Vibrating Wire Temperature Sensor

User Manual

Man184	2.1.0	07/08/2014	Final	Kim Malcolm	Chris Rasmussen
Manual No.	**Revision**	**Date**	**Originator**	**Checked**	**Authorised for Issue**

Contents

Section 1 : Theory of Operation

The Theory of operation is that a tensioned steel wire is clamped axially inside a cylindrically shaped, stainless steel body and is made to vibrate at its fundamental frequency by means of electrical pulses fed from a readout box, through a cable, to an electronic coil and permanent magnet assembly mounted close to the wire. Temperature changes cause the stainless steel body to expand and contract at a different rate than the vibrating wire. This causes a corresponding change in the wire tension and in its frequency of vibration.

Vibration of the wire in the permanent magnetic field induces an alternating current in the electronic coil with the same frequency. The readout box used to pluck the wire is now used to measure this frequency, which can then be related to the temperature by means of a calibration factor supplied with each gauge.

Section 2 : Installation

The Vibrating Wire Temperature Sensor can be installed inside boreholes, buried in fill, or cast inside concrete. They are fully waterproof. No particular requirements are needed. Preliminary readings should be taken to ensure that the sensor is functioning properly. Most models incorporate a thermistor that can be used as a check on the vibrating wire readout.

2.01 Readout procedures

Connect the black and red leads to the VW Readout Box and take the reading.

The thermistor readout can be displaced directly in °C or the thermistor can be read on the green and white conductors using a digital ohmmeter in conjunction with the conversion Table B-1 in Appendix A. Allowance for cable resistance may be necessary (22 gage cable has a resistance of 20Ω/300 meters.

Section 3 : Data Reduction

The temperature (T) is given by the formula:

$$T = K (R_O - R_1) \text{ in degrees centigrade}$$

Where: R_O is the reference reading at 0°C
R_1 is the subsequence reading
K is the gage factor

A typical calibration sheet showing the gauge factor is shown in Appendix A.

Section 4 : Troubleshooting

Maintenance and troubleshooting of vibrating wire temperature sensors confined to periodic checks of cable connections and maintenance of terminals. The transducers themselves are sealed and cannot be opened for inspection.

- A normal resistance between black and red conduction is 180Ω±5Ω plus cable resistance (20Ω/300m).
- A normal resistance between white and green conduction depends on the temperature

If the resistance deviates from the norms, inspect the cable for damage.

Range	Standard: -20°C to +80°C Optional: any 200°C span from -200°C to 200°C
Resolution	0.04°C (approximate)
Accuracy	±0.5% F.S
Frequency Range	2000-3000Hz
Diameter	19mm
Length	125mm
Weight	115gm
Cable	4 conductor shielded .22awg

Appendix A. Typical Calibration Sheet

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Soil Instruments Limited. Registered in England. Number: 07960087. Registered Office: 3rd Floor, 1 Ashley Road, Altrincham, Cheshire, WA14 2DT, UK

CALIBRATION CERTIFICATE
VIBRATING WIRE THERMOMETER

Model Number : **1060-050** **Date of Calibration :** **24/04/2014**

Serial Number : **1407669**

Calibrated By : **J Jenner**

CALIBRATION RESULTS

Temperature Applied (°C)	Readings In (F²/1000)	Calculated Temperature Linear (°C)	Calculated Temperature Polynomial (°C)	Error Linear (%FS)	Error Polynomial (%FS)
-19.6	3455.0	-19.58	-19.50	-0.02	0.06
4.1	4162.3	3.99	3.95	-0.06	-0.10
29.0	4913.5	29.02	28.94	0.04	-0.04
53.5	5654.4	53.70	53.66	0.18	0.14
78.2	6385.3	78.05	78.12	-0.14	-0.07

Linear Gauge Factor (K) : -0.03332 **(°C / digit)**

Calculated Temperature (Linear): $T = K (R_0 - R_1)$

Polynomial Gauge Factors : **A:** 6.7802E-08 **B:** 0.0326496 **C:** -133.118

Calculated Temperature (Polynomial): $T = AR_1^2 + BR_1 + C$

Reference reading at 0°C (R_0) : 4043 (Regression zero)

The instrument detailed hereon has, as applicable, been tested and calibrated in accordance with procedures, which are part of our ISO9001:2008 Quality Management System and unless otherwise indicated, performs within +/- 0.5% as specified. Thus, the instrument conforms in all respects to our relevant specifications and drawings.

Certified : ______________________ Line Manager

Appendix B. Thermistor Linearization using Steinhart and Hart Log Equation

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

Basic Equation:

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

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 +149° C. span.

Appendix C. Conversion Table

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	111
174.5K	-48	14.90K	-8	2221	32	490.9	72	145	112
162.7K	-47	14.12K	-7	2130	33	474.7	73	141.1	113
151.7K	-46	13.39K	-6	2042	34	459	74	137.2	114
141.6K	-45	12.70K	-5	1959	35	444	75	133.6	115
132.2K	-44	12.05K	-4	1880	36	429.5	76	130	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	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	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	108	58.3	148
17.53K	-11	2523	29	543.7	69	157.6	109	56.8	149

soil INSTRUMENTS

EC Declaration of Conformity

Soil Instruments Ltd., located at 34 Bell Lane, Uckfield, East Sussex, TN22, 1QL, United Kingdom.

We hereby declare that the devices described below are in conformity with the directives listed. In the event of unauthorised modification of any devices listed below, this declaration becomes invalid.

Type: STANDARD VIBRATING WIRE TEMPERATURE SENSOR

Product Model: T3 VW temperature sensors

Relevant EC Directives and Harmonized Standards:

2004/108/EC Electromagnetic Compatibility directive, as amended by **EN61326-1, ed3**

The product(s) to which this declaration relates is in conformity with the essential protection requirements of 2004/108/EC Electromagnetic Compatibility directive, as amended by EN61326-1, ed3. The products are in conformity with the following standards and/or other normative documents:

EMC: Harmonized Standards: EN 61326-1:2006 Lab Equipment, EMC

IEC61000-6-3:2007 Emission standard for residential, commercial and light-industrial environments
IEC61000-4-2:2008 Electrostatic discharge immunity test
IEC61000-4-3:2006 Radiated, radio-frequency, electromagnetic field immunity test
IEC61000-4-4:2012 Electrical fast transient/burst immunity test
IEC61000-4-5:2005 Surge immunity test
IEC61000-4-6: 2008 Immunity to conducted disturbances, induced by radio-frequency fields
IEC61000-4-11:2004 Voltage dips, short interruptions and voltage variations immunity tests

I hereby declare that the equipment named above has been designed to comply with the relevant sections of the above referenced specifications. The items comply with all applicable Essential Requirements of the Directives.

Philip Day

Date: 4/2/2016

Manufacturing Manager,

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