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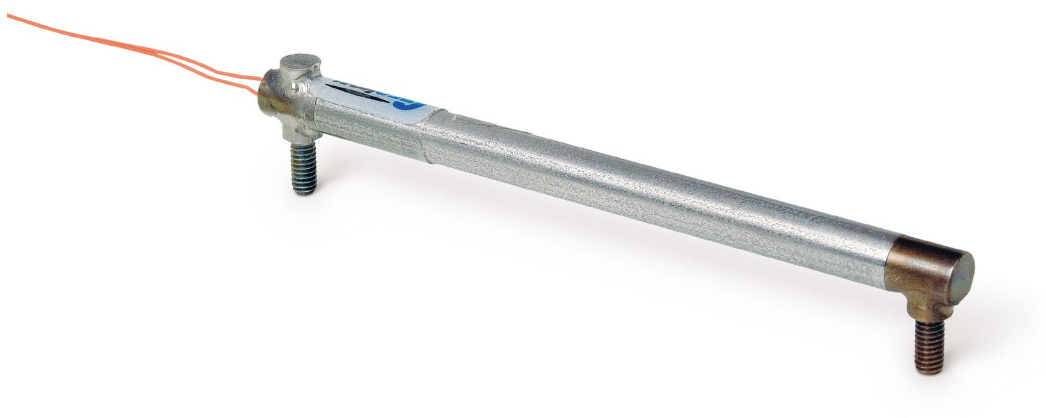
Instruction Manual

Model 4422

Monument Crackmeter



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EQUATIONS

1. INTRODUCTION

GEOKON Model 4422 Monument Crackmeters are designed to measure movement across joints and cracks in monuments. The small size is designed to render the crackmeter as unobtrusive as possible. The shaft of the Monument Crackmeter has three small holes drilled in it. A metal pin is supplied for insertion inside one of these holes. These holes and the metal pin are designed to assist the user in selecting the range of the crackmeter so that it can be set to measure mainly tensions, mainly compressions, or both, depending on which hole the metal pin is inserted. The maximum range is four mm.

The instrument consists of a vibrating wire sensing element in series with a heat treated, stress relieved spring, which is connected to the vibrating wire at one end, and to a connecting rod at the other. As the connecting rod is pulled out from the gauge body, the spring is elongated, causing an increase in tension in the vibrating wire. The increase in tension (strain) of the wire is directly proportional to the extension of the connecting rod. This change in strain allows the Monument Crackmeter to measure the opening of a joint very accurately.

Monument Crackmeters are designed to be read by one of the various readout boxes available from GEOKON.

2. INSTALLATION

2.1 Preliminary Tests

Upon receipt of the instrument, the gauge should be checked for proper operation (including the thermistor). The Crackmeter normally arrives with its shaft secured at approximately 50% of its range, by the metal pin placed inside the middle of the three holes, (see Figure 1). This holds the instrument in tension in its midrange position. (This also helps protect it during shipping).

CAUTION! Do not rotate the shaft of the Crackmeter more than 180 degrees. This may cause irreparable damage to the instrument. Never extend the crackmeter beyond its working range.

Connect the gauge to the readout box and take a reading. (See Section 3 for readout instructions.) The midrange position should give a reading of about 4500 on Channel B. Gently pull on the ends of the gauge and the readings should be stable and in the range of 2500 to 6000 on Channel B.

Checks of electrical continuity can also be made using an ohmmeter. Resistance between the gauge leads should be approximately 50 ohms, ±5 ohms. Remember to add cable resistance when checking (22 AWG stranded copper leads are approximately 14.7Ω/1000' or 48.5Ω/km, multiply by two for both directions). Between the green and white should be approximately 3000 ohms at 25° (see Table 6), and between any conductor and the shield should exceed two megohms.

2.2 Crackmeter Installation

The Monument Crackmeter is provided with threaded rods that can be either grouted in short drill holes or epoxied to the surface. It will normally be found more convenient to fix the cable in place before the crackmeter is attached.

The crackmeter may be installed at its midrange position by leaving the metal pin in (see Figure 1 and Figure 2 in the following subsections) or the pin may be removed, allowing the initial gauge reading to be set for the anticipated direction of movement. When setting the gauge position using a portable readout, use the reading ranges in Table 1 to determine the proper position.

