DOTS Software user guide

Revision 2.1.1

SCIENTIFIC BIOPROCESSING

Content

About this user guide

This user guide contains all information on the DOTS Software, its components, and how to use them. The workflows for preparing experiments with related SBI hardware are included in this user guide. For quick overviews, Quick Start Guides are available for DOTS Software and all related hardware.

For detailed technical information on our hardware refer to our hardware user guides.

Contact us at insights@scientificbio.com if you require any documentation on SBI's products.

Throughout this user guide, you will find warning and information boxes that look like the following:

Warnings: Important aspects that must be considered for a proper function of DOTS Software

Information: Helpful information to improve your experience with the DOTS Software.

To ensure that this user guide provides you all information you need during your work with the DOTS Software, we rely on your feedback. Do not hesitate to contact us about errors, missing information, or incomprehensibilities so that we can improve this document and keep it up to date with your requirements.

This user guide and the DOTS Software may be subjected to changes and improvements without further notice.

DOTS Software User Guide revisions

Revision 0	15.09.2022	Initial document
Revision 1.1	18.11.2022	Added Backup & Restore and LIS advanced Pause / Resume features (new DOTS Software release)
Revision 1.2	03.04.2023	Updated screenshots and added improved features for data export and control of grouped Objects (new DOTS Software release)
Revision 1.2.1	11.04.2023	Added section for "Importing a DOTS data file" and improved formatting
Revision 1.2.2	19.07.2023	Added section for "Turbo Templates – Rapid Experiment Start" and updated formatting
Revision 1.3	12.11.2023	Updated screenshots and added sections for "Graph Configuration" and "Auto and Batch-assign" of Devices during Experiment setup. (New DOTS Software release).
Revision 2.0	18.04.2024	Updated screenshots and added sections describing new available Application Templates and Task Templates, Licensing of Templates, new Features "auto .csv export", "Notification trigger" including e-mail notifications. (New DOTS Software release, product launch MPS (Multiparameter Sensor) and DO Sensor Pills).
Revision 2.0.5	04.07.2024	Updated description of Task "Fluorescence (MPS)" including new mode for high sensitivity measurement (New DOTS Software Release).

Revision 2.1	13.12.2024	Added sections describing new available Application and Task Templates (“Biomass monitoring”, “DO monitoring”, “Fluorescence monitoring”, and “Shaker monitoring”, “Shaker control”). Updated description of Task control workflows including new available control features: Start and Start/Stop conditions using a logic builder, combined actions from Dashboard Object List, restart an already finished Task (New DOTS Software Release).
Revision 2.1.1	11.02.2025	Updated sections describing Application and Task Templates, including new functionalities for LIS Feeding Tasks (combination of profile-based and feedback-control LIS Feeding) (New DOTS Software Release).

About DOTS Software

DOTS Software, a cornerstone of SBI's DOTS platform, is your tool for easy handling of sensors, actuators, and bioprocesses.

Monitoring multiple process parameters in real-time enables optimal control over your experiments. The DOTS Software unifies the data of all SBI sensors and offers comprehensive visualization and analysis - for a better understanding of your bioprocesses.

The DOTS Software concept

The DOTS Software combines simplified bioprocessing with multi-level team and project management. When setting up experiments in the DOTS Software, the bioprocess structure can be as simple as you want and as complex as you need – to the point where you can create a digital twin of your real-life bioprocess. Flexible user management allows you to collect all your important data in one place while maintaining individual access restrictions.

Learn more about the DOTS Software concept in the following sections.

Experiments, Objects, Processes, and Tasks

Everything in DOTS is about **Objects**.

An **Object** can be anything that you want to monitor or control – A vessel, like a Shake Flask, or even a whole room. Objects can be grouped to form Experiments. For example, a series of replicates or a screening could be an **Experiment**. Every **Object** within an **Experiment** has user-defined Processes, Tasks, and Devices related to monitoring of different parameters with different sensors. (Figure 1).

Processes include the measurements and actions performed to gain more informational data on an Object. Several Processes can be defined to divide the overall (bio)Process into different stages. Each stage, or Process, can be assigned different sets of measurements and actions.

Tasks contain the detailed configuration for a measurement or action, usually an automatized sensing or actuator job. Tasks directly control your hardware, e.g., **Devices** like a CGQ sensor or a LIS drive.

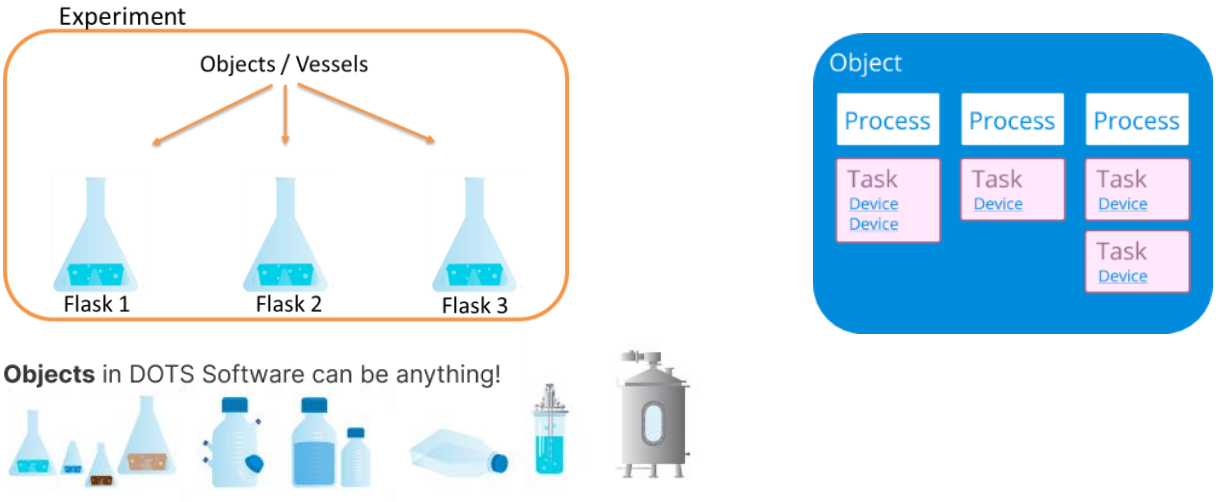


Figure 1: Experiments and Objects in the DOTS Software

Team and Project management

DOTS Software is designed as a multi-user solution. Within one institution, every user logs in to the same instance of the DOTS Software with his/her own user account. Admins manage the User Pool of the institution by assigning them to Teams and Projects. Furthermore, Users are assigned roles within the DOTS Software hierarchy: Within a Project, Users can be Project Editors or Viewers; within a Team, Users can be Team Leaders or Members. This way, each User receives his/her own set of permissions with respect to the Experiments and data in the DOTS Software. Admins also control the access to Devices by assigning them to specific Teams.

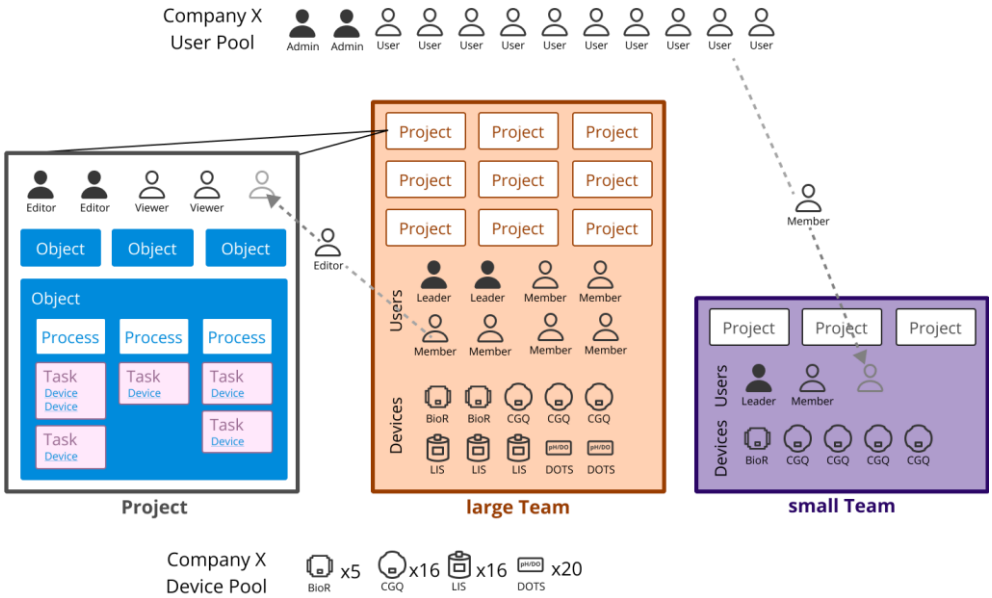


Figure 2: Projects are dynamic containers for Objects, and Users as Project Editors or Viewers. Teams are dynamic containers for Objects, Users as Team Leaders or Members, and Devices.

Application Templates

A well-designed workflow is the basis for every successful bioprocess. In the DOTS Software, **Application Templates** are used to define the complete structure and workflow of a bioprocess.

DOTS Software offers several preconfigured Application Templates for specific applications, which cover typical Experiment setups in biological labs. Templates are made delivered via various License types, which are explained in the following section Licensing models for Application and Task Templates. Available Templates are listed in Table 1. Feel free to contact us if your application is missing or you have suggestions for the current templates!

