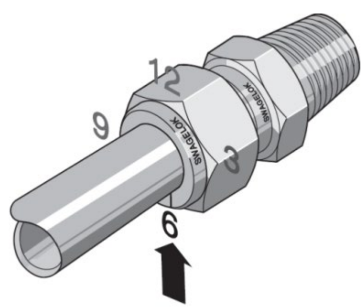

Figure 7 - Make a Mark at Six O'clock

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.)

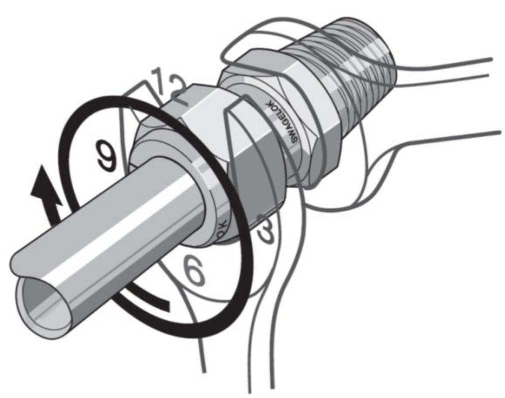

Figure 8 - Tighten One and One-Quarter Turns

C.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.*

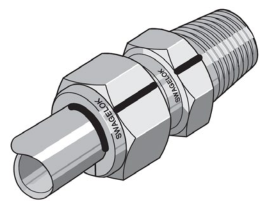

Figure 9 - Marks for Reassembly

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.

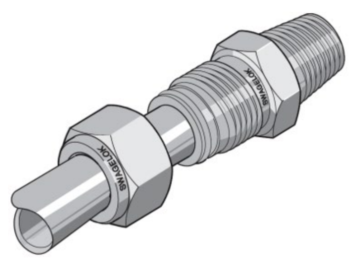

Figure 10 - Ferrules Seated Against Fitting Body

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.

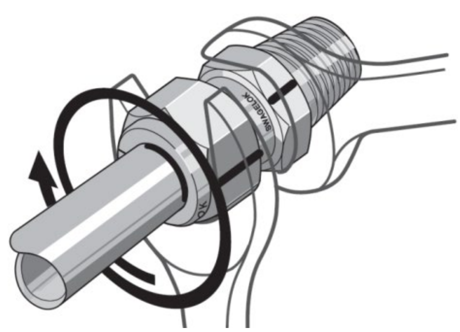

Figure 11 - Tighten Nut Slightly