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Installation Manual

Model 6160

MEMS Tiltmeter

(REV L 12/11)

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1. INTRODUCTION

1.1. Theory of Operation

The Geokon Model 6160 MEMS Tiltmeter is designed for permanent long-term monitoring of changes in tilt of structures such as dams, embankments, foundation walls and the like. The basic principle is the utilization of tilt sensors attached to the structure being studied to make accurate measurement of inclination. See Figure 1.

A typical installation is shown in Figure 1..

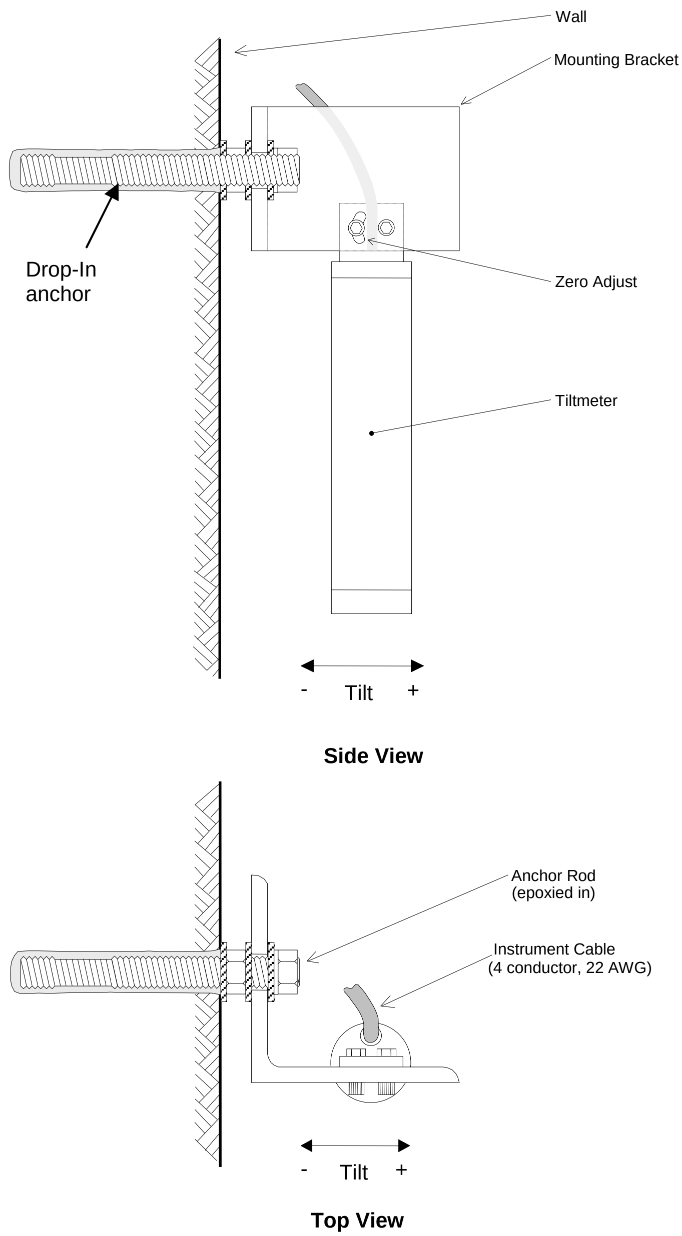

Figure 1 - Model 6160 Uniaxial Tiltmeter Installation

1.2. Tilt Sensor Construction

The sensor comprises one or two micro-electrical-mechanical-sensor, (MEMS), mounted inside a sealed housing. The Housing has a mounting bracket on its upper end for connecting the sensor to a Mounting Bracket. Biaxial systems use two transducers mounted at 90° to each other. Each housing contains a thermistor for reading temperatures.

