



RST INSTRUMENTS LTD.

MULTI POINT 100mm
STROKE COMBO
EXTENSOMETER

Instruction Manual

RST Instruments Ltd.
11545 Kingston St
Maple Ridge, BC Canada V2X 0Z5
Tel: (604) 540-1100
Fax: (604) 540-1005
e-mail: info@rstinstruments.com

Multi Point (100mm Stroke) Combo Extensometer Instruction Manual

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Table of Contents

1	INSTALLATION TOOLS	1
2	INSTALLATION OF THE MPBX SYSTEM	1
3	LINEAR POTENTIOMETER ELECTRICAL CONNECTIONS.....	6
4	VW ELECTRICAL CONNECTIONS	6
5	TAKING A READING WITH DEPTH MICROMETER	8
6	WIRING DIAGRAM	8
	APPENDIX.....	9

Table of Figures

Figure 1: Anchor Arrangement.....	1
Figure 2: Head General Arrangement.....	2
Figure 3: Grout Housing Installation	2
Figure 4: Installing additional lengths of Rods	3
Figure 5: Head Installation	5
Figure 6: VW Wiring Diagram	6
Figure 7: VW Displacement Transducer Calibration Sheet	7
Figure 8: Taking a Reading with a Depth Micrometer.....	8

1 INSTALLATION TOOLS

Before Installing the MPBX system, the following tools are required:

1. hacksaw and cable saw	2. Loctite© #222
3. allen keys	4. PVC Cleaner
5. wrenches	6. PVC cement
7. screwdrivers	8. 2 pairs of Vise Grips®
9. metal file	10. Tape or gear clamp (for securing Grout line to anchor)

2 INSTALLATION OF THE MPBX SYSTEM

These installation instructions are general and may be altered to suite site conditions.

1. Calculate the distances between each Anchor, starting from the deepest to shallowest. These calculations will determine the length of rods and sheaths to install before starting the next anchor. For example; if each anchor was spaced 30m apart, then 30m worth of rods and sheaths would be installed on an Anchor before installing the next Anchor.
2. Organize the Rods and PVC Sheaths into per borehole and per anchor groups, and verify all lengths are present (for each anchor to reach its target depth). Number each rod at both ends with its sequence in the installation order, and a letter to designate what anchor the rods belong to. For example the first rod threaded to the deepest anchor would have a 1A at both ends with the next rod having 2A at both ends, etc (The next anchors' rods would be labeled with a "B" etc).
3. If possible, trim each anchors last piece of PVC Sheath to length, so that when it is installed in its final position, it will end up flush with the top of the Grout Collar (see Figure 5). This will eliminate trimming the sheaths to length with a Cable Saw once all of the anchors have been installed.

