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# LIS user guide

A handbook for automated feeding in shake  
flask applications



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## Introduction and general considerations

Welcome to the LIS user guide and congratulations for your decision of choosing the LIS system to feed your shake flasks. The idea of this user guide is to give you access to all information required to install, integrate and use the LIS within your laboratory everyday life. Generally, it is strongly recommended to read this user guide prior to any installation or operation works with the LIS system.

Important aspects, hints or summaries are highlighted by grey boxes.

Important aspect:

This kind of grey box will be used throughout the complete document for the indication of important aspects, hints or summaries.



Caveats are indicated by warning signs.



Dangers are indicated by this type of sign

In order to ensure that this user guide provides you all information you need during your work with the LIS, we as aquila biolabs are reliant on your feedback. Do not hesitate to contact us to share your ideas regarding errors, missing information or incomprehensibilities so that we can improve this document and keep it up to date with your requirements.

This user guide is still under development and should be recognized as preliminary. This user guide, the LIS device and the LIS software may be subjected to changes and improvements without further notice.

The latest manual is available on our homepage under  
[www.aquila-biolabs.de/service/downloads](http://www.aquila-biolabs.de/service/downloads).

In case of any question that might arise during the work with LIS do not hesitate to contact us (Contact details on pp. 44).

LIS user guide revisions:

Revision 0	30.08.2017	- initial document
Revision 1	17.11.2017	- added troubleshooting guide, update
Revision 1.0.1	02.04.2018	- added LIS Software Guide, general update

## The LIS-system – an overview



*figure 1 LIS System*

LIS stands for **L**iquid **I**njection **S**ystem. It allows automated feeding for shake flasks. The LIS system consists of four different components, the LIS Drive, the LIS Cartridge, the LIS Coordinator (available as add-on) and the LIS software (available as add-on). Each component serves a different purpose. The LIS Cartridge is a pre-sterilized, ready-to-use single use liquid container that holds the liquid.



*figure 2 LIS Cartridge*

The LIS Drive is the physical heart of the LIS-system, as it performs the communication and dispensing tasks. It can be used in a stand-alone mode, where the Drive is controlled via its display, or in a wireless mode. Here, several Drives are connected to the LIS Coordinator through a 2.4 Ghz wireless connection, which organizes all the communication traffic between the LIS software and the Drives (only with software add-on).



*figure 3 LIS Drive (left) and LIS Coordinator (right)*

Furthermore, the LIS software is the user's window to the world of automated feeding in shake flasks fermentations. The LIS Software does all the visualization, communication, and controlling works that is required in order to provide all LIS users an intuitive and comfortable solution to prepare, run and store their experiments.

## Glucose feeding profile 1

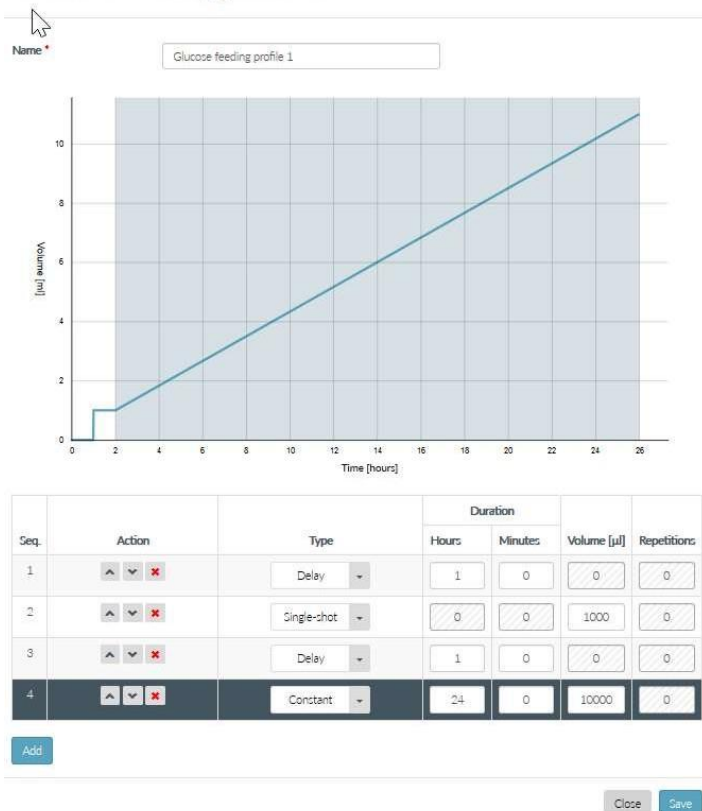


Figure 4 Profile generator of the LIS software



## Technical Specifications

LIS Drive	
input voltage	5 VDC $\pm$ 5%
input current	min. 200 mA
height (with mounting ring)	approx. 88 mm
additional height on shake flask	approx. 70 mm
Temperature	
operating temperature	15 – 45 °C
charging temperature	15 – 40°C
Battery (built-in)	
Type	Li-Ion
Capacity	300 mAh
Runtime when fully charged <sup>1</sup>	about 1 week
Charing time	approx. 2 h
Charging Source	USB 2.0 Port
Radio	
Frequency	2.4 Ghz
Range <sup>2</sup>	up to 30 m
Pump	
Flow rate	max. 1 ml/min