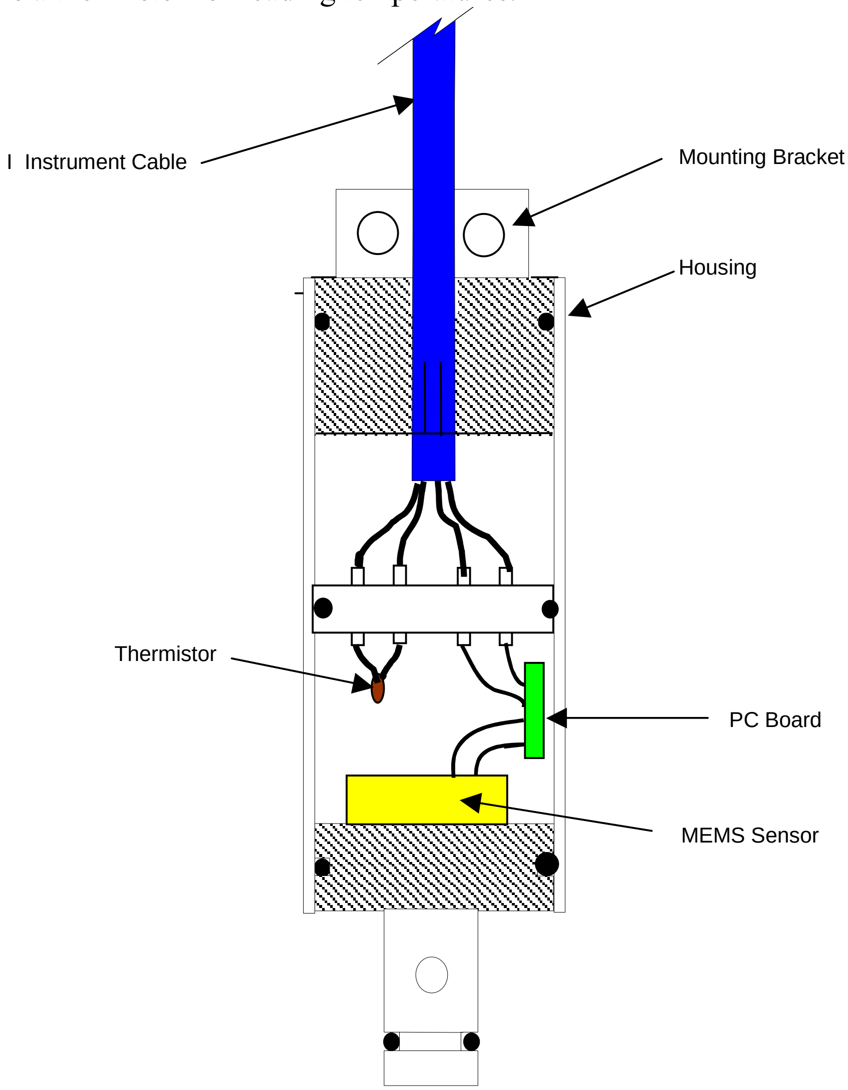

Figure 2 - Model 6160 Uniaxial Tilt Sensor

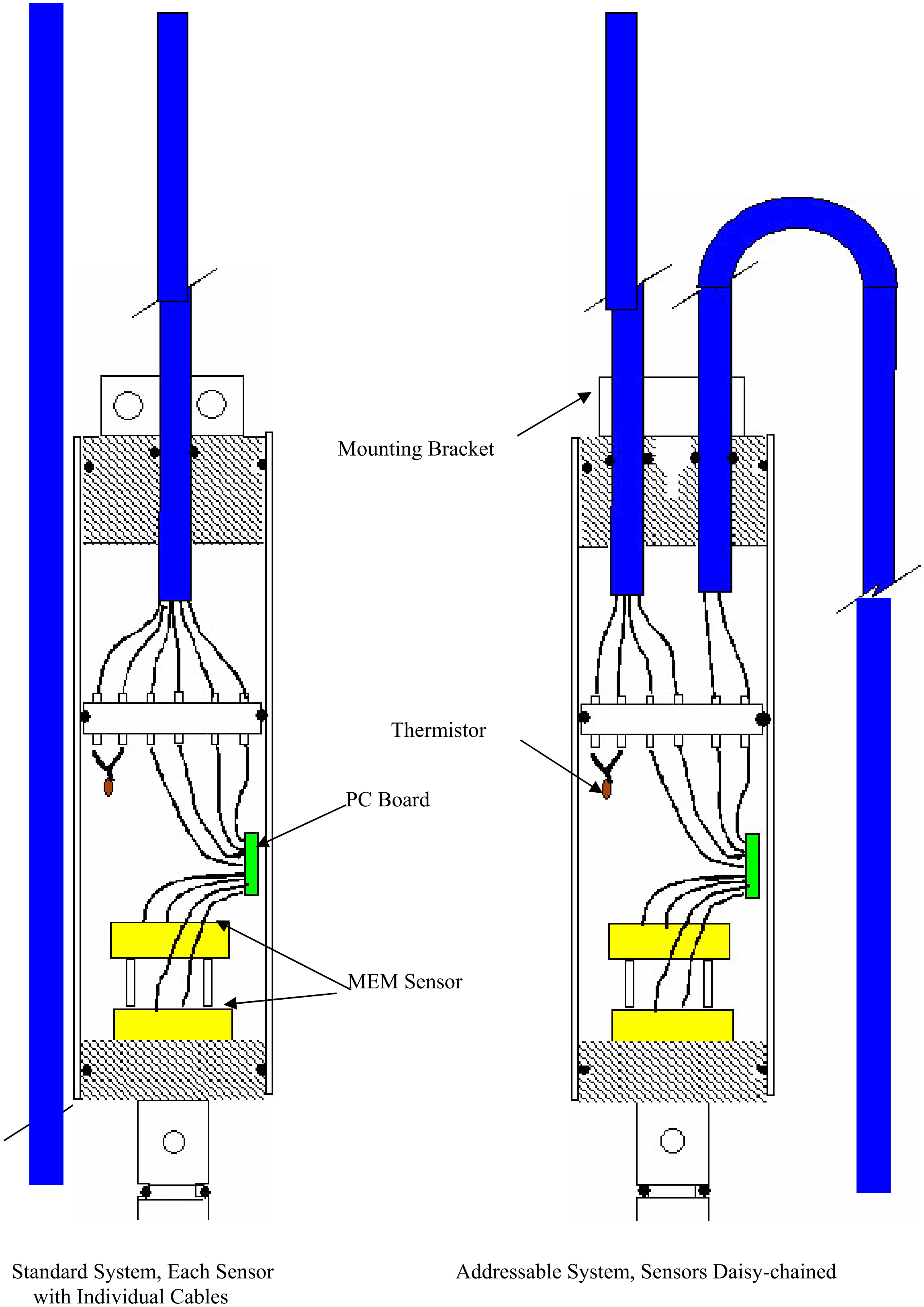

Figure 3 - Model 6160 Biaxial Tilt Sensor

2. INSTALLATION

2.1. Preliminary Tests

Prior to installation, the sensors need to be checked for proper operation. Each tilt sensor is supplied with a calibration sheet, which shows the relationship between output voltage and inclination. The tilt sensor electrical leads are connected to a Datalogger or RB-500 readout box (see section 3) and the current reading compared to the calibration readings. Carefully hold the sensor in an approximately vertical position and observe the reading. The sensor must be held in a steady position. The readings should be close to the factory vertical reading. The temperature indicated by the thermistor should be close to ambient.

Checks of electrical continuity can also be made using an ohmmeter. Resistance between any conductor and the shield or the case should exceed 2 megohm.

