

**CIBERTEC S.A.**

**Feeding Control System**

**SMART WAITER (v2)**

**USER MANUAL**

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## 2 INTRODUCTION

The purpose of *Smart Waiter* System is to control feeding and drinking patterns of rodents which are located in their regular living cages.

The system comprises a central control unit and one or many feeder/drinker units. Each unit has a weighting scale incorporate to continually monitor and report intake to the control unit.

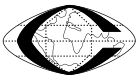
The control unit can manage a combination of up to 64 feeders/drinkers using user defined protocols which are then assigned to the units. It's possible to assign a different protocol per unit per day for maximum versatility. Each protocol is comprised by an arbitrary number of steps which control the door's opening hour and the duration and maximum intake for the feeding episode.

The units are battery powered and wireless connected to the controller. These features allow keeping the animals' environment free of wires.

The system can be completely visualized and controlled using the controller unit's touch screen, and using the Wi-Fi functionality it can also be controlled with a browser through any connected device (PC, laptop, tablet, smartphone, etc).

During an experiment a log in CSV format is created and stored in the controller's internal storage. These log files can be downloaded and visualized from a PC even while the experiment is running.

At any time the state of all the feeders/drinkers can be checked either through the controller's screen or from a connected device. This information includes errors such as connection problems, incorrect door state and warnings for low battery conditions. Furthermore automatic warning emails can be configured to be sent when errors or warnings appear in the system.



### 3 SYSTEM DESCRIPTION

#### 3.1 Controller

The controller unit is an ABS cage with 7" touchscreen (800 x 480 pixels), soft power button and micro USB female power connector.

- a. Soft power button
- b. ABS cage
- c. 7" Touch Screen
- d. Forced ventilation grid
- e. Female micro USB connector



#### 3.2 Feeders

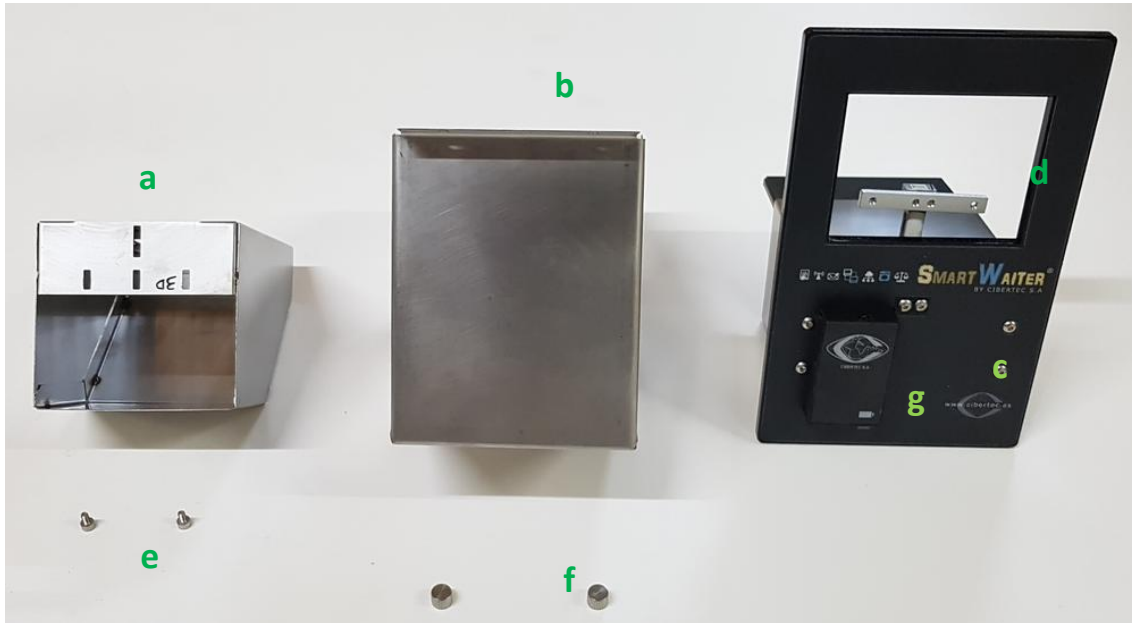
Included with each feeder you should find the following items:

- a. Feeder
- b. Battery holder
- c. Spare batteries
- d. Screws





The feeder is comprised of the following parts and it can be disassembled for cleaning procedures:

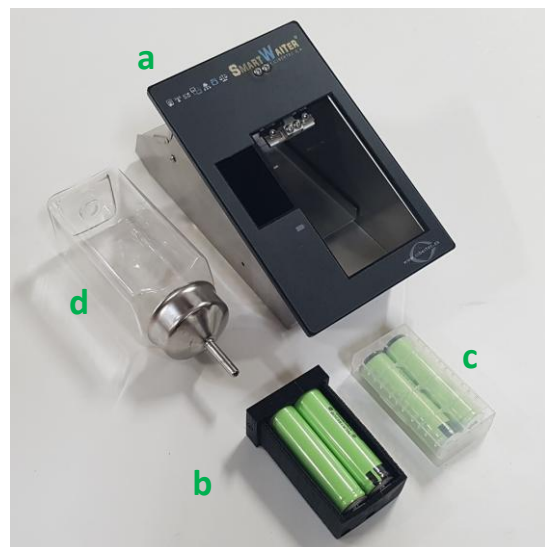


- a. Food Container
- b. Protecting shell
- c. Top cover
- d. Straining gauge
- e. Gauge screws
- f. Shell screws
- g. Battery holder

### 3.3 Drinkers

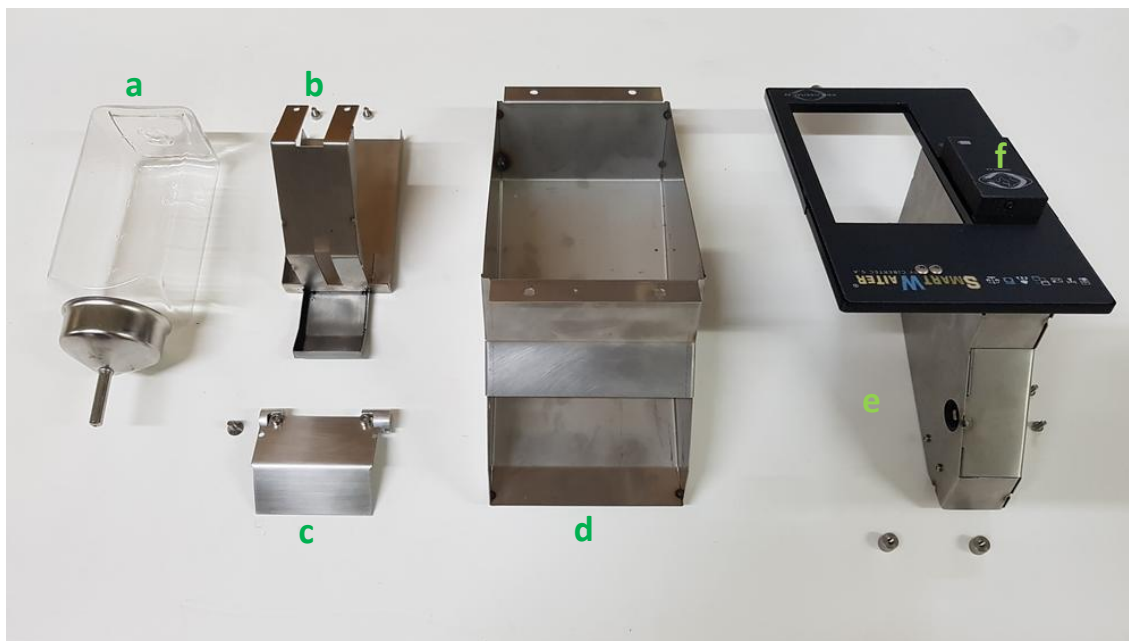
Included with each drinker you will find the following items:

- a. Drinker
- b. Battery holder
- c. Spare batteries
- d. Bottle





The drinker can be disassembled for cleaning procedures:



- a. Bottle
- c. Door
- e. Drinker

- b. Bottle container
- d. Protecting shell
- f. Battery holder





## 4 SETTING UP

To setup an *Smart Waiter* system follow the instructions in this chapter

### 4.1 Controller

- 1- Connect the controller to a 220 V socket using the power supply.
- 2- Power on the controller unit by pressing one time on the soft power button. After a few seconds controller application starts and the menu is displayed in the touch screen. To shut down the controller use the power button or the corresponding menu option. Once pressed, it's advised to wait at least 8 seconds before removing the power supply cord in order to give time to the controller for saving any open files and avoid file system damage. **IMPORTANT:** failure to comply with this procedure could cause permanent damage to the controller unit (like in regular PC).
- 3- Place the controller close to feeders/drinkers units. When operating it is recommended to have the controller unit as close as possible to the feeders in order to minimize connection problems. Although antenna specs support up to 20 meters, it is recommended to check the system in its final placement before starting experiments.

### 4.2 Feeders

- 1- The food container comes unscrewed to avoid damage during transport. To assemble it, first remove the screws shown in the picture:

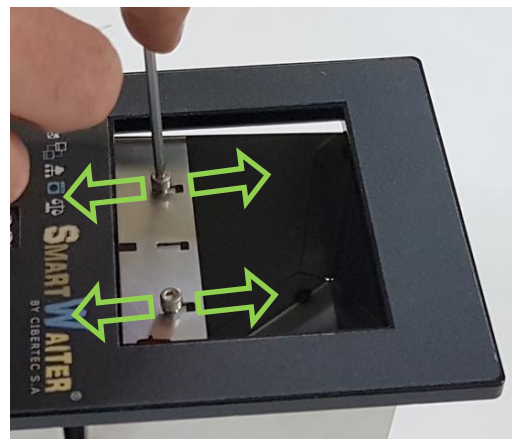




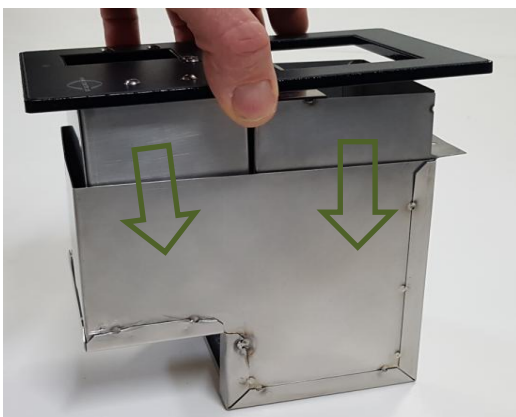
- 2- Using an Allen key loosen the front screw (don't remove it) and then holding from the top cover extract the feeder from the protecting shell. If there is a plastic bag inside the protecting shell remove it.



- 3- Now hold the Feeder as shown in the picture and align the food container with the holes making sure it doesn't touch the feeder body and tighten the screws.



- 4- Place back the feeder into the protecting shell and tighten the retaining screw to secure it in place





5- Tighten the screws under the top cover



6- Insert the batteries in the removable battery holder following the right polarity and insert battery holder into the feeder:

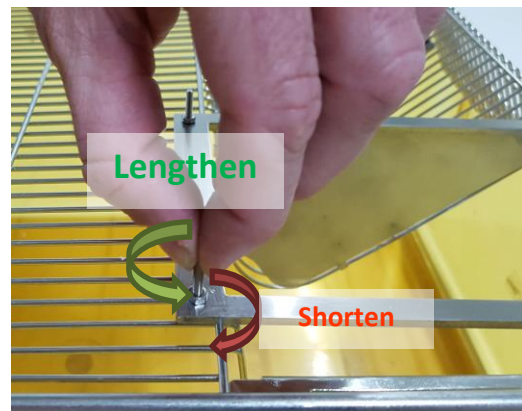
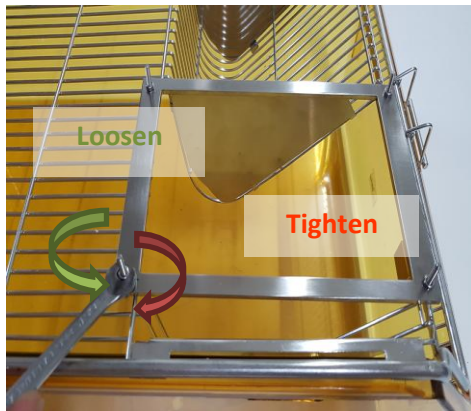


7- Place the feeder into the animal cage aligning the holes in the underside of the feeder's top plate with the screws on top of the cage :



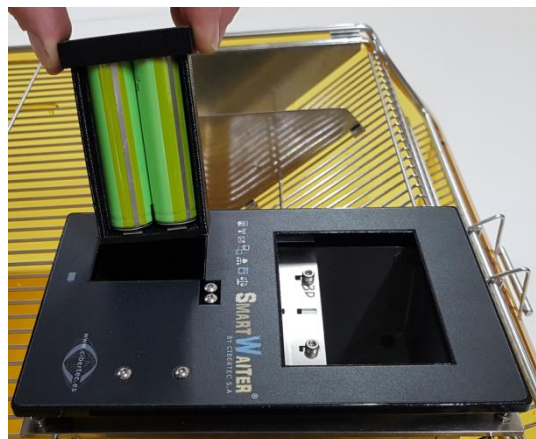


- 8- To increase weighting accuracy is important that the feeder's top plate is flat and leveled. To assist in this procedure you can adjust the height of each screw by first loosening the nut and then turning it with the hand in the required direction :