---

<sup>1</sup> dependent on feeding profile

<sup>2</sup> dependent on environment

## Cartridge

Sterilization Procedure	Ethylene Oxide (EtO)
Fitting Flask Type	straight neck (no brim)
Fitting Flask Outside Diameter	38 mm ( $\pm 0.3$ mm)
Fitting Flask Minimum Inside Diameter	33 mm

## Recommended software requirements (LIS Software)

CPU	current dual core @ 2 GHz/core or better
RAM / HDD	$\geq 4$ GB / $\geq 10$ GB
Operating system	Microsoft Windows 7 or newer with JRE 8
Screen resolution	1920 x 1080 pixels
Web browser	Tested with Firefox V 54.0.1

It is strongly recommended to disable automated updates in the Windows operation system settings, to prevent undesired system restarts upon Windows Update events.

On Windows 10, a restart blocking service should be installed to prevent system restarts in the night due to Windows Update.

It is recommended to use the "High performance" power plan in the Windows power options.

You can also contact us to verify your chosen system settings.

## Recommended operating conditions

Temperature	10 – 45 °C
Humidity (relative)	0 – 80% (non-condensing)
Filling volume	max. 25 ml <sup>3</sup>

Tested Shaking speeds                      tested with fresh Infors clamps

shaking diameter ≤ 2.5 cm

100-125 ml shake flask                      max. 250 rpm

250-300 ml shake flasks                      max. 300 rpm

500-2000 ml shake flasks                      max. 250 rpm

shaking diameter ≤ 5.0 cm

100-300 ml shake flask                      max. 250 rpm

500-1000 ml shake flasks                      max. 225 rpm

2000 ml shake flasks                      max. 200 rpm

Note: values might be different when sticky stuff is used or other add-ons are used (e.g. the Cell Growth Quantifier by aquila biolabs). Please carefully determine acceptable shaking speeds with your setup.

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<sup>3</sup> Depending on shaking speed and diameter.

## Warnings



Do not use the LIS system or any of its components in water bath shakers! This might result in electric shocks, which could damage your health, the LIS and any other electric device around.



Be careful when mounting the LIS cartridge onto the shake flasks. Some shake flasks show a bigger neck diameter. Do not try to force the cartridge onto such flasks as they could break. Instead, use flasks that easily fit.



Be careful when handling the mounting rings. They might have sharp edges that might cause injuries such as cuts.



Do not spill liquids over the LIS drive.



In general, do not use inorganic or organic acids and bases, organic solvents or detergents to clean the LIS drive! Some organic solvents or detergents might be allowed for cleaning, but you should only use those being mentioned in the user guide.



Always stop the shaker before doing anything with the LIS components or the shake flasks. Especially for mounting and dismounting purposes, the shaking movement should be always turned off to avoid damage to your health and to the devices and flasks on the shaker.



Any kind of opening, manipulating or copying LIS devices as well as decompiling, reverse-engineering, copying or distributing LIS software or the LIS firmware components is strictly prohibited in accordance with German and international law and may lead to compensation claims.

The LIS Drive contains a lithium ion battery. Take special care considering following aspects:

- Do not dispose the battery / the LIS Drive into normal waste.
- Do not heat or dispose the battery into fire, water or other liquids.
- Do not put the Drive into a microwave, washing machine or a drying machine.
- Never use a damaged battery.
- Never disassemble a LIS Drive.
- Should a battery unintentionally be crushed, thus releasing its contents, rubber gloves must be used to handle all battery components. Avoid inhalation of any vapors that may be emitted.
- Take care when shipping the LIS Drive. Inform yourself about shipping regulations of lithium ion battery containing devices.
- Do not charge / discharge the battery outside the operating temperature range (0-45°C)
- For longer storage of the LIS Drive, the battery should be in a 50% charged state.





### WEEE conformity

WEEE-Registration-No.: 61144888

The aquila biolabs GmbH, Arnold-Sommerfeld-Ring 2, 52499 Baesweiler, Germany, herewith declares compliance of all electronic components of the LIS system with the Council Directive 2012/19/EU.