2.2. Installation Instructions

Uniaxial and Biaxial Installation Instructions

1. The first step is to install the uniaxial/biaxial mounting bracket (see Figure 4), which is designed for mounting on vertical walls.

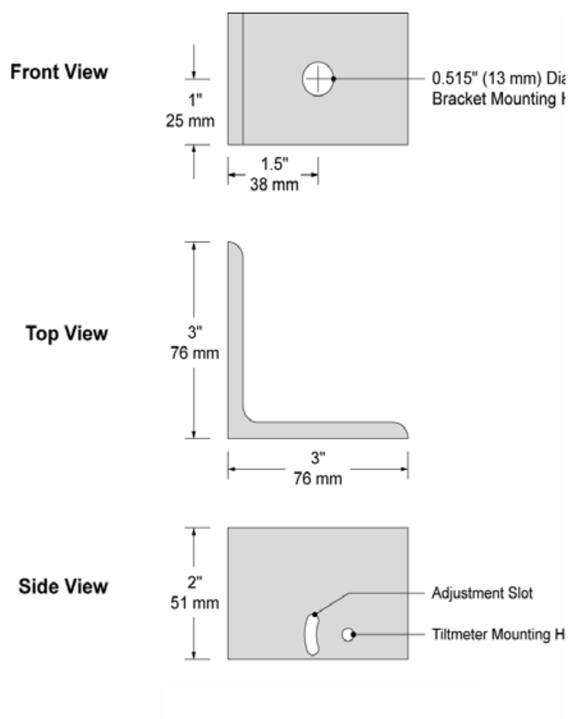

Figure 4 - Tiltmeter Mounting Bracket

Mark the location on the wall and drill, using a hammer drill, a 12mm (½") hole approximately 37 mm (1½") deep. Clean the hole thoroughly, blowing out with compressed air if possible. Insert the 3/8" drop-in anchor with setting pin into the hole. The threaded end should be closest to the opening. Using the supplied setting pin tool and a hammer, set the anchor with 2 or 3 sharp blows on the setting pin. Thread the supplied 3/8-16 anchor rod into the anchor. Attach the mounting bracket to the anchor rod using the supplied hardware as illustrated in Figure 4. Use a bubble level or other leveling device to align the bracket so that the transducer mounting face is vertical. Now tighten the 3/8-16 nut.