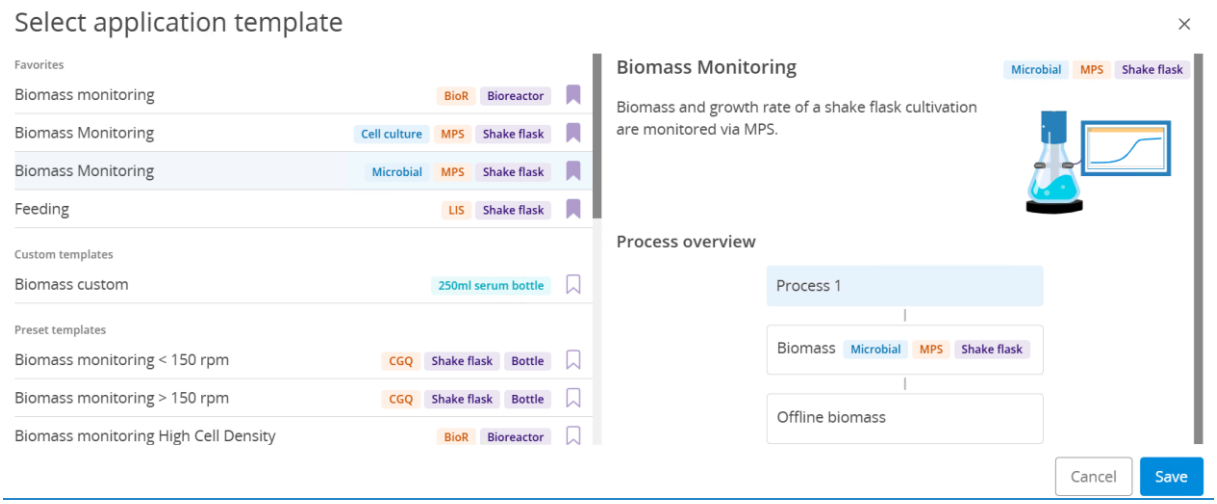


Figure 3: DOTS Software Application Templates.

Application Templates available in the DOTS Software

The Application Templates listed below are installed with the DOTS Software. Each Application Template contains a predefined set of **Task Templates** – the smallest building blocks of the DOTS Software. These Task Templates directly control your Devices and are programmed with all hardware settings.

All Templates come with a screening option. With this option, the measurement settings of each Task can be modified for individual Replicates of an Experiment (compare section “Individual Object Configuration” in the Experiment Creation wizard). Examples for screening applications are optimizing feeding strategies or exploring the influence of different carbon sources on an organism’s growth.

Table 1: List of Application Templates

Template [Application] **[Device]** [Vessel]	Example Application	Page
Biomass monitoring **[BioR]** [1]	Monitor growth of culture in bioreactor vessel	75
Biomass monitoring [Cell culture] **[MPS]** [2]	Monitor growth of cell culture in Shake Flask with the Multiparameter Sensor (MPS)	76
Biomass monitoring [Microbial] **[MPS]** [2]	Monitor growth of microbial culture in Shake Flask with the Multiparameter Sensor (MPS)	76
Biomass monitoring < 150 rpm **[CGQ]** [3]	Monitor growth of culture in Shake Flask at shaking frequency below 150 rpm	78
Biomass monitoring > 150 rpm **[CGQ]** [3]	Monitor growth of culture in Shake Flask at shaking frequency equal to and above 150 rpm	78
Biomass monitoring High Cell Density **[BioR]** [1]	Monitor growth of culture in bioreactor vessel with expected high cell densities (run a test Experiment or contact our support team to find out if you should use normal or high cell density mode for the BioR)	75

Biomass-based feeding **[LIS+CGQ]**	Trigger feeding of a liquid into a Shake Flask when a specific backscatter or growth rate is detected by the CGQ sensor.	79
DO and Fluorescence Monitoring [Cell culture] **[MPS]** [2]	Monitor DO (Dissolved Oxygen) and fluorescence at selected excitation/emission wavelengths of cell culture in Shake Flask with the Multiparameter Sensor (MPS). Biomass is measured as well.	76
DO and Fluorescence Monitoring [Microbial] **[MPS]** [2]	Monitor DO (Dissolved Oxygen) and fluorescence at selected excitation/emission wavelengths of microbial culture in Shake Flask with the Multiparameter Sensor (MPS). Biomass is measured as well.	76
DO monitoring [Cell culture] **[MPS]** [2]	Monitor DO (Dissolved Oxygen) of cell culture in Shake Flask with the Multiparameter Sensor (MPS). Biomass is measured as well.	76
DO Monitoring **[DOTS DO]** [Flow Loop]	Monitor DO (Dissolved Oxygen) in any flow loop, e.g., at a bioreactor, using a DO Flow Cell	80
DO monitoring [Microbial] **[MPS]** [2]	Monitor DO (Dissolved Oxygen) of microbial culture in Shake Flask with the Multiparameter Sensor (MPS). Biomass is measured as well.	76
DO-based Feeding **[LIS+MPS]**	The DO (Dissolved Oxygen) signal of a shake flask cultivation is used to control a LIS feed. Biomass is measured as well.	81
DO-based Feeding with Fluorescence monitoring **[LIS+MPS]**	The DO (Dissolved Oxygen) signal of a shake flask cultivation is used to control a LIS feed rate. Biomass and Fluorescence are monitored as well.	81
Feeding **[LIS]**	Feed a liquid into a Shake Flask according to a pre-defined feeding profile using the LIS system	82
Fluorescence monitoring [Cell culture] **[MPS]**	Monitor fluorescence at selected excitation/emission wavelengths of cell culture in Shake Flask with the Multiparameter Sensor (MPS). Biomass is measured as well.	76
Fluorescence monitoring [Microbial] **[MPS]**	Monitor fluorescence at selected excitation/emission wavelengths of microbial culture in Shake Flask with the Multiparameter Sensor (MPS). Biomass is measured as well.	76
pH & DO Monitoring **[DOTS pHDO]** [Flow Loop]	Monitor pH and DO (Dissolved Oxygen) in any flow loop, e.g., at a bioreactor, using pH and DO Flow Cells	80
pH Monitoring **[DOTS pH]** [Flow Loop]	Monitor pH in any flow loop, e.g., at a bioreactor, using a pH Flow Cell	80

1 In high cell density mode, the sensitivity of the BioR measurement is lower compared to the standard mode. This means that low cell densities in the beginning of an experiment might not be monitored since they do not exceed the background noise. In contrast, the high cell density mode enables measurements of far higher densities, where the standard mode would already be saturated.

2 Measurement configurations have been optimized for typical process conditions of two main application areas, cell culture and microbial, which differ substantially in shaking parameters, filling volumes, cell morphology and others. For special applications, such as filamentous fungi cultivations, please contact our support team.

3 For the template > 150 rpm, a function is implemented that automatically pauses and resumes the measurement based on the measured shaking speed (rpm). This results in no data being recorded while the shaking speed is below 150 rpm, e.g., the shaker is stopped for a sampling event (otherwise, an artifact/peak would be generated in the data). For the template < 150 rpm, this function is turned off, because a proper determination of a stopped shaker vs a shaker with low shake speed cannot be guaranteed.

You can design your own Application Templates in the DOTS Software by creating **Custom Application Templates**. While custom templates require more clicks to setup, they do not have to be built from scratch. The Task Templates used to define the Application Template come preconfigured and customizable. Build your bioprocess by combining Task Templates specific for your application.

Table 2: Preconfigured vs. Custom Application Templates

Feature	Preconfigured	Custom
Number of clicks	Low	High
Device configuration	Preset with option to customize	Customizable
Process Logic	Preset	Customizable

Licensing models for Application and Task Templates

Licenses in the DOTS Software are distributed on the Task level. That means, all Application Templates that contain valid Task licenses can be used, as shown exemplary in Figure 4. Furthermore, Custom Experiments can be configured using the licensed Tasks.

Number of seats. Each Task License includes a specific number of **seats**, which refers to the number of Tasks of this type that can be run in parallel. For example, if 25 seats for the Task "Biomass (MPS)" are licensed, the user(s) of this DOTS instance can start up to 25 Tasks. After that, running Biomass tasks must be stopped to be able to start new Biomass Tasks. Planned Tasks are not affected by the license seats, they may just not be able to start.

One active license seat is required for each running Task, including those inside different replicates of an Experiment, but also those inside the same Replicate. For example, two seats of the Task "Fluorescence" are required to execute two different modes of measurement (normal / high sensitivity) in the same shake flask.

Offered License types are

- **Perpetual License**: Buy once with predefined expiration date (or no expiration date). This license is bound to a specific DOTS Software major release version (e.g. DOTS Software 2), updates within the same major version (e.g. v 2.1, 2.2, 2.3 …) are included in this license type. When DOTS Software is updated to a new major release version (e.g. v 3.0), a new perpetual license is required.
- **Subscription license**: Pay yearly to keep the license (active renewal required). Other payment intervals on request. Subscription licenses always include the latest software version, as long as the subscription is running.

In the example below, the customer routinely performs DO based Feeding experiments using MPS (multiparameter sensors) and the LIS system. The team holds three perpetual licenses for the required Tasks "DO", "Biomass", and "Feeding" in DOTS Software version 2.0. For a new Project with a fluorescent-tagged product, the existing MPS are enabled to measure Fluorescence. A Fluorescence (MPS) Task is licensed as subscription and the subscription can be ended or extended when the Project is closed, or a follow-up project is started.

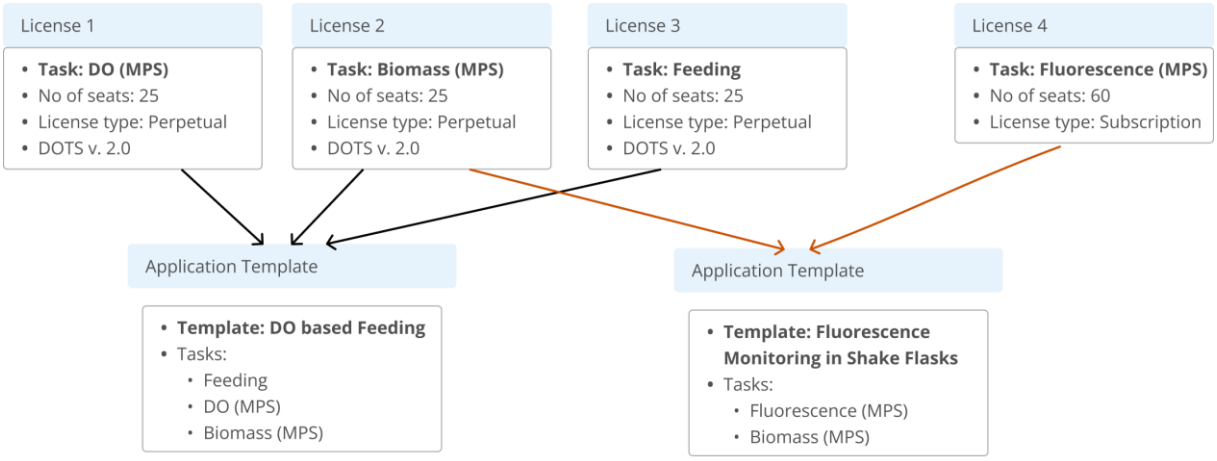


Figure 4: DOTS Software Licenses – Examples of Licenses and Task Templates that are based on these Licenses

Licenses are distributed for the usage in one specific instance of DOTS Software. Upon first time use, and after every license renewal, the license needs to be activated. This can be done automatically via Online Licensing, or manually (Offline Licensing). Both workflows are available on the Admin Page – Licences Tab (see respective chapter on p. 29). Licensed and Unlicensed Templates appear in DOTS Software as shown in Figure 5.