Approximate Midrange Reading	Approximate Reading to Measure Extensions	Approximate. Reading to Measure Compression
4000-4500	2500-3000	5500-6000

Table 1 - Crackmeter Reading Ranges

2.2.1 Drill Hole Type

For the standard range crackmeter (4 mm), **drill two 9 mm (3/8") diameter holes, spaced 114.3mm (4.5") apart, to a depth of 25 mm (one inch).** A drill-hole-spacer-bar is available (part number 4422-3) to make this easier. Drill one hole then place a slightly smaller drill in the hole and use the spacer bar to locate the second hole.

Screw the two stainless steel studs onto the threaded rods, fill the drill holes with epoxy or quick setting cement, and push the studs into the grout or epoxy with the metal pin holding the crackmeter at the midrange position still in place. When the grout or epoxy has hardened then the metal pin can be removed.

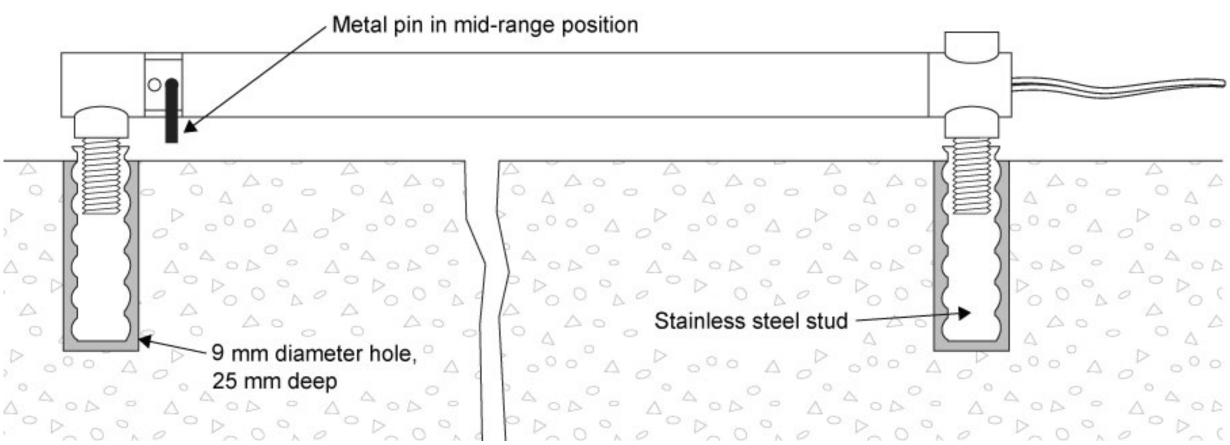

Figure 1 - Model 4422-1 Monument Crackmeter, Groutable Anchor Type

2.2.2 Surface Mounting

For surface mounting two stainless steel feet are supplied that can be screwed on to the threaded rods. Prepare some quick setting epoxy and apply to both the surface of the monument and to the surface of the stainless steel feet. With the metal pin holding the crackmeter in its midrange position still in place, press the feet down on to the monument surface and hold in place until the epoxy sets up. Remove the metal pin.