#### 4.3 Drinkers

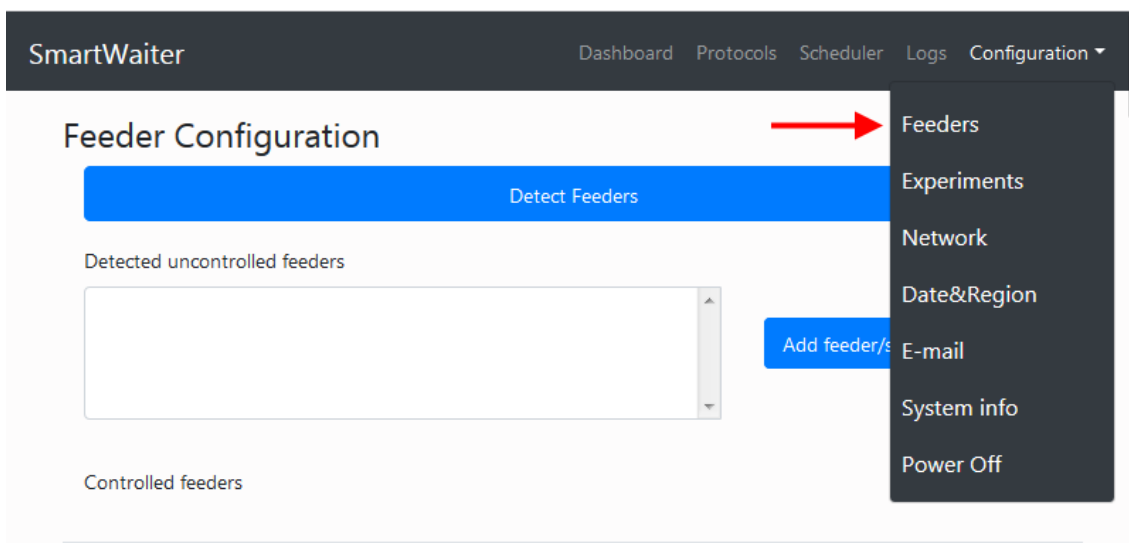
Insert the batteries into the drinker and place it near the controller unit.



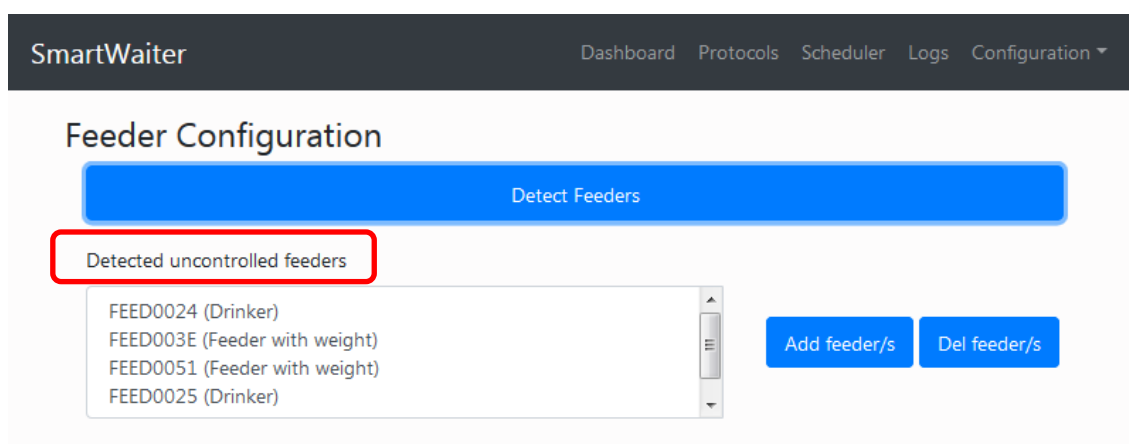


### 4.4 Pairing and configuring

1- Select **Configuration->Feeders** from the *Smart Waiter* controller menu:



2- Press **Detect Feeders** button to search for powered Feeders/drinkers in range. When detected, they will appear in the “Detected uncontrolled feeders” box. Select the feeders that are going to participate in the experiments and add them to the “Controlled feeders” list by pressing the “**Add feeder/s**” button. If “**Del feeder/s**” button is pressed instead, the selected feeders will disassociate from the controller unit. To associate them again with the controller, remove and insert back the feeder battery or just wait 1 minute before following again the procedure to detect feeders.



3- The feeders listed in Controlled feeders list can be edited (name) or forgotten (will appear again in the uncontrolled feeder list). Only the controlled feeders appear in the Dashboard screen and can participate in experiments.



SmartWaiter Dashboard Protocols Scheduler Logs Configuration ▾

## Feeder Configuration

[Detect Feeders](#)

Detected uncontrolled feeders

- FEED0024 (Drinker)
- FEED003E (Feeder with weight)
- FEED0051 (Feeder with weight)
- FEED0025 (Drinker)
- FEED003D (Feeder with weight)

[Add feeder/s](#) [Del feeder/s](#)

Controlled feeders

Name	Type		
Feeder FEED0007	Feeder with weight	<a href="#">Edit</a>	<a href="#">Forget</a>
Feeder FEED0008	Feeder with weight	<a href="#">Edit</a>	<a href="#">Forget</a>

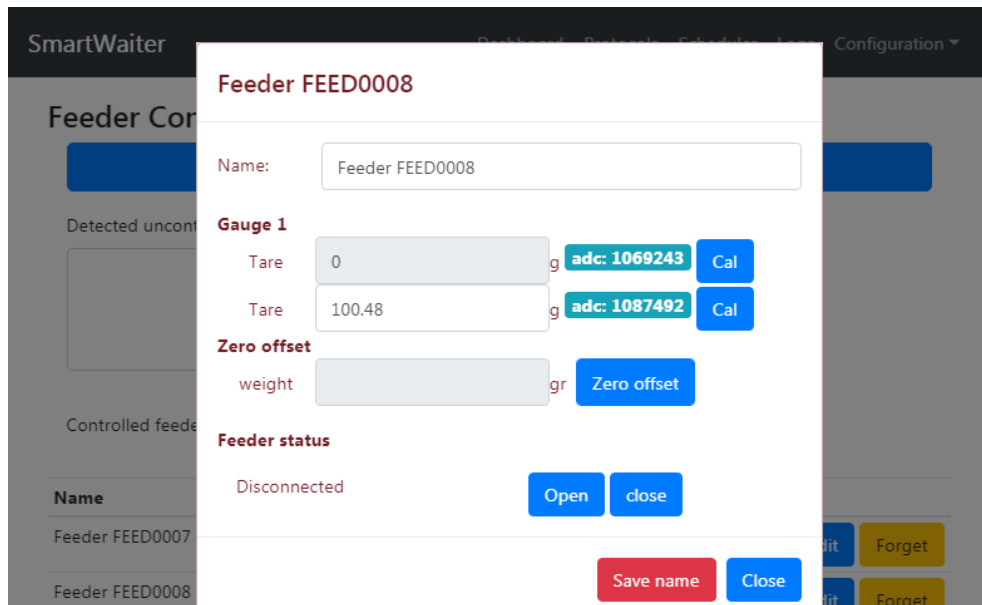
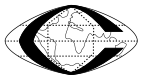
- 4- It is important to add to the “*Controlled feeders*” list only the feeders that are going to be used in the experiment, since disconnected feeders could generate unnecessary status errors and warning messages and make log files grow larger faster.