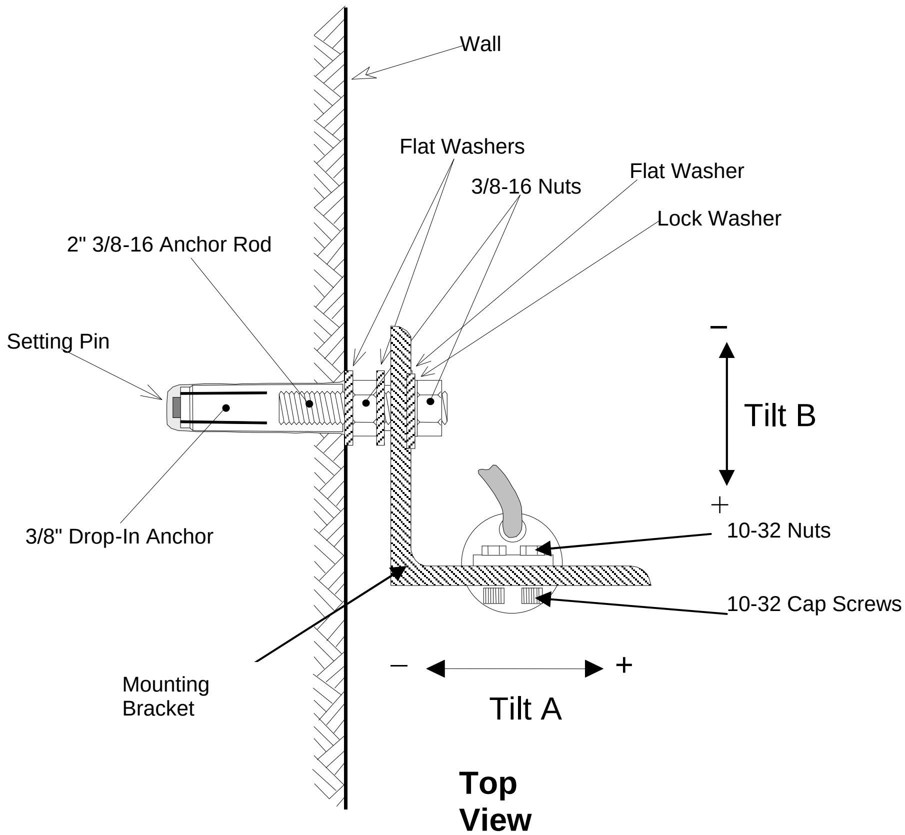

Figure 5 – Uniaxial or Biaxial Tiltmeter Installation Details

2. Now, the uniaxial or biaxial tiltmeter sensor may be installed. Attach the tiltmeter housing to the mounting bracket using the supplied 10-32 cap screws, washers and nuts. Do not tighten the cap screws yet. Attach a portable readout such as the RB-500 (see Section 3 for readout instructions) and observe the reading. Adjust the sensor in the slot of the mounting bracket while observing the readout until the tiltmeter reads within ±0.15 volts of the zero reading as shown on the calibration sheet (sample, Figure 8) supplied with the sensor. When the desired reading is reached, tighten the cap screws to secure the tiltmeter in place. Check the reading again after tightening to make sure it still reads within ±0.15 volts of the zero reading.

   If the tiltmeter is installed in an exposed location in a construction area and/or if the installation is in direct sunlight it should be covered with a protective enclosure and/or insulation.

With a biaxial sensor the second, (B), MEMS sensor is included in the housing and is attached with its positive direction 90° clockwise from the positive direction of the first sensor (looking downwards in plan). Adjustment of the zero reading for the B sensor is accomplished by loosening the 3/8-16 nut and rotating the Mounting Bracket.

2.3. Splicing and Junction Boxes

For manual readout using a RB-500 readout box, cables from the individual sensors are connected to a switch-box using the wiring code shown in Appendix A. If a Datalogger is used the cables are connected directly to the Multiplexer using the same wiring code.

The cable used for making splices should be a high quality twisted pair type with 100% shielding (with integral shield drain wire). When splicing, it is very important that the shield drain wires be spliced together! Splice kits recommended by Geokon (i.e. 3M Scotchcast™, model 82-A1) incorporate casts placed around the splice 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.

2.4. Lightning Protection

The Model 6160 MEMS Tiltmeter, unlike numerous other types of instrumentation available from Geokon, does not have any integral lightning protection components, i.e. transzorbs or plasma surge arrestors. Usually this is not a problem. However, if the instrument cable is exposed, it may be advisable to install lightning protection components, as the transient could travel down the cable to the gage and possibly destroy it.

Note the following suggestions;

- If the tiltmeter 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.
- Lighting arrestor boards and enclosures are available from Geokon that install near the instrument. The enclosure has a removable top so, in the event the protection board (LAB-3) is damaged, the user may 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 gage. See Figure 6. Consult the factory for additional information on these or alternate lightning protection schemes.
- Plasma surge arrestors can be epoxy potted into the gage cable close to the sensor. A ground strap would connect the surge arrestor to earth ground, either a grounding stake or other suitable earth ground.