Electronic components may contain various hazardous substances that could possibly exhibit negative impacts on your health and the environment. In order to avoid those effects aquila biolabs encourages you to make use of the appropriate local take-back and recycling systems for disposing electrical and electronic equipment. By doing this you are furthermore significantly reducing the pressure on natural resources and thus preserve our planet for subsequent generations.

Components that are affected by this declaration carry the following pictogram:



Date of declaration: 20.07.2017  
Name, position of the undersigned: David Frank, Managing Director  
Production

A handwritten signature in blue ink, appearing to read 'D. Frank', is written over the printed name and position.



### FCC compliance

FCC ID: VNR-ATSAMR210UA-0

This is a Class A product.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) this device may not cause harmful interference, and
- (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.



## Installation, quick start and handling

### Controlling the LIS Drive



*figure 5 controlling the Drive*

- Make sure the transport security lock (piece of plastic below the knob) is removed, otherwise the knob cannot be pushed
- Pressing and holding the knob for approx. 1 second turns on the LIS Drive
- Turning the Knob left or right allows you to move in the menu and/or increase and decrease numerical values
- A Single press on the knob selects an entry or confirms an input
- Pressing and holding the knob for more than 5 seconds triggers a forced shutdown of the LIS Drive (only use this function if problems occur)

## Main Menu Structure

```
MainMenu      il 75%
>Status
Control
Experiment
Settings
Shutdown
```

- **Status:** Shows the experiment status if an experiment is running
- **Control:** Start or stop an experiment, shutdown the LIS Drive
  - **Leakage Test:** test the assembly for leakage
  - **Estimate:** estimate volume in cartridge (beta-function)
  - **Prepare:** start the pressure regulation
  - **Start:** start your experiment
  - **Stop:** stop your experiment
  - **Manual Dispense:** manually pump with the Drive
- **Experiment:** Setup of the dispensing protocol
- **Settings:** Change settings of the LIS Drive
- **Shutdown:** power off your LIS Drive

## LIS Drive Menu Structure

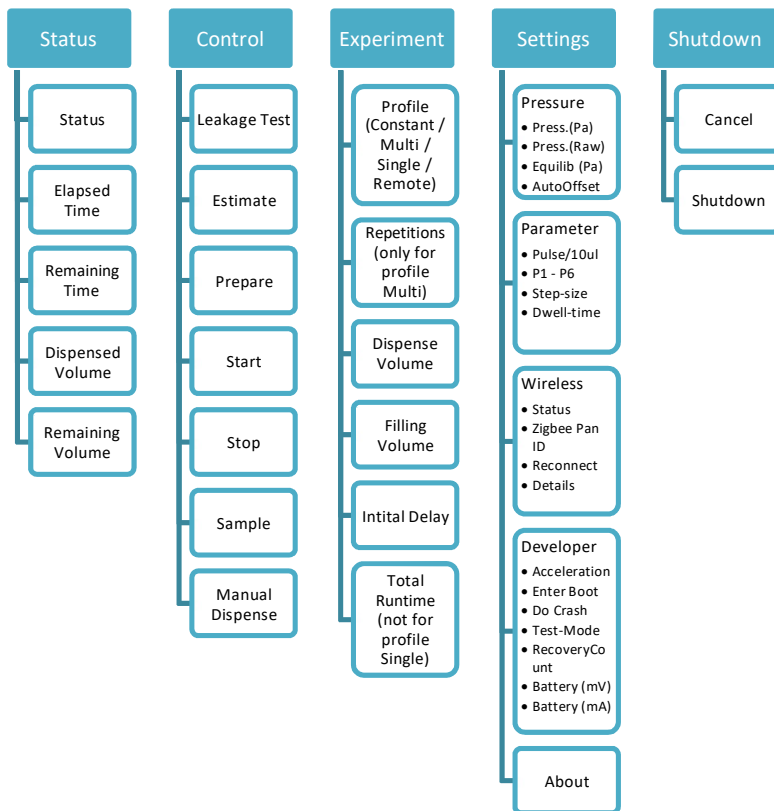
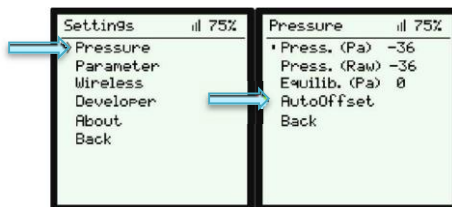


figure 6 Menu structure of the LIS Drive

## Running an LIS Experiment

### 1. Auto Offset the Pressure

Before using the LIS Drive the pressure sensor needs to be blanked. The Drive has a function called “**AutoOffset**” to set the actual blank.