## 4.5 Calibrating

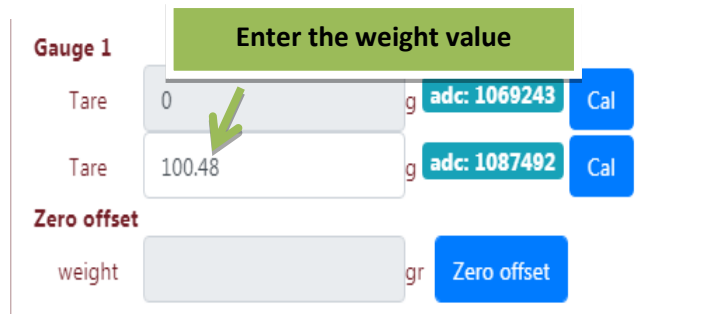
Before running the first experiment is mandatory that all the feeders and drinkers are calibrated, otherwise an error will be shown if you try to start a new experiment.

To calibrate you will need a known weight, such as the one included with the *Smart Waiter* system, and following the next procedure:

1. Empty the food container and make sure it's clean and doesn't have any particles that could alter the weight. In the Smart Waiter unit go to Configuration->Feeders, locate the feeder you want to calibrate and click the corresponding edit button.
2. Click the **Cal** button next to the Tare 0 label and wait until the feeder calibrates. This process can take up to 30 seconds. Try not to touch or move the feeder in any way because that could impede the calibration. When the calibration finishes a message will appear on the screen showing the results and if it's been successful a new *ADC* value will be shown next to the Cal button.



- Put the calibrated weight centered on top of the food container (over the gauge) as shown in the following picture, enter the weight value into the Tare text box and click the **Cal** button. Again try not to touch or move the feeder during the process. If the feeder detects too much variation in the samples it won't be able to end the process successfully and will show an error message.






The calibration should be checked from time to time to make sure the unit maintains its precision.



### 4.5.1 Advanced Calibrating

In order to calibrated several feeders at the same time select **Configuration->Calibration** from the *Smart Waiter* controller menu:

Name	cal 0	cal N
Feeder FEEDCECE	0g, adc: -1 1970/01/01 01:00:00	-1 g, adc: -1 1970/01/01 01:00:00
Undef FEED00DE	0g, adc: -- --	-- g, adc: -- --
Undef FEED0022	0g, adc: -- --	-- g, adc: -- --
Feeder FEED00D1	0g, adc: -- --	-- g, adc: -- --

1. Select feeders which have to be calibrated by pressing in the feeder list or pressing **Select all** button to select all of them.
2. Empty all the selected food containers and make sure they are clean and don't have any particles that could alter the weight.
3. Click the **Cal Og** button and wait until feeders will be calibrated. During calibration a processing icon  is shown over each feeder row and when finished, in case of success a green tag icon  will be shown or in case of fail a red exclamation icon  will be shown over each feeder row. This process can take up to 30 seconds. Try not to touch or move feeders in any way because that could impede the calibration. When the calibration finishes the ADC value and calibration date will be shown for each calibrated feeder in the list in **Cal 0** row.
4. Put calibrated weights centered on top of all feeders food container to be calibrated (over the gauge), enter the weight value into the **Tare** text box and click the **Cal** button. Again try not to touch or move the feeder during the process. If the feeder detects too much variation in the samples it won't be able to end the process successfully and will show an error message. When the calibration finishes the ADC value and calibration date will be shown for each calibrated feeder in the list in **Cal N** row.
5. Remove the calibrated weights and press **Zero** button. When the zero calibration finishes the calibration procedure has finished.

If at any step a feeder calibration fails it can be individually calibrated by selecting just the feeder to be calibrated again.





## 4.6 Zero offset

If you need to include anything into the food container and don't want it to be counted as weight you can use the zero offset button to define the current weight as 0 grams. Also if the unit doesn't mark correctly 0g when the food container is empty you can press **Zero offset** button to mark the current weight as 0 grams.

## 5 RUNNING EXPERIMENTS

To change the feeders schedule or the protocols, it's mandatory that there is no running experiment, so stop any running experiment in the Dashboard screen.

### 5.1 Create a new Protocol

- 1- Select **Protocols** in the top menu to list all the protocols in the system. Defined protocols can be edited or deleted using the **EDIT** and **DEL** buttons next to them.

SmartWaiter Dashboard Protocols Scheduler Logs Configuration ▾

### Protocols List

#	Protocol	Last modified		
0	Protocolo 1	2019-01-15 13:55:33	Edit	Del
1	Twice a day	2018-10-15 10:34:25	Edit	Del
2	Three feeds	2019-01-15 17:02:39	Edit	Del

New protocol

- 2- To create a new protocol press **New Protocol** button



- 3- When creating a new protocol, enter the name of the protocol and Press + button to add as many protocol steps as required. Steps can be deleted by pressing the – button.

#	Name	Start Time	Duration	Max. Intake	-
#1	Step 1	09:00 AM	1	0 grs	-
#2	Step 2	05:00 PM	1	0 grs	-

- 4- Insert the name of the step, the Start Time, Duration and Max. Intake. Once a step enters in execution it will continue running until any of its ending conditions, duration and max. intake is meet. **IMPORTANT:** For Smart Dose devices only Start Time parameter is relevant. The other parameters can be left to its default values.
- 5- After creating the protocol press **SAVE BUTTON** to store the protocol and make the changes permanent. If protocol page is left, any unsaved change will be lost.



## 5.2 Creating a Schedule

Once some protocols are defined, they can be assigned to feeders and programmed in the Scheduler menu. Remember that in order to change the schedule there should not be any experiment running.

- 1- Stop any running experiment by pressing the **Stop** button in the Dashboard.
- 2- Press **Schedule** option in *Smart Waiter* controller menu. Schedule will be displayed (See FIG 5.2-1).
- 3- Select the week to be scheduled. Then click over a feeder to assign it a protocol. If the “Mono” option is selected, the protocol will be used for all the feeders; if it’s unchecked a different protocol can be selected for each feeder. If the “Equal days” option is selected, the same protocol will be used for all the days of the week; if it’s unchecked a different protocol can be selected for each day of the week.
- 4- Schedule as many weeks as desired by following the previous step. The schedule of the week can be spread to following weeks by pressing the **Spread** button and selecting the week until the same schedule will be copied.
- 5- Once the schedule has been programmed press **SAVE SCHEDULE** button. Any unsaved changes will be lost If schedule page is left.

