WaterMark Soil Sensors with DataHog Interface

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1. INTRODUCTION

The WaterMark soil moisture sensor is an electrical resistance type sensor with a signal output in ohms. It measures soil moisture or soil suction in units of centibars where zero centibars represents a saturated soil and 200 centibars represents a very dry soil.

In order to be connected to the Skye DataHog or MiniMet datalogger an interface is required to convert the resistance output of the sensor to millivolts.

This manual describes the measurements obtained when using the WaterMark sensors with Skye dataloggers via such as interface.

2. INSTALLATION

The WaterMark sensor has been fitted with a logger interface which is inside the small black box, in line with the sensor cable. This box is completely waterproof and can be safely buried in the soil during installation if necessary.

Detailed installation instructions for the WaterMark sensors themselves are contained in the WaterMark literature enclosed with the sensors.

Always soak the sensors in water overnight and install when still wet. Bury the sensors at the desired depth, ensuring a snug fit into the soil and eliminating air pockets. Make sure there is good contact between the sensor and soil at all points.

Connect the round 5 pin plug at the cable end to the appropriate socket on the DataHog or MiniMet datalogger (these sockets are usually labelled WaterMark).

(Or in the case of loggers fitted with terminal blocks, connect the WaterMark sensor cables to the appropriately labelled terminals, taking note of the wire colour indications.)

PLEASE REMEMBER THAT SOCKETS ON THE DATAHOG OR MINIMET LOGGER ARE NOT WATERPROOF UNLESS THERE IS EITHER A SENSOR PLUG OR WATERPROOF DUSTCAP FITTED.

WIRING DETAILS FOR DATAHOG CONNECTOR

Pin 1	Red	Positive power supply (5V)
Pin 2	Blue	Sensor output
Pin 3	not connected	
Pin 4	not connected	
Pin 5	Grey (cable screen)	Power supply & output ground

3. USE WITH OTHER DATALOGGERS

This WaterMark interface has been designed for use with the Skye DataHog or MiniMet datalogger, using the 5.000 volt regulated sensor excitation supply.

If it is to be used on other dataloggers, please ensure a 5V power supply else the calibration data supplied in this manual will be incorrect.

Please also note that the interface is not protected against any power supply reversal.

WIRING DETAILS FOR WIRE ENDED SENSORS

Red	Positive power supply (5V)
Blue	Sensor output
Grey (cable screen)	Power supply & output ground

4. INTERPRETATION OF READINGS

The direct output of the WaterMark sensor is resistance in Ohms. The output of the sensor via the logger interface is in millivolts. Table 1 shows soil moisture (or soil suction) readings in centibars relating to the resistance (ohms) and millivolt signals.

The WaterMark's relationship between soil moisture in centibars and resistance (in ohms or converted to millivolts by the logger interface) is not a linear one. This relationship is least linear towards the 'wet' soils end, in the region of zero to 80 centibars, whereas at the 'dry' end of the curve (80-200) the relationship becomes much more linear.

The Skye DataHog or MiniMet datalogger can be easily set up to read the direct output from the sensor's interface, giving accurate data over the entire soil moisture range of 0-200 centibar. These readings would be in millivolts however, and would require conversion to centibar either manually or in a spreadsheet such as Excel.

So for the user's convenience the Skye DataHog or MiniMet datalogger has been set up to automatically convert the millivolt signals to centibars of soil moisture / suction. The more linear end of the WaterMark's relationship curve between 80 and 200 centibars has been used to program the datalogger. This gives a better accuracy of conversion to centibars for drier soils in this range. For wet soils outside this range the readings should be regarded as trend indications only.

Figure 1 shows the graph of soil moisture in centibars against the mV output in the 80-200 centibar range. This is the conversion which has been used to program the datalogger.

Figure 2 shows the percentage error of the conversion calculation (mV to centibars) for this range.

If you would prefer the DataHog or MiniMet datalogger to convert the millivolt signal to centibars over a different range, or to read out directly in millivolts for later conversion on EXCEL or similar, please see Chapter 4.

5. CHANGE DATAHOG / MINIMET PROGRAMMING

The DataHog or MiniMet datalogger is factory set to give the WaterMark's soil moisture readings optimum accuracy over the range 80-200 centibar. Readings below 80 centibar should be regarded as trend only.

If you would prefer the DataHog or MiniMet datalogger to convert sensor readings to centibars over a different range, please see Chapter 4.1 below.

Or if you would prefer the datalogger to read out directly in millivolts for later conversion in EXCEL or similar, please see Chapter 4.2 below.

5.1. Change the range of centibar conversion

This example shows how we have set up the DataHog / MiniMet logger for the range 80 to 200 centibars. You can apply a 'best fit' line to any part of the range between zero and 200 centibars. Choose the range you prefer and follow these steps, changing the figures as appropriate.

1. Enter in Excel or a similar spreadsheet, the figures of centibars and millivolts shown in Table 1.
2. Choose the centibar range you wish to program into the datalogger (in this case 80-199 centibar). Draw an XY scatter graph for this range. Add a linear trend line and display the equation of this trend line. You should get a graph similar to Figure 1.
3. The equation of the trend line is of the type y=Ax+B. (In our example, y=6.6765x+681.31). This equation type is also used to program the Skye datalogger. In configuring the logger, the A part of the equation is related to the Full Scale Value, the B part of the equation is related to the Offset Count.
4. Please see Chapter 3.2.10 of the DataHog or MiniMet logger manual for details of the following calculations.
   To calculate the Full Scale Value:
   FSV = ((1/A) / 1) * 2000 = ((1/6.6765)/1)*2000 = 299.56
   To calculate the Offset Count:
   OC = B *1 *9.5 = 681.31 *1 *9.5 = 6742
5. To enter these new values into the logger:

a) Connect the DataHog or MiniMet logger to the PC and start the communications software as usual
b) Have the logger manual and Hardware Configuration Certificate in front of you as reference
c) Wake up the logger to reveal the Main Menu
d) Press '9' to choose 'Option 9 - Set Ax+B calibration factors'
e) Enter the software channel for the sensor you wish to configure (e.g. 00 or 01 etc.)
f) Enter the Full Scale Value as calculated above. You must use the format of 5 digits plus a decimal point, with no leading zeros (e.g. 299.56)
g) Enter the Offset Count as calculated above. Enter as 4 digits only and + for the sign (e.g. 6742 and +)

h) The figures you have just entered will be displayed for you to confirm. If OK, press 'Y' and you will return to the Main Menu.
i) Repeat steps d) to h) for each WaterMark channel to be configured.
j) Press ESCAPE to return the datalogger to logging mode.
k) Write the new Full Scale Values and Offset Counts on the Hardware Configuration Certificate for your future record.

It is always advisable to reset the memory of the DataHog / MiniMet logger after changing any settings and before leaving to store new readings.

5.2 Change to read out directly in millivolts

There are no calculations involved in changing the DataHog or MiniMet logger to read out directly in millivolts, just default values to enter.

1. Connect the DataHog or MiniMet logger to the PC and start the communications software as usual
2. Have the logger manual and Hardware Configuration Certificate in front of you as reference
3. Wake up the logger to reveal the Main Menu
4. Press '9' to choose 'Option 9 - Set Ax+B calibration factors'
5. Enter the software channel for the sensor you wish to configure (e.g. 00 or 01 etc.)
6. Enter the Full Scale Value as 2000.0 (you must use the format of 5 digits plus a decimal point, with no leading zeros).
7. Enter the Offset Count as 0000 and + (enter 4 digits only and the sign as +).
8. The figures you have just entered will be displayed for you to confirm. If OK, press 'Y' and you will return to the Main Menu.
9. Repeat steps 4) to 8) for each WaterMark channel to be configured.
10. Press ESCAPE to return the datalogger to logging mode.
11. Write the new Full Scale Values and Zero Offset counts on the Hardware Configuration Certificate for your future record.

It is always advisable to reset the memory of the DataHog / MiniMet logger after changing any settings and before leaving to store new readings.

The millivolt readings stored by the DataHog or MiniMet logger can now be converted to soil moisture (soil suction) in centibar using the figures in Table 1.

TABLE 1

WaterMark Sensor Outputs in Ohms (direct from sensor) and in millivolts (via logger interface) against centibars of soil moisture / suction

Centibars	Resistance in Ohms	mV from logger interface
0	550	106.36
5	800	134.01
10	1100	166.92
15	2000	262.49
20	3000	364.85
25	4000	462.63
30	5000	556.22
35	6000	646.02
40	6800	715.52
45	7600	782.73
50	8400	847.45
55	9200	910.28
60	9950	967.78
65	10700	1021.39
70	11430	1074.35
75	12200	1128.39
80	12875	1174.85
85	13550	1220.23
90	14225	1264.28
95	14900	1307.47
100	15575	1349.58
105	16200	1387.56
110	16825	1425.01
115	17450	1461.66
120	18075	1497.21
125	18700	1532.4
130	19325	1566.69
135	19950	1600.49
140	20575	1634.68
145	21200	1667.01
150	21825	1698.9
155	22450	1729.93
160	23075	1760.6
165	23700	1790.7
170	24325	1820.07
175	24950	1849.08
180	25575	1877.41
185	26200	1905.1
190	26825	1932.6
195	27450	1959.6
199	27950	1980.7

FIGURE 1
Soil Moisture (centibar) v Millivolt output (range 80-200 centibar)

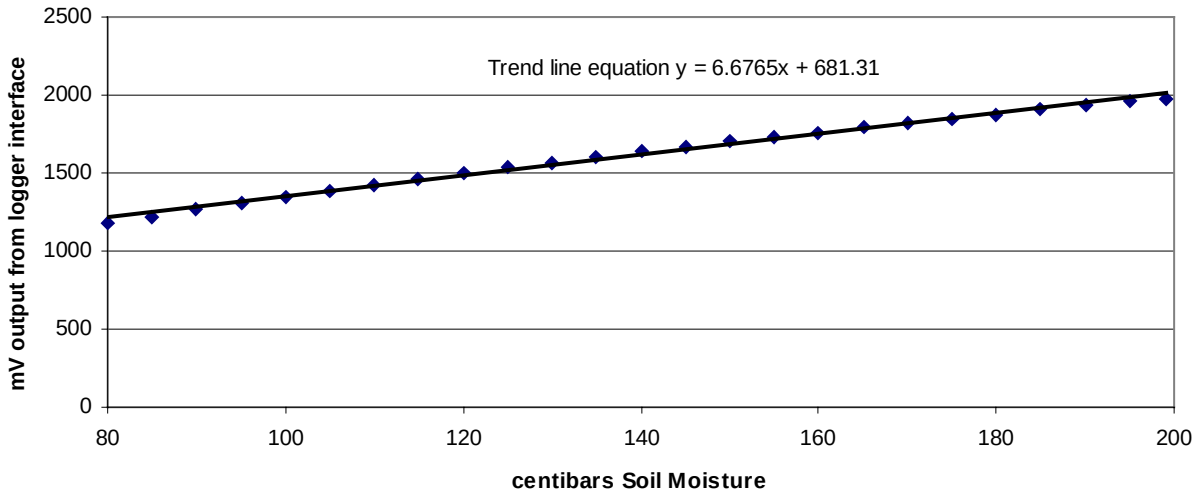

FIGURE 2
Percentage Error for Conversion of mV to centibar (range 80-200 centibar)