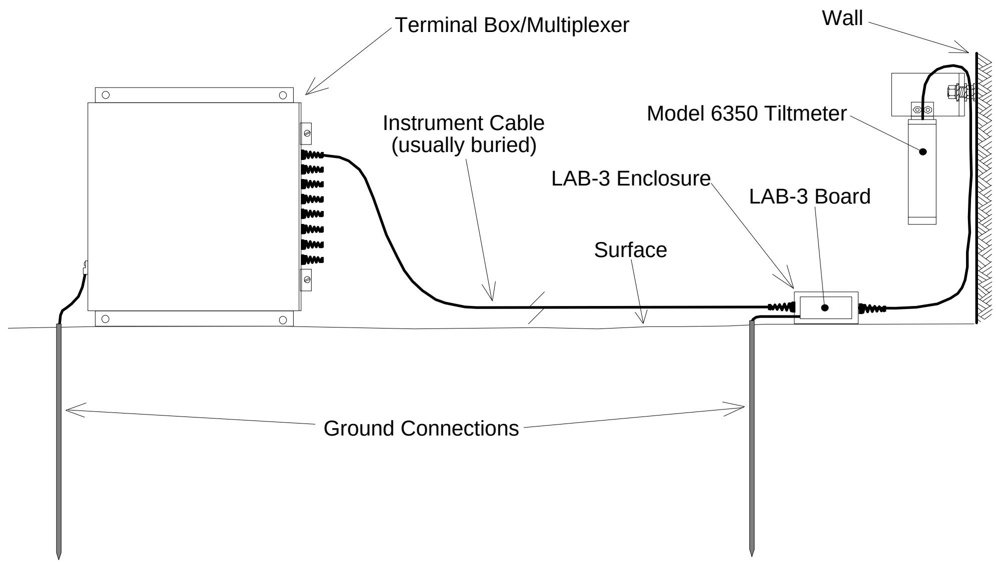

Figure 6 - Lightning Protection Scheme

3. TAKING READINGS

3.1 Dataloggers

In most cases the 6160 MEMS Tiltmeter will be monitored continuously and automatically using a Datalogger. Connections to the Geokon Model 8021 Micro-1000 Datalogger, which uses a Campbell Scientific CR1000 MCU are shown in Appendix C Page 13.

3.2 RB-500 Readout Box

The RB-500 readout box is designed to take readings for manually transcribing into a field book; it has no storage capabilities. This method is useful for reading systems that do not require continuous monitoring. The RB-500 readout box is also useful during initial installations and for setting up Datalogger systems.

3.3 Measuring Temperature

Although the temperature dependence of the MEMS tilt meter is tiny, and usually does not require compensation, it sometimes happens that temperature effects can cause real changes of tilt, therefore each MEMS tilt sensor is equipped with a thermistor for reading temperature. This enables temperature-induced changes in tilt to be distinguished from tilts due to other sources. *The RB-500 will not read temperatures* a separate digital ohmmeter is required. (or a GK403 or GK 404)

The thermistor gives a varying resistance output as the temperature changes. See the wiring diagram in Appendix C, page 14 for the wiring code. Appendix B shows the conversion of resistance to temperature.

The above remarks apply mainly to structures exposed to sunlight: in these situations it is not uncommon for the structure to expand and contract differentially during to course of the day. For land-slide applications where the MEMS sensors are buried in the ground, temperature variations are very small or non-existent and ground movements are unaffected by temperatures. In these situations it is not necessary to measure temperatures.

4. DATA REDUCTION

4.1.Tilt Calculation

The output of the MEMS Sensor is proportional to the sine of the angle of inclination from the vertical. For the ± 15 degree sensor the FS output is approximately ± 4 volts. The reading, **R**, in volts displayed on the RB-500 readout box, and the inclination, **θ,** is given by the equation:

$$\theta = (R_1 - R_{zero})\ G \quad \text{degrees}$$

Equation 1 Inclination versus volts.

Where **R** is the current reading in volts, R_{zero} is the reading at θ =zero, and **G** is the Gage Factor shown on the calibration sheet for the Model 6160 tiltmeter. Note that for measurements of tilt, i.e changes of inclination, where R_0 is the initial reading and R_1 is a subsequent reading, the small zero reading, R_{zero} at zero inclination cancels out so that

$$\text{Calculated Tilt} = G(R_1 - R_0)$$

Equation 2 Tilt versus volts

4.2. Temperature Correction

The Model 6160 MEMS Tiltmeter has very small temperature sensitivity equal to +1 arc second per degree centigrade rise. The tilt corrected for temperature is:

$$\text{Tilt} = G(R_{1corr} - R_0) \text{ degrees}$$

Where $R_{1corr} = R_1 - 0.0003\ (T_1 - T_0)$

Equation 3 Tilt versus volts corrected for Temperature.

The structure being monitored usually is affected by temperature to some degree. An important point to note is that sudden changes in temperature will cause both the structure and the Tiltmeter to undergo transitory physical changes, which will show up in the readings. The gage temperature should always be recorded, and efforts should be made to obtain readings when the instrument and structure are at thermal equilibrium. The best time for this tends to be in the late evening or early morning hours. **For best results the tiltmeter should be shielded from direct sunlight.**

4.3. Environmental Factors

Since the purpose of the inclinometer installation is to monitor site conditions, factors that may affect these conditions should 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 or reservoir levels, excavation and fill levels and sequences, traffic, temperature and barometric changes, changes in personnel, nearby construction activities, seasonal changes, etc.

5. TROUBLESHOOTING

Maintenance and troubleshooting of the MEMS sensors used in the Model 6160 Tiltmeter are confined to periodic checks of cable connections. The sensors are sealed and there are no user-serviceable parts.