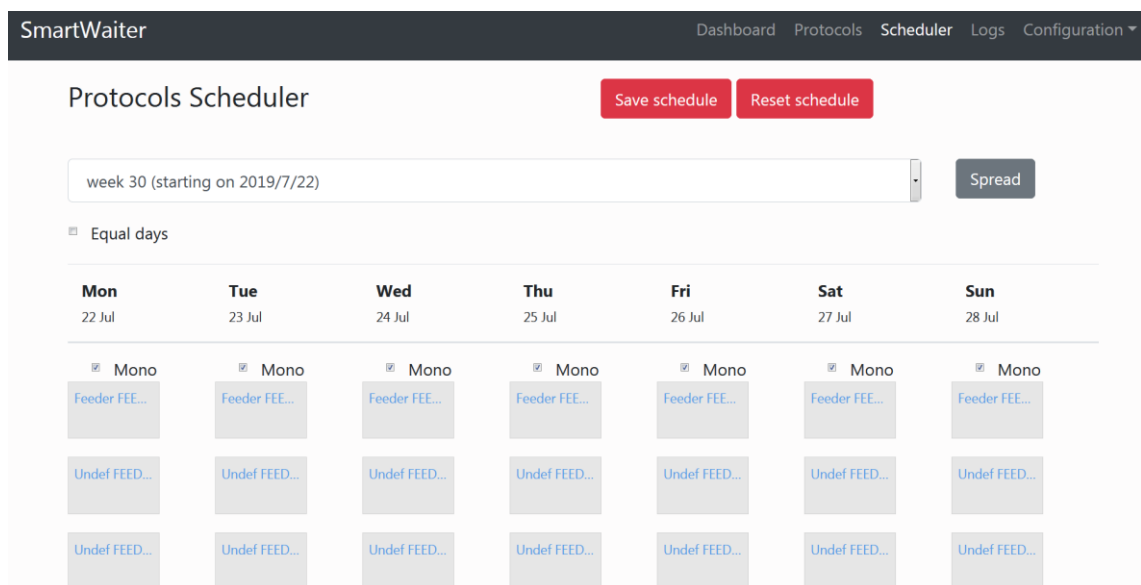


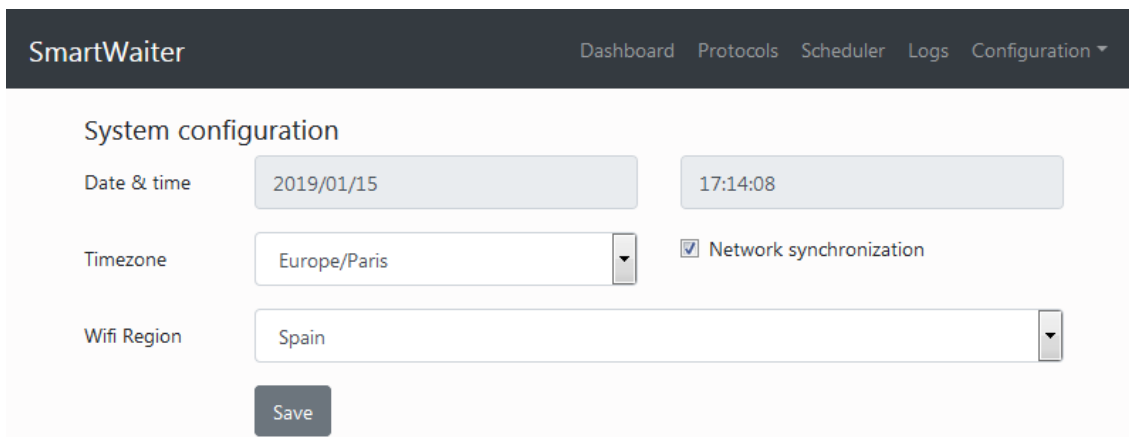
FIG 5.2-1



### 5.3 Date and Region

It's important to set the right date and time in the controller unit before running any experiments.

Press **Configuration->Date&Region** and configure date, time, time zone and Wi-Fi region. If Network Synchronization is activated and the *Smart Waiter* controller is connected to a network with Internet access, time and date will be automatically updated according to the time zone setting.



### 5.4 Running an experiment

Once everything has been correctly set up, a new experiment can be started by pressing on the “Start” button in the Dashboard menu (See FIG 5.4-1) and entering a name for it. The Dashboard shows the following information:

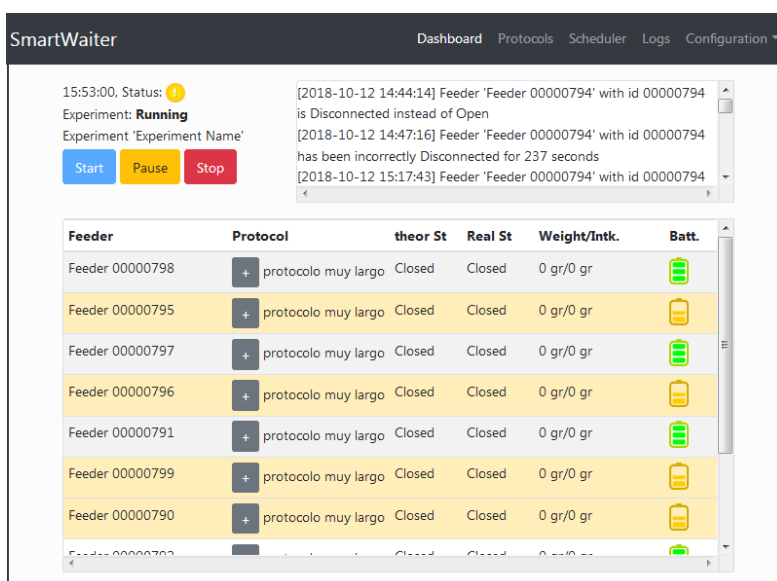








FIG 5.4-1



- 1- **Time:** Current system time is shown in the top left corner.
- 2- **Status:** The current status of the system. It could be
  - a.  (OK) if all the feeders are OK;
  - b.  (WARNING) if any of the Feeders' batteries needs replacement or
  - c.  (ERROR) if there is an error in at least one of the Feeders.
- 3- **Experiment:** Shows experiment execution state. It can be running, paused or stopped.
- 4- **Experiment Name:** shows the configured experiment name
- 5- **Play, Pause and Stop** buttons: To handle experiment execution.
- 6- **Error Log Window:** on the top right corner. Lists any errors that may have occurred during the experiment. When a protocol error happens (theoretical and real state don't match for at least 50 seconds), a first log line is written reflecting the incidence. If the anomaly is solved, a second line will be generated showing for how long the erroneous state had been held. Any feeder that has been disconnected for more than 50 seconds will be considered a protocol error.
- 7- **Feeders table:** lists all the controlled feeders (See Chapter 4.2 to add or remove feeders to the experiment). The table contains the following columns:
  - a. **Feeder name:** If a name has been given to the feeder it will be shown here. If no name has been given it will show a default one based on the feeder internal ID (see Smart Dose Feeders Set Up chapter).
  - b. **Protocol:** The protocol assigned to the feeder for today. Press the + button to expand the protocol and visualize its steps.
  - c. **Theor. St.:** Theoretical state is the state in which the feeder should be, according to the assigned protocol and current date and time. It can be *Open* or *Closed*. In Smart Dose feeder *Open* means that one portion is going to be delivered.
  - d. **Real St.:** Indicates the actual state of the feeder. For Smart Dose feeder it could be *Close* when it is in the deliver position, *Opening* when it is rotating to the next deliver position or *Disconnected*.
  - e. **Weight/Ink.:** In Smart Dose feeder this column does not have any meaning. For other *Smart Waiter* device types with weight capability it shows the current food weight and the food intake in the current step.
  - f. **Batt.:** shows battery status:  means fully charged;  means medium and  means low charge and that the battery needs to be replaced.



## 5.5 Battery replacement

Any time that a battery enters the low battery state, it's recommended to replace it. If it happens while an experiment is running, it is not required to stop it since the feeder will be automatically reconnected when a new battery is inserted again. The only consideration is to check the current protocol to avoid manipulating the feeder when a new step is due.

To change a battery, follow the following procedure:

- 1- Extract the battery holder
- 2- Remove the batteries from the battery holder using the battery extractor as shown in the image:



- 3- Insert new charged batteries into the holder and push it back again into place:



- 4- Charge the just removed batteries in the provided charger as soon as possible. Never store away batteries when they are in the low battery state. Over discharging a LiPo battery can damage it or decrease duration. LiPo batteries do not suffer from a “memory” effect and can be charged as often as required even if they are not in the low battery state. This practice will significantly increase battery life.



## 5.6 NETWORK CONFIGURATION

When connected to a network, the *Smart Waiter* system can be controlled from other devices using a modern browser. It also can send e-mail on errors and synchronize the date and time. So we recommend connecting it to a Wi-Fi network for normal operation.

To connect to a network go to **Configuration->Network** menu option. A list of available networks in range is displayed (press update button to search again and update the list). Connect to the desired one by pressing the **Join** button and entering the password at the prompt. *Smart Waiter* can only connect to networks with a password. Open access networks will not work.

Once connected to a network, the assigned IP address can be consulted in the left column. Using this IP any device (PC, laptop, smartphone) in the same network and with a web browser can connect to the *Smart Waiter* system with the following URL:

[http://assigned\\_IP\\_address](http://assigned_IP_address)

So, for example if the assigned IP address is 192.168.1.56, the URL will be

**http://192.168.1.56**

Depending on network configuration it could be possible to access the smart waiter from other locations using VPN, Remote Desktop or similar software.



## 6 EXPERIMENT SETTINGS

In this section you can configure some details about the experiments:

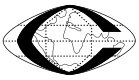
The screenshot shows the 'SmartWaiter' configuration page. At the top, there is a navigation bar with 'Dashboard', 'Protocols', 'Scheduler', 'Logs', and 'Configuration'. The main content area is titled 'Experiments configuration' and contains several settings:

- Force close:** A slider set to '1 m'. Description: 'maximum time in minutes without a stable weight to force a temporary door close'.
- Disable force close:** A checked checkbox. Description: 'when the step doesn't have a max intake defined'.
- Wait for stable weight:** A checked checkbox. Description: 'When starting a new step, don't open the door until we have a valid stable weight'.
- Only if step has a max intake:** An unchecked checkbox. Description: 'Only wait for stable weight before opening door if the step has a max intake defined'.
- Maximum intake left:** A slider set to '3%'. Description: 'to end step if a force close is activated (only if max intake is defined for the step)'.
- Extra summary lines:** A slider set to 'off'. Description: 'Add an extra summary line each x minutes to the summary log'.
- E-mail warnings:**
  - Minimum food warning:** A slider set to '3 g'. Description: 'minimum quantity in grams to send an e-mail warning (only one mail per day per feeder will be sent)'.
  - Send mail on:** Two checked checkboxes: 'on experiment error' and 'on low battery'.

A 'Save' button is located at the bottom of the configuration area.

- **Force close:** Sometimes, due to normal animal movements, the system won't be able to take a stable weight measure for a long time. If you have an experiment's step configured to close the feeder when the intake reaches a particular weight this can be a problem. With this setting you can configure how much time *Smart Waiter* will allow the door to be open without a stable weight taken. Once the door enters the forced close state it will remain closed until a valid stable weight can be read.
- **Disable force close:** Force close is always active in case a max intake will be defined but it can be disabled in case max intake will not be defined marking this check box.
- **Wait for stable weight:** When the door is going to be open for a new step it will first wait for a stable weight measurement.
- **Only if step has a max intake:** In case "Wait for stable weight" parameter is active, it will be only applied when the incoming step has max intake defined.
- **Maximum intake left:** If a force close is triggered and the weight measured is close to the limit, it can be better to just end the step than to open again the door and risk the feeding limit is surpassed. With this setting you can control how close to the feeding limit the intake has to be to end the step.





- **Extra summary lines:** For each experiment a summary log is created with a row per step data for each feeder but with this parameter additional rows can be added each x minutes for each feeder.
  
- **Email warnings:** Definition of over which events an email will be sent:
  - **Minimum food warning:** If this parameter is defined a warning email will be sent when food amount is under the defined parameter in grams.
  
  - **On experiment error:** when this option is checked, the *Smart Waiter* system sends a new mail when a feeder holds an incorrect state for more than 50 seconds. This is only applicable when an experiment is running.
  
  - **On low battery:** sends a new mail when a feeder enters the medium or low battery state. It will only send one mail for each feeder, day and state change. When a new experiment is started the low battery information is reset and new mails will be sent if there are feeders in the medium or low battery condition.



## 7 LOGS

*Smart Waiter* generates two CSV files for each experiment, detailed log and summary log. These files can be downloaded from a connected device (even while the experiment is running).

If the facility where the *Smart Waiter* unit is located doesn't have a Wi-Fi network available and the experiment Log is required, please note that many smart phones have the ability to create a mobile hot spot to which both, the *Smart Waiter* unit and a PC can connect. In this way it will be possible to download the CSV for an experiment and then turn off the hot spot.