DOTS will remind Users of expiring licenses prior to the expiration date in predefined intervals (30 days, 21 days, 14 days, 7 days, 1 day).

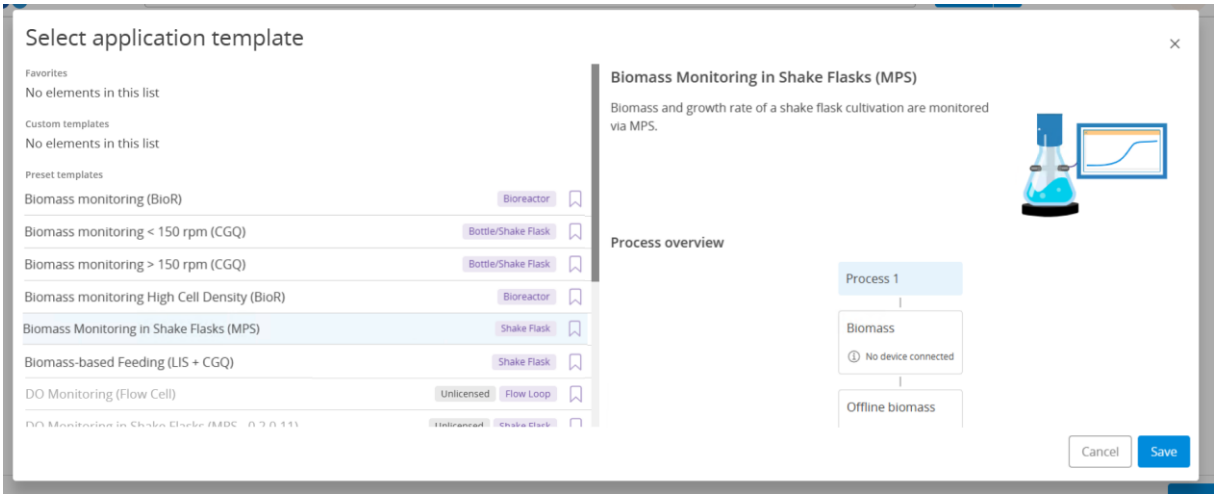


Figure 5: DOTS Application Templates in DOTS Software. Unavailable Templates are labeled “Unlicensed”.

Compatible Hardware / Devices

Different Devices can be interconnected to perform anything from a simple measurement to a complex series of Tasks. All SBI products can be integrated with the DOTS Software (Table 3). Selected third-party devices will continuously be added to the list (Table 4)– we will keep you updated on our website and in the newsletter.

Table 3: SBI Devices and compatibilities with the DOTS Software

Product	Function	Compatibility
CGQ / CGQ Bior Sensor	Online biomass monitoring in shake flasks and bioreactors	Sensors with Serial number format: CGQ-SP-F, CGQ-SP-B, CGQ-SP-C might require a firmware update. Sensors with Serial number format: CGQ-SP100-BV are incompatible.
CGQ Hub	Connection between CGQ and CGQ BioR Sensors and the controlling computer	8 port Hub: Serial numbers > 100 16 port Hub: Ask our support team
CGQ / CGQ BioR Gateway	Enables integration of a CGQ BioR Sensor with a 3rd party software	Incompatible
LIS Drive	Automated feeding in shake flasks	All (with the latest firmware)
LIS Wireless Hub	Connection between LIS Drives and the computer	All (with the latest firmware)
DOTS Fiber Optic Sensor with Flow Cells	Luminescence-based pH and / or DO monitoring	All
MPS (Multiparameter Sensor)	Online biomass, DO (dissolved oxygen), and fluorescence monitoring in shake flasks	All (with the latest firmware)
MPS Hub (7 or 16 ports)	Connection between MPS and the controlling computer	All

Table 4: Third-party devices compatible with the DOTS Software

Product	Compatibility
Kuhner shaker	Kuhner Shaker-Z/X series (ISF1-Z, LS-Z, Kelvin+, ISF1-X, ISF4-X, LT-X) via a NET60 module. For details see p. 41.

Contact our support team for instructions on how to update device Firmware. We are also happy to provide the hardware user guides and Quick Start Guides for all our products.

The DOTS Software takes one step further towards automation in the laboratory. It is designed as an all-in-one solution for all kinds of users and applications. New products and functions are constantly being developed at SBI that can later be integrated into the platform.

Check out our website at www.scientificbio.com or subscribe to our newsletter at https://www.scientificbio.com/subscription-center to get the latest updates on new applications and products.

Technical information

The DOTS Software is based on a frontend-backend architecture. The frontend handles the user interface (UI) of the software and is browser-based, which means that you open it from a web browser, while the backend is the brain of the DOTS Software and operates in the background. DOTS is currently optimized for desktop usage but can be accessed via mobile Devices.

All functions of the DOTS Software are accessed via a web browser, while the backend handles the communication between software and Devices, data storage and Processing, notifications, and all other services of the software. The Frontend, i.e., the web browser can be closed at any time without affecting running Experiments. Even backend restarts or Software updates can be performed while Experiments are running. There might be a delay of incoming data while the backend is stopped, but measurements resume as soon as the backend is running again. Measured data from Experiments are stored in a central database and can be exported and downloaded in .xlsx or .dotsdata (for import on other instances of DOTS Software) data format.

Because of the frontend-backend architecture of the DOTS Software, the software can be deployed on individual computers or run on a server computer that is accessible from other computers in the same network. Ask your admin to share the network address of the computer on which DOTS is running and type the network address into the browser address bar on your own computer. Contact our support team for additional help with network deployments of the DOTS Software.

The hardware requirements of the computer running the DOTS Software depend on the number of users and Devices. For a typical single-computer deployment, the recommended hardware requirements are:

- OS: Windows 10 (ensure OS version supports required browser version) or Windows 11
- RAM: Min. 8 GB
- CPU: min. 4 physical cores with at least 1.8 GHz
- Web browsers:
    - Microsoft Edge version 113 or newer
    - Google Chrome version 113 or newer
    - Mozilla Firefox version 113 or newer

Admins are responsible for adjusting Windows settings: The DOTS Software is intended to run constantly, since there are always bioprocesses running in the lab. Make sure to set the correct energy saving and Windows Update settings to prevent the computer from installing updates, entering sleep or energy-saving mode, or shutting down while DOTS is running. The DOTS Software will not shut down unless you force it to, or you shut down the computer that runs the Software.

- Start > Settings > Windows Update
- Start > Settings > System > Power & battery > Screen & Sleep (Advanced power settings)
- We recommend using the “High Performance” power plan. Contact our support Team to verify your settings.

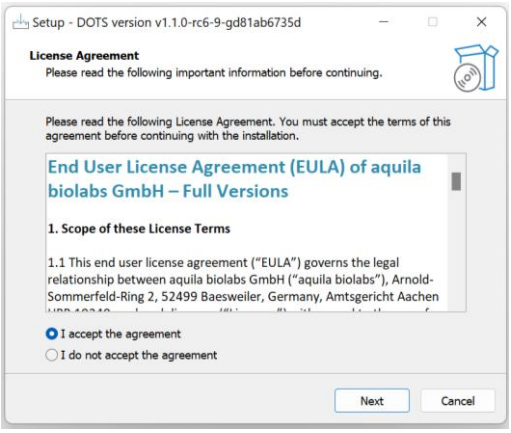
Installation and setup

Follow the steps below to install the DOTS Software. Don't hesitate to contact us if you need assistance. We are always happy to help!

NOTE: The same process is used for first-time installation of the DOTS Software and when updating the software to a new version.

We do not recommend updating the DOTS Software to a new version while Experiments are running. Any updates should be done once all Experiments are complete and active measurements are stopped.

Installing and updating the DOTS Software



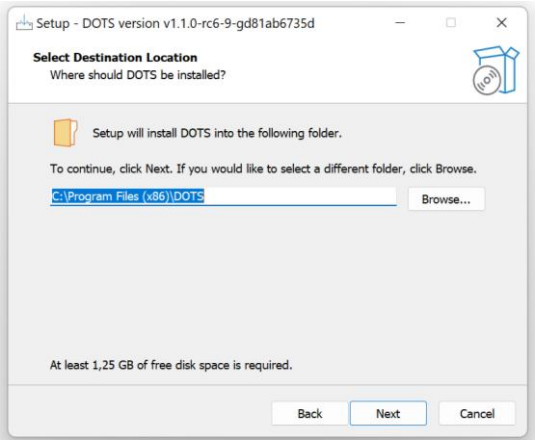
(Windows) System admin rights are required for first-time installation and when updating the software to a new version.

For first-time installation, run the DOTS-setup.exe delivered on a USB-Stick and follow the on-screen instructions.

To update the software, download the new version files from the link in the DOTS Software Update email. If you did not receive an email, check with your administrator, and contact us at insights@scientificbio.com to be added to the email list.

Accept the End User License Agreement and click Next.