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

Symptom: Tilt Sensor Readings are Unstable

- ✓ Is there a source of electrical noise nearby? Most probable sources of electrical noise are motors, generators and antennas. Make sure the shield drain wire is connected to ground whether using a portable readout or datalogger.
- ✓ Does the readout work with another tilt sensor? If not, the readout may have a low battery or be malfunctioning.

Symptom: Tilt Sensor Fails to Read

- ✓ Is the cable cut or crushed? This can be checked with an ohmmeter. The nominal resistance of the thermistor is 3000 ohms at 25 degrees C. If the approximate temperature is known, the resistance of the thermistor leads can be estimated and used as a cable check. Remember to add cable resistance when checking (24 AWG stranded copper leads are approximately 25.7Ω/1000' or 84.5 Ω/km, multiply by 2 for both directions). If the resistance reads infinite, or very high (megohms), a cut wire must be suspected. If the resistance reads very low (<20Ω) a short in the cable is likely.
- ✓ Does the readout or datalogger work with another tilt sensor? If not, the readout or datalogger may be malfunctioning.

Symptom: Thermistor resistance is too high.

- ✓ Is there an open circuit? Check all connections, terminals and plugs.

Symptom: Thermistor resistance is too low.

- ✓ Is there a short? Check all connections, terminals and plugs.
-]✓ Water may have penetrated the interior of the tilt sensor. There is no remedial action.

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MEMS Tilt Sensor Calibration

Model Number: MEMS Tilt Sensor

Calibration Date: February 06, 2008

Serial Number: Sensor A 08-542

Temperature: 25.5 °C

Technician:

Inclination (degrees)	Inclination (sinθ)	* Reading 1st Cycle (Volts)	* Reading 2nd Cycle (Volts)	* Average Reading (Volts)	Error in θ (%FS)	Calculated sinθ (%FS)
10.00	0.1737	2.7616	2.7590	2.7603	-0.05	0.02
8.002	0.1392	2.2190	2.2165	2.2178	0.01	0.00
6.000	0.1045	1.6743	1.6727	1.6735	0.05	0.00
4.002	0.0698	1.1281	1.1280	1.1281	0.05	0.00
2.002	0.0349	0.5803	0.5802	0.5802	0.03	-0.01
0.000	0.0000	0.0322	0.0320	0.0321	0.00	0.00
-2.002	-0.0349	-0.5155	-0.5157	-0.5156	-0.02	0.02
-4.002	-0.0698	-1.0625	-1.0632	-1.0629	-0.03	0.02
-6.000	-0.1045	-1.6081	-1.6089	-1.6085	-0.03	0.02
-8.002	-0.1392	-2.1524	-2.1538	-2.1531	0.00	0.02
-10.00	-0.1737	-2.6947	-2.6958	-2.6953	0.07	0.00

6150 and 6155 In-Place Inclinometer Gage Factor (G): 0.06368 (sinθ/ Volt)

Temperature Correction Factor -0.0003 (T_1-T_0) Volts / °C

Deflection = GL(R_1-R_0) mm (inches)

6160 Tiltmeter Gage Factor (G): 3.6617 (degrees/ Volt)

Temperature Correction Factor -0.0003 (T_1-T_0) Volts / °C

Calculated Tilt = G(R_1 - R_0) degrees

Wiring Code: See manual for further 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 7 - Sample Model 6160 or 6150 Calibration Sheet

APPENDIX A - SPECIFICATIONS

A.1. MEMS Tilt Sensor

Model:	**6160**
Range:	±15°
Full Scale Output:	+/- 4 Volts
Frequency Response:	-3db @ 8-28 Hz
Resolution:[1]	+/-2 arc seconds, (+/- 0.01mm/m)
Accuracy:[2]	+/- 3 arc seconds
Linearity:[3]	+/- 0.07%FS
Thermal Zero Shift:	0.0003 volt/°C rise
Operating Temperature	-20 to +70° C -4 to 158° F
Power Requirements:	6160-1 (Uniaxial): +12V (nom) @ 30mA 6160-2 (Biaxial): +12V (nom) @ 45mA
Diameter:	1.250", 32 mm
Length:	7.375", 187 mm
Weight:	1.5 lbs., 0.7 kg.
Materials:	304 Stainless Steel
Electrical Cable:	3 twisted pair (6 conductor) 24 AWG Foil shield, Polyurethane jacket, nominal OD = 6.3 mm Or 6 twisted pair (12 conductor) 24 AWG Foil shield, Polyurethane jacket, nominal OD = 7.9 mm

Table A-1 Model 6160 Tilt Sensor Specifications

Notes:

[1] Depends on readout equipment. For best results requires a 4 ½ digit digital voltmeter. Averaging will yield resolution on the order of 2 arc seconds
[2] Based upon the use of a second order polynomial
[3] The output of the MEMS sensor is proportional to the sine of the angle of tilt