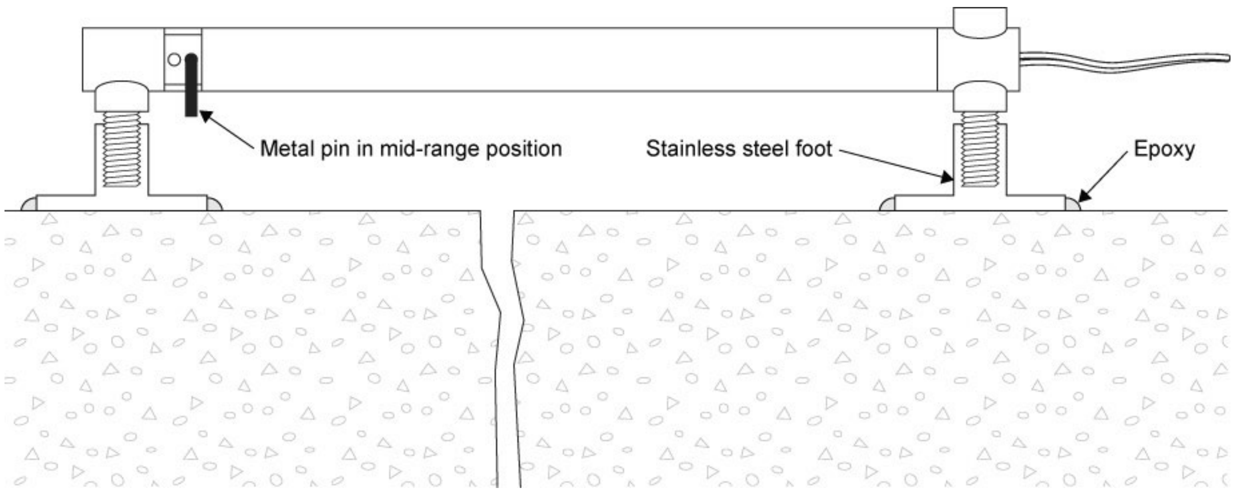

Figure 2 - Model 4422-2 Monument Crackmeter, Surface Mounting Type

2.3 Initial Readings

Initial readings must be taken and carefully recorded along with the temperature at the time of installation. These readings serve as a reference for subsequent deformation calculations.

2.4 Cable Installation and Splicing

The cable should be routed to minimize the possibility of damage due to moving equipment, debris or other causes. The cable can be protected using flexible conduit, which can be supplied by GEOKON.

Terminal boxes with sealed cable entries are available from GEOKON for all types of applications. These allow many gauges to be terminated at one location with complete protection of the lead wires. The interior panel of the terminal box can have built-in jacks or a single connection with a rotary position selector switch. Contact GEOKON for specific application information.

Because the vibrating wire output signal is a frequency rather than a current or voltage, variations in cable resistance have little effect on gauge readings; therefore, splicing of cables has no ill effects, and in some cases may in fact be beneficial. The cable used for making splices should be a high-quality twisted pair type, with 100% shielding and an integral shield drain wire. **When splicing, it is very important that the shield drain wires be spliced together.** Always maintain polarity by connecting color to color.

Splice kits recommended by GEOKON incorporate casts, which are placed around the splice and are then filled with epoxy to waterproof the connections. When properly made, this type of splice is equal or superior to the cable itself in strength and electrical properties. Contact GEOKON for splicing materials and additional cable splicing instructions.

Cables may be terminated by stripping and tinning the individual conductors and then connecting them to the patch cord of a readout box. Alternatively, a connector may be used which will plug directly into the readout box or to a receptacle on a special patch cord.

2.5 Lightning Protection

Unlike numerous other types of instrumentation available from GEOKON, monument crackmeters do not have any integral lightning protection components, such as transorbs or plasma surge arrestors. Usually this is not a problem, however, if the instrument cable is exposed, it may be appropriate to install lightning protection components, as the transient could travel down the cable to the gauge and possibly destroy it.

Suggested Lightning Protection Options:

- If the instrument is connected to a terminal box or multiplexer, components such as plasma surge arrestors (spark gaps) may be installed in the terminal box/multiplexer to provide a measure of transient protection. Terminal boxes and multiplexers available from GEOKON provide locations for the installation of these components.
- Lighting arrestor boards and enclosures are also available from GEOKON. These units install where the instrument cable exits the structure being monitored. The enclosure has a removable top to allow the customer to service the components or replace the board if the unit is damaged by a lightning strike. A connection is made between the enclosure and earth ground to facilitate the passing of transients away from the displacement transducer. See Figure 3.
- Plasma surge arrestors can be epoxied into the instrument cable, close to the transducer. A ground strap then connects the surge arrestor to an earth ground, such as a grounding stake or the rebar itself.

Consult the factory for additional information on available lightning protection.

