

Odyssey Capacitance Water Level Logger.

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Principal of Operation.

A capacitor consists of two conducting plates or cylinders separated by a non-conducting insulating material. This insulator is called a dielectric. The value of the capacitor (if the distance between the plates is fixed) is directly proportional to the area of the two plates in the capacitor.

The stability of the dielectric material governs the stability or quality of the capacitor. Teflon is used as the dielectric in DATAFLOW probes, as it is one of the best dielectric materials available and also has good long-term stability. Teflon has zero moisture absorption; its characteristics are therefore not altered by water immersion.

The Teflon-covered measuring element forms one plate of the capacitor and the Teflon is the insulator or dielectric. The second plate is the water in which the probe is immersed. As the water level varies, the area of water that is in contact with the Teflon surface also varies. The water is like a cylinder that is moving up and down the cylindrical Teflon-lined element. Hence the variation in capacitance is directly proportional to the height variation of the water in contact with the Teflon. The brass counterweight at the base of the sensor element is also used to make electrical contact with the water.

The capacitance value is measured by the electronic module that is mounted at the top of the probe and recorded by the Odyssey recorder that is also included in the electronic module. This module converts the value of the capacitance into a digital signal so that the Odyssey data recorder measures it.

Two modes of operation are possible when the recorder is set up.

- 1) Linear sensor scan mode. Each time the recorder reads the sensor; a value is stored in the log.
- 2) Compressed data mode. The sensor is scanned at a fixed time interval. Data is only recorded if the value measured has altered from the last recorded value by more than the resolution factor that has been set when the recorder was started. This provides very compact data files from slow or sporadically changing water levels.

NOTE! The compressed data mode can only be used on sensors up to two metres. The three and five metre sensors can only be used in the linear mode.

Installation Methods.

The Odyssey water level probe does not have a shroud on the sensor element. For open water applications the probe should be mounted inside a stilling well, this can be made of PVC pipe or galvanised iron pipe.

For groundwater measurement in water bores the probe is simply lowered into the bore. The bore casing or stilling well that the probe is mounted in should be vertical, otherwise

the Teflon element may touch the side of the pipe that it is mounted in and water will be retained between the Teflon element and the pipe. This will result in a measurement error at that point in the measurement range.

When the probe is installed a manual water height measurement of the water level should be taken so that a true starting point can be verified in the data when it is processed. This correction will take into account any shift in the offset figure obtained when the probe was calibrated. The manually read water level can be included in the calibration file relative level value. This will enable actual true water levels to be calculated from a known datum point.

The method of installation will vary with each application; following is a list of suggested methods for some common applications.

- 1) **Above ground small catchment**, with V-notch weir and stilling pond. The probe and Odyssey recorder can be mounted in a 37mm (inside diameter) PVC or galvanised pipe, the pipe being attached to a star picket using hose clamps. This pipe will act as a stilling well to limit level variations caused by wind-created ripples on the water surface. The top cap of the Odyssey data recorders has a suspension plug with a hole in it. This is used to tie a stainless steel or nylon suspension line so that the Odyssey probe may be suspended from the top of the stilling well.
- 2) **Groundwater**. Odyssey data recorders are fitted with a suspension plug on the top cover. This is used to tie a stainless steel or nylon suspension line so that the Odyssey probe may be suspended from the top of the water well down to the water.
- 3) **Stream gauging**. A suitable stilling well MUST be used in this application. The stilling well and the anchoring method must also be strong enough to withstand the force of the stream flow. 37mm (inside diameter) PVC pipe is generally adequate.
- 4) **Tide recording** in oceanographic or estuarine applications. Generally a stilling well is required to eliminate wave action and produce a clean recording.

Teflon Sensor Cleaning.

The Teflon sensor element should be carefully cleaned using either water and detergent or methylated spirits. This will remove any deposits that have formed on the element. Care should be taken not to bend the flexible element beyond a 100mm radius as the internal cable may become permanently bent. The Teflon, although reasonably tough, should not be pulled over any sharp surface as this may puncture the element and render the sensor unserviceable.

