

<b>MARINE SCOTLAND - SCIENCE</b>  <b>LABORATORY MANUAL</b>	<b>SOPFL 1020</b>	<b>Page 1 of 12</b>
	<b>Issue No</b>	<b>4.00</b>
<b>Internal Calibration of Field Loggers and Database Site/Single Sensor Setup</b>	<b>Issued By</b>	
	<b>Date of this Issue:</b>	<b>03/12/2019</b>

## 1 Introduction and scope

This procedure covers the site/sensor setup in the FLEObs database for single sensor dataloggers, the analytical procedure and methodology for calibration of field dataloggers.

## 2 Principle of the method

All new loggers and those which have been returned from deployment in the field are calibrated against two reference loggers which have been calibrated by UKAS accredited lab 0601 (ETI Ltd.), see [SOPFL 1010](#). This process ensures consistent cross calibration across all loggers and identifies any differences in logger bias and performance prior to and subsequent to deployment. The loggers are cross calibrated over the temperature range 0-30°C in a circulating water bath. Ice is added and the water left to rise to the temperature of the room. The temperature can then be increased beyond 30°C using the water bath heater and allowed to cool back to room temperature. Any difference in the field dataloggers is then quantified through the relationship with the reference logger.

A calibration equation and a second equation describing uncertainty can then be generated to traceable recognised national standards.

## 3 Reference materials

Externally calibrated “Reference Loggers”

Reference logger 2: Tinytag Aquatic 2 Serial number 733784

Reference logger 3: Tinytag Aquatic 2 Serial number 865626

## 4 Reagents

N/A

<b>MARINE SCOTLAND - SCIENCE</b>  <b>LABORATORY MANUAL</b>	<b>SOPFL 1020</b>	<b>Page 2 of 12</b>
	<b>Issue No</b>	<b>4.00</b>
<b>Internal Calibration of Field Loggers and Database Site/Single Sensor Setup</b>	<b>Issued By</b>	
	<b>Date of this Issue:</b>	<b>03/12/2019</b>

**5 Equipment**

- Water bath EN1983
- Water bath EN2111
- Computer with access to FLEObs database with Tinytag Explorer software version 4.8 or higher installed
- Tinytag Aquatic 2 TG-4100 dataloggers
- Inductive download pad ACS 3030
- Tinytag Aquatic 2 TG-4100 Reference dataloggers
- Tinytag serial cable CAB-0007
- Thermometer T267
- CR2450N, 3 volt button cell battery
- Tinytag Aquatic 2 seal (1320.1017)
- SGM 494 silicone grease (or similar)
- Vice
- Screwdriver (capable of passing through the hole on top of the logger)

**6 Environmental control**

The analyses are carried out in a climate controlled laboratory. Room temperature is set at 20°C, variation is as per the manufacturers specification.

**7 Interferences**

N/A

**8 Sampling and sample preparation**

N/A

<b>MARINE SCOTLAND - SCIENCE</b>  <b>LABORATORY MANUAL</b>	<b>SOPFL 1020</b>	<b>Page 3 of 12</b>
	<b>Issue No</b>	<b>4.00</b>
<b>Internal Calibration of Field Loggers and Database Site/Single Sensor Setup</b>	<b>Issued By</b>	
	<b>Date of this Issue:</b>	<b>03/12/2019</b>

## 9 Analytical procedure

### Setting up new logger/sensor configuration in FLEObs

Summary:

1. Add logger (section 9.1)
2. Add sensor (section 9.2)
3. Add sensor logger configuration (section 9.3)
4. Add location (9.4)
5. Add site (9.5)
6. Adding a Location and Site to a Logger/Sensor Configuration. (9.6)
7. Change sensor configuration to the correct medium type (9.7)

### 9.1 Logger

- 9.1.1 **Pre-requisites:** Ensure the **Logger Make** (i.e. Gemini Data Loggers) and **Logger Model** (i.e. TG-4100) have already been added to FLEObs. In the side menu panel, click on the **plus** next to **Look up lists**, click on **logger make** and **logger model**.
- 9.1.2 Check if the Logger (serial number) already exists within the current list
- 9.1.3 In the side menu panel, click on the plus next to **Lookup list**
- 9.1.4 Click on **Loggers**
- 9.1.5 **Order** the Serial No. by clicking once on the header labelled "Serial No."
- 9.1.6 Scroll down and check to see if this serial number has already been set-up
- 9.1.7 If not, then you will need to add a new logger serial number
- 9.1.8 **Right-click** anywhere in the **data panel**
- 9.1.9 Choose **Insert** if adding a new **logger serial number**
- 9.1.10 Click on the **drop-down list** next to the **Logger Make** and select the Logger Make
- 9.1.11 Click on the **drop-down list** next to the **Logger Model** and select the Logger Model
- 9.1.12 Enter the **Serial No.** of the Logger

