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Instruction Manual

Model 4427

VW Long Range Displacement Meter

(Doc Rev M.2, 06/04/24)

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EQUATIONS

1. INTRODUCTION

The GEOKON Model 4427 Long Range Displacement Meter, (LRDM), is designed to measure displacements of up to two meters magnitude between two points. Typical applications include the monitoring of crack openings due to mining, and the monitoring of unstable slopes.

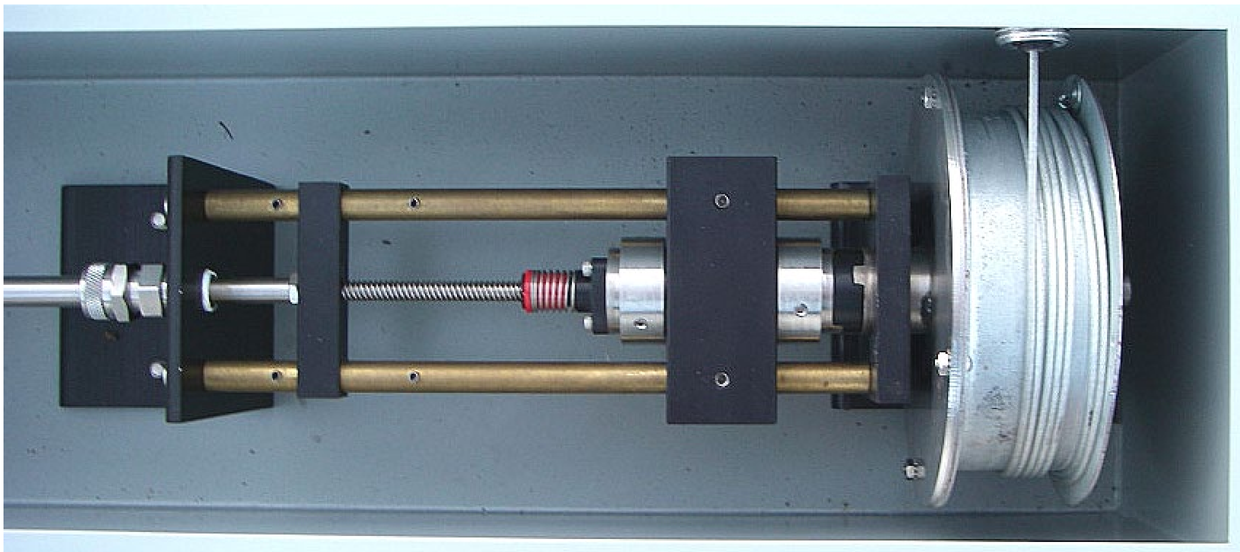

Figure 1 - 4427 Internal Mechanism

2. SYSTEM COMPONENTS

The Device consists of a drum on which is wound a length of 1/16 inch, nylon-jacketed, stainless steel aircraft cable. As movement occurs, the cable reels off the drum, and the drum turns. (The tension on the cable is maintained by a constant force spring inside the drum). The drum is connected to a lead-screw in such a way that the rotation of the drum is converted into a linear motion of the lead screw. The lead-screw is connected to a Model 4450 Vibrating Wire Displacement Transducer, which measures the linear motion. In this way a one-meter movement of the aircraft cable is converted into roughly 25 mm movement of the Transducer. The whole mechanism is enclosed within a rainproof enclosure.

A thermistor is included with the transducer so that temperature changes can be monitored.

The enclosure has a gasketed, hinged cover and is mounted on a three-inch threaded PVC pipe flange, which will mate with a three-inch pipe designed to be installed and grouted inside a borehole drilled perpendicular to the slope. This standpipe can be provided by the installer or is available at GEOKON.

Also included with the enclosure is a “weak link” for attachment between the tensioned aircraft cable inside the sensor enclosure and the extension cable, which stretches between the two points being monitored.

Figure 2 - The Weak Link

Experience has shown that unless this extension cable is fenced off there is a danger of large animals or pieces of equipment blundering into it; this can seriously damage the internal sensor mechanism. Should this happen, the weak link is designed to break at a relatively low cable tension, thus preventing damage to the mechanism from over-ranging. Also supplied is a compression spring which absorbs the shock of the recoil of the cable if the weak link is broken.