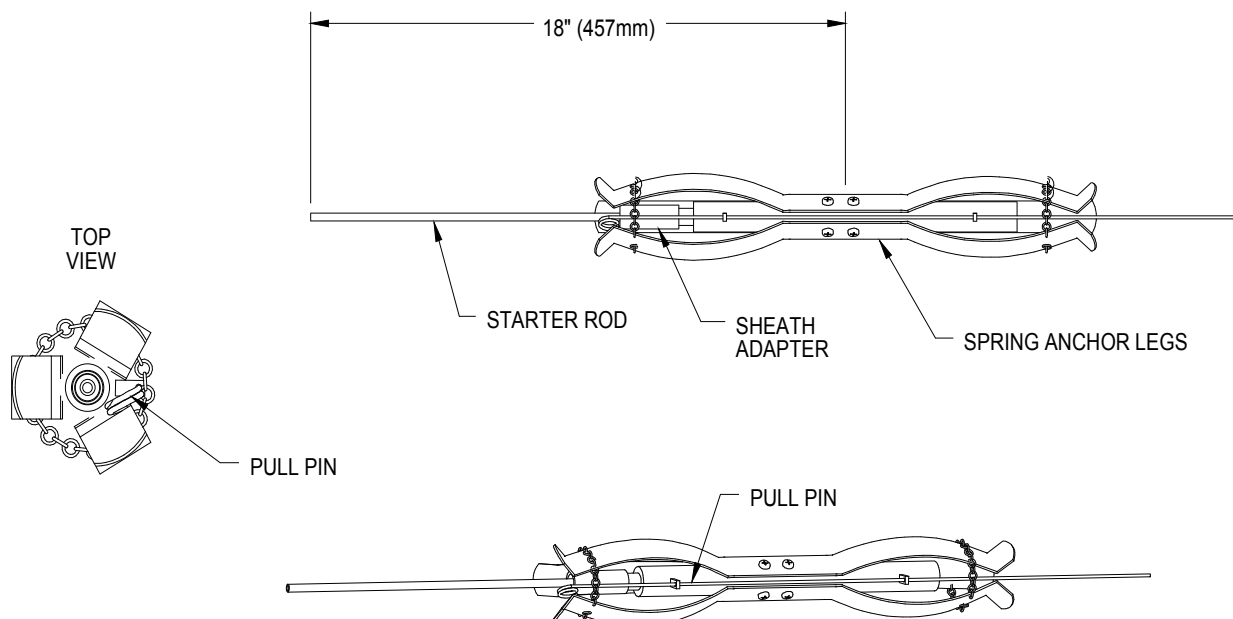


Figure 1: Anchor Arrangement (Spring Anchors Shown)