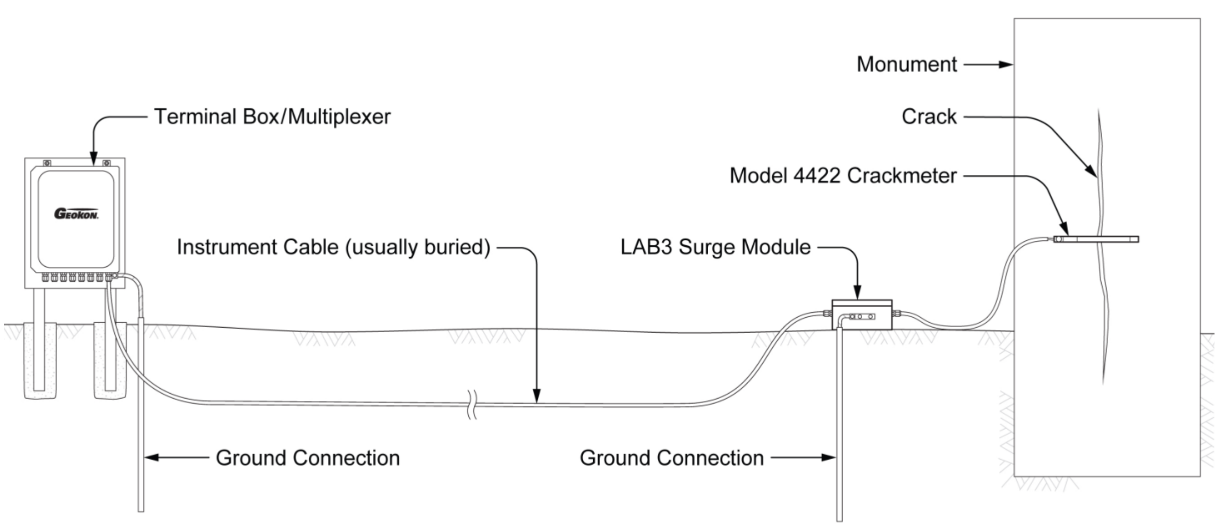

Figure 3 - Lightning Protection Scheme

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 strandmeter (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 4). Insert the Lemo connector into the GK-404 until it locks into place.

Figure 4 - 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 5 for troubleshooting suggestions. For further information, please refer to 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 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.

3.2.2 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).

3.2.3 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 5 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 5 for troubleshooting suggestions. For further information, consult the GK-405 Instruction Manual.

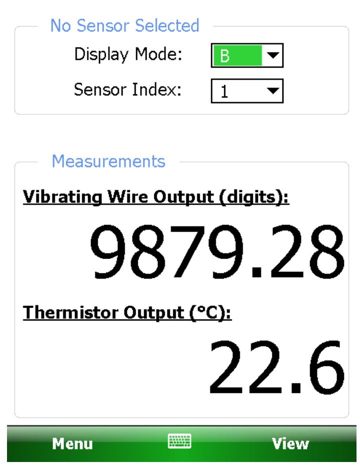

Figure 5 - Live Readings – Raw Readings

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” and “F”. Consult the GK-403 Instruction Manual for additional information.

3.3.1 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.

3.3.2 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).

3.3.3 Operating the GK-403

1) Turn the display selector to position “B” (or “F”).
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.

If the no reading displays or the reading is unstable, see Section 5 for troubleshooting suggestions.

The unit will automatically turn off after approximately two minutes to conserve power.

3.4 Measuring Temperatures

Each crackmeter is 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-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: 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 14.7Ω for every 1000 ft., or 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 6.

4. DATA REDUCTION

4.1 Displacement Calculation

The basic unit utilized by GEOKON for measurement and reduction of data from Vibrating Wire Displacement Transducers is "digits". Calculation of digits is based on the following equation:

$$\text{Digits} = \left(\frac{1}{\text{Period}}\right)^2 \times 10^{-3} \text{ or Digits} = \frac{\text{Hz}^2}{1000}$$

Equation 1 - Digits Calculation

To convert digits to deformation, use Equation 2.

$$D_{uncorrected} = (R_1 - R_0) \times G \times F$$

Equation 2 - Deformation Calculation

Where;
R_1 is the current reading.
R_0 is the initial reading, usually obtained during installation (see Section 2.3).
G is the gauge factor, usually millimeters or inches per digit.
(See the example calibration sheet shown in Figure 6.)
F is an optional engineering units conversion factor, see Table 2.