To see a list of all the experiments, go to the **Logs** menu. Each experiment shows a "Del" button (to allow deleting old experiments and freeing space if more is required) and a CSV button along with some experiment details. Press the CSV button to download and open the CSV files in the associated CSV viewer on your system. **Important:** The *Smart Waiter* controller doesn't have CSV viewing capabilities and so the CSV button is not shown in the unit itself.

The system appends a new line to the detailed CSV file each 4 seconds. Each line contains the following columns:

- Date: in yyyy/mm/dd format
- Time: hh:mm:ss

And for each feeder

- Protocol: protocol name
- Step: step name
- Feeder name
- Battery status: 0- full; 1- medium; 2- Low; 3- Unknown (when feeder is disconnected)
- Weight
- Real state: 0- Close; 1- Delivery confirmed by Smart Dose feeder; 3- Opening (delivery in process); 5- Disconnected
- Theoretical state: 0- Close; 1- next delivery due

Summary log CSV contains a line per defined step for each feeder. Additional data can be added following "Extra summary lines" parameter defined in experiment setting menu (see Experiment Setting chapter).

For a Smart Dose feeder, when the protocol defines a new food deliver, the theoretical status is changed from 0 to 1 and is kept that way until the Smart Dose confirms the delivery (real state column changes to 1) or the duration for the step is exceeded. Then the theoretical state column will return to 0. As the Smart Dose only wakes up briefly each 8 seconds and then enters sleep mode to save battery, it is normal to have three or four 1 values (Open) in the theoretical state before having a feeder delivery confirmation (value of 1 in the real state column).



## 8 EMAIL WARNING MESSAGES

The *Smart Waiter* can be configured to send e-mails on several conditions. To configure this feature go to **Configuration->E-mail** option in the top menu.

The screenshot shows the 'SmartWaiter' configuration page with the 'Configuration' menu open and 'E-mail' selected. The configuration fields are as follows:

- To:** This is the address that will receive the emails
- SMTP Servers:** Specify the SMTP server address. Below this, it says "you can specify more than one SMTP server separating them with ;". There is a checkbox for "Server needs authentication".
- User:** Specify smtp user
- Password:** Specify smtp password (with a toggle for visibility)
- Encryption:** None (dropdown menu)
- Port:** Specify smtp server port number
- From address:** This is the address the emails will come from

Buttons for 'Save' and 'Test' are located at the bottom of the form.

Select the email addresses that will receive the mails. If more than one recipient is needed, separate them with a ',' (comma) or an space.

The rest of the fields have to be filled according to the email account information. Consult your e-mail provider for the correct parameters.

On top of those messages, if the unit is getting low on disk space (<20%) an e-mail warning will be sent to the configured address.



## 9 SYSTEM INFORMATION

Press **Configuration->Systems Information** menu to get information about the current *Smart Waiter* unit.

The screenshot shows the SmartWaiter web interface. At the top, there is a navigation bar with the following items: Dashboard, Protocols, Scheduler, Logs, and Configuration (with a dropdown arrow). Below the navigation bar, the main content area is titled "System Information". It contains two sections: "Disk Space" and "Temperature".

Disk Space	
total size:	<b>28G</b>
Used space:	<b>5.4G</b>
Free space:	<b>21G</b>
% free:	<b>21%</b>

Temperature	
CPU temperature:	<b>47.2°C</b>



## 10 CLEANING

### 10.1 Smart Dose rotary feeders

Follow the following recommendations to clean the different parts of the *Smart Waiter* system:

- Food container: They are made of methacrylate, use a neutral soapy water to clean it. **Warning:** do not use alcohol based solutions. Methacrylate can be irreparably damaged by alcohol.
- Fixing plate, Rotary Plate, Base plate and column box: are made of stainless steel and can be cleaned with a damp cloth with neutral soapy water.

### 10.2 Feeders

To better clean the feeders follow this procedure:

- 1- Loosen the front retaining screw (without removing it) with an Allen key



- 2- Remove the screws in the top cover's underside and slide the feeder out of the protecting shell.

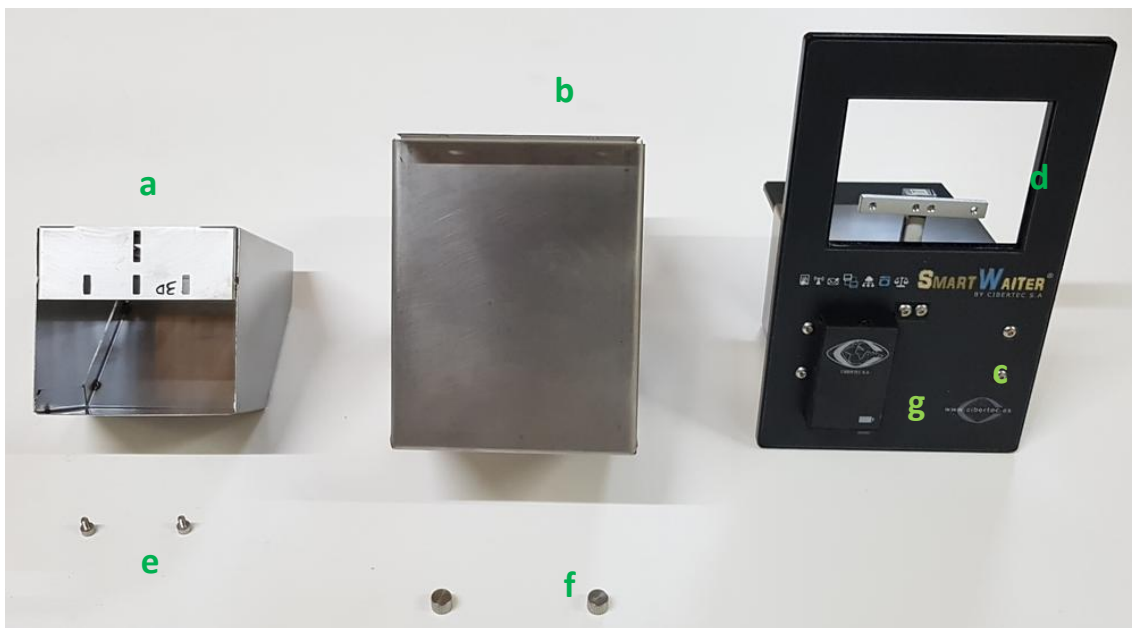




3- Unscrew the food container from the gauge



4- You can use an auto clamp to clean the food container and the protecting shell