- Make sure **no filter or cartridge is connected** to the Drive
- Go to „**Settings**” then „**Pressure**” and check if the value of the entry „**Pressure**” is around 0 (+/- 5 counts)
- If the value differs, go to „**AutoOffset**” and press the knob
- Now the Pressure is blanked and the Drive is ready to use

### 2. Set up an experiment



- Go to “**Experiment**”, choose the feeding profile and enter your individual feeding parameters:
  - **Dispense Volume:** Overall volume to be dispensed into the flask
  - **Repetitions:** Number of dispensing steps to discharge the dispense volume (only for Multi-Shot profile)
  - **Filling Volume:** Volume of liquid in cartridge
  - **Initial Delay:** Time before first dispensing action
  - **Total Runtime:** Total time of the experiment (initial delay + dispensing time)
- Confirm the feeding profile by clicking “**Back**”

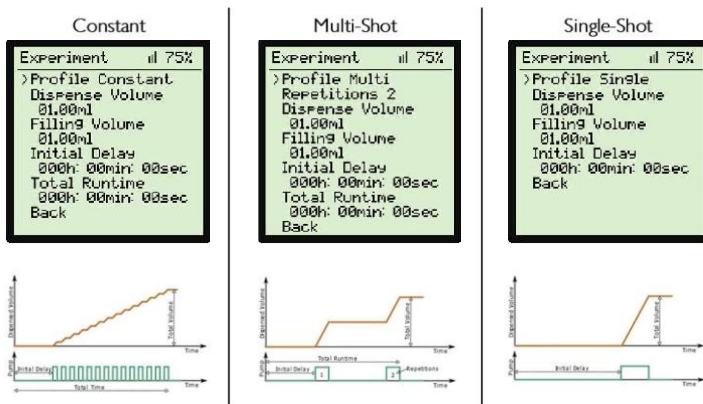
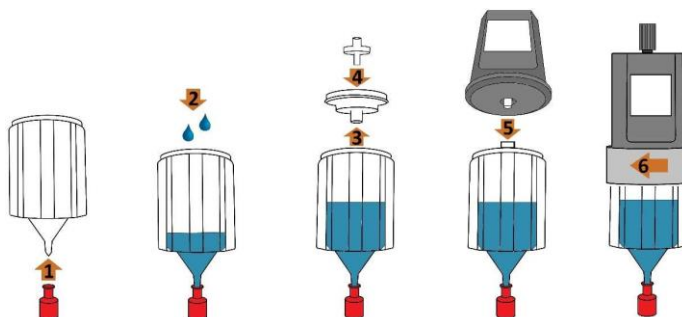


figure 7 different types of feeding profiles

## 3. Setting up the LIS Cartridge



*figure 8 process of filling and installing the cartridge*

1. Take your flask, fill it with media and make sure it is inoculated with your organism.
2. Open the sterile packed LIS Cartridge and the sterile Luer plug package. Now use the Luer plug to close the cartridge (figure 8, step 1).
3. Now put the cartridge on the shake flask (this will allow you to have both hands free and make it easier for you to fill the cartridge). With a pipette fill your feeding solution into the cartridge (2). Please make sure that you do not use more than 25ml and that you know how much volume is in the cartridge.
4. Use the lid of the LIS cartridge to seal the cartridge air-tight (3). This step is very crucial, so please ensure that the lid sits tightly on the cartridge (you should feel a “snap-fit”)
5. Install the sterile filter on the lid of the cartridge. (4)
  - a. Always keep the cartridge upright (do not allow liquid to touch the hydrophobic gas filter)

6. Now slightly pull the cartridge a bit upwards so that it sits loosely on the flask. Please ensure that no liquid spills into the sterile filter when doing this.

### Make sure your LIS Drive is fully charged and the pressure sensor blanked as described in “Running an LIS Experiment

7. Auto Offset the Pressure” (page 21)
8. Now install the LIS Drive on the cartridge (5).
9. Use the ring of the drive to tightly mount the drive onto the cartridge (6). This step is crucial, thus, please screw drive and cartridge tightly together until they become one rigid unit. If you hold the cartridge in one hand and try to move the drive with the other, the drive should not wobble!

The LIS Cartridge is designed to fit 38 ( $\pm$  0.3) mm straight neck Erlenmeyer shake flasks. Do not try to fit it on other types of flasks.

#### 4. Leakage Test

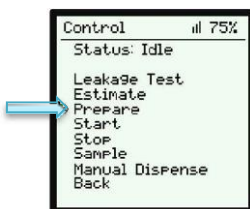
Before starting an experiment, it is good practice to test the whole system for proper assembly. As the LIS System controls the pressure inside the cartridge, a leakage could lead to decreased battery life or uncontrolled fluid release.