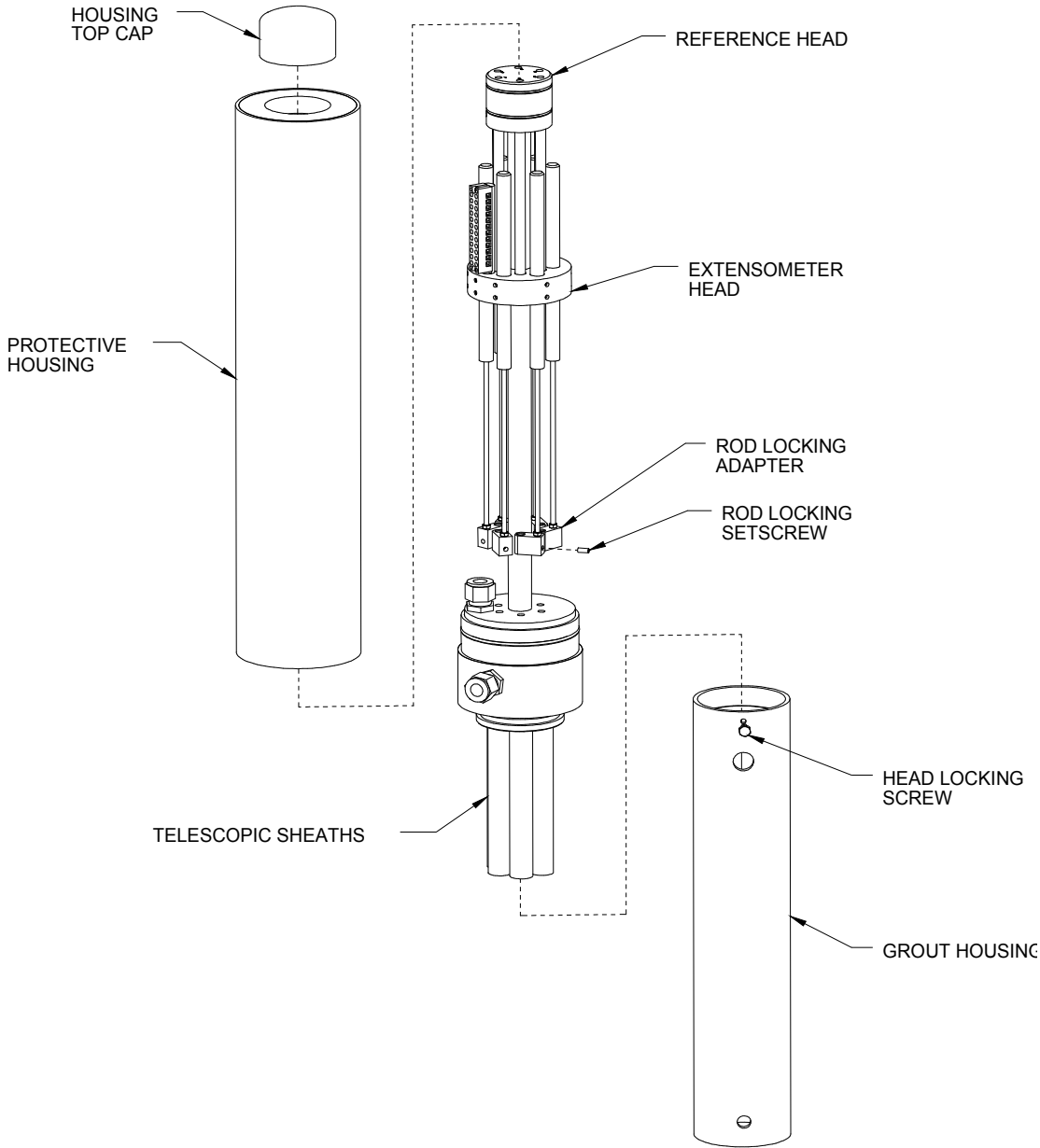


Figure 2: Head General Arrangement

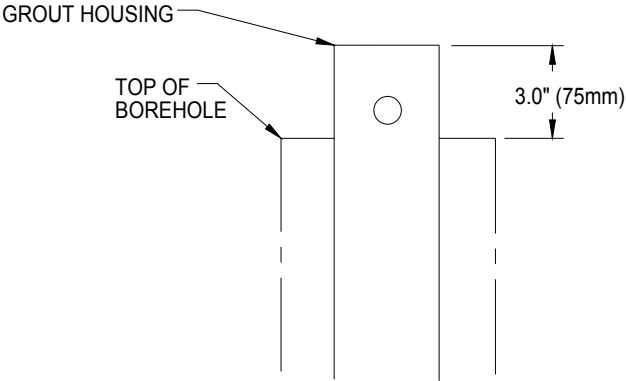


Figure 3: Grout Housing Installation

4. Insert the Grout Collar into the borehole (the top of the Grout collar should be a minimum of 3"[75mm] above the top of the bore hole see Figure 3) and wedge into place with rags soaked in grout. Install Grout Line Access and Safety Line Access Tubes in the annulus between the Grout Collar and the Borehole.
5. Locate the deepest Anchor, and, if applicable, remove the Starter Rod from the Anchor.
6. If applicable apply LOCTITE[®] to the screw threads at the end of the Starter Rod, and thread the Starter Rod onto the Borehole Anchor (as shown in Figure 1).
7. Clean the contact surfaces of the PVC Coupling and both ends of a full-length PVC Sheath, with a PVC Cleaner.
8. Slide the Sheath over the next full length Rod to be installed.
9. Apply LOCTITE[®] to the screw threads at the end of the Rod, and thread it into the Starter Rod, while holding the PVC Sheath at bay.
10. Apply PVC Cement to the outer diameter (male end) of the clean PVC Sheath.
11. Insert the PVC Sheathing, into the Coupling, rotating slightly during insertion.
12. Attach a Safety Line to the Anchor
13. If applicable, secure a grout line to the bottom of the Anchor (This step is performed once per borehole, unless multi-stage grouting is performed).
14. If installing Spring Anchors, attach a Pull Line to the Trigger pin of the Spring Anchors, leave a little slack in the line, and then tape the line to the sheath (**Caution: take care not to activate the Spring Anchor prematurely, by accidentally pulling on the Pull Line**).
15. Lower the Rod assembly into the borehole and lock off with a pair of Vise Grips[®] (gripping on the SS Rod).
16. Clean both ends of a piece of PVC Sheathing.
17. Insert the next full-length Rod into the cleaned PVC Sheathing.
18. Apply LOCTITE[®] to the screw threads of the Rod, and then thread into the previously installed Rod, while holding the PVC Sheathing at bay.