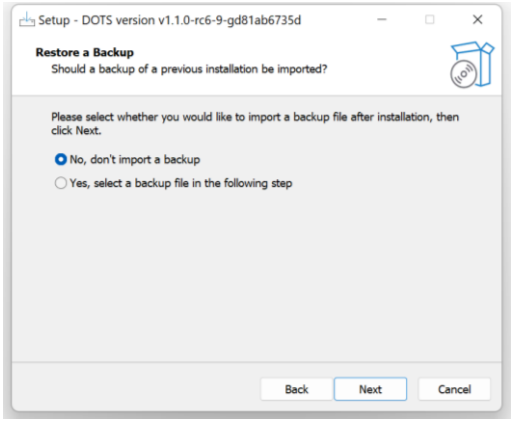
Figure 6: DOTS Software Installation – Step 1



For first-time installation, select the location where you would like the DOTS Software program files to be saved.

This step is not required when updating the software to a new version.

Figure 7: DOTS Software Installation – Step 2

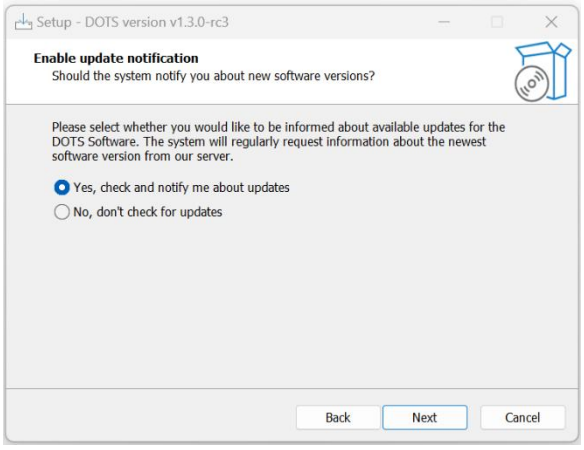


Select whether to import data from another DOTS installation during setup.

Leave the default "No" selected for first-time installation of DOTS without a backup file since no data exists yet, and when updating the software to a new version. **This selection will allow the installer to update the software while keeping all previously collected data so you can resume use of the software right where you left off.**

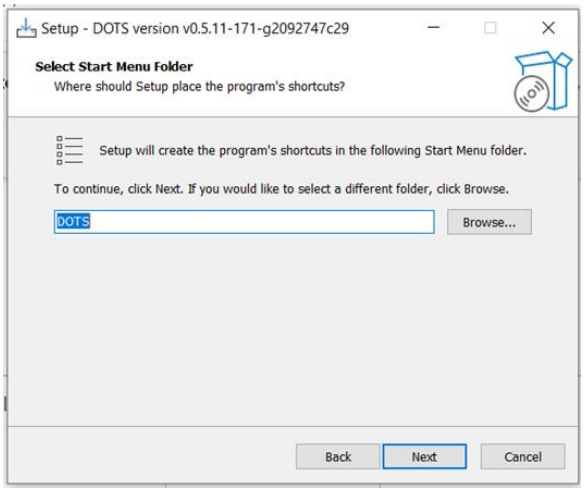
Select "Yes" if you would like to import data from another installation of DOTS. **This option is useful if are installing DOTS on a new computer and want to restore your data.** If you make this selection, you will advance to the screen shown in Figure 17 where you will be prompted to select the Backup file before moving on to Step 4 of the installation process.

Figure 8: DOTS Software Installation – Step 3



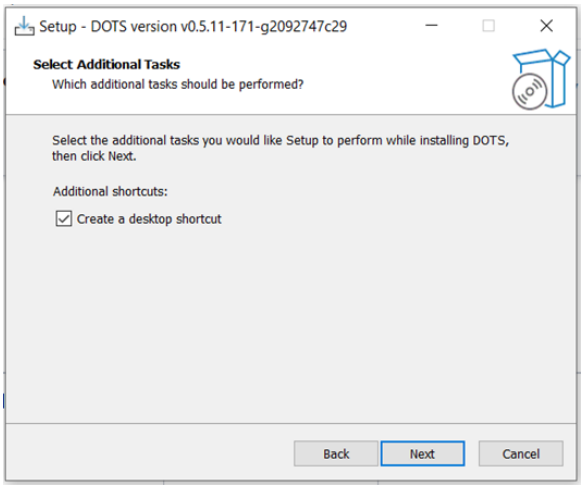
Select whether you want to receive in-software notifications when new versions are available for update.

Figure 9: DOTS Software Installation – Step 4



This step is not required when updating the software to a new version.

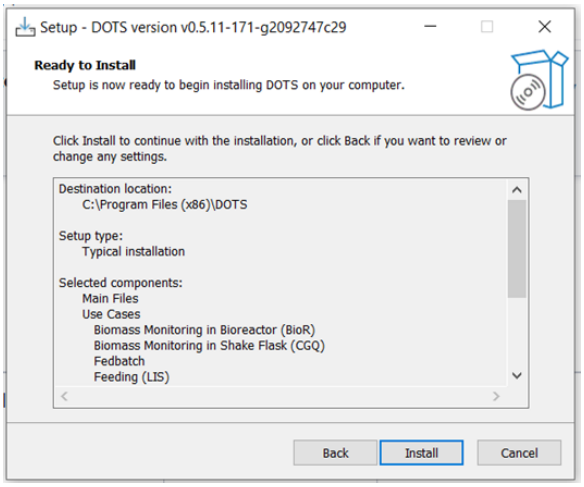
Figure 10: DOTS Software Installation – Step 5



Check this box if you want a Desktop shortcut to the DOTS Software.

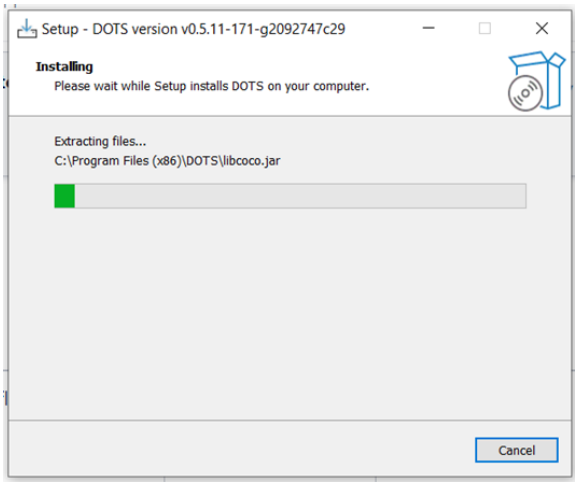
This step is required for both first-time installation and updating the software.

Figure 11: DOTS Software Installation – Step 6



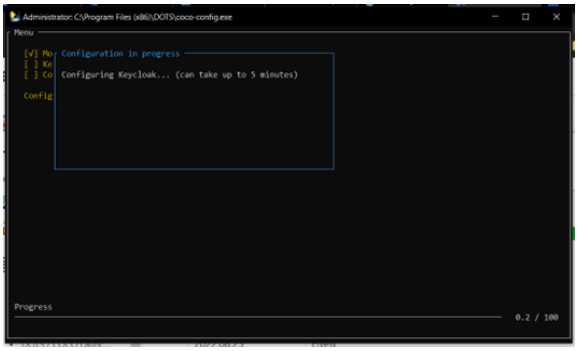
Click “Install” to start the process of installation or updating.

Figure 12: DOTS Software Installation – Step 7



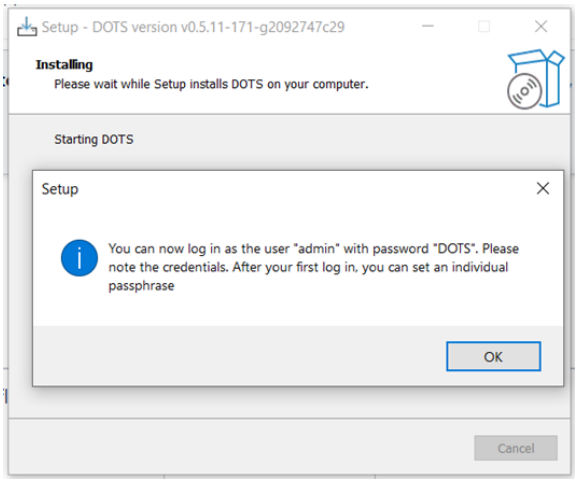
Wait for the DOTS Software to be installed or updated on your computer.

Figure 13: DOTS Software Installation – Step 8



A black window will open during the installation process. All three checkboxes should switch to “checked” and the window should close automatically. If a checkbox is missing and the window does not close by itself, please contact our support team.

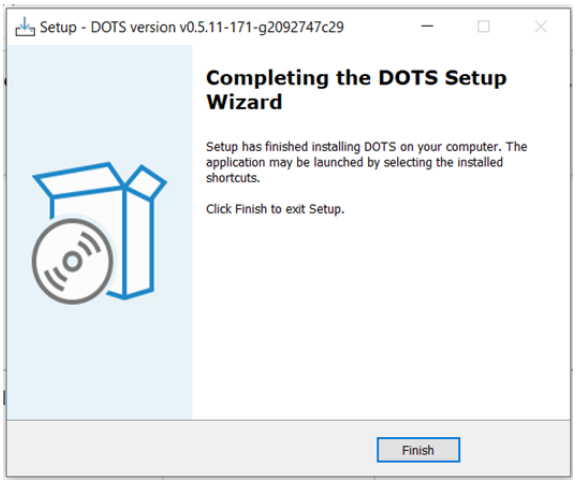
Figure 14: DOTS Software Installation – Step 9



Once the setup is done, you will get a notification with the first-time log in data. Click “Ok” to complete the installation Process.

Record the log in data for when you start the DOTS Software for the first time.

Figure 15: DOTS Software Installation – Step 10



Click “Finish” to complete the DOTS Software installation.