- To test the assembly, go to “Control” → “Leakage Test”
- The LIS Drive will start a program to analyze the tightness of the system. This will take up to 2 minutes.
- Wait until a message pops up indicating if the system is tight or not
- If the assembly does not pass the leakage test, please check following aspects:
  - Is the lid properly installed on the cartridge?

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- Is a sterile filter installed between cartridge and drive?
- Do you use an unused cartridge?
- If the leakage test is successful, you can go on

## 5. Prepare your LIS System



After programming the LIS Drive and filling the Cartridge, LIS is now ready to be started:

- Choose “**Control**” in the main menu and then “**Prepare**”
- Wait until LIS stops pumping air
- Now the luer plug (red) can be removed



## 6. Assemble the Feed System



*figure 9 assembled LIS System*

- Place the Drive with the cartridge carefully on the flask
- Fix the flask carefully on the shaker



Avoid tilting the filled cartridge too much. The liquid inside the cartridge must not get in contact with the sterile filter as this would block the filter.

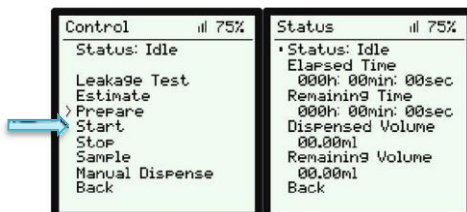


Avoid strong shocks as they could lead to unwanted drop release into the shake flask



The LIS Cartridge is designed to fit 38 mm straight neck Erlenmeyer shake flasks. Some of these flasks have bigger or smaller outer diameter. Do not force the cartridge on these flasks as the glass could break. Use flasks that fit instead.

## 7. Start the Experiment



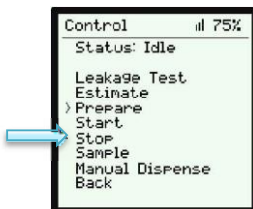
- Go to **“Control”** then **“Start”** to start the experiment
- On successful start, you will be forwarded to the **„Status”** screen, where you will have an overview of your experiment

## 8. Sampling

If you want to take a sample from your culture during an experiment, you can use the “Sample” function of the LIS Drive. Sampling does not pause the time. All feeding steps during the sample period will not be performed but directly carried out after the sample mode is stopped.

- Select **“Control”** → **“Sample”** on the LIS Drive.
- The status should now say **“Sample”**.
- Then take a sample from the flask and afterwards select **“Sample”** again to leave the sample mode, the status should now show **“Run”**.

## 9. Stop the Experiment



- Go to **“Control”** and then **“Stop”** to stop the experiment
- To shut down the Drive, go to the main menu then **“Shutdown”**



Attention: The Cartridge is a single-use product, proper operation can only be guaranteed for the first time it is used. Repeated use will lead to leakage. The cartridge is not autoclavable.

### Using a needle with big shake flasks

Depending on the shake flask used, you may want to use a needle while shaking to make sure the drops fall into the liquid and do not stick to the side of the shake flask. We recommend using a needle for shake flasks with a volume of 500 ml or greater. The Cartridge bottom has a male luer connector where you can attach needles (e.g. B. Braun Sterican needles).

As the LIS Drive is controlling the pressure inside the LIS Cartridge to avoid unwanted drop release, the height of the water head is an important aspect. In order to work properly, the LIS Drive needs to be individually configured for each type of needle.

Contact aquila biolabs GmbH for further information about the usage of needles with LIS and proper configuration.

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## LIS Software and Coordinator

### Introduction

The LIS Coordinator add-on with the LIS Software enables the remote controlling and monitoring of multiple LIS Drives and the usage of advanced feeding profiles. The LIS Coordinator connects to the computer by USB and to the LIS Drives wirelessly using the 2.4 GHz band.

### Installation


Run the Setup application and follow the on-screen instructions to install the LIS Software on your computer.

- Make sure your computer meets the requirements mentioned under “Recommended software requirements”
- Make sure you have admin rights to install the software
- Make sure you have the Java Runtime Environment 8 or newer installed

### Starting and stopping the LIS Software


#### Starting the LIS Software

To start the LIS Software, open the Windows start menu and choose “LIS Software” or double click the shortcut on the desktop, if available. In case the LIS Software is configured to start with Windows automatically or if it is already running, you can also double-click the LIS-Software icon in the Windows

notification area .

A browser window will open with the LIS user interface.

## Exiting the LIS Software

If you want to exit the LIS Software, right click on the LIS icon  in the notification area and select "Exit".