<b>MARINE SCOTLAND - SCIENCE</b>  <b>LABORATORY MANUAL</b>	<b>SOPFL 1020</b>	<b>Page 4 of 12</b>
	<b>Issue No</b>	<b>4.00</b>
<b>Internal Calibration of Field Loggers and Database Site/Single Sensor Setup</b>	<b>Issued By</b>	
	<b>Date of this Issue:</b>	<b>03/12/2019</b>

- 9.1.13 Click on the **drop-down list** next to the **Logger Type** and select the Logger Type (Physical Logger for Tinytags)
- 9.1.14 Click on the **drop-down list** next to the **Storage Type** and select the storage Type (No. of Readings for Tinytags)
- 9.1.15 Enter the **No. of Days Remaining Warning** as 21 (when the number of days until the logger is full is less or equal to this number, that logger configuration line will become **yellow**. This will become **red** when the logger is full). You will also receive an email telling you which logger is nearing its full date.
- 9.1.16 Click on the **drop-down list** next to the **Fixed Sensors** and select **Yes** if the logger is a fixed logger or select **No** if the logger is not a fixed logger (for Tinytags, the logger is always fixed, since it cannot change its logger/sensor configuration)
- 9.1.17 Enter any **Description** associated with the logger
- 9.1.18 Click **OK**

## 9.2 Sensor

- 9.2.1 **Pre-requisites:** Ensure the **units of measurement** (°C), **sensor type** (Temperature), **sensor make** (i.e. Gemini Data Loggers), and **sensor model** (TG- 4100) have already been added. In the side menu panel, click on the **plus** next to **Look up lists**, click on **units of measurement**, **sensor make** and **sensor model**.
- 9.2.2 Check if the Sensor (serial number) already exists within the current list
- 9.2.3 In the side menu panel, click on the plus next to **Lookup list**
- 9.2.4 Click on **Sensors**
- 9.2.5 **Order** the Serial No. by clicking once on the header labelled "Serial No."
- 9.2.6 Scroll down and check to see if this serial number has already been set-up
- 9.2.7 If not, then you will need to add a new sensor serial number
- 9.2.8 **Right-click** anywhere in the **data panel**
- 9.2.9 Choose **Insert** if adding a new **Sensor serial number**

<b>MARINE SCOTLAND - SCIENCE</b>  <b>LABORATORY MANUAL</b>	<b>SOPFL 1020</b>	<b>Page 5 of 12</b>
	<b>Issue No</b>	<b>4.00</b>
<b>Internal Calibration of Field Loggers and Database Site/Single Sensor Setup</b>	<b>Issued By</b>	
	<b>Date of this Issue:</b>	<b>03/12/2019</b>

- 9.2.10 Click on the **drop-down list** next to the **Sensor Make** and select the Sensor Make (e.g. Gemini Datalogger)
- 9.2.11 Click on the **drop-down list** next to the **Sensor Model** and select the Sensor Model (e.g. TG-4100)
- 9.2.12 Enter the **Sensor Serial No.** of the Sensor (for Tinytags this is the same as for the Logger Serial No.)
- 9.2.13 Click on the **drop-down list** next to the **Fixed** and select **Yes** if the sensor is a fixed sensor or select **No** if the sensor is not a fixed sensor
- 9.2.14 Click on the **drop-down list** next to the **Sensor Type** and select the Sensor Type (i.e. Temperature)
- 9.2.15 Click on the **drop-down list** next to the **Unit of Measurement** and select the Unit of Measurement (i.e. °C)
- 9.2.16 Enter any **Description** associated with the sensor
- 9.2.17 Click **OK**

You now have all the pre-requisites to set up the logger / sensor configuration. This is where you match up the Logger serial number with the same Sensor serial number.