Regular probe cleaning and calibration checking has been shown to be of vital importance to ensure accurate measurement.

Calibration.

Required:

- Waterproof marker pen.
- PC running the Odyssey software with a connection to the logger.
- Vessel containing enough water to immerse the sensor. A wide bucket is sufficient. For accurate results use water obtained from the area where you are planning to deploy the logger.

Bottom Up Calibration.

To provide a calibrated value that is increasing from the bottom of the probe upward, (as would be required for surface catchments), the bottom of the counter weight is used as the zero reference point (this is the method described in this instruction).

Top Down Calibration.

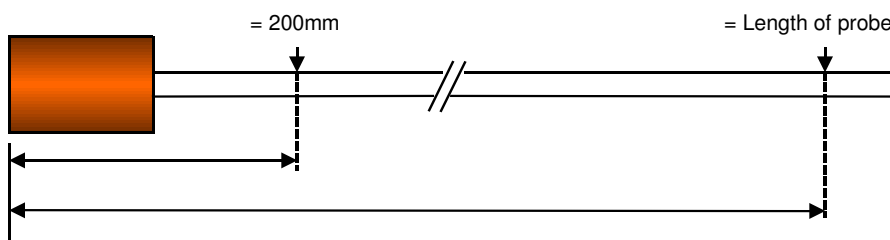
If the probe is used in a bore and the water levels are required as a measurement from the top of the bore down to the water level, then the probe should be calibrated from the top down.

Remove the top cap from the logger and use the point where the top cap meets the logger housing as the zero reference point. Follow the instructions described below but use this as your reference point instead of the bottom of the counter weight.

Obtaining Calibration Values.

1. On the Teflon sensor gently mark two points using a waterproof marker. The first point should be 200mm up from the bottom of the counter weight and second marked at the point that is equal to the specified length of the probe. For example, if you have a 2m probe the second mark should be 2m up from the bottom of the counter weight.

Figure 1.



2. Unscrew the cap on the logger and connect the unit to the PC using the serial interface cable. Once connected select 'Probe Trace' mode by the clicking on the button shown below. (This is located near the top of the screen)

Probe Trace mode Button -



3. In the 'probe trace' window select 'Capacitance Water Level' and, when prompted, select the length of the probe.
4. Click on the 'Start Trace Mode' button. At this point you should see some figures begin to appear on the screen. These are *raw data* values.

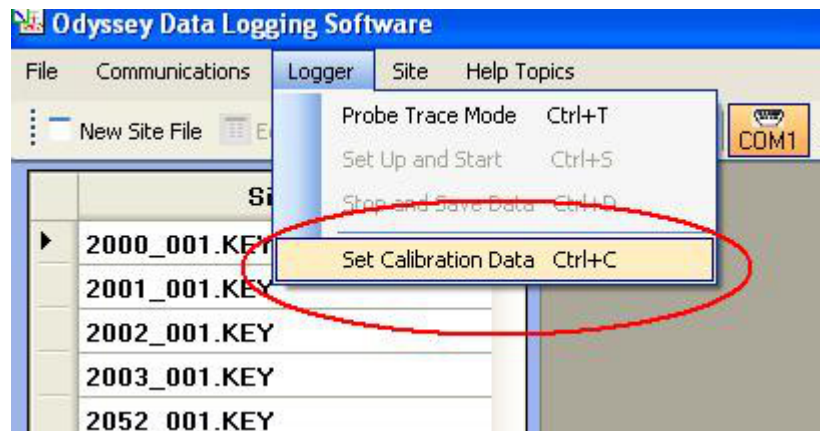
Important: To calibrate a probe the raw data values must be used. If your computer is producing data using a previous calibration, then totally ambiguous results will be produced.