From→ To↓	Inches	Feet	Millimeters	Centimeters	Meters
Inches	1	12	0.03937	0.3937	39.37
Feet	0.0833	1	0.003281	0.03281	3.281
Millimeters	25.4	304.8	1	10	1000
Centimeters	2.54	30.48	0.10	1	100
Meters	0.0254	0.3048	0.001	0.01	1

Table 2 - Engineering Units Conversion Factors

For example, if the initial reading (R_0) is 4000 digits, the current reading (R_1) is 5000, and the gauge factor is 0.001077 mm/digit, then the deformation change is calculated as follows:

$$D_{uncorrected} = (5000 - 4000) \times 0.001077 = +1.077 \text{ mm}$$

(Note that increasing readings (digits) indicate that the crack is widening.)

To use the Polynomial Gauge factors given on the Calibration Sheet: Use the value of R_0 and Gauge Factors A and B, with the displacement (D) set to zero, to calculate the new value of C. Next, substitute the new value of R_1, and use A, B, and the new value of C, to calculate D.

4.2 Temperature Correction

Because GEOKON's Vibrating Wire Displacement Transducers have a small coefficient of thermal expansion, in many cases correction may not be necessary. However, if maximum accuracy is desired, or the temperature changes are extreme (>10 °C), a correction may be applied based on the following equation:

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

Equation 3 - Thermally Corrected Deformation Calculation

Where;
R_1 is the current reading.
R_0 is the initial reading.
G is the linear gauge factor.
T_1 is the current temperature.
T_0 is the initial temperature.
K is the thermal coefficient (see Equation 4).

The temperature coefficient of the mass or member to which the Crackmeter is attached should also be taken into account. By correcting the transducer for temperature changes the temperature coefficient of the mass or member may be distinguished.

Tests have determined that the thermal coefficient, K, changes with the position of the transducer shaft. Hence, the first step in the temperature correction process is to determine the proper thermal coefficient based on the following equation:

$$K = ((R_1 \times M) + B) \times G$$

Equation 4 - Thermal Coefficient Calculation

Where;
R_1 is the current reading.
M is the multiplier from Table 3.
B is the constant from Table 3.
G is the linear gauge factor from the supplied calibration sheet (Figure 6).

Multiplier (M):	0.000281
Constant (B):	0.813372

Table 3 - Thermal Coefficient Calculation Constants

The following example shows that corrections for temperature change are usually small and can often be ignored.

R_0 = 4773 digits
R_1 = 4589 digits
T_0 = 20.3 °C
T_1 = 32.9 °C
G = 0.001307 mm/digit
K = (((4589 × 0.000281) + 0.813372) × 0.001307) = 0.002748
$D_{corrected} = ((R_1 - R_0) \times G) + (((T_1 - T_0) \times K)$
$D_{corrected} = ((4589 - 4773) \times 0.001307) + (((32.9 - 20.3) \times .002748)$
$D_{corrected} = -0.240488 + 0.034625$

$D_{corrected} = -0.206$ mm

4.3 Environmental Factors

Since the purpose of the crackmeter installation is to monitor site conditions, factors that may affect these conditions should always be observed and recorded. Seemingly minor effects may have a real influence on the behavior of the structure 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, traffic, temperature and barometric changes, weather conditions, changes in personnel, nearby construction activities, excavation and fill level sequences, seasonal changes, etc.

GEOKON

Vibrating Wire Displacement Transducer Calibration Report

Model: S-A4422-4MM

Serial Number: 1843001

Calibration Instruction: CI-4400

Cable Length: N/A

Calibration Date: March 20, 2020

Temperature: 21.8 °C

Technician: Kathy Rogers

GK-401 Reading Position B

Actual Displacement (mm)	Gauge Reading 1st Cycle	Gauge Reading 2nd Cycle	Average Gauge Reading	Calculated Displacement (Linear)	Error Linear (%FS)	Calculated Displacement (Polynomial)	Error Polynomial (%FS)
0.0	2467	2466	2467	0.00	-0.11	0.00	0.03
0.8	3083	3082	3083	0.80	0.01	0.80	-0.02
1.6	3695	3695	3695	1.60	0.02	1.60	-0.09
2.4	4313	4312	4313	2.41	0.19	2.40	0.08
3.2	4920	4921	4921	3.20	0.05	3.20	0.03
4.0	5526	5526	5526	3.99	-0.17	4.00	-0.03

(mm) Linear Gauge Factor (G): 0.001307 **(mm/ digit)** **Regression Zero:** 2470

Polynomial Gauge Factors: **A:** 4.3879E-09 **B:** 0.001272 **C:** ______

Calculate C by setting D = 0 and R_1 = initial field zero reading into the polynomial equation

(inches) Linear Gauge Factor (G): 0.00005144 **(inches/digit)**

Polynomial Gauge Factors: **A:** 1.7275E-10 **B:** 0.00005006 **C:** ______

Calculate C by setting D = 0 and R_1 = initial field zero reading into the polynomial equation

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

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

Refer to manual for temperature correction information.