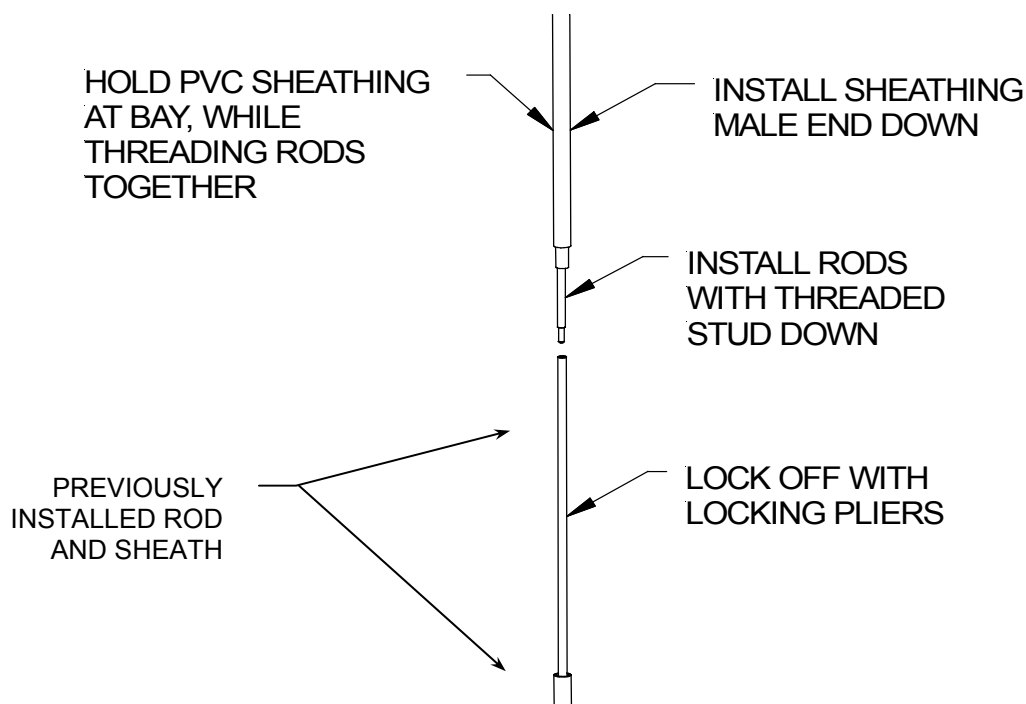


Figure 4: Installing additional lengths of Rods

19. Grip the exposed end of the newly installed Rod (above Sheathing), and then remove Vise Grips® from below (Do not lower the Assembly yet).
20. Apply PVC Cement to the outer diameter (male end) of the PVC Sheath at bay, and then insert it into the installed Sheathing, slightly rotating during insertion.
21. Lower the assembly into the borehole. **If applicable all precautions should be taken to prevent the Pull Lines from being misfired, and they should be clearly marked, identifying which Pull Line belongs to which Anchor.**
22. Repeat procedures 16-21 until the Anchor has reached the depth, as calculated in STEP 1, where the next Anchor is required for installation.
23. Locate the next deepest Anchor, and, if applicable, remove the Starter Rod from the Anchor.
24. If applicable apply LOCTITE© to the screw threads at the end of the Starter Rod, and thread the Starter Rod onto the Borehole Anchor (as shown in Figure 1).
25. If installing Spring Anchors, attach a Pull Line to the Trigger pin of the Spring Anchors, leave a little slack in the line, and then tape the line to the sheath (**Caution: take care not to activate the Spring Anchor prematurely, by accidentally pulling on the Pull Line**).
26. Secure the Anchor to the Safety Line.
27. Clean the contact surfaces of the PVC Coupling and both ends of a full-length PVC Sheath, with a PVC Cleaner.
28. Insert the next full-length Rod into the cleaned PVC Sheathing.
29. Apply LOCTITE© to the screw threads of the Rod, and then thread it into the Starter Rod, while holding the PVC Sheathing at bay.
30. Apply PVC Cement to the outer diameter (male end) of the clean PVC Sheath.
31. Slide the PVC Sheathing, over the installed rod, and into the Coupling, rotating slightly during insertion.
32. Clean both ends of a piece of PVC Sheathing.
33. Insert the next full-length Rod into the cleaned PVC Sheathing.
34. Apply LOCTITE© to the screw threads of the Rod, and then thread into the previously installed Rod, while holding the PVC Sheathing at bay.
35. Grip the exposed end of the newly installed Rod (above Sheathing), and then remove Vise Grips® from below (Do not lower the Assembly yet).
36. Apply PVC Cement to the outer diameter (male end) of the PVC Sheath at bay, and then insert it into the installed Sheathing, slightly rotating during insertion.
37. Repeat steps 32-36 for the remaining installed anchors, until the assembly is ready to be lowered down the borehole.
38. Lower the assembly into the borehole. **If applicable all precautions should be taken to prevent the Pull Lines from being misfired, and they should be clearly marked, identifying which Pull Line belongs to which Anchor.**
39. Repeat the above procedure, adding rods and sheaths to their respective Anchor in the hole and lowering the Anchor Assemblies as a complete unit, for the remaining Anchors. **Don't forget to secure each Anchor to the Safety Line, and, if applicable, take the necessary precautions to prevent the Pull Lines from being misfired, and making sure they are clearly marked, identifying which Pull Line belongs to which Anchor.**
40. If applicable, install the Sheath Alignment Disk far enough from the top of the sheaths so it will end up ~8" (200mm) below the top of the grout collar when the Anchors reach their target depths (see Figure 5). Secure in place with a few wraps of tape.
41. Once the Anchors have reached their target depths, secure the Safety Line.