### 9.3 Logger / sensor configuration

- 9.3.1 Check if the **logger Configs** already exists within the current list
- 9.3.2 In the side menu panel, click on **“Logger Configs”**
- 9.3.3 Within the **panel labelled “Filter”**, click on **Search** (all the Logger/Sensor configurations that have already been set-up are displayed)
- 9.3.4 **Order** the Serial No. by clicking once on the header labelled **“Serial No.”**
- 9.3.5 Scroll down and check to see if this serial number has already been set-up.
- 9.3.6 If not, then you will need to add a new Logger/Sensor configuration

<b>MARINE SCOTLAND - SCIENCE</b>  <b>LABORATORY MANUAL</b>	<b>SOPFL 1020</b>	<b>Page 6 of 12</b>
	<b>Issue No</b>	<b>4.00</b>
<b>Internal Calibration of Field Loggers and Database Site/Single Sensor Setup</b>	<b>Issued By</b>	
	<b>Date of this Issue:</b>	<b>03/12/2019</b>

- 9.3.7 **Right-click** anywhere in the **data panel**
- 9.3.8 Choose **Insert** if adding a new **Logger Configs**
- 9.3.9 Enter the **Valid From date** and **time** in the format **dd/mm/yyyy hh:mm:ss** (this is the date you are joining the logger/sensor together)
- 9.3.10 Enter the **Memory Capacity** (the memory capacity depends on Tinytag type: e.g. Aquatic 2 = 32000),
- 9.3.11 Enter the **Memory Offset** (for Tinytags this is always 0),
- 9.3.12 Enter the **Current Recording Frequency** (this is measured in seconds, therefore if the recording frequency was every 15 minutes, then the current recording would be 15 x 60 = 900)
- 9.3.13 Click **select logger** and choose the correct serial number
- 9.3.14 Click the **Sensor Configurations** tab and click **Add New Sensor Configs**
- 9.3.15 In the highlighted first column click **Select sensor** and choose the correct serial number
- 9.3.16 Click **OK**
- 9.3.17 Select **Medium** type for deployment environment, leave blank as unassigned
- 9.3.18 Enter a "1" in **Memory required** (this is always 1 for Tinytags)
- 9.3.19 Click in the **Instantaneous box**, a tick will appear (it is always instantaneous for Tinytags)
- 9.3.20 Go back to the logger tab and make sure the current site and location is left as unassigned
- 9.3.21 Click **OK** – you have now joined the sensor to the logger, to an unassigned site

## 9.4 Location

- 9.4.1 Check if the location already exists within the current list

<b>MARINE SCOTLAND - SCIENCE</b>  <b>LABORATORY MANUAL</b>	<b>SOPFL 1020</b>	<b>Page 7 of 12</b>
	<b>Issue No</b>	<b>4.00</b>
<b>Internal Calibration of Field Loggers and Database Site/Single Sensor Setup</b>	<b>Issued By</b>	
	<b>Date of this Issue:</b>	<b>03/12/2019</b>

9.4.2 In the side menu panel, click on the **plus** next to **Lookup List**

9.4.3 Click on **Locations / Sites**

9.4.4 If not, then you will need to add a location

9.4.5 **Right-click** anywhere in the **data panel**

9.4.6 Choose **Insert** if adding a new location

9.4.7 Enter the **Location name**, **Location code**, and any **Description** associated with that location

9.4.8 Click **OK**

## 9.5 Site

9.5.1 **Pre-requisites:** Ensure the location has already been added

9.5.2 Check if the site already exists within the current list

9.5.3 In the side menu panel, click on the plus next to **Lookup List**

9.5.4 Click on **Sites**

9.5.5 If not, then you will need to add a new site

9.5.6 **Right-click** anywhere in the **data panel**

9.5.7 Choose **Insert** if adding a new site

9.5.8 Enter the **Site name**

9.5.9 Click on the **drop-down list** next to the **Location Name** and select the **location** which is associated with that site

9.5.10 Enter the **Site code**, **Easting**, **Northing**, **Latitude**, **Longitude**. At this stage check that the site does not already exist and that the site plots to a water course using ARC GIS or Google Maps

9.5.11 Click **OK**

<b>MARINE SCOTLAND - SCIENCE</b>  <b>LABORATORY MANUAL</b>	<b>SOPFL 1020</b>	<b>Page 8 of 12</b>
	<b>Issue No</b>	<b>4.00</b>
<b>Internal Calibration of Field Loggers and Database Site/Single Sensor Setup</b>	<b>Issued By</b>	
	<b>Date of this Issue:</b>	<b>03/12/2019</b>

## 9.6 Adding a Location and Site to a Logger/Sensor configuration

9.6.1 When you know where the logger/sensor is to be located and what the medium type is:

9.6.2 In the side menu panel, click on **Logger Configs**

9.6.3 Within the **panel labelled “Filter”**, click on **Search** (all the Logger/Sensor configurations that have already been set-up are displayed)

9.6.4 **Order** the Serial No. by clicking once on the header labelled “Serial No.”