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

Figure 6 - Typical 4422 Monument Crackmeter Calibration Sheet

5. TROUBLESHOOTING

Maintenance and troubleshooting of monument crackmeters is confined to periodic checks of cable connections and maintenance of terminals. Once installed, the crackmeters are usually inaccessible and remedial action is limited. **Gauges should not be opened in the field.** Should difficulties arise, consult the following list of problems and possible solutions. Return any faulty gauges to the factory. For additional troubleshooting and support, contact GEOKON.

Symptom: Thermistor resistance is too high

- ✓ It is likely that there is an open circuit. Check all connections, terminals, and plugs. If a cut is located in the cable, splice according to instructions in Section 2.4.

Symptom: Thermistor resistance is too low

- ✓ It is likely that there is a short. Check all connections, terminals, and plugs. If a short is located in the cable, splice according to instructions in Section 2.4.

- ✓ Water may have penetrated the interior of the crackmeter. There is no remedial action.

Symptom: Instrument 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?

- ✓ Is the crackmeter shaft positioned outside the specified range (either extension or retraction) of the instrument? Note that when the transducer shaft is fully retracted with the alignment pin inside the alignment slot the readings will likely be unstable because the vibrating wire is under-tensioned.

- ✓ Is there a source of electrical noise nearby? Likely candidates are generators, motors, arc welding equipment, high voltage lines, etc. If possible, move the instrument cable away from power lines and electrical equipment or install electronic filtering.

- ✓ Make sure the shield drain wire is connected to ground whether using a portable readout or datalogger. Connect the shield drain wire to the readout using the blue clip. (Green for the GK-401.)

- ✓ Does the readout work with another gauge? If not, it may have a low battery or possibly be malfunctioning.

Symptom: Instrument Fails to Read

- ✓ Is the cable cut or crushed? Check the resistance of the cable by connecting an ohmmeter to the gauge leads. Table 4 shows the expected resistance for the various wire combinations; Table 5 is provided for the user to fill in the actual resistance found. Cable resistance is approximately 14.74Ω per 1000' of 22 AWG wire. Multiply this factor by two to account for both directions. If the resistance is very high or infinite (megohms), the cable is probably broken or cut. If the resistance is very low (<20Ω), the gauge conductors may be shorted. If a cut or a short is located in the cable, splice according to the instructions in Section 2.4.

- ✓ Does the readout or datalogger work with another gauge? If not, it may have a low battery or possibly be malfunctioning.

Vibrating Wire Sensor Lead Grid - SAMPLE VALUES					
	Red	**Black**	**White**	**Green**	**Shield**
Red	N/A	≅50Ω	infinite	infinite	infinite
Black	≅50Ω	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 4 - Sample Resistance

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

Table 5 - Resistance Work Sheet

APPENDIX A. SPECIFICATIONS

A.1 Model 4422 Crackmeter

Range:	4 mm / 0.16 inches
Resolution:[1]	0.025% FSR
Linearity:	0.25% FSR
Thermal Zero Shift:[2]	< 0.05% FSR/°C
Stability:	< 0.2%/yr (under static conditions)
Overrange:	115% FSR
Temperature Range:	-20 to +80 °C
Frequency Range:	1400 - 3500 Hz
Coil Resistance:	50 Ω, ±5 Ω
Cable Type:[3]	Two twisted pair (four conductor) 22 AWG Foil shield, PVC jacket, nominal OD=6.3 mm (0.250")
Cable Wiring Code:	Red and Black are the VW Sensor; White and Green the Thermistor.
Length:(midrange, end to end)	125 mm / 4.908 in.

Notes:
[1] Minimum; greater resolution possible depending on readout.
[2] Depends on application.
[3] Polyurethane jacketed cable available.

A.2 Thermistor

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 5 - 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 6 - Thermistor Resistance versus Temperature