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:

$$T = \frac{1}{A + B(LnR) + C(LnR)^3} - 273.2$$

Equation B-1 Convert Thermistor Resistance to Temperature

Where; T = Temperature in °C.
LnR = Natural Log of Thermistor Resistance
$A = 1.4051 \times 10^{-3}$ (coefficients calculated over the −50 to +150° C. span)
$B = 2.369 \times 10^{-4}$
$C = 1.019 \times 10^{-7}$

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 B-1 Thermistor Resistance versus Temperature

APPENDIX C WIRING CODE

03-250V0 cable	Connector Pin Designation	Uniaxial MEMS **with** Thermistor	Connector Pin Designation	Biaxial MEMS **without** Thermistor
Red	A	12VDC	A	12VDC
Red's Black	B	Ground	B	Ground
White	C	A Out Diff +	C	A Out Diff +
White's Black	D	A Out Diff -	D	A Out Diff -
Bare	E	Shield	E	Shield
Green	J	Thermistor	F	B Out Diff +
Green's Black	K	Thermistor	G	B Out Diff -

Table C-1 Cable 03-250V0 Wiring

06-312V0 Cable	Connector Pin Designation	Biaxial MEMS **with** Thermistor
Red	A	12VDC
Red's Black	B	Ground
White	C	A Out Diff +
White's Black	D	A Out Diff -
Bare	E	Shield
Green	F	B Out Diff +
Green's Black	G	B Out Diff -
Blue	J	Thermistor
Blue's Black	K	Thermistor

Table C-2 Cable 06-312V0 Wiring

APPENDIX D **6160 Standard Addressable Systems**

Description:

The standard 6160 addressable system incorporates a Distributed Multiplexer Circuit Board that allows multiple MEMS type tiltmeters, uniaxial or biaxial, to be connected as “drops” off of a single bus.

The tiltmeter “string” is addressed via ENABLE and CLOCK signals in the same manner as the Geokon Model 8032-16 Channel Multiplexer.

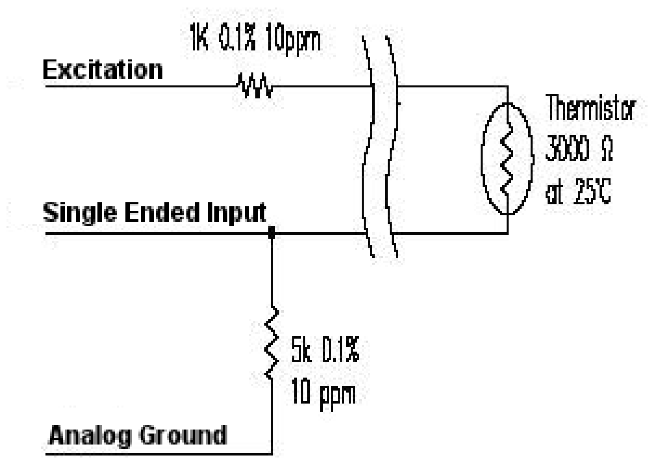
The addressable tiltmeter string is “enabled” by raising the appropriate Datalogger Control Port to 5V. After the string has been enabled, a delay of 125 mS is required before executing the 1st of the two clock pulses required to activate the 1st channel. Once the channel is selected, a delay of 100 mS is required for the sensor to warm-up. The sensor’s A-axis is read 100 times and then the average of these readings is stored. The sensors B-axis is then read. Finally, the sensor’s thermistor is read through a bridge completion circuit and the temperature is calculated using a polynomial formula. Examples of CRBASIC programming can be found in Appendix F.

Wiring:

06-312V0 Cable Color	Connector Pin Designation	Addressable MEMS System (Logic Level Style)
Yellow	A	A-axis Output Differential +
Yellow’s Black	B	A-axis Output Differential -
Brown	C	B-axis Output Differential +
Brown’s Black	D	B-axis Output Differential -
Red	E	12VDC
Red’s Black	F	Ground
White	G	Reset
White’s Black	H	Ground
Green	J	Clock
Green’s Black	K	Ground
Blue	L	Thermistor*
Blue’s Black	M	Thermistor*
Bare	P	Shield

Table D-1 Addressable MEMS (Logic Level Style) Wiring

*<u>*1K and 5K precision resistors are used to complete the thermistor bridge circuit:</u>*



<u>Figure D-1 Thermistor Bridge Circuit</u>

<u>Specifications for Addressable System (Logic Level Style) Circuit Board:</u>

Board Dimensions:	4.5"(L) x 1.155"(W) x 0.4"(H)
Power Requirements:	+12V (+/- 3V) 110mA (max) when active 700uA (max) standby
Operating Temperature:	-20 to +70° C
Contact Resistance:	100 mΩ (typ)
Contact Breakdown Voltage:	1500 Vrms
Relay open/close time:	4mS (max)

APPENDIX E **CRBASIC PROGRAMMING**

Programming the MEMS Tiltmeter with CRBASIC

Description:

CRBASIC is the programming Language used with Campbell Scientific CRBASIC Dataloggers. Campbell's Loggernet Software is typically used when programming in CRBASIC. The MEMS sensor should be read with the VoltDiff instruction and the output averaged 100x. No Thermistor in this example.