The LIS Software needs to run all the time while LIS experiments are running. Only exit the software if your LIS Drives are not performing remote controlled experiments currently.

## Using the LIS Software

### The user Interface

The LIS Software consists of two parts: the so-called frontend and backend. The frontend is the user interface and it is running in a web browser. We recommend using Firefox as the default browser as the LIS Software is tested to work properly with it.

The backend is the connection between the graphical user interface and the LIS Coordinator and is running in the background. You can close the frontend without harm as the functionality of the software is assured by the backend.

Navigating in the LIS Software:

The LIS Software uses tabs to navigate through the different functions:



*figure 10 Tabs of the LIS Software*


*Table 1 LIS Software Tabs and their functions*

<b>Tab</b>	<b>Function</b>
<b>Experiments</b>	<ul style="list-style-type: none"> <li>- List of experiments planned / running / done</li> <li>- Progress of running experiments</li> <li>- Adding new experiments</li> </ul>
<b>Profiles</b>	<ul style="list-style-type: none"> <li>- Define templates of feeding profiles that can be used when creating experiments</li> </ul>
<b>LIS Drives</b>	<ul style="list-style-type: none"> <li>- List of known Drives</li> <li>- Connection Status</li> <li>- Battery level</li> <li>- Signal strength</li> <li>- Change the name of a LIS Drive</li> </ul>
<b>Parameters</b>	<ul style="list-style-type: none"> <li>- Define parameter sets for different applications (e.g. use of special fluids / use of needles with the LIS System)</li> </ul>
<b>Archive</b>	<ul style="list-style-type: none"> <li>- See archived experiments</li> </ul>
<b>Settings</b>	<ul style="list-style-type: none"> <li>- Connect to LIS Coordinator</li> <li>- Change name of Coordinator</li> </ul>

The Status Bar:



*figure 11 status bar*

The Status Bar is located on the lower part of the user interface. On the left, it shows if the LIS Coordinator is properly connected to the software. The center gives information about the software version and the question mark symbol  on the right can be clicked in order to open the LIS user guide.

## Connecting the LIS Coordinator

1. Make sure you connect the LIS Coordinator with a micro USB cable to the computer.
2. On the LIS Software, go to the tab "Settings"
3. Choose the right COM-Port of the Coordinator
4. Click on "Connect". You should see a message indicating that the connection is established.
5. After connecting the LIS Coordinator, you can see which PanID it uses under "PanID"

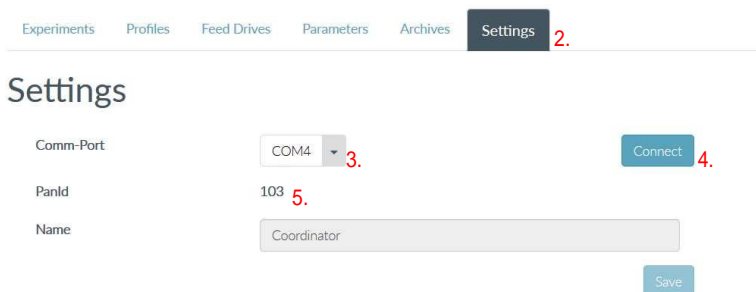


figure 12 Settings page


In the status bar of the LIS Software you can also see the connection status of the coordinator: Coordinator is connected to "COM4".

## Connecting the LIS Drives

If your LIS Drives are not configured yet to connect to the LIS Coordinator on the shown PanID, do following steps:

1. On the **LIS Drives** go to “**Settings**” → “**Wireless**”
2. Set the “**Zigbee PAN ID**” to the same number the LIS Software is showing on the “Settings” tab after connecting the LIS Coordinator



3. After successful connection, the LIS Drive should show a connection indicator in the top right corner of the display: 
4. On the **LIS Drives** go to “**Experiment**” and change “**Profile**” to “**Remote**”




5. The connected LIS Drives are now visible in the software on the “**LIS Drives**” tab






## Running an Experiment



Before you can run remote experiments with the LIS system you need to define experiments. Each LIS Drive you want to use needs its own experiment.

- Go to the “Experiments” tab in the LIS Software
- Click on the button “Add new Experiment” 
- Fill in all relevant information.

Mandatory Information (indicated by \*):

- a. Experiment
    - i. Name: name of the experiment
    - ii. LIS Drive: choose the LIS Drive that should run this experiment
  - b. Physical Parameters
    - i. Parameter Set: choose the appropriate Parameter Set for your experiment (usually the Standard Parameters)
  - c. Bioprocess Parameters
    - i. Filling Volume LIS Cartridge: type in the filling volume of the LIS Cartridge in  $\mu\text{l}$  (this should be as exact as possible)
  - d. Profile
    - i. Choose a Profile template from the dropdown list (if available) or define a new profile with the profile editor below (See “Create a new Feeding Profile”, page 37)
- Click “Save”
  - The saved experiment will be added to the experiments list on the “Experiments” tab.