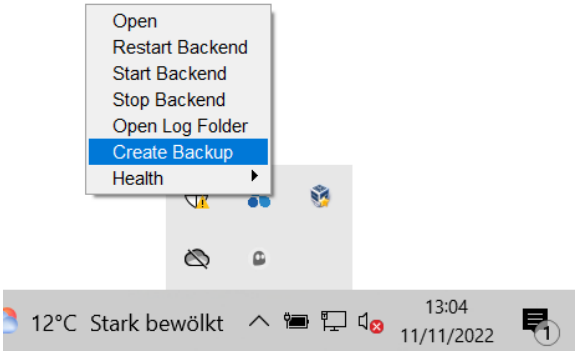
Figure 16: DOTS Software Installation – Step 11

Restoring the DOTS Software from a Backup File

The DOTS Software can be restored based on a backup file from a previous installation of the software. All data collected up to the time of the backup will be included and loaded into the new installation of the DOTS Software. To create a backup file and restore your historical data, follow the steps below.

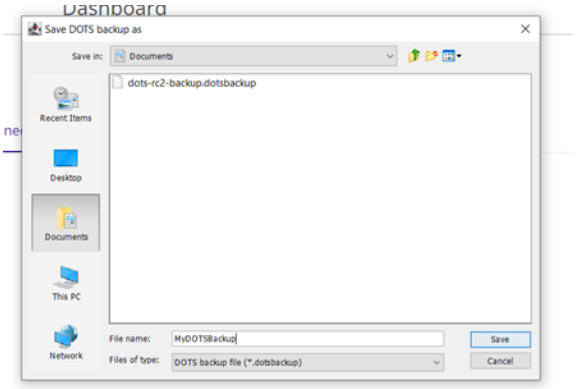
Note that admin rights are required to create a backup file.

Creating a Backup File



Right click on the DOTS System Tray icon and select “Create Backup”

Figure 17: Creating a backup file – Step 1



Enter a name for the backup file and define where you would like the file to be saved.

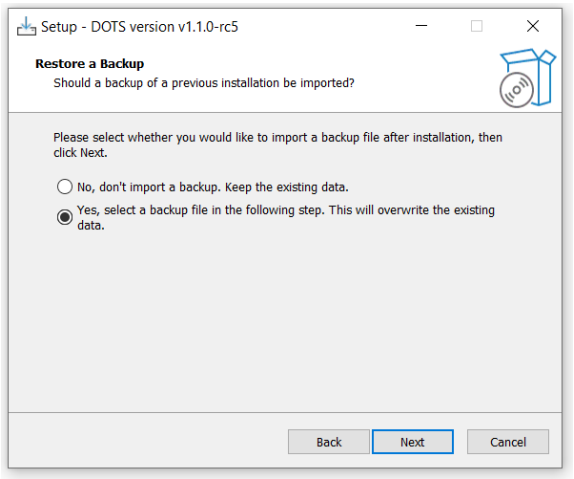
Click “Save”

Figure 18: Creating a backup file – Step 2

The backend will stop for a short time to perform the backup routines and generate the backup file. To ensure the backup file contains all data, make sure no experiments are running when you create the backup.

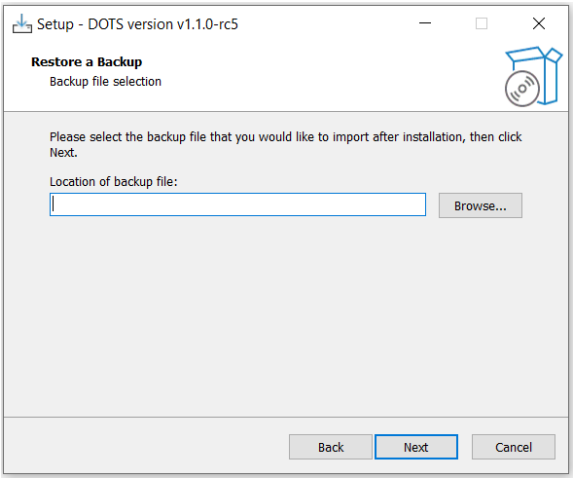
Use regular names for backup files. Names containing symbols that are generally not allowed for files in Windows (e.g., asterisk *) cannot be used to create a backup.

Additional installation steps



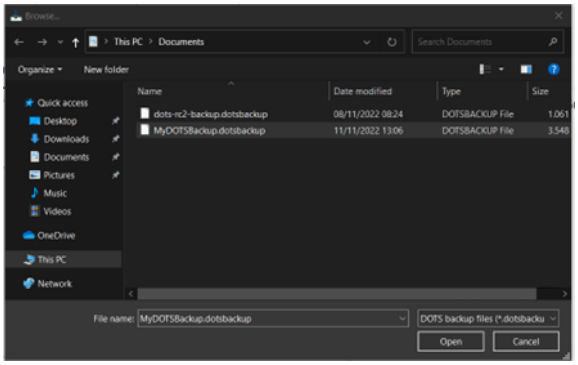
To restore previously collected data with a new installation of the DOTS Software, select “Yes’ during Step 3 of the installation process.

Figure 19: DOTS Software Installation – Step 3



Navigate to the location where you saved the backup file by clicking “Browse”

Figure 20: DOTS Software Installation – Step 3a



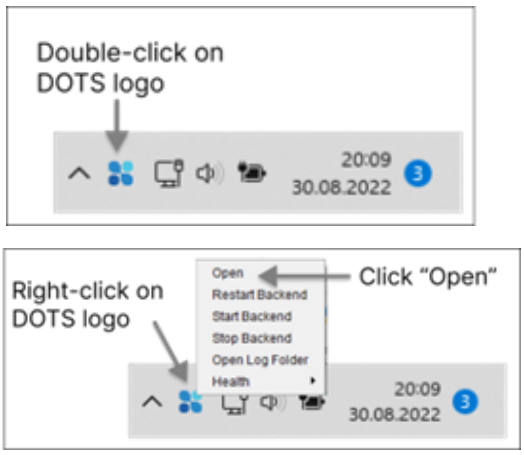
Select your backup file and click “Open”

You will be redirected to the screen shown in Step 3a. Click “Next” to resume the normal installation process from Step 4 (Figure 6).

Figure 21: DOTS Software Installation – Step 3b

Getting started with the DOTS Software

To start the DOTS Software, double-click either the Desktop icon or the DOTS System tray icon, or right-click the DOTS tray icon and click “Open”. Alternatively, you can search for and launch the DOTS Software App from the computer Start menu.

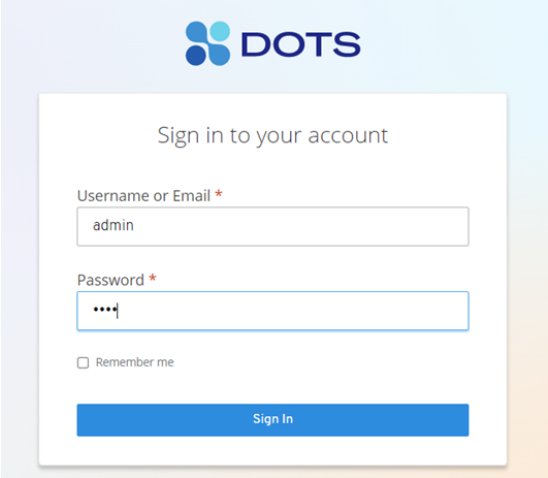


Double-click on the DOTS Desktop icon or the DOTS tray icon to start the DOTS Software.

You can also right-click on the DOTS tray icon to see a full menu. Click on “Open” to start the DOTS Software from the menu.

If you cannot see the DOTS icon, you might have to expand the tray area via the upright arrow ^.

Figure 22: Starting the DOTS Software from the tray icon



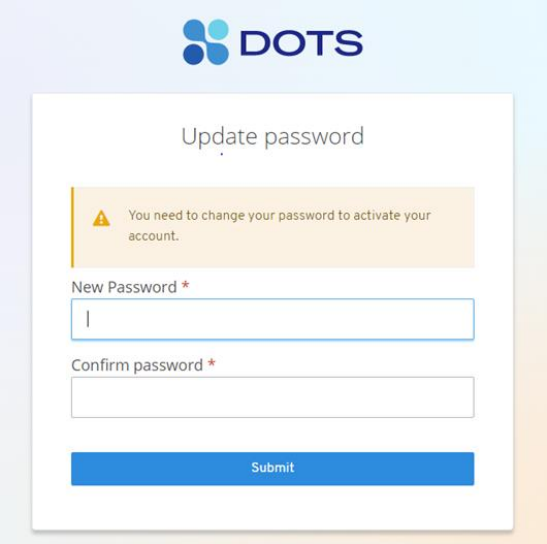
Your default browser opens the DOTS login page. If you want to use a different browser, copy & paste the address or just type “localhost” into your browser address bar.

Login with the default admin account:

- Username = admin
- Password = DOTS

Bookmark the login page in your web browser for future quick access.

Figure 23: Logging into the DOTS Software with the default admin account

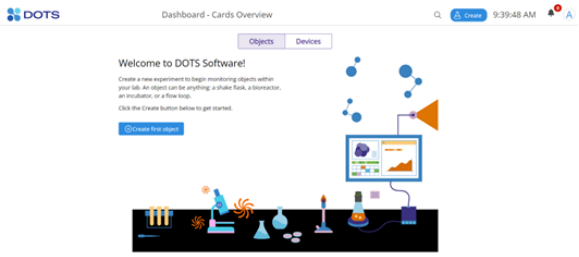


You will be prompted to change the default admin password.

Type in a new password for the User “admin”. This will be the login information for the account with administrative privileges.

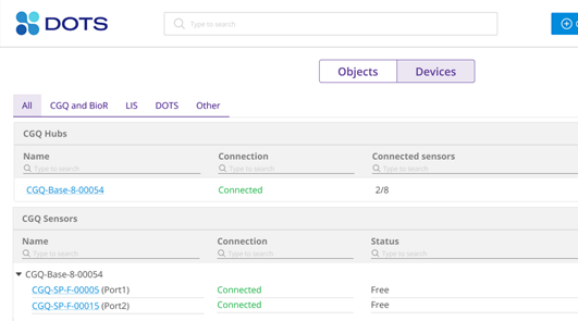
Make sure to remember your new password.

