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Instruction Manual

Model GK-401

Vibrating Wire Readout

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1. THEORY OF OPERATION

The GK-401 Vibrating Wire Readout is used to excite and read out vibrating wire gages which include: strain gages, crackmeters, piezometers, total pressure cells, etc. The basic principle is that a wire that is held under tension has a specific natural or resonant frequency of vibration which is dependent on the strain and the length of the wire. If the wire is plucked, as in a stringed instrument, the frequency will always be the same provided that the strain and length do not change. Vibrating wire gages have specific fixed lengths of wire, and the change in strain is measured by measuring the change in vibration frequency. The readout box provides the means of exciting the wire and reading the resultant frequency.

In use, a pulse of varying frequency is generated by the Readout Box and is applied to an electromagnetic coil assembly which is located close to the sensing wire. When a frequency corresponding to that of the wire is generated, the wire is "plucked" and vibrates at that frequency. The wire continues to vibrate after the "pluck" ends and a signal, primarily the resonant frequency, is induced in the coil assembly and transmitted to the readout where it is conditioned and displayed.

The GK-401 amplifies the return signal, converts it to a square wave and counts 255 cycles of vibration. This is then manipulated by the processor to display the required units: period, frequency squared or microstrain. For weaker gage signals the processor counts fewer cycles to try to obtain consistent readings during the signal decay period. The gage factors and arithmetic functions are stored in the EPROM and can be changed for special application by obtaining custom EPROMs from Geokon.

2. TAKING READINGS

Different gages have different frequency characteristics and the GK-401 has a 6-position selector: five positions with specific functions and one general position for period readout.

Generally, positions B, C, D and E are used for all Geokon gages. Position A is used to obtain period of vibration readings for gages in the range of approximately 500 to 5000 Hz. The table in the readout lid instruction panel describes positions for specific model numbers. Table 1 shows the model numbers, readout positions and pertinent information.

Display Position	Geokon Model No.	Display Units	Excitation Range	Gage Factor
A	All[1]	Period in μseconds[2]	450-6000 Hz	None
B	4210 4300BX 4400 4500 4600 4700 4800 4900	$f^2 \times 10^{-3}$ (digits)	1500-3500 Hz	1.000
C	4000	μstrain	450-1200 Hz	4.062[3]
D	4200	μstrain	450-1200 Hz	3.304[3]
E	4100	μstrain	1500-3500 Hz	0.391[3]
F	4300EX	$f^2 \times 10^{-3}$ (digits)	2500-6000 Hz	1.000

Notes:

[1] General position for all gages; possibility of harmonics in 4000 and 4200 gages at very low strain levels.

[2] The period readings can be very useful for greater resolution of strain measurements. Also, measurements as low as 0.1 μstrain can be made (see individual manuals).

[3] Factor multiplies digits ($f^2 \times 10^{-3}$).

Table 1 - GK-401 Display Position vs. Geokon Model Number

To take readings the gage is connected via the patch cord to the readout, the readout display is set to the proper position and the box is turned on. A reading will appear in the display and should remain constant, plus or minus one digit. The readout will turn itself off after approximately 4 minutes. The reading is updated once a second and the display is updated only when the reading changes. Readings should be checked against previously recorded data and any unusual data should be retaken and noted.

3. DATA REDUCTION

Individual gage instruction manuals discuss how data is taken, recorded and reduced, but a few important procedures for taking data are noted here.

1) Always take zero or no load readings and record pertinent data which may include but not be limited to: temperature, barometric pressure, weather conditions, water levels, fill levels, nearby construction activity, etc. Initial readings properly obtained are the baseline for all further measurements.

2) Always obtain stable readings; if a reading fluctuates be sure to note it.

3) Compare current readings with previous readings while at the site; numbers sometimes get transposed in notebooks.

4) Use permanent notebooks or field data sheets whenever possible.

4. MAINTENANCE AND TROUBLE SHOOTING

4.1 Battery

The GK-401 uses one 12-volt rechargeable, lead acid type battery to run the Readout. This battery has an extremely long shelf life and will lose approximately 2% of it's charge per month sitting on the shelf. At 60°F (15°C) the box will operate continuously for a minimum of 20 hours; at -20°F (-30°C) this period is cut to less than 10 hours. At higher temperatures the capacity goes up however, the useful service life decreases.

This battery can be expected to last 3 to 5 years, or between 250 and 500 discharge and recharge cycles.

Recharging is accomplished by a charger which is included with each readout. Overnight (10 to 12 hours) is usually long enough to bring the battery to full charge. The charger can be left plugged in whenever the Readout is not is use (recommended) to ensure full charge on the battery at all times. As the battery ages, the on-time will be reduced, and at some point, will be very short and recharging will not help. At this point the battery will need to be replaced. Battery packs are available from Geokon, or a battery can be purchased locally (see Appendix A for battery specifications) and installed by the user (see Appendix D for battery replacement instructions).

In cases where the battery will no longer operate in the field Geokon should be contacted for remedial measures.