42. If applicable, trigger each Spring Anchor, starting from the deepest to the shallowest, removing the Pull Line afterwards.
43. Grout the Borehole, and allow it to set.
44. Using a Cable Saw, trim all of the PVC Sheaths flush with the top of the Grout Collar and use a file to create a slight chamfer on the outer edge (this will aid the o-rings in the Telescopic Sheaths to slide over the installed sheaths).
45. Trim the Rods 21.25" [540mm] or 27.75" [705mm], if VW Sensors are used, above the top of the Grout Collar.

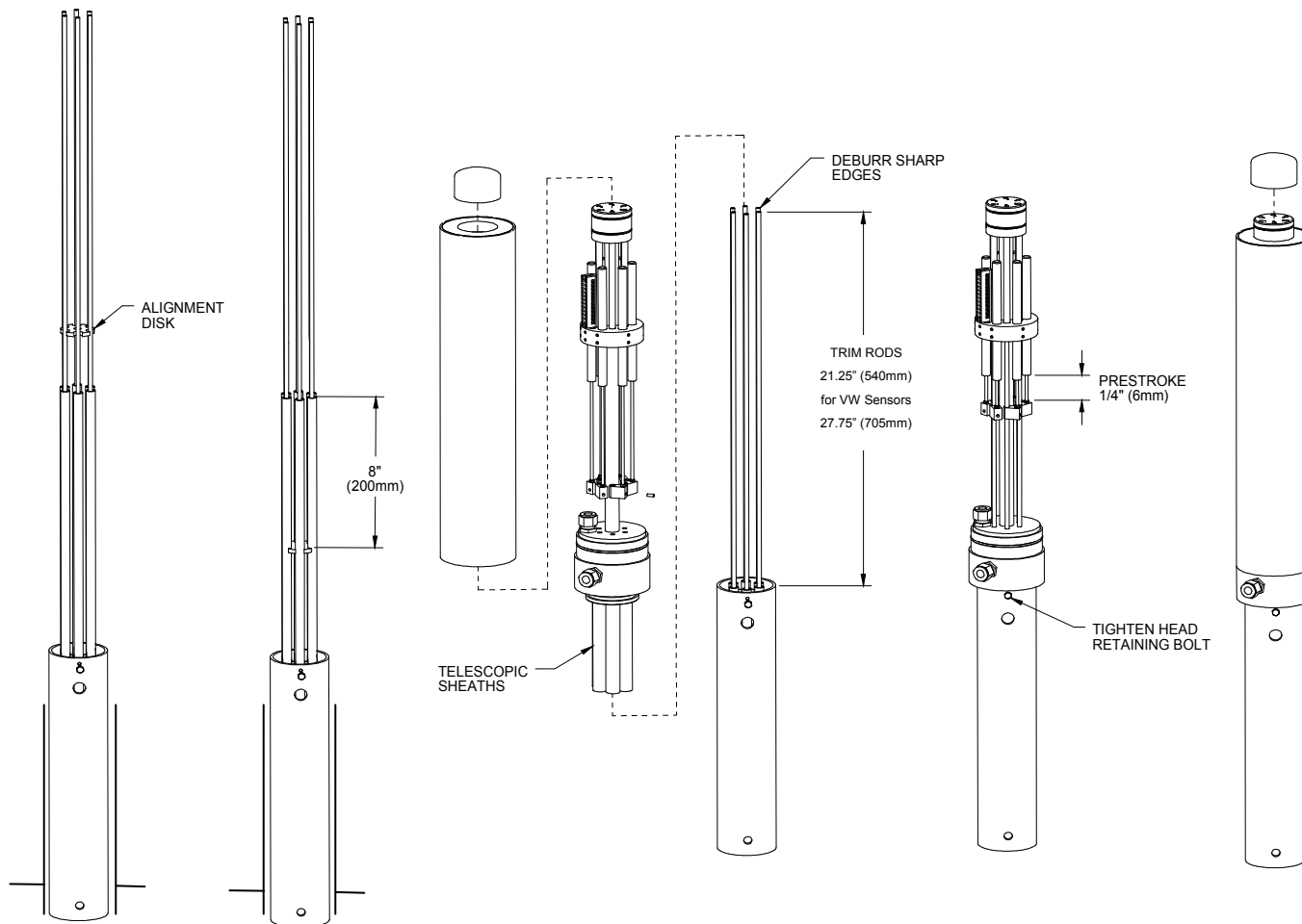


Figure 5: Head Installation

46. Grind the top end of the Rod by using a file, to remove burrs and flatten the top.
47. Remove the PVC Top Cap and PVC Housing off of the Extensometer Head as shown in Figure 5.
48. Remove the protective shipping materials.
49. Slide the Extensometer head onto the Rods, aligning Anchor #1 with the hole stamped #1 on the Reference Head, until the head is resting on the grout housing. If necessary lubricate the installed sheaths in the borehole and loosen the Rod Locking Setscrews (to allow the Rods to pass through the Rod Locking Adapters see Figure 1).
50. Lock the Head in place by tightening the Head retaining Bolt.
51. Using the Grease Nipple, fill the grease trap until grease is seen exiting through the rod holes.
52. Replace the Housing and Top Cap.

3 LINEAR POTENTIOMETER ELECTRICAL CONNECTIONS

1. Remove the PVC Top Cap and PVC Housing off of the Extensometer Head