Figure 24: Setting a new admin password



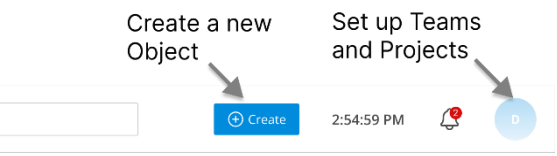
The software will open to the Dashboard. You can switch between the Devices and Objects (Experiments) view by clicking the tabs at the top of the page.

Figure 25: DOTS Software Dashboard – Objects view



To get started, connect your Devices to your computer. They will appear automatically in the Device List.

Figure 26: DOTS Software Dashboard – Devices view



To begin monitoring objects in your lab right away, create an Experiment. It will be assigned to a Default Team and Project. (You can move the Object to a custom Team and Project later.)

To set up your own DOTS Software Team and Project infrastructure, follow the steps in the next section.

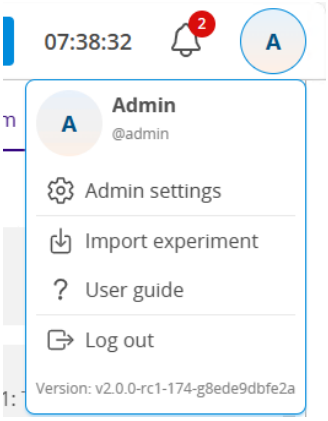
Figure 27: How to Create an Experiment or navigate to the Admin page

Setting up the DOTS Software infrastructure

The Admin Page

The Admin Page provides tools to organize the whole Team and Project infrastructure within the DOTS Software. Any user with admin rights can access the Admin Page via the user icon in the top right corner of the screen. From there, an admin can manage User accounts and access rights to Projects and Devices, as well as monitor system status.

Tip: All service functions can be monitored by the blue panels at the top of the Admin Page (green circle = healthy).



1. Access the Admin Page
2. Import a .dotsdata file to upload experimental data from another instance of DOTS.
3. Access the most recent pdf of the DOTS Software user guide.
4. Logout of your account.
5. View which version of the software is currently installed on your computer.

From the **Admin Page**, you will:

1. Check the health of the Backend services.
2. View log files.
3. Create User accounts.
4. Set up Teams.
5. Define Projects.
6. Assign Devices to Teams.

Details are explained in the following panels.

Figure 28: Navigating to the Admin Page

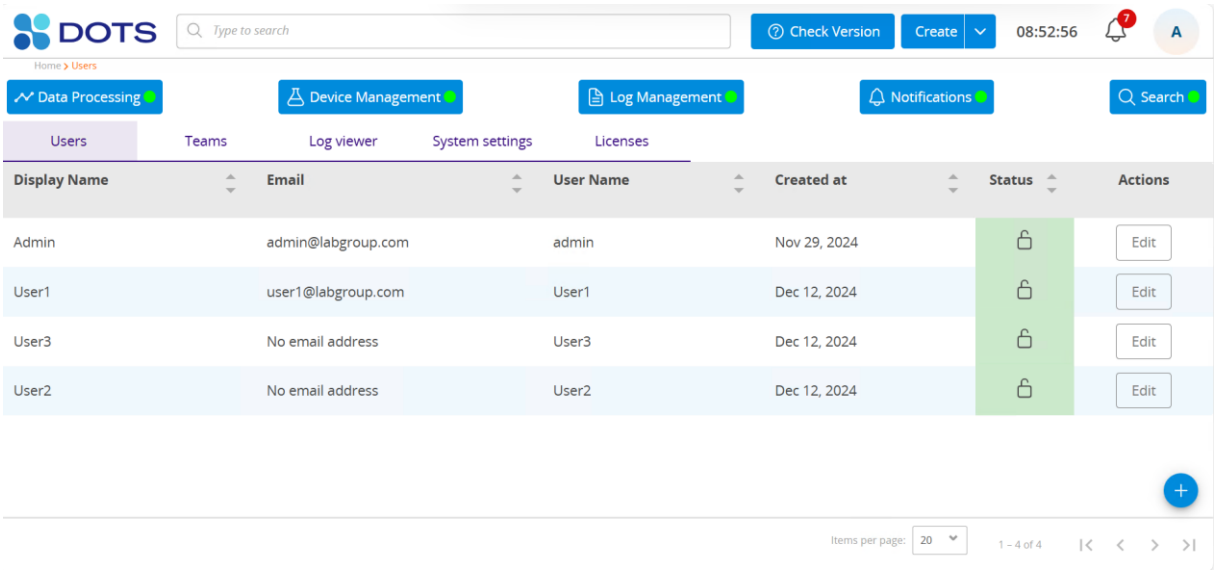


Figure 29: Admin Page overview („Users" Tab).

The Admin Page – Backend service health indicators

The blue health indicators in the top row of the Admin Page inform you if there is a serious problem with one of the different backend services of the DOTS Software. Because they operate independently from one another, even if one service fails the rest will continue to function as normal. For example, if there is a problem with the "Notification" service, your Experiments are unaffected, and data will still be recorded. If a problem occurs, check the Log Viewer tab for details and contact our support team.

Figure 30: Admin Page – Service status panels

The Admin Page – Log Viewer tab

While frontend errors are collected by the Notifications center and are visible to all users, backend errors are written in log files and stored on the computer that runs the DOTS Software. Admins can review these errors on the Admin Page in the "Log Viewer" tab and can filter by the type of message or show only errors in a certain time range.

When a serious problem occurs, all log files need to be sent to our developers so they can analyze the problem.

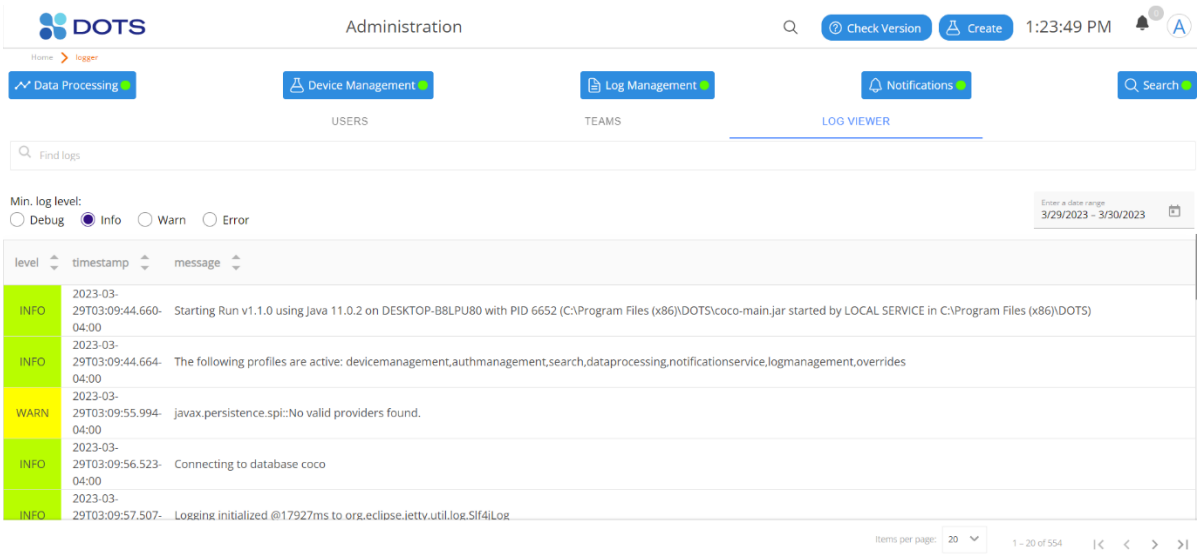
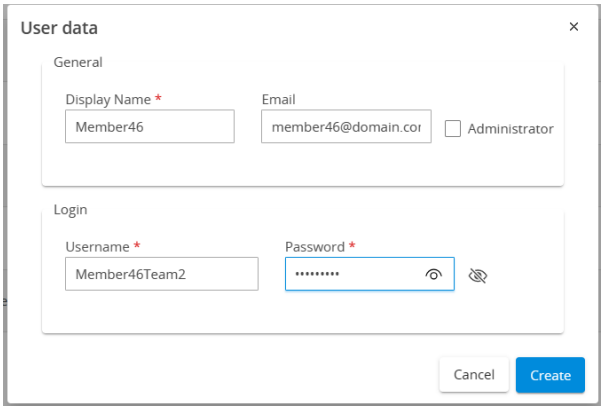


Figure 31: Admin Page – Log Viewer tab

The Admin Page – Users tab

Manage Users. To create a new User account, click on the plus icon on the bottom right. Follow the steps in Figure 32.To modify details of a User account, click on the "Edit" button behind a user in the list. In the pop-out window, make your changes, and click "Save". Note that the password will not be overwritten if you do not enter anything new in the field "password".



- Enter a Display Name (the name that will be visible to all other users) and login name with password.

Enter an e-mail address if the features of the

- will be used to send out e-mail notifications to this user
- Decide whether this User should have admin rights by checking the respective checkbox.
- Click "Create". You will now see the new user in the Users list.
- Hand the login data to the person that you created the account for

Figure 32: Creating new User accounts in the DOTS Software

Block / Unblock Users. Users with a green lock on the Admin page overview (Figure 29) can use DOTS Software. A red lock means the User account is blocked, i.e., the User cannot log in. Change the lock by simply clicking on it.

The Admin Page – Teams tab

Each Object in DOTS must be assigned to exactly one Project that belongs to a specific Team. Go to the “Teams” tab to access Teams.