9.6.5 Find the serial number to be changed/configured, right click on it and select **Edit**

9.6.6 Change the **Valid From** date to the date when it is located at a site

9.6.7 Change the current recording frequency if required

9.6.8 Change the **Current Location** and **Current Site** to the correct ones (you should already have these set up in the site/location information)

9.6.9 Click on the **drop-down list** next to **Current Location** and select the **Current Location**

9.6.10 Click on the **drop-down list** next to **Current Site** and select the **Current Site**

9.6.11 When all the details have been changed click – OK

9.6.12 A box will appear asking whether you want to add a new logger configuration – click **YES**

9.6.13 The previous configuration is now unassigned and the current configuration is the site you selected.

## 9.7 Change the Sensor Configuration to the correct medium

9.7.1 In the side menu panel, click on **Sensor Configs**

9.7.2 Within the **panel labelled “Filter”**, click on **Search** (all the Logger/Sensor configurations that have already been set-up are displayed)



<b>MARINE SCOTLAND - SCIENCE</b>  <b>LABORATORY MANUAL</b>	<b>SOPFL 1020</b>	<b>Page 9 of 12</b>
	<b>Issue No</b>	<b>4.00</b>
<b>Internal Calibration of Field Loggers and Database Site/Single Sensor Setup</b>	<b>Issued By</b>	
	<b>Date of this Issue:</b>	<b>03/12/2019</b>

- 9.7.3 **Order** the Serial No. by clicking once on the header labelled “Serial No.”
- 9.7.4 Right-click on the correct serial number and select **Edit**
- 9.7.5 You can now change the **Current Medium** type (e.g. to surface water). The date when the logger/sensor was added to the site should be displayed as this is the most current configuration (the one that was just set up)
- 9.7.6 Click **OK** – you now have a sensor/logger/site configuration
- 9.7.7 You can check this by going; Logger Configs, right clicking the serial number of interest and clicking View. In logger configuration you should see the date and time the logger was deployed, reading frequency and the site location. In sensor configurations you should see your current configuration in the correct medium (e.g. surface water). In previous configurations you should see the first configuration with no site or medium assigned.

## 9.9 Setting up the calibration experiment in the laboratory

### 9.9.1 Logger Preparation

New loggers are ready for calibration as at 9.9.2. Field loggers returned for recalibration or because of an error should be disinfected and have the batteries and seals changed within 3 years (as per 9.9.1.1-9.9.1.2) and then be re-calibrated as per 9.9.2.

#### 9.9.1.1 Disinfection

All Loggers returned to the laboratory should be either sprayed or dipped in a solution of 1% Virkon Aquatic and left to air dry. The logger serial numbers in each treatment must be recorded against the Virkon batch number and the date of treatment.

#### 9.9.12 Battery replacement procedure

Open the logger housing by fixing the base in a vice then using a screwdriver through the hole in the top of the logger housing twist anticlockwise until the housing separates. Remove the battery and leave the unit overnight to discharge. This allows any error messages to

<b>MARINE SCOTLAND - SCIENCE</b>  <b>LABORATORY MANUAL</b>	<b>SOPFL 1020</b>	<b>Page 10 of 12</b>
	<b>Issue No</b>	<b>4.00</b>
<b>Internal Calibration of Field Loggers and Database Site/Single Sensor Setup</b>	<b>Issued By</b>	
	<b>Date of this Issue:</b>	<b>03/12/2019</b>

clear before inserting a new battery.

Insert a new battery and replace the seal using silicone grease to lubricate the whole seal as an additional waterproofing measure. If the logger was previously showing an error message check that the logger will connect to a laptop and that the error message has been cleared before proceeding to 9.9.2. Any logger with a persistent error message should be removed for further investigation or returned to Gemini dataloggers.