3. INSTALLATION

Two styles of installation are available: - pedestal mounted and pipe mounted.

3.1 Pipe Mounted

The Transducer enclosure can be mounted on a three-inch steel pipe threaded at its upper end to mate with the flange on the underside of the sensor enclosure. In the case of an unstable slope the enclosure will probably be at the up-hill point and the three-inch pipe will be grouted or firmly wedged into a borehole drilled perpendicular to the slope. The second moving point should consist of a similar three-inch pipe grouted or wedged in place at the desired distance from the first mounting point. Figure 3 shows a typical set-up

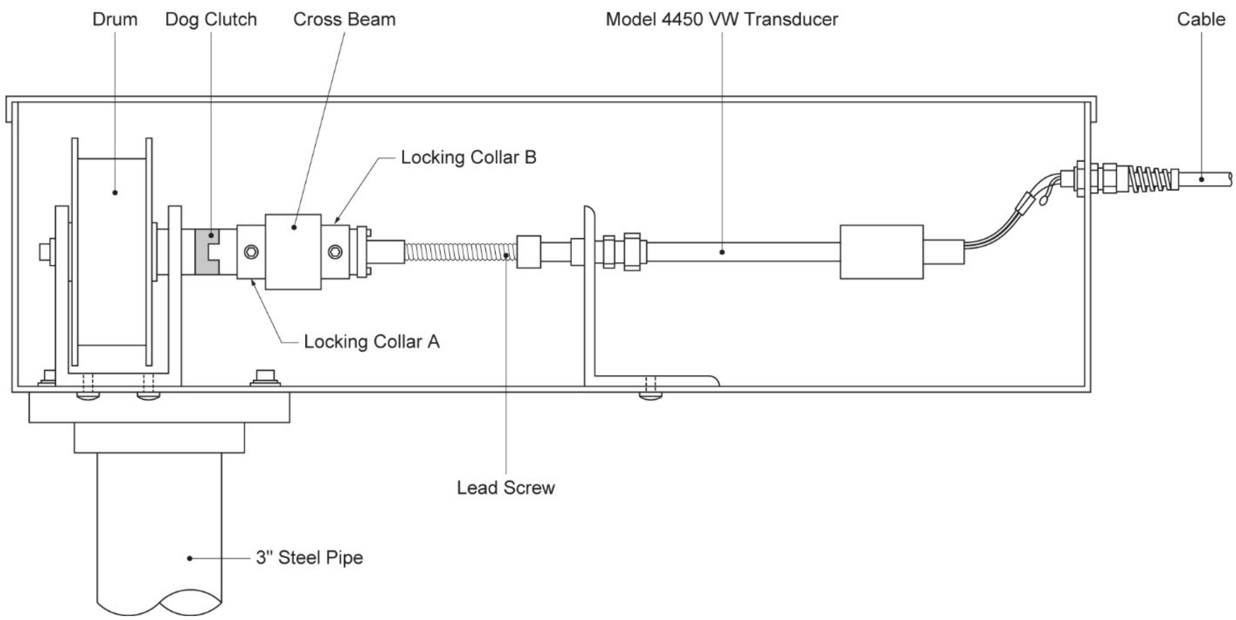

Figure 3 - Pipe Mounted Long Range Displacement Meter

3.2 Pedestal Mounted

At locations where drilling a hole is not possible the readout enclosure can be mounted on a pedestal. Here the Transducer Enclosure is bolted to a steel Mounting Plate which is then bolted to a flat surface measuring approximately nine-inch square. Ideally, the plane of this surface should be inclined to be parallel to the plane of the extension wire; (in the case of measurements down a slope this would mean parallel to the slope). Once this surface has been created, in wood or concrete then four bolt holes need to be drilled in it with the same bolt pattern as the four 3/8-inch holes drilled in the Mounting Plate, these holes are then used to install 1/4-inch Rawl drop in anchors for concrete, (available through GEOKON), or 1/4-inch lag screws in wood. A typical set up is shown in Figure 4 on the following page. Instructions for the Rawl drop-in anchors are as follows:

Using a masonry drill or other suitable equipment, drill two 3/8 inch, (10 mm), diameter holes 1.25", (32 mm), deep at the proper locations.