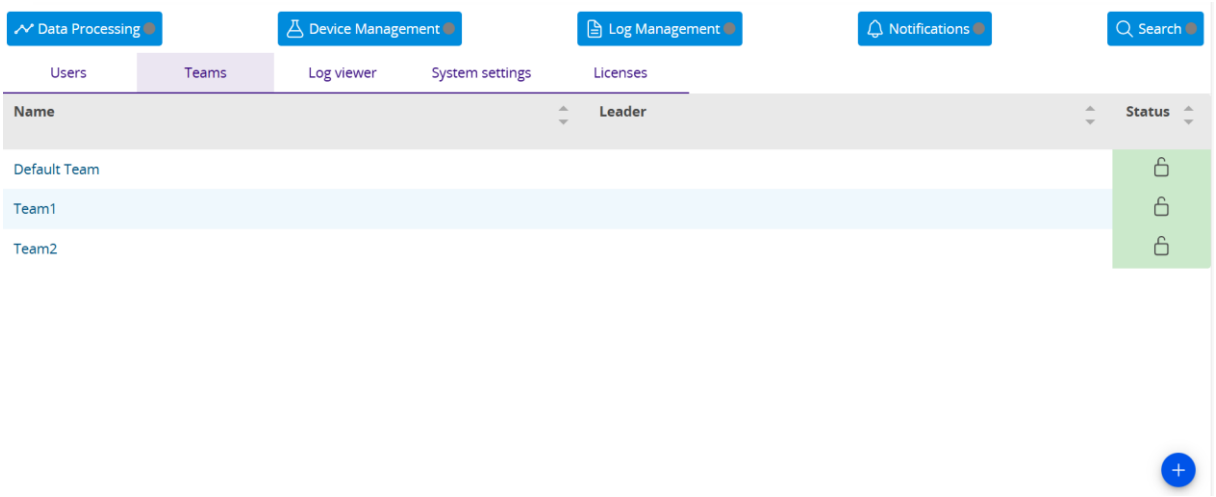
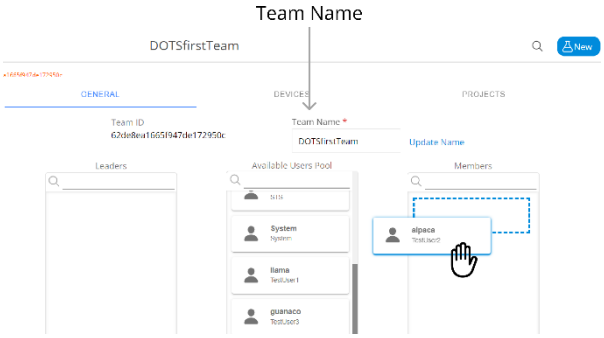


Figure 33: Admin Page overview: “Teams” tab

Click on the plus on the bottom right to create a new Team or click on an existing Team to modify it. This directs you to the Team Page, which contains its own tabs that are explained in the following sections.

The Admin Page – Teams: General tab

After creating a new Team or clicking on an existing Team Name from the Admin Page, you will be directed to the Team overview page (General tab) which contains additional tabs for Projects and Devices. These tabs enable the Admin to assign Projects and Devices to different Teams.



Set up Teams
Go to the “Teams” tab and click on the blue **+** symbol in the bottom right corner. Enter a Team Name and click “Create Team”.

A list of all previously created Users will appear. Use drag & drop to assign Users to a Team, either as Team Leaders or Team Members. (See for access rights.)

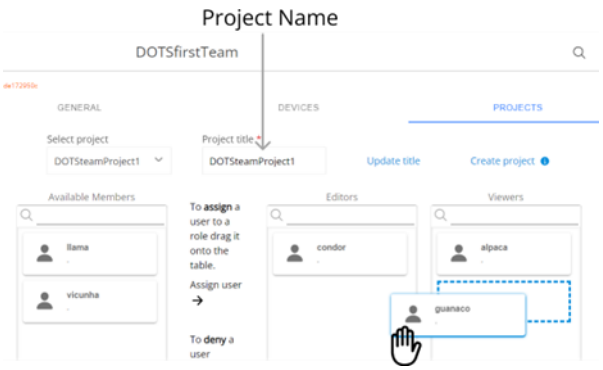
Manage Teams
Click on an already-existing Team Name. You will be directed to the General tab for that Team, where you can update the Team name and edit which users are Team Leaders vs Team Members.

Users must be part of a Team to be able to use DOTS.

Figure 34: Setting up new Teams in the DOTS Software

The Admin Page – Teams: Projects tab

The Project tab of the Team Page can be accessed by Admins, but also Users with Team Leader rights.



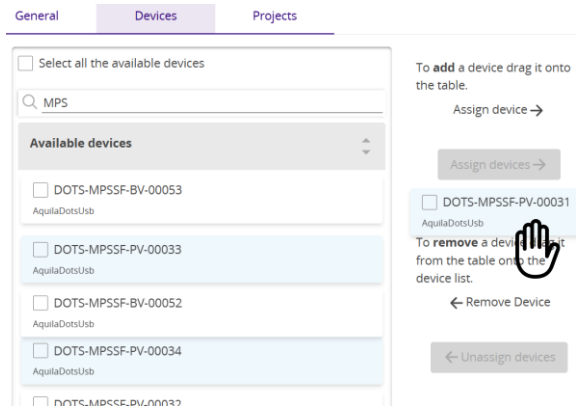
Define Projects
If you are a Team Leader, click on “Team Management” from the User icon in the top right corner of the DOTS Software. Go to the “Projects” tab for a previously created Team.

Type in a Project name in the “Project title” box and click “Create project”. Use drag & drop to assign Users from the Team (left list) to the Project as either editors (middle list) or viewers (right list). (See for details on access rights.)

Manage Projects
Select an existing Project from the “Select project” drop-down. Enter a new name in the “Project title” box and click “Update title” to update a Project name. Use drag & drop to edit which Members have editing vs viewing rights.

Figure 35: Defining new Projects in the DOTS Software

The Admin Page – Teams: Devices tab



Assign Devices:
Go to the “Devices” tab for a previously created Team. All Devices that have ever been connected to the computer will appear in the far-right list. Use drag & drop to assign Devices to a Team. Use the search bar and the check-box “Select all the available devices” for easier assignment.

Assigned devices may only be used by members of the corresponding Team / Project.

Important: Devices that have not been assigned will not be accessible to Users on newly created Teams / Projects. Make sure to assign all relevant devices.

Block Devices
Move a Device from the left list back to the right using drag & drop. The Device will no longer be accessible to the Team.

Figure 36: Assigning Devices to Teams in the DOTS Software

The Admin Page – System settings tab

System settings contain options for CSV auto export and e-mail configuration.

If auto export is enabled, all DOTS Experiment data will be continuously exported to .csv files with the specified settings. For each experiment, one file is generated in the specified folder.

To enable DOTS to send e-mails, an e-mail account for DOTS needs to be setup. Once done, enter the server details in the DOTS e-mail configuration and click “Save”.

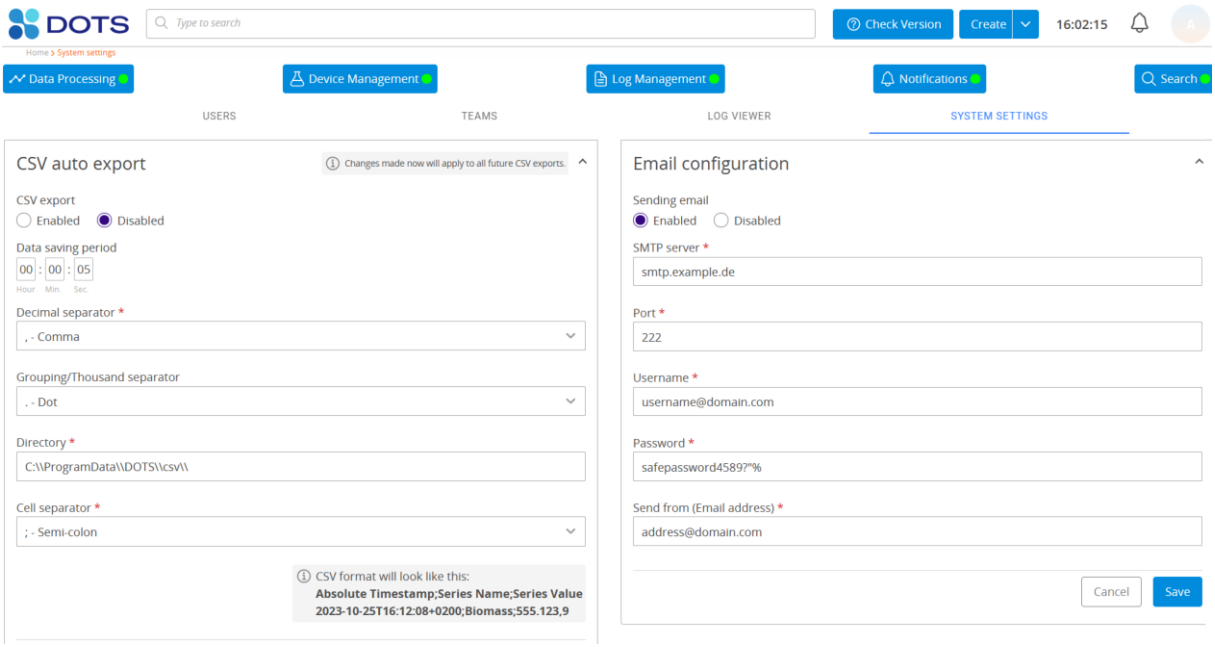


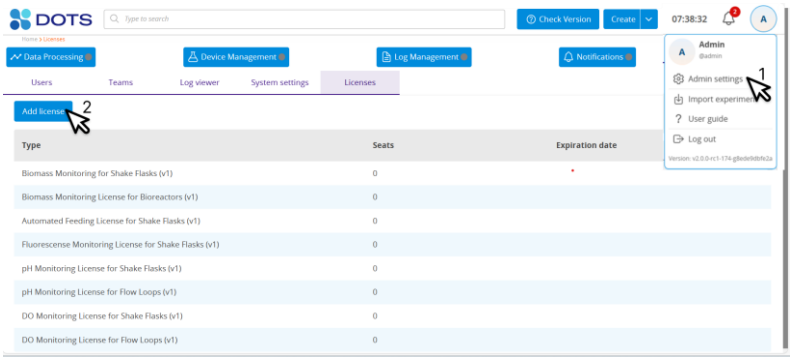
Figure 37: Configuring CSV auto export and e-mail settings in DOTS.