- Optional: if you want to run several similar experiments, you can copy an existing experiment by using the “Duplicate Experiment” function. Simply click the duplicate button . A new window will pop up where you can make changes (make sure to change the selected LIS Drive) and save the duplicated experiment.
- Prepare your LIS Drive and LIS Cartridge as described in the chapter “**Setting up the LIS Cartridge**”, page 23
- Do a leakage test as described in the chapter “**Leakage Test**”, page 24
- Make sure the LIS Drive is configured to the “Remote” profile (as described under “Connecting the LIS Drives”, page 33).
- On the experiments list, click the “**Prepare**” button  of your experiment in the column “**Control**”. Alternatively, you can select multiple experiments with the check boxes and click on “Prepare X Experiments” to prepare multiple experiments at a time
- The LIS Drive will now start pumping air out of the cartridge to create an initial negative pressure. It will stop pumping when correctly prepared. Now carefully remove the cartridge from the flask and remove the red luer plug.
- Put the cartridge back onto the flask. Your flask is now ready to be used on the shaker.
- To start the experiment, click the “**Start**”  button of your experiment located on the “**Control**” column on the “**Experiments**” tab. Alternatively, you can select multiple experiments with the check boxes and click on “Start X Experiments” to start multiple experiments at a time

- The LIS Drive will now start your experiment. The status will change to “Running”. You can track the progress by checking the “Remaining Time / Total Time” or “Current Volume / Target Volume”
- After your experiment is finished, the status will change to “Finished”. The LIS Drive will remain active to control the pressure so that no remaining liquid will be dispensed from the LIS Cartridge
- If you want to stop the experiment, use the “Stop”  button located in the “Control” column. Please be aware that this will also stop the pressure control of the LIS Drive and additional liquid might drip out of the cartridge into your shake flask.
- By clicking the “Move to Archive” button  (located in the “Action” column on Experiments tab) you can move stopped experiments to the archive and your experiments list stays clean. Archived experiments can be found by navigating to the “Archive” tab.

## Create a new Feeding Profile

1. Go to the **“Profiles”** tab and click on **“Add new profile”**
2. **Name** the profile
3. Please note, that the maximal volume of the cartridge is 25ml and the minimal volume per feeding step is 100 ul by default. To configure your own feeding profile, click on **“Add”** to add a segment to our profile. Choose one of the followings **“Types”**
  - o **Delay**
    - Time period without dispensing
  - o **Single Shot**
    - Single dispensing action of Y ul
  - o **Multi-Shot**
    - Means **“Within X hours add a volume of Y ul into the culture by Z equal repetitions”**
  - o **Constant**
    - Means **“Within X hours add a volume of Y ul into the culture”**. The standard volume per repetition is the smallest one possible (usually 100 ul), but it can be changed in the Parameter Set (P7, P-Controller volume dead-band)
4. By adding further segments, you can create your own feeding profile. Once you are finished make sure to save the profile by clicking on **“Save”**. The profile will now be listed under **“Profiles”**.

Seq.	Action	Type	Duration		Volume [µl]	Repetitions
			Hours	Minutes		
1	▲ ▼ ✖	Delay	1	0	0	0
2	▲ ▼ ✖	Single-shot	0	0	1000	0
3	▲ ▼ ✖	Delay	1	0	0	0
4	▲ ▼ ✖	Multi-shot	1	0	2000	10
5	▲ ▼ ✖	Delay	0	30	0	0
6	▲ ▼ ✖	Constant	5	0	2000	0

figure 13 feeding profile editor with exemplary combination of feeding segments

### Add new Parameters

As the LIS System controls the pressure in the headspace of the LIS Cartridge, several properties have an impact on the parameters used for the pressure control. For example, the height of the water column or the density of the liquid inside the cartridge need to be considered.

In order to use the LIS System with big shake flasks, needles with a female Luer connector can be connected to the tip of the LIS Cartridge. Thus, the position of the drop release can be moved downwards inside the shake flask, so that these drops do not stick to the wall of the shake flasks. As the usage of needles will increase the height of the water column, the parameters need to be adjusted.

The “Standard Parameter” supplied with the LIS Software are designed to work with common water-like solutions as long as no needle is attached to the LIS Cartridge.