Insert the expansion anchors into the holes, with the slotted end down and then, insert the setting tool provided, small end first, into the anchor and expand the anchor by hitting the large end of the setting tool with several sharp hammer blows.

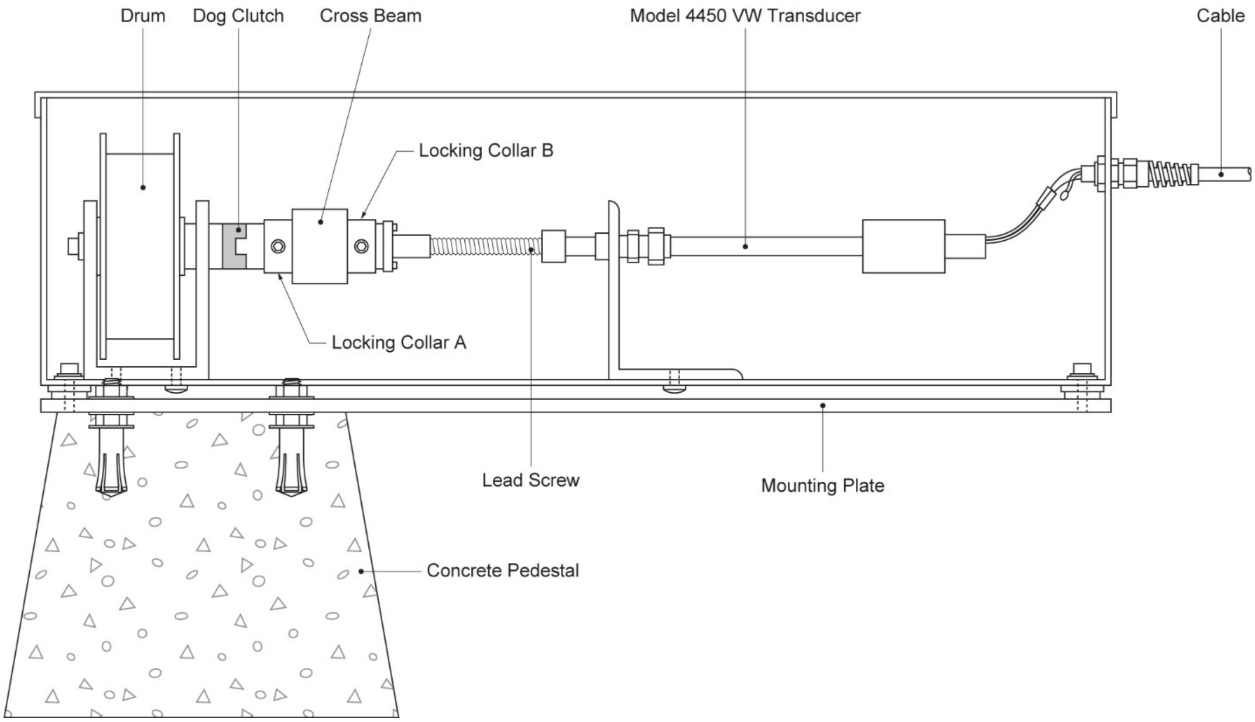

Figure 4 - Pedestal Mounted Long Range Displacement Meter

3.3 Installing the Weak Link and Extension Cable

The extension cable is used to cover the distance between the two points. A length of plastic coated 1/16-inch aircraft cable is supplied for this purpose. The cable has two loops which are shipped loosely held by two cable clamps. When the Transducer enclosure has been installed and the remote anchoring station, attach the extension cable to the anchor station and tighten the two cable clamps. Using the snap-swivel hooks the ends of the weak link, hook the weak link onto the extension cable loop and on to the end loop of the cable wound on the drum in the enclosure.