4.2 Readout System

If the readout system fails to operate properly, and the cause is not the battery, Geokon should be contacted. The unit should not be opened in the field. A few checks can be made, however:

- If zeros appear in the display with gages connected, patch cords should be checked for continuity between contacts and clip leads (see Appendix B).
- The gage itself should be checked; see gage manual.
- The processor may need to be reset, which can be accomplished by turning the unit off and on.
- The selector position may be incorrect (see Table 1).
- Noise levels may be excessive; try reading a gage in a different area; try connecting the ground lead (white or green clip) to the shield drain wire.

4.3 Calibration

The readout should be sent periodically (every 12 months) back to the manufacturer for inspection, cleaning, and calibration. A nominal fee will be charged for the service, but it is highly recommended.

APPENDIX A - GK-401 SPECIFICATIONS

Excitation Range:	450 to 6000 Hz, 170 to 2250 μseconds
Measurement Range:	400 to 9500 Hz, 105 to 2500 μseconds
Measurement Resolution:	Period: 0.1 μsecond Strain[1]: 1 μstrain
Accuracy:	0.1% of reading
Excitation:	5 volt square wave
Temperature Range:	−20° to +120°F, −30° to +50°C
Microprocessor:	80C85 CPU operating @ 3.072 MHz 256 Bytes SRAM, 2048 Bytes EPROM
Oscillator Frequency:	6.144 MHz
Display:	5-digit LCD, .7" high
Battery:	(1) 12 volt Panasonic lead acid LC-SD122EU
Battery Capacity:	2.0 Amp Hour
Operating Current:	110 mA
Operating Time:	minimum 20 hours @ 60°F
Quiescent Current:	20 μA
Input Connector, Gage:	Lemo, FGG-1K-303-CNAC470
Input Connector, Charger:	Lemo, FGG-0K-303-CNAC37
Dimensions:	6½×4×8½", 165×102×216mm
Weight:	5 pounds, 2.3 kg.

Notes:

[1] In the strain mode (greater resolution is possible in positions A, B and F).

APPENDIX B - CONNECTOR PINOUTS

Gage Connector

Pin	Description	To
1	Ground	Green Clip Lead
2	Gage Positive	Red Clip Lead
3	Gage Negative	Black Clip Lead

Old Style Gage Connector (6 pin, Lemo ERA-1E-306-CNL)

Pin	Description	To
1	Ground	Green Clip Lead
2	No Connection	NA
3	Gage Positive	Red Clip Lead
4	No Connection	NA
5	Gage Negative	Black Clip Lead
6	No Connection	NA

Charger Connector

Pin	Description	To
1	Charger Negative	Charger Black Lead
2	No Connection	NA
3	Charger Positive	Charger Striped Lead

APPENDIX C - BATTERY PACK REPLACEMENT INSTRUCTIONS

Note the following instructions:

1) Remove the eight phillips-head screws on the face panel.

2) Pull out the face panel (the panel fits very tightly in the box and may have to be pried out carefully with a screwdriver).

3) Remove the four Phillips-head screws from the bottom of the box.

4) Carefully pull the pack from the box (it is a tight fit).

5) If a new pack has been supplied, connect the leads to the readout assembly and reverse the above steps. If just the battery has been purchased, the old battery must be removed from the pack and the new one wired in the same manner, and glued into the pack before putting the pack into the case. (RTV holds it in place very nicely).

NOTE: The only screws that should be removed from the outside of the GK-401 are the 8 screws on the face panel and the four screws on the bottom of the box. All others are meant to remain permanently.

APPENDIX D - THERMISTOR LINEARIZATION

A thermistor (temperature sensing device) is normally encapsulated with all Geokon vibrating wire sensors. Use an ohmmeter to measure the resistance (usually the green and white leads from the gage cable). The following equation or Table 2 can be used to determine the temperature in degrees centigrade.

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

Steinhart and Hart Log Equation: $$T = \frac{1}{A + B(LnR) + C(LnR)^3} - 273.2$$

where: T = Temperature in °C.

LnR = Natural Log of Thermistor Resistance

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

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

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

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

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 2 - Thermistor Resistance vs. Temperature

APPENDIX E - READING OTHER MANUFACTURERS' SENSORS

Most vibrating wire gages available today have frequency characteristics that are within the range of operation of the GK-401 Readout Box, and if they have the type of electromagnetic coil that is used in the pluck and read system of the GK-401, it can be used to read them.

Gage factors need to be known in order to convert readings to engineering units. The readings can be taken in the period mode, Position A and, conversions to strain, pressure, etc. can be made using the manufacturers' factors supplied with the gages.

The table below lists approximate operating frequency ranges for different wire lengths for reference.

Wire Length	Frequency Range
1"	2500-5000 Hz
2"	1200-3000 Hz
3"	825-2000 Hz
4"	600-1600 Hz
6"	450-1000 Hz
10"	250-650 Hz

Table 3 - Vibrating Wire Length vs. Frequency Range