5. With the probe trace running, lower the sensor into the water vessel until the water reaches the first mark at 200mm. Hold the probe at this point until the raw data reading is steady and write this value down.
6. Repeat step 5 but this time lower the sensor until the water reaches the second mark. If you are using a bucket the sensor can be gently coiled as long as the entire length is submerged. Write down the raw data value recorded.

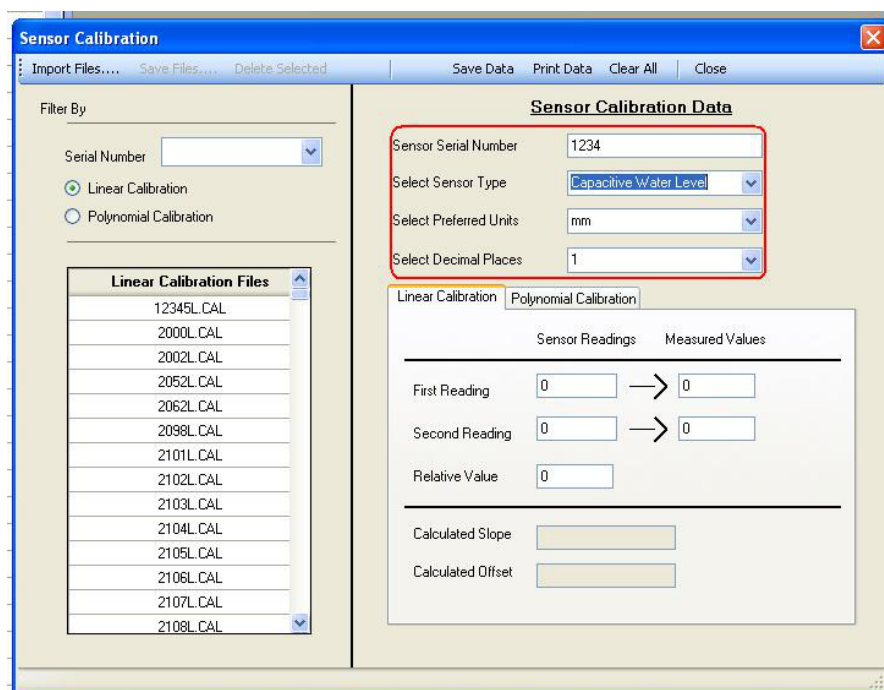
=Creating a calibration file.

With the values you obtained from the previous steps, a calibration file can now be created for your logger using the Odyssey software. Note: this calibration data will automatically be applied to all data downloaded from the calibrated logger.

1. Using the Odyssey software, select 'Logger' from the menu bar at the top of the screen and from the drop down menu click on 'Set Calibration Data'.



2. On the right side of the 'Sensor Calibration' screen, enter the serial number of your logger, select 'Capacitive Water Level' as the sensor type and choose your preferred units. Ensure that the 'Linear Calibration' tab is selected.



3. In the '*Measured Values*' fields enter the depths marked on the sensor. In our example the first value = 200 and second = 2000, these values are in mm. (If carrying out a 'top down' calibration reverse the readings so the first value = 2000 and second = 200).
4. In the 'Sensor Readings' fields enter the corresponding raw data values obtained earlier and then click 'Save Data'. Your calibration has now been created for this logger. A calibration file is required for each logger you have.

When downloading data from your calibrated loggers the data will be automatically formatted to display in the units you selected in step 2 i.e. mm.

If you need to apply the calibration data to a previously downloaded data block you can open the data block using the 'Data Work Sheet' tab on the main window and from the menu bar select 'Site' and then ReCalibrate Data Block

Capacitance Probe Calibration Calculation.

This is not required to calibrate your logger and only serves as reference.