- a. Food Container
- b. Protecting shell
- c. Top cover
- d. Straining gauge

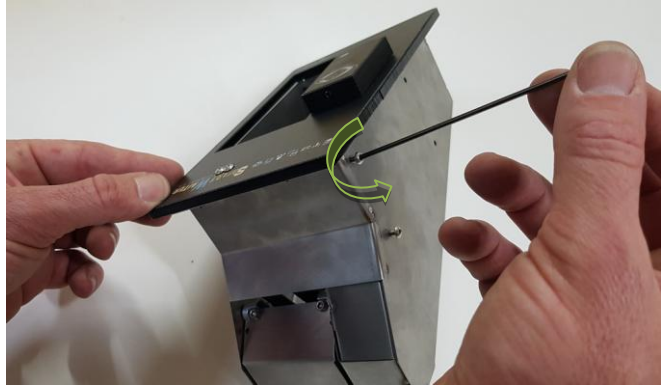
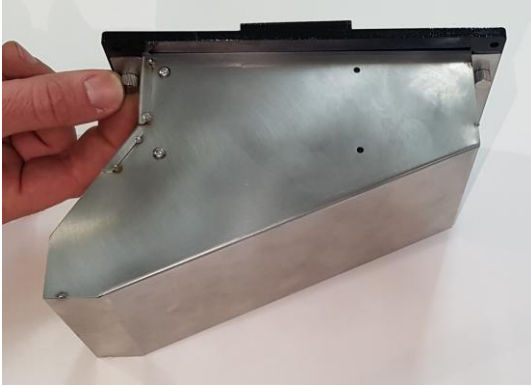
- e. Gauge screws
- f. Shell screws
- g. Battery holder



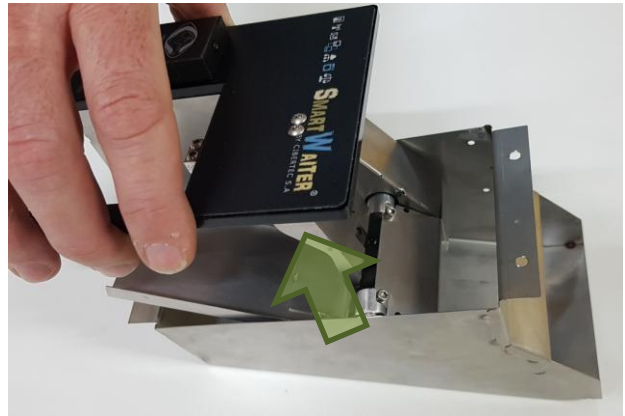
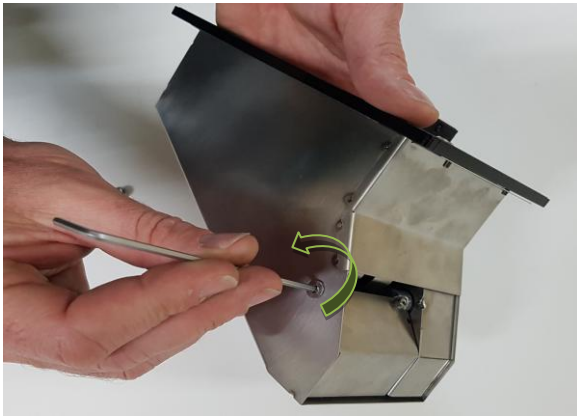
### 10.3 Drinkers

To better clean a drinker follow this procedure:

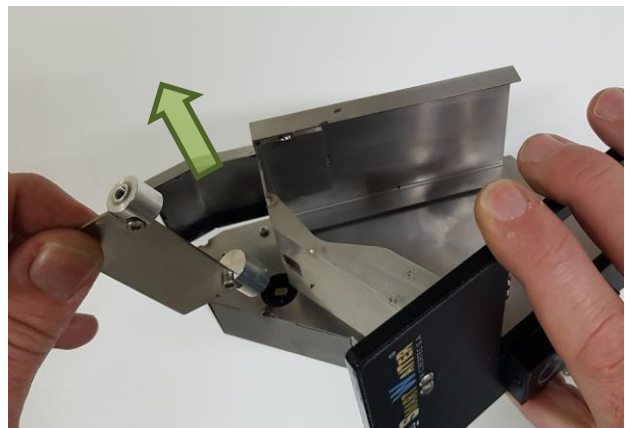
- 1- Remove the top's underside screws and then, using an Allen key remove the side screws



- 2- Remove the door screw and slide the drinker out of the protecting shell



- 3- Remove the door

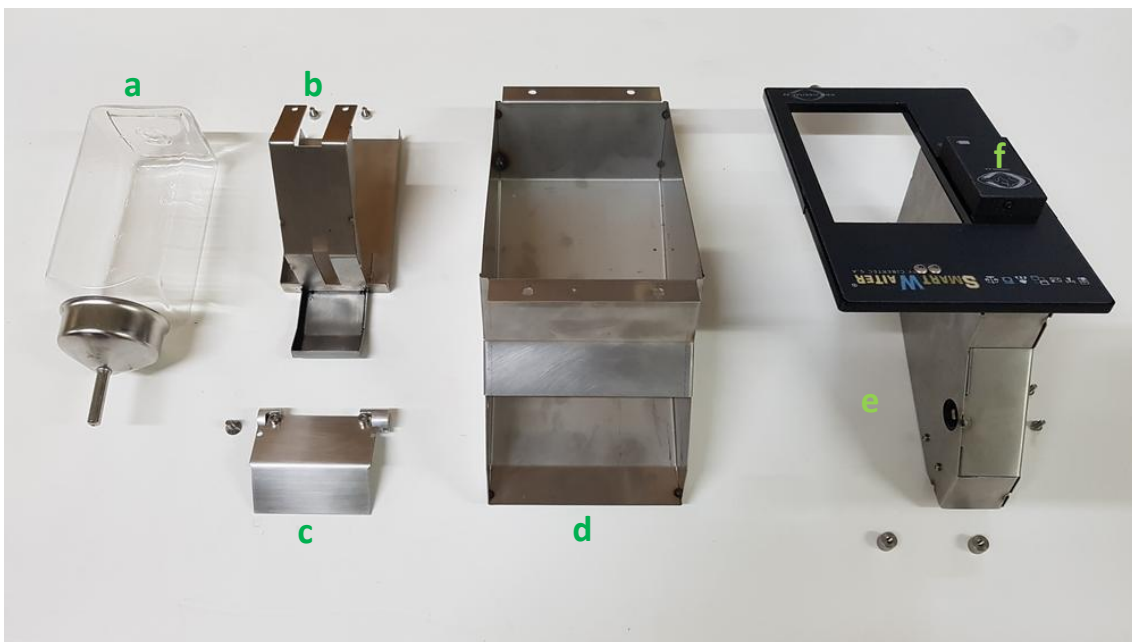




4- Unscrew the bottle holder from the gauge



5- You can autoclave the bottle holder, the door and the protecting shell



- a. Bottle
- c. Door
- e. Drinker

- b. Bottle container
- d. Protecting shell
- f. Battery holder