### 9.9.2 Logger setup

Programme the reference loggers, using the Tinytag software set the absolute start time to 1.5 hours after the loggers are placed in the water to allow the loggers to reach equilibrium prior to recording. Any problematic data (noisy between-logger signals) at the start and end of the experiment can be excluded when running the R code during the calibration process. Set the measurement interval to 1 minute or as long as required to allow the logger to run for the duration of the experiment. Programme the field loggers to start at the same time as the reference loggers and with the same measurement interval or at an interval which is divisible by the calibration logger sampling frequency. The make of the logger should be entered into the description field and should match the make as registered in FLEObs, this is including the correct spaces and capitalisation. For instruction on the use of Tinytag software see [SOPFL 1030](#).

### 9.10 Calibration procedure

- 9.10.1 Place the loggers on the fixings in an empty water bath in Lab 4. The reference loggers are ideally placed in the middle of the bath and in the centre of the water column. Loggers should be arranged to allow free movement of water around each logger, and in a manner which will securely maintain their position in the water column, keeping them submerged for the duration of the calibration.
- 9.10.2 The aim is to reach a temperature of 0°C at the time when the loggers are programmed to start, with little remaining ice in the water bath, as this can interfere with the uniformity of the water temperature.
- 9.10.3 Add water from the cold tap to the water bath until the water reaches around 2/3rds of the final water depth. Once it is submerged, switch on the stirrer to maintain circulation in the bath.
- 9.10.4 Collect ice from the Scotsman ice machine in room 56, and add slowly to the water in the

<b>MARINE SCOTLAND - SCIENCE</b>  <b>LABORATORY MANUAL</b>	<b>SOPFL 1020</b>	<b>Page 11 of 12</b>
	<b>Issue No</b>	<b>4.00</b>
<b>Internal Calibration of Field Loggers and Database Site/Single Sensor Setup</b>	<b>Issued By</b>	
	<b>Date of this Issue:</b>	<b>03/12/2019</b>

water bath and mix well, this avoids the ice clumping together. An ice box is available in lab 4 to transport the ice.

- 9.10.5 Check the water temperature, using thermometer T267 in EN1983 or the digital display on EN2111 which is mounted in the water bath (note that the thermometer should be totally immersed) and add more ice or water incrementally depending on the temperature to maintain 0°C.
- 9.10.6 Once this has been attained, place the lid on the water bath and leave it to slowly come to room temperature. The water bath is well insulated and this process can take a couple of days.
- 9.10.7 Once the water bath is at room temperature, switch on the water bath heater and set to above 30°C. Check the water temperature, using thermometer T267 in EN1983 or the digital display on EN2111 and once the temperature has exceeded 30°C switch off the heater and leave the water bath to equilibrate back to room temperature, usually for a couple of days. **Avoid** running calibration procedures over a protracted period as this produces a large amount of unnecessary data that has to be removed prior to obtaining calibration coefficients for the logger.

## 9.11 Download and data storage

9.11.1 Create a new folder in:



where [ddmmyy] is the start date of the calibration.

- 9.11.2 Once the water bath has returned to room temperature, remove all the loggers from the water bath and dry. Download them using the Tinytag software on a networked laptop.
- 9.11.3 Save all the calibration data from the individual loggers in the folder created, with the file for each logger named as the logger “[serial number]\_[ddmmyy]”. The data from the calibration loggers should be named as “[serial number]\_[ddmmyy]\_cal (2 or 3)”.
- 9.11.4 Once all the loggers are downloaded, highlight all the datalogger files from the experiment and open them all together. Next, click on “view” and then “create new overlay”, “select all files” and then “move”. Inspect the data. If there are obvious marked differences associated with a particular logger, put the logger aside for further investigation and inform the Principal investigator or the Investigator. In the case of Tinytag data this can be performed readily using

<b>MARINE SCOTLAND - SCIENCE LABORATORY MANUAL</b>	<b>SOPFL 1020</b>	<b>Page 12 of 12</b>
	<b>Issue No</b>	<b>4.00</b>
<b>Internal Calibration of Field Loggers and Database Site/Single Sensor Setup</b>	<b>Issued By</b>	
	<b>Date of this Issue:</b>	<b>03/12/2019</b>

the Tinytag explorer software. In the case of other loggers it will be necessary to compile and plot the data manually.

9.11.5 To continue with the calculation of calibration coefficients follow [SOPFL 1025](#) from section 9.2.2.9 assuming that the preparation in sections 9.1 to 9.2.1 has already been completed.

**10 Calculation of results**

Individual logger bias will be corrected via queries to the FLEObs database.

**11 Precision and bias**

From results of calibration

**12 Reports**

Not applicable.

**13 Safety**

RA FL03 and COSHH FL04

**14 Literature references**

Not applicable.