Adjust the extension cable length by pulling cable through the two cable clamps until the wire is tight and the wire tension is taken by the drum. Connect the readout cable to the readout box. Pull approximately four inches of cable off the drum so that there is some movement of the transducer as revealed by a change of reading on the readout box. Tighten the two extension cable clamps and the two clamps on the weak link assembly.

3.4 Cable Installation

The cable should be routed and protected in such a way to minimize the possibility of damage due to moving equipment, debris or other causes. Cables can be spliced to lengthen them, without affecting gauge readings. Always waterproof the splice completely, preferably using an epoxy-based splice available from the factory.

Figure 5 - A Typical Installation on an Unstable Slope

3.5 Electrical Noise

Care should be exercised when installing instrument cables to keep them as far away as possible from sources of electrical interference such as power lines, generators, motors, transformers, arc welders, etc. Cables should never be buried or run with AC power lines. The instrument cables will pick up the 50 or 60 Hz (or other frequency) noise from the power cable and this will likely cause a problem obtaining a stable reading. Contact the factory concerning filtering options available for use with the GEOKON dataloggers and readouts should difficulties arise.

3.6 Lightning Protection

The Model 4427 Vibrating Wire Long Range Displacement Meter can be supplied with integral lightning protection components, i.e. transzorbs or plasma surge arrestors. If the instrument cable is exposed, it might be appropriate to install lightning protection components, as the transient could travel down the cable to the gauge and possibly destroy it.

Note the following suggestions;

- If the gauge is connected to a terminal box or multiplexer components such as plasma surge arrestors (spark gaps) can be installed in the terminal box/multiplexer to provide a measure of transient protection. Terminal boxes and multiplexers available from GEOKON provide locations for installation of these components.

- Lighting arrestor boards and enclosures are available from GEOKON that can be installed inside the enclosure. The enclosure has a hinged lid, so that if the protection board (LAB-3) is damaged, the user can service the components (or replace the board). A connection is made between this enclosure and earth ground to facilitate the passing of transients away from the gauge. (As shown in Figure 6.)

- Alternatively, plasma surge arrestors can be included inside the enclosure close to the sensor. A ground strap would connect the surge arrestor to earth ground, either a grounding stake or other suitable earth ground.

Consult the factory for additional information on these or alternate lightning protection schemes.

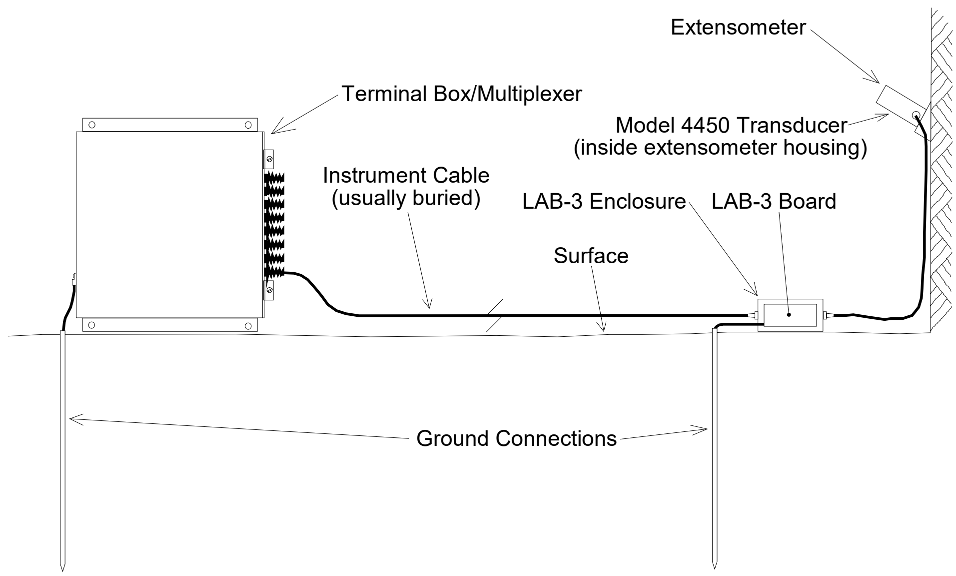

Figure 6 - Lightning Protection Scheme

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.