2. Make electrical connections to a Datalogger (see Wiring Diagram section) and adjust the sensors to approximately 10% of full range or ¼”(6mm) which ever is less, leaving a minimum of 90% of their stroke left to measure in the direction of anticipated movement. Simply apply a known excitation voltage, 10V max, (**Do not apply a current**) take the value read and divide it by the applied excitation voltage this will give a ratio which can be multiplied to the stroke of the linear potentiometer to give a measurement linear measurement. For example, if 5V was applied to a 100mm Stroke Linear Potentiometer, and a reading of 2.5V was taken then;

$$\text{Measurement} = \frac{\text{Voltage Read}}{\text{Excitation Voltage}} * \text{Potentiometer Range}$$

$$\text{Measurement} = \frac{2.5V}{5.0V} * 100mm = .5 * 100mm = 50mm$$

3. Lock the Rod Adapter onto the Rods by tightening the Rod Locking Setscrews.
4. Record the Serial Number of the Reference Head and record the Rod Reference Number and the Potentiometers initial reading. Refer to the relevant DataLogger Operating manual for instructions on taking readings.
5. Repeat steps 2-4 for all the sensors.
6. Install the PVC Housing and Top Cap.

4 VW ELECTRICAL CONNECTIONS

After the installation, the measurements may be obtained by using RST Vibrating Wire Readouts. Connect the wires as per the schematic. (If it is necessary to check the connections inside the head, then note that the wires coming out of the vibrating wire sensors generally use these colors: the black and red wires carry the frequency signal that is proportional to the vibrating wire strain, whereas the green and white wires are connected to the thermistor. The shield is the bare wire.)

