Ystumtec Ltd.

ST5: 5 Point Soil Temperature Probe user guide (V1.1)

Pant y chwarel, Ystumtuen, Ceredigion, SY23 3AF, UK

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1 Overview

This simple to use temperature probe contains 5 separate sensors at 5 depths: 5cm, 15cm, 25cm, 35cm and 45cm. It is completely sealed and can be completely buried if required (although you should mark precisely where you buried it to avoid losing it!). Data is stored on a uSD card in a CSV format. The card can be popped out of the unit and the data can then be imported into a spreadsheet or other application as required. The sampling rate is set to once per 30 minutes by default, but can be changed by editing a plain text file on the uSD card. The highest rate that can be achieved is

around once every 8 seconds. At the standard 30 minute sampling period a battery life of around 1 year can be expected, at 15 minute sampling rate around 6 months etc. It should be noted that the low cost nature of this device means that the sampling periods will not be precise and may drift somewhat with variations in temperature, although variations of more than 2% are unusual under normal conditions.

In order to use the logger the following steps are required:

1. Prepare a uSD card by writing the plain text files *DELAY.TXT* and *SAMPLES.TXT* as described in the sections below to the card (or insert the card provided). Any text editor such as Windows *notepad.exe* or Linux *Vim* can be used to do this.

2. Remove the end cap from the sensor by withdrawing the plastic spring clip, compressing the locking ring and pulling the end cap off the tube. The locking ring must be fully compressed to allow the end cap to be withdrawn. Withdrawing the cap will result in some scratching of the body tube: this is normal.

3. Insert the uSD card into the uSD slot which can be seen in the end of the probe circuit board with the shiny gold contacts facing the circuit board. The card must be fully pressed in to the holder and will lock in place when correctly inserted. The card can be removed by pressing the card a second time after which it will pop out. Insertion and removal are more easily achieved by using a pair of tweezers.

4. Move the power switch which is mounted on the end of the board to the "ON" position, which is when the slider is closer to the edge of the board. When the probe is powered on an LED will flash twice inside the tube.

5. The probe will then begin logging data at the rate specified in the *DELAY.TXT* configuration file.

6. Replace the end cap: push the end cap firmly down onto the tube until the rubber "O-ring" is felt to slide onto the tube. Check that the cap is properly seated and then push the removable plastic clip back over the locking ring to retain it.

7. Insert the probe into the location to be monitored. When insering the probe be sure not to damage it: unless the material to be monitored is very soft you should make a hole first using a digging-bar, auger, corer or other similar tool.

We recommend experimenting with the probe uisng a relatively short delay between readings and checking that you understand how the probe works and are obtaining data correctly before prolonged deployment. To check that recording is working as expected, remove the end cap, turn off the probe using the switch, push the uSD card down to pop it out and then withdraw it using tweezers. Insert the uSD card into a reader device and examine the contents of *LOG.TXT*. The file should contain one line of data per reading with 5 temperatures (5cm depth first and 45cm depth last) and the number of seconds since recording began at the end of each line.

2   Physical Considerations

The design has been tested over the range -20°C to 60°C and functioned correctly throughout, although all components used are rated to -40°C or lower, so it can be expected to operate below -20°C. If the logger is intended for use at very low temperatures (less than -20°C) then care should be taken to ensure that the uSD card used is able to operate under such conditions. Under very low temperature conditions the battery life will be significantly reduced and the sensor housing strength will be significantly reduced and care should be taken to avoid exposure to mechanical impact and other loads. Always ensure that the end cap has been fully pressed on to the probe body before deployment. In the event of water ingress the probe should be switched off immediately and inverted with the end cap removed to drain as much water as possible from inside the casing and then placed in a warm (30°C) dry place for 48 hours to allow any remaining moisture to escape from inside the sensor.
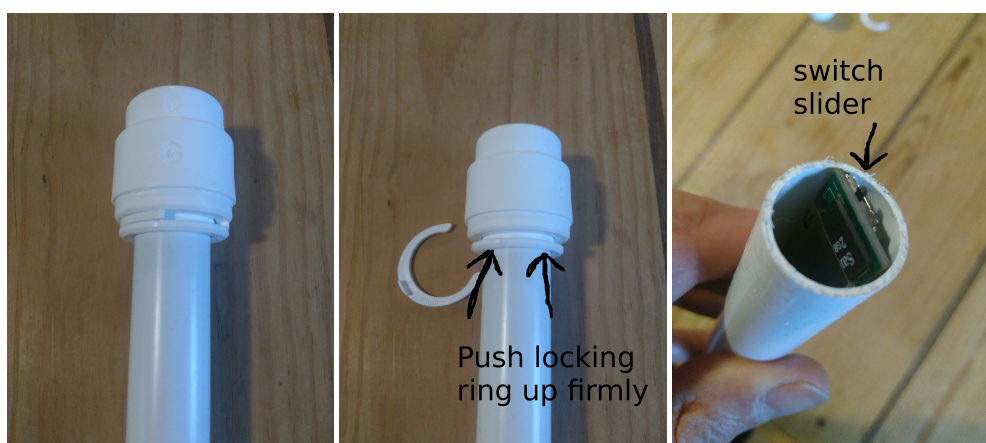

Figure 1: Removing the plastic clip and the cap

3   File formats and examples

When working correctly the uSD card should contain 3 files in the root folder. Any other files and folders will be ignored. These three files are:

DELAY.TXT which should contain a single number on the first line which specifies the number of seconds to wait between readings. The probe has a time resolution of 8 seconds, so numbers of seconds that are not divisible by 8 will rounded down to the nearest multiple of 8. So, for example, delays of 8, 32, 1200 and 3600 seconds will result in 8s, 32s, 20m and 1h delays respectively; but delays of 15, 60 and 2700 seconds will result in delays of 8s, 56s and 44m 56s respectively. The following file will result in readings being made every half hour:

```
1800
```

SAMPLES.TXT which should also contain a single number on the first line whch in this case specifies the number of readings to be averaged over during each temperature reading. The default value is 1 which means that a single reading is made and saved directly to the log file. Any larger value results in the specified number of measurements being made and the mean calculated and saved to the uSD card. Making temperature readings takes 500ms, and thus increasing the number of samples will affect the timing of readings slightly as well as decreasing the battery life of the probe. The largest value permitted is 100 and the smallest value permitted is 1. The follwing file will reault in averaging over 5 samples:

```
5
```

LOG.TXT which will contain the readigs that have been made by the probe. Each line contains the temperature readings from one sensing event (averaged according to the specified sampling value contained in *SMAPLES.TXT*). The values on each line are ordered as: *temp. at 5cm, temp. at 15cm, temp. at 25cm, temp. at 35cm, temp. at 45cm, seconds since start*. Each time that the probe is powered off the seconds timer will reset, and logging will continue to the *LOG.TXT* file. Example file containing data from a probe using a 3600 second (one hour) delay that has been powered off and back on after 3 hours:

```
19.24, 19.72, 20.13, 21.37, 22.58, 0
19.14, 19.69, 19.98, 21.17, 22.88, 3600
19.19, 19.78, 20.05, 21.24, 23.18, 7200
19.10, 19.62, 20.18, 21.10, 22.98, 10800
18.01, 17.91, 17.65, 17.28, 18.15, 0
18.34, 18.12, 17.93, 17.58, 18.27, 3600
```