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

Figure 7 - 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) 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. If no reading displays or the reading is unstable, consult Section 6 for troubleshooting suggestions.
For further information, please refer to 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 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.

4.2.2 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 8 shows a typical vibrating wire output in digits and thermistor output in degrees Celsius. If no reading displays or the reading is unstable, see Section 6 for troubleshooting suggestions. For further information, consult the GK-405 Instruction Manual.

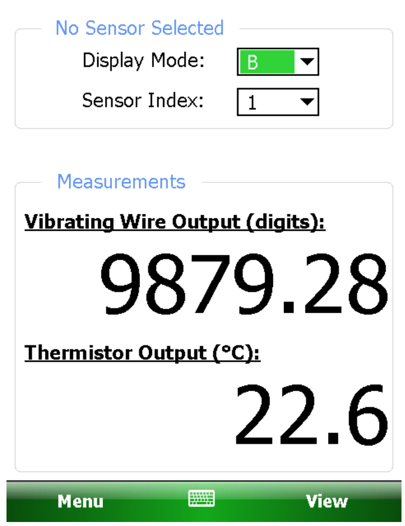

Figure 8 - Live Readings – Raw Readings

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". Consult the GK-403 Instruction Manual for additional information.

4.3.1 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.

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 might 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.

If the no reading displays or the reading is unstable, see Section 6 for troubleshooting suggestions. The unit will automatically turn off after approximately two minutes to conserve power.

4.4 Measuring Temperatures

All vibrating wire transducers are equipped with a thermistor, which 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-404, and GK-405 readout boxes will read the thermistor and display the temperature in degrees C.

To read temperatures using an ohmmeter: Connect an ohmmeter to the green and white thermistor leads coming from the displacement 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 approximately 14.7 Ω for every 1000 ft. (48.5Ω per km) at 20 °C. Multiply these factors by two to account for both directions. Look up the temperature for the measured resistance in Appendix B, Table 4.

5. DATA REDUCTION

5.1 Displacement Calculation

The basic units utilized by GEOKON for measurement and reduction of data from Vibrating Wire Displacement Meters are "digits". The units displayed by the GK-404 and GK-405 in position "B" are digits. Calculation of digits is based on the following equation:

$$\text{Digits} = \left(\frac{1}{\text{Period}}\right)^2 \text{x } 10^{-3}$$

Or

$$\text{Digits} = \frac{\text{Hz}^2}{1000}$$

Equation 1 - Digits Calculation

The magnitude of any movement is calculated from the following equation:

$$\text{Displacement} = D = (R_1 - R_0) \times F$$

Equation 2 - Displacement Calculation

Where;
R_0 is the initial reading taken at installation (Using channel B on the readout, the initial reading should be around 3000 digits.)
R_1 is a subsequent reading.
F is the linear gauge factor (in mm or inches per digit), taken from the model 4427 calibration report supplied with the equipment. Figure 9 in Appendix C.1 shows a typical model 4427 long range displacement transducer calibration report.

<u>For example:</u>
If;
R_0 = 3083 digits
R_1 = 4228
F = 0.2223 mm/digit

Then;
Displacement = (4228 − 3083) × 0.2223 = +254.5 mm
Note that increasing readings (digits) indicate increasing extensions.

5.2 Temperature Correction

5.2.1 The Transducer Alone

The Model 4427 Long Range Vibrating Wire Displacement Transducer uses a Model 4400 displacement transducer which has a small thermal response; small enough that in many cases correction may not be necessary. However, if maximum accuracy is desired or the temperature changes are large (>10° C) corrections can be applied by applying the following equation:

$$D_{corrected} = F(R_1 - R_0) + K(T_1 - T_0)G$$

Equation 3 - Thermally Corrected Displacement Calculation

Where;
F is the linear gauge factor (in mm or inches per digit) from the **model 4427 calibration report** supplied with the equipment. (Figure 9 in Appendix C.1 shows a typical model 4427 long range displacement transducer calibration report.)
R_1 is the current reading.
R_0 is the initial reading.
T_1 is the current temperature ºC.
T_0 is the initial temperature ºC.
K is the thermal coefficient (see Equation 4).
G is the linear gauge factor (in mm or inches per digit) from the **model 4400 calibration report** supplied with the equipment. (Figure 10 in Appendix C.2 shows a typical model 4400 displacement transducer calibration report.)