If you want to add other parameter sets, do following steps:

1. Go to the “Profiles” tab
2. Click on “Add New Parameters” or click the “Duplicate Parameter” button of an existing parameter set
3. A window will open, fill in the desired parameter that meet your application
4. Click “Save”



Using wrong parameters might lead to inaccuracy, unwanted drop release or no dispensing. Please contact [aquila biolabs](mailto:info@aquila-biolabs.com) for more information regarding the right parameters for your application.

## Charging the LIS Drive



*figure 14 micro USB port of the LIS Drive*

- Use a micro-USB cable to connect the Feed Drive to a free USB port (computer or wall-plug charger)
- Usually it takes approx. 2 hours to fully charge a LIS Drive



Unplug the charger after charging is completed. Do not let the LIS Drive charge for longer than four hours.

## Disinfection



Ensure that you have disconnected all LIS devices and cables from any kind of power supply, to prevent damages to the electronics, to connected devices and to your health.



Ensure that all LIS devices and cables are completely dry after disinfection, before you reconnect them to each other and to the power supply and USB.

The LIS Drive and cables can be disinfected by wiping them softly with 70% ethanol wipes.

## Updating the LIS Drive Firmware

In case you want to update the firmware on the LIS Drive, ask the aquila biolabs service for the newest release. We will also provide you with a detailed instruction how to update the firmware.

To Enter the bootloader mode for firmware updates, take a LIS Drive and navigate to:

**“Settings” → “Developer” → “Enter Boot”**

In case you accidentally entered the Boot Mode, press the knob longer than 5 seconds to power off the device. After turning it on again the LIS Drive will be in normal operation mode.

In Case there is a firmware problem with the LIS Drive and you are not able to control the Drive with the knob to enter the Boot-Mode, you can use the Bootloader Dongle to enter this mode for firmware updates. Use the supplied Micro-USB cable to connect the Dongle to the LIS Drive. Contact the aquila biolabs Service for further instructions.



*figure 15 LIS Drive Bootloader-Dongle*



Never interrupt a firmware update process as this could lead to a broken LIS Drive. Be sure the micro USB cable is sitting firmly.

Problem	Possible causes	Solution
Cartridge leaky / pump does not stop in prepare mode	Lid not closed properly	Close lid properly (the lid snaps to the cartridge, make sure it sits completely flat and its pressed down everywhere)
	Repeated use of cartridge	The cartridge is a single use product, use new cartridge
	Wrong filling volume entered	Put in the actual filling volume under "Experiment" and hit prepare to check
	Wrong pressure parameters	The default parameters are for water and comparable solutions. If you have solutions with different physical properties (e.g. significant higher / lower density) you need to adjust the parameters. Usually it is sufficient to lower / increase the P5 value. Contact the aquila biolabs service for more information.
	Sterile filter is wet	The supplied sterile filter gets blocked when it comes in contact with liquids. Make sure it does not get wet, especially while tilting the LIS System (the acceptable tilting angle is dependent on the filling volume of the cartridge)
	Wrong pressure offset	See section "Auto Offset the Pressure"
Air bubbles rising up through the nozzle	Wrong filling volume entered	See above
	Wrong pressure parameters	See above
Displays shows "Bootloader" / LED blinks alternating red and green	The Drive is in bootloader mode	Long press (> 5 seconds) the knob to power off the drive. After turning it on again it will be in normal operation mode



Problem	Possible causes	Solution
Dispensing accuracy not acceptable	Pressure or calibration parameters do not fit the liquid properties	The default parameters are for water and comparable solutions. If you have solutions with different physical properties (e.g. significant higher / lower density) you need to adjust the parameters.  Contact the aquila biolabs service for more information.
Drive does not turn on	Battery empty	Connect to charger
Drive shut down during experiment	Battery drained due excessive pump activity	See "Cartridge leaky" above
	Low battery level at experiment start	Start experiment with fully charged Drive start
LIS Drive not visible in LIS Software	LIS Coordinator not properly connected	Connect the LIS Coordinator to the LIS Software as indicated in this user guide
	LIS Drive turned off	Turn on the LIS Drive
	Wireless deactivated on the LIS Drive	On the LIS Drive, go to "Settings" → "Wireless" → "Zigbee PanID" and set the correct PanID
	LIS Drive not connected properly	On the LIS Drive, go to "Settings" → "Wireless" and choose "Reconnect"
Experiment cannot be prepared / started in the LIS Software	Experiment details not complete	Add mandatory information to the experiment details.
	No LIS Drive assigned	Assign a LIS Drive to the experiment
	Assigned LIS Drive not available	Make sure the assigned LIS Drive is turned on and properly connected to the LIS Coordinator

Problem	Possible causes	Solution
	LIS Coordinator not properly connected	Connect the LIS Coordinator to the LIS Software as indicated in this user guide

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