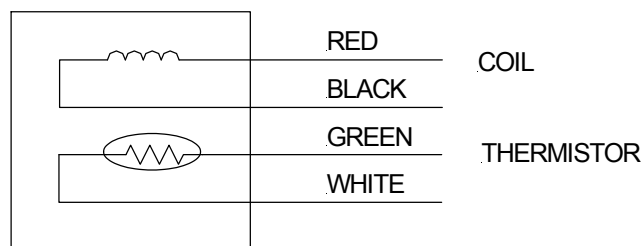


Figure 6: VW Wiring Diagram

The readouts will output the displacement in Digits ($\text{Hz}^2 * 10^{-3}$) and the calibration factor (found on the particular calibration sheet, see the sample calibration sheet, Figure) may be used to convert to engineering units (i.e. mm). The readout will output the temperature in °C. If an Ohmmeter is used directly on the green and white wires, the equation in the appendix can be used to calculate the temperature.

Refer to Calibration sheet for data conversions to linear units.

Vibrating Wire Displacement Transducer Calibration					
Customer:				CLIENT	
Model:				4450-1-25 mm	
Serial Number:				12345	
Mfg Number				03-337	
Range:				25 mm	
Temperature:				22.4 °C	
Calibration Date:				14-Feb-03	
Calibration Standard Control Numbers:				338, 407, 500, 524, 529	
Cable Length:				3 Meters	
Cable Colour Code:	red / black (coil)			green / white (thermistor)	
Thermistor type:				3 Kohms	
Displacement	First	Second	Average	Change	
Pressure	Reading	Reading	Readings		% Linearity
(mm)	(B units)	(B units)	(B units)	(B units)	(%)
0.00	2857	2855	2856		-0.22
5.08	4051	4049	4050	1194	0.08
10.16	5234	5231	5233	1183	0.19
15.24	6404	6402	6403	1171	0.09
20.32	7579	7576	7578	1175	0.06
25.40	8739	8738	8739	1161	-0.20
Calibration Factor:			C.F.=	0.004319	mm / B unit
Regression Zero:				2869	B Unit
Reading Conversion=	(Reading - Regression Zero)*C.F.				
B unit = Hz² x 10⁻³					
Refer to manual for temperature correction information					
Function Test at shipment (VW 2104 Reading)					
Position "B":	5451.8		Date:	28-Feb-03	
Temperature:	20.6 °C				
The above instrument was found to be in tolerance in all operating ranges					
Calibration has been done with standards traceable to the NIST, in compliance with ANSI Z540-1					
Technician:	_____				

Figure 7: VW Displacement Transducer Calibration Sheet

5 TAKING A READING WITH A DEPTH MICROMETER

1. Remove the PVC Top Cap.
2. **Record the Serial Number** marked on the top of the Reference Head.
3. Insert the Depth Micrometer into the hole until its base sits flush on top of the Reference Head.
4. Turn the knob of the Micrometer, lowering the feeler gauge into the hole, until it clicks, (i.e. has reached the top of the Rod) and then record the reading.
5. Replace the PVC Top Cap
6. Repeat steps 1-5 for each Borehole installation

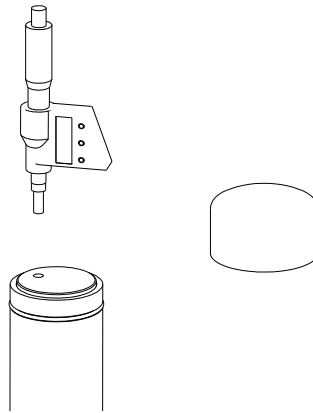


Figure 8: Taking a Reading with a Depth Micrometer

6 WIRING DIAGRAM

See attached.

APPENDIX

The following equation may be used to convert the measured thermistor resistance R (Ω) to temperature T ($^{\circ}\text{C}$).

$$T = \frac{1}{1.4051 * 10^{-3} + 2.369 * 10^{-4} * \ln(R) + 1.019 * 10^{-7} * (\ln(R))^3} - 273.2$$

Alternatively, the values may be looked up directly in Table 1.

Table 1: Thermistor Resistance (Ω) versus Temperature ($^{\circ}\text{C}$)

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	141.11	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
77.99K	-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	-35	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	282.4	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	56.92	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	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