Tests have determined that the thermal coefficient, K, changes with the position of the transducer shaft. The first step in the temperature correction process is determination of the proper thermal coefficient. For new displacement transducers, refer to Equation 4. For displacement transducers manufactured prior to 2021, refer to Equation 5.

$$K = MR_1 + B$$

Equation 4 - Thermal Coefficient Calculation

Where;
R_1 is the current reading.
M is the multiplier from Table 1.
B is the constant from Table 1.

Model:	4427-1-1M	4427-1-2M
Multiplier (M):	0.000369	0.000376
Constant (B):	0.572	0.328

Table 1 - Thermal Coefficients

5.2.2 The Extension Cable

The elongation of the extension cable (stainless steel aircraft cable) under ambient temperature rises can be compensated by using the following compensation factor:

$$+ L \times 17.3 \times 10^{-6} (T_1 - T_0) \text{ inches or mm}$$

Equation 5 - Elongation Correction

Where;
L is the length of the aircraft cable in inches or millimeters
T_0 is the initial temperature reading in degrees Centigrade.
T_1 is a subsequent temperature reading in degrees Centigrade.

5.3 Environmental Factors

Since the purpose of the displacement transducer installation is to monitor site conditions, factors, which may affect these conditions, should always be observed and recorded. Seemingly minor effects can have a real influence on the behavior of the situation being monitored and may give an early indication of potential problems. Some of these factors include, but are not limited to: blasting, rainfall, tidal levels, excavation and fill levels and sequences, traffic, temperature and barometric changes, changes in personnel, nearby construction activities, seasonal changes, etc.

6. TROUBLESHOOTING

Consult the following list of problems and possible solutions should difficulties arise. Consult the factory for additional troubleshooting help.

Symptom: Displacement Transducer Readings are Unstable

✓ Is the readout box position set correctly? If using a datalogger to record readings automatically are the swept frequency excitation settings correct? Try reading the displacement transducer on a different readout position.

✓ Is there a source of electrical noise nearby? Most probable sources of electrical noise are motors, generators, transformers, arc welders and antennas. Make sure the shield drain wire is connected to ground whether using a portable readout or datalogger. If using the GK-403, GK-404 or GK-405 connect the clip with the blue boot to the shield drain wire. (Green for the GK-401.)

✓ Does the readout work with another displacement transducer? If not, the readout might have a low battery or be malfunctioning. Consult the appropriate readout manual for charging or troubleshooting directions.

✓ Has the transducer gone outside its range? If so, the transducer can be reset using the installation instructions in Section 3.

Symptom: Displacement Transducer Fails to Read

✓ Is the cable cut or crushed? This can be checked with an ohmmeter. Nominal resistance between the two gauge leads (usually red and black leads) is 180Ω, ±10Ω. Remember to add cable resistance when checking (22 AWG stranded copper leads are approximately 14.7Ω/1000 ft. or 48.5Ω/km, multiply by two for both directions). If the resistance reads infinite, or very high (megohms), a cut wire must be suspected. If the resistance reads very low (<100Ω) a short in the cable is likely.

✓ Does the readout or datalogger work with another transducer? If not, the readout or datalogger might be malfunctioning. Consult the readout or datalogger manual for further direction.