The formula used in the computer program to generate calibrated data is: -
Where: -

$$RES = \frac{DATA - OFF}{SL} + RL$$

RES	=	Resultant calibrated water level value
SL	=	Slope of sensor
OFF	=	Offset value for sensor
RL	=	Relative value from bore collar to sensor position
DATA	=	The un-calibrated value read by the probe

If the sensor values are as follows,

- Sensor bottom position 200mm recorder reading 1712
- Sensor top position 2000mm recorder reading 4342

The resulting calibration data is: -

$$\text{Slope} = \frac{4342 - 1712}{2000 - 200} = 1.461$$

$$\text{Offset} = 1712 - (200 \times 1.461) = 1419$$

Sensor Top position		200mm down from 'O' ring reading 4371
Sensor Bottom position		2000mm down from 'O' ring reading 1714
Slope	=	-1.476
Offset	=	4666

The relative value if it is to be used must be measured from the bore collar to the top reference point on the probe.

For example: The relative value measurement from the bore collar to the top of the sensor is 10 metres. The raw data value is 2345.

When solved in the above equation the sensor measurement is:
 $(2345 - 4666) / -1.476 = 1572\text{mm}$

The calibrated water level = $1572 + 10000 = 11572\text{ mm}$.
This is the depth of the water from the ground surface or bore collar.

Errors.

The Odyssey water level probe is a linear measuring system, however errors can still occur.

Reading Higher Than Actual on Falling Water Level.

Sediments or suspended solids are forming a coating on the Teflon sensor. This deposit will hold a film of water and cause a slight elevation of the reading. This type of error will only be a problem when the rate of movement of the water is high. For slow movement in the water level the sediment will dry before it can cause a significant error in the reading.

Frequent probe cleaning is the best method to reduce this type of error. It will only be a problem in water that is very heavily laden with silt and has a fast rate of decline. Pressure differentials can be created in a stilling well by incorrect positioning of a stilling well in flowing water. This may cause elevation or depression of the reading depending on the positioning of the water inlet holes in the stilling well. Try to position the water inlet holes so that the stream flow has minimal effect on the water level inside the stilling well. A bottom vented stilling well will generally overcome this problem. A copper water inlet tube will help to lessen the problems of algae deposits in the stilling well (Copper is algacidal).

Reading Lower Than Actual on Rising Water Level.

This type of error may be caused by deposits on the Teflon that are non-wetting. The result of this will be an apparent increase in the Teflon wall thickness. The Teflon element should be cleaned to discourage this type of deposit from forming.

A second cause of this error is the release of dissolved gases from the water. This will only be a problem on waters that are highly aerated. This causes the formation of tiny bubbles on the Teflon and will cause an apparent depression of the reading. If this is suspected a sample of water should be taken and left to stand for 24 hours to see if gas bubbles form on the container wall. A double stilling well may reduce the problem by reducing the water exchange rate and thus dissolved gas in the stilling well.

PVC SHROUD



A 37.5mm (inside diameter) PVC pipe can be used as a stilling well as the logger housing is sized to catch in the top of the pipe. It should have 6mm holes drilled every 20cm over the entire length of the piece of pipe. This allows water to freely enter the well and helps to ensure that the water level measurements are linear over the entire length of the sensor element.

Memory Storage Capacity.

Normal Mode.

Single channel recorders. These store 2 bytes per reading.

The amount of memory is capable of recording 32764 records. The time span in days can be calculated by dividing 32764 by the number of logs per day.

Example. A scan time of 30 minutes has 48 recordings each day. The total number of days is [†]682 days. A scan of 10 minutes has 144 recordings each day. The total number of days is 227 days.

When the memory is full the recorder shuts down.

Compressed Mode.

*This logging method is most suitable for slow moving groundwater and above groundwater run-off from rain. Each water level change uses 4 bytes of memory. At midnight of each day an end of day flag is entered and also the actual water level this uses 4 bytes. The number of days that the memory will record is dependent on the variations of the water level being measured. If the water level is changing very frequently, it would be better to use linear logging.

[†]**Note:** *When using a long scan time or compressed mode it is possible for the battery to expire before the memory becomes full.*