Sample Program:

```
'Declare Public Variables for Reading MEMS Sensor

Public MEMS_1
Public MEMS_2
Public MEMS_3
Public MEMS_Output  'Output of the MEMS Sensor

'Store MEMS Output every 2 minutes

DataTable (MEMS_EXAMPLE,1,-1)
    Sample (1,MEMS_Output,IEEE4)
EndTable

BeginProg

    '2 min scan interval

    Scan (2,min,0,0)

            'Read MEMS Sensor on Differential Channel 1 and average 100x Readings

            Delay(0,100,mSec)
            MEMS_3 = 0
            For MEMS_1 = 1 To 100
                    VoltDiff (MEMS_2,1,mV5000,1,False,0,250,0.001,0)
                    MEMS_3 = MEMS_3 + MEMS_2
            Next
            MEMS_Output = MEMS_3 / 100

            CallTable MEMS_EXAMPLE
    NextScan
EndProg
```

Programming the Addressable MEMS Tiltmeter with CRBASIC

Description:

CRBASIC is the programming Language used with Campbell Scientific CRBASIC Dataloggers. Campbell's Loggernet Software is typically used when programming in CRBASIC. The MEMS sensor should be read with the VoltDiff instruction and the output averaged 100x.

Sample Program:

'The following sample program reads 20 addressable Bi-Axial MEMS Gages and Thermistors. The A-Axis is read on Differential Channel 1, the B-Axis is read on Differential Channel 2 and the Thermistors are read with Single Ended Channel 5 and the bridge excited with EX1. The string is enabled with Control Port 1 and clocked with control port 8.

'Declare Public Variables for Reading MEMS Sensor and Thermistor

```
Public MEMS_1
Public MEMS_2
Public MEMS_3
Public THERM_1
Public THERM_2
Public THERM_3
Public Channel  'Counter
Public Reading_A  'Output of the A Axis
Public Reading_B  'Output of the B Axis
Public Reading_THERM  'Output of Thermistor

'Store MEMS Output every 5 minutes

DataTable (MEMS_EXAMPLE,1,-1)
    Sample (1,Reading_A,IEEE4)
    Sample (1,Reading_B,IEEE4)
    Sample (1,Reading_THERM,IEEE4)
EndTable

BeginProg

    '5 min scan interval

    Scan (5,min,0,0)

            'enable String using C1
            PortSet(1,1)

            'Delay
            Delay(0,125,MSEC)
```

```
'counter for number of sensors
For Channel = 1 To 20

    '1st clock using C8
    PortSet(8,1)
    Delay(0,10,MSEC)
    PortSet(8,0)
    Delay(0,10,MSEC)

    'Delay
    Delay(0,100,mSec)

    'Read the A-axis

    'Reset the temporary storage location
    MEMS_3 = 0

    'counter
    For MEMS_1 = 1 To 100

        'differential voltage measurement on DIFF1
        VoltDiff (MEMS_2,1,mV5000,1,False,0,1000,0.001,0)

        'Sum the readings
        MEMS_3 = MEMS_3 + MEMS_2

        'Increment To 100
    Next

    'Calculate the Average reading value
    Reading_A = MEMS_3 / 100

    'Read the B-axis

    'Reset the temporary storage location
    MEMS_3 = 0

    'counter
    For MEMS_1 = 1 To 100

        'differential voltage measurement on DIFF2
        VoltDiff (MEMS_2,1,mV5000,2,False,0,1000,0.001,0)

        'Sum the readings
        MEMS_3 = MEMS_3 + MEMS_2

        'Increment To 100
    Next
```

```
                    'Calculate the Average reading value
                    Reading_B = MEMS_3 / 100

                    'Delay
                    Delay(0,100,msec)

                    'Read the thermistor

                    'half bridge measurement - SE5 AND EX1
                    BrHalf(THERM_1,1,mV2500,5,VX1,1,2500,0,1000,250,2.5,0.0)

                    'Calculate the temperature
                    THERM_2 = THERM_1 / 5000

                    THERM_3 = (2.5 - (THERM_2*1000) - THERM_1)/THERM_2

                    Reading_THERM = 1/(.0014051 + (.0002369*LOG(THERM_3)) +
(.0000001019*(LOG(THERM_3)^3))) - 273.2

                    '2nd clock using C8
                    PortSet(8,1)
                    Delay(0,10,MSEC)
                    PortSet(8,0)
                    Delay(0,10,MSEC)

                    'Next sensor
            Next

            'Disable String
            PortSet(1,0)

            CallTable MEMS_EXAMPLE
    NextScan
EndProg
```