APPENDIX A. SPECIFICATIONS

A.1 Model 4427 Long Range Displacement Meter

Range:	1 meter	2 meters
Resolution:	0.025% FS	
Linearity:	0.5% FS	
Stability:	< 0.2%/yr (under static conditions)	
Overrange:	10%	
Cable Tension:	7 to 13 Kgm	
Weak-Link Capacity:	18 Kgm	
Dimensions Enclosure:	590 x 150 x 150 mm	
Temperature Range:	-40 to +80 degrees C	
Weight:	13 Kgm	
Frequency Range: (standard model)	1400 - 3500 Hz	
Coil Resistance:	180 Ω, ±10 Ω	
Cable Type:	Two twisted pair (four conductor) 22 AWG Foil shield, PVC jacket[1], nominal OD=6.3 mm (0.250")	

Table 2 - Model 4450 Displacement Transducer Specifications

Notes:
[1]Polyurethane jacket cable available.

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 6 - 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 3 - Thermistor Resistance Versus Temperature

APPENDIX C. TYPICAL CALIBRATION REPORTS

C.1 Model 4427 Calibration Report

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

Vibrating Wire Long Range Displacement Transducer Calibration Report

Range: 1000 mm

Model Number: 4427 series

Serial Number: 06-1779

Calibration Date: April 10, 2006

Calibration Instruction: CI-VW LRD

Temperature: 24.7 °C

Technician: *KLBellavance*

GK-401 Reading Position B

Actual Displacement (mm)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Displacement (Linear)	Error Linear (%FS)	Calculated Displacement (Polynomial)	Error Polynomial (%FS)
0	2792	2792	2792	-0.487	-0.05	-0.200	-0.02
200	3694	3692	3693	199.8	-0.02	199.7	-0.03
400	4602	4600	4601	401.6	0.16	401.4	0.14
600	5496	5488	5492	599.7	-0.03	599.4	-0.06
800	6392	6386	6389	799.1	-0.09	799.0	-0.10
1000	7295	7294	7295	1000.3	0.03	1000.6	0.06

(mm) Linear Gage Factor (F): 0.2223 (mm/ digit) **Regression Zero: 2794**

Polynomial Gage Factors: A: 1.04942E-07 B: 0.2212 C: -618.67

(inches) Linear Gage Factor (F): 0.008751 (inches/ digit)

Polynomial Gage Factors: A: 4.13156E-09 B: 0.008710 C: -24.357

Calculated Displacement: **Linear, $D = F(R_t - R_0)$**

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

Refer to manual for temperature correction information.

Function Test at Shipment:

GK-401 Pos. B : 2687 Temp(T_0): 21.2 °C Date: April 10, 2006

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 9 - Typical Calibration Report for Model 4427 *Long Range* Displacement Transducer

C.2 Model 4400 Calibration Report

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

Vibrating Wire Displacement Transducer Calibration Report

Range: 25 mm

Calibration Date: February 14, 2006

Serial Number: 06-1779

Temperature: 22.8 °C

Cal. Std. Control Numbers: 406, 344, 057, 529

Calibration Instruction: CI-4400 Rev: C

Technician:

GK-401 Reading Position B

Actual Displacement (mm)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Displacement (Linear)	Error Linear (%FS)	Calculated Displacement (Polynomial)	Error Polynomial (%FS)
0.0	2295	2294	2295	-0.063	-0.25	-0.006	-0.02
5.0	3512	3510	3511	5.021	0.08	5.009	0.04
10.0	4715	4713	4714	10.05	0.19	10.00	0.01
15.0	5909	5907	5908	15.04	0.15	14.99	-0.02
20.0	7098	7095	7097	20.01	0.02	20.00	-0.02
25.0	8280	8278	8279	24.95	-0.21	25.00	0.02

(mm) Linear Gage Factor (G): 0.004179 **(mm/ digit)** **Regression Zero:** 2310

Polynomial Gage Factors: **A:** 1.18886E-08 **B:** 0.004053 **C:** -9.3691

(inches) Linear Gage Factor (G): 0.0001645 **(inches/ digit)**

Polynomial Gage Factors: **A:** 4.68055E-10 **B:** 0.0001596 **C:** -0.36886

Calculated Displacement: **Linear,** $D = G(R_1 - R_0)$

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

Refer to manual for temperature correction information.

Function Test at Shipment:

GK-401 Pos. B : ______ Temp(T_0): ______ °C Date: ______

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 10 - Typical Calibration Report for Model 4400 Displacement Transducer