The Admin Page – Licenses tab

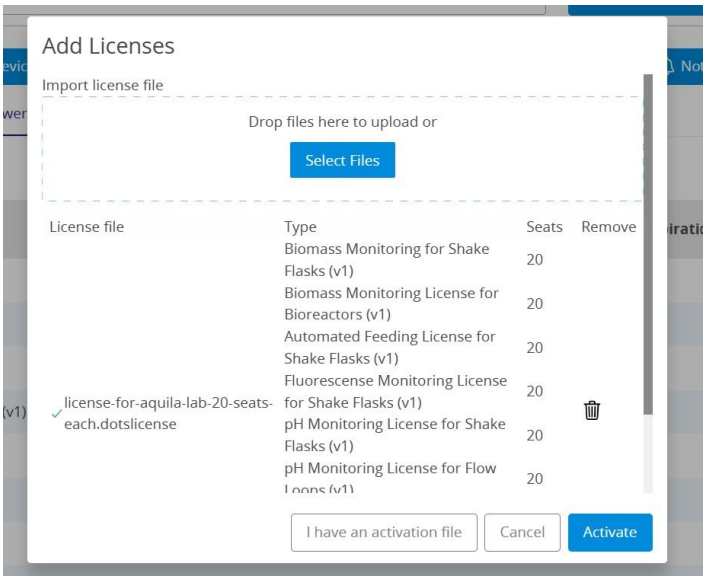
Licenses are managed by Admins. They are shipped as .dotslicense file via e-mail or USB stick. Licenses are activated automatically after addition to DOTS (see below "Online License activation (automatic)") if the DOTS instance has internet access. If this is not the case, refer to the section below "Offline License activation".

Licenses are activated for a specific hardware. You can reuse license files on the same hardware after a DOTS reinstallation (in case the DOTS version remains compatible with your License).

Online License activation (automatic)



1. Log in as an Admin and go to the Admin Page.
2. Go to the Tab "Licenses" and click the blue button on "Add Licences"

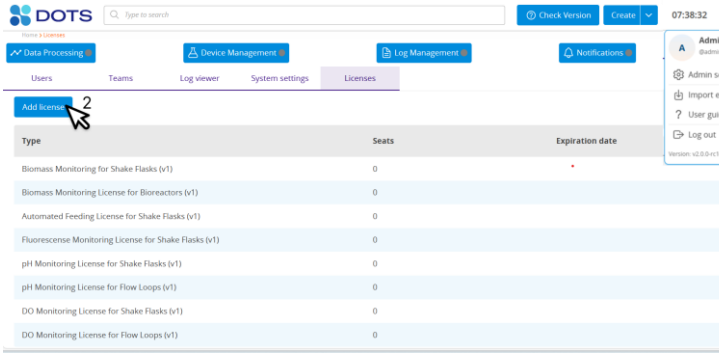


3. In the popout dialog, upload your licence file(s) via the dropzone. The seats contained in this license are shown.
4. Click “Activate”. DOTS Software automcatically connects to the Licensing Server and the licenses will get activated.
5. Once the dropzone disappears and only the list of your activated Licenses is shown, click “Done”.

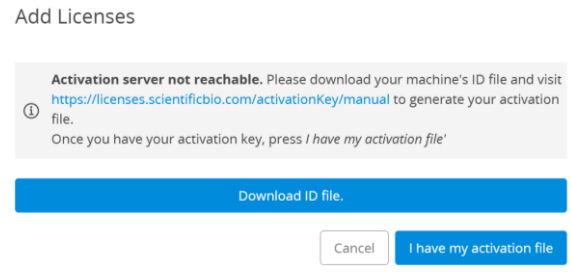
Figure 38: Adding DOTS Software Licenses – Automatic License activation

Offline License activation

In case the PC with the DOTS instance does not have internet access, DOTS Software recognizes that the licensing server is not available. License activation can be done manually in this case.

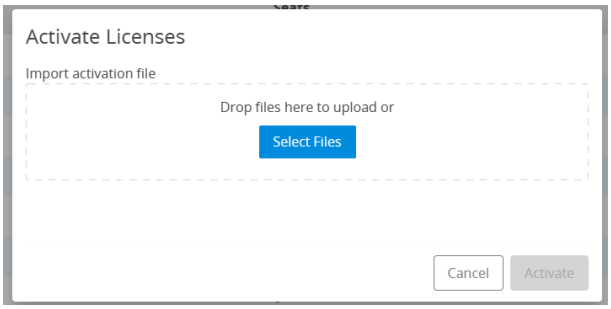


1. Log in as an Admin and go to the Admin Page.
2. Go to the Tab “Licenses” and click the blue button on “Add Licences”



3. DOTS Software recognizes that the activation server cannot be reached. Follow the instructions. Click on the blue button “Download ID file”. This will start an automatic download of a .dotshwid file. Transer this file and the license file to a computer with internet access.

4. Enter the website specified by DOTS Software: https://licenses.scientificbio.com/activationKey/manual
5. Upload your license file and hardware ID file, and click on Activate.
6. An automatic download of a .dotsactivation file will start. Transfer this file, which contains the now activated License, to the PC that runs your DOTS instance.



7. Repeat step one. In the popout, click on “I have my activation file”. Upload the file via the dropdown field and click “Activate”.

Figure 39: Adding DOTS Software Licenses – Automatic License activation

User accounts

There are three types of User accounts in the DOTS Software with different access levels and permissions.

- Admins have access to the Admin Page, i.e., full control of Teams, Projects, and Devices.
- Team Leaders have access to the Team Management Page, and thus have control of Projects.
- Users can be granted either Viewer or Editor rights and cannot manage Teams or Projects.

Clicking the round User icon in the top right corner of the Dashboard will display the full username and provide a path to either the Admin Page (for Admins) or the Team Management page (for Team Leaders). Note that the displayed name and the login name can differ, see "The Admin page – Users tab" section.

Users can logout of their accounts by clicking the icon in the bottom left of the pop-out ( ).

The current version of DOTS Software is displayed on the bottom right of the pop-out.

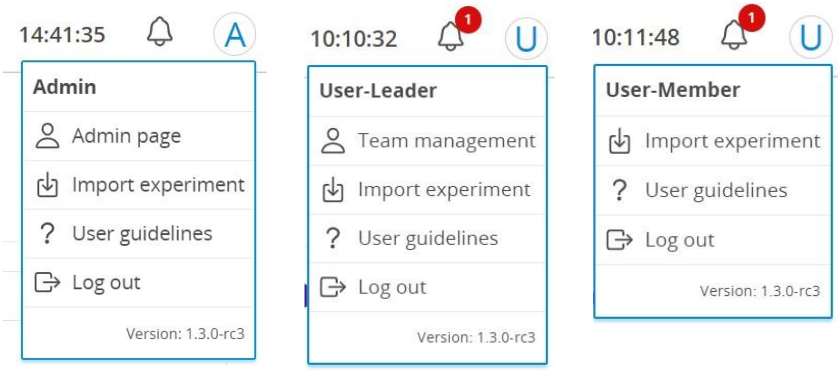


Figure 40: Available permissions for each of the three types of User accounts

Team and Project management (Admins and Team Leaders)

In the DOTS Software, multiple Teams can be defined by the system Administrator. Each Team has its own set of users, Projects, and Devices. With the DOTS hierarchy, it is possible to use a single instance of DOTS Software and keep knowledge and data within defined Teams and Projects. You decide who has access to which data – with maximum flexibility.

Teams and Projects are managed on different levels by Admins, Team Leaders, and Project Editors. Table 5 summarizes all rights and functions of the possible User Roles.

Table 5: Access rights and User roles

Level	User roles	
Account	Admin Can add, block, unblock user accounts Can promote user to admin Can define Teams and assign Devices and users to the Teams (“Team leader” or “member” role)	User Cannot create Teams or assign Devices and licenses Roles are assigned to a user: Leader, Member, Editor, Viewer
Team	Leader Can create new Projects within the Team Can assign / remove any user – who is part of the Team already – to a Project within the respective Team	Member Can create, modify, or view Objects within a Project Cannot create Projects or add / remove users Can assign new Experiments to different Projects
Project	Editor Objects can be created and modified	Viewer Objects can be seen but not modified

Based on the different User levels, the resulting workflow in a Team using the DOTS Software is as follows:

Table 6: Workflow and User roles

Step	Minimum User level	Tasks
Setup DOTS Software basic components	Admin	Create user accounts (Admin / non-Admin) Create Teams Connect Devices to the DOTS Software
Create Team infrastructure	Admin	Assign Users to Teams as Leaders or Members Assign Devices to Teams
Manage Team and Projects	Team Leader	Create Projects Assign Team Members to Projects as Editors or Viewers
Perform Experiments	Project Editor	Create Experiments and assign to Projects
View Experiments	Project Viewer	View Experiments and Object data Download Object data

DOTS Software components and functions

The Menu bar and central components

The header of any page – the **Menu bar** - connects the main components in the DOTS Software. From the Menu bar, you can access:

- The Dashboard with overviews on Experiments and Devices
- The Search bar – type in the name of anything you are looking for, from Objects to Tags
- The Notification center – see alerts and messages related to system performance and Experiment status
- The Experiment Creation wizard, including Turbo Templates – your fast track to monitoring Objects in the lab
- The User center – all functions around Team and Project Management (for Admins and Team Leaders), the DOTS data import button, access to the Software User Guide, and the account logout button.

The Dashboard

The Dashboard is the default page in the DOTS Software. From the Dashboard, you get a first look at the Menu bar as well as an overview on Experiments, Object data, and Devices integrated with the DOTS Software. Use the tabs at the top of the page to toggle between Objects and Devices.

Objects can be shown in a Card view or List view, while Devices are displayed in filterable lists. Object Cards provide a compact overview which combine certain monitoring and control functions with a data preview. The Object list provides more detailed background information on each Object, as well as a shortcut to data export.

Use the toggle on the top right to switch between Card view and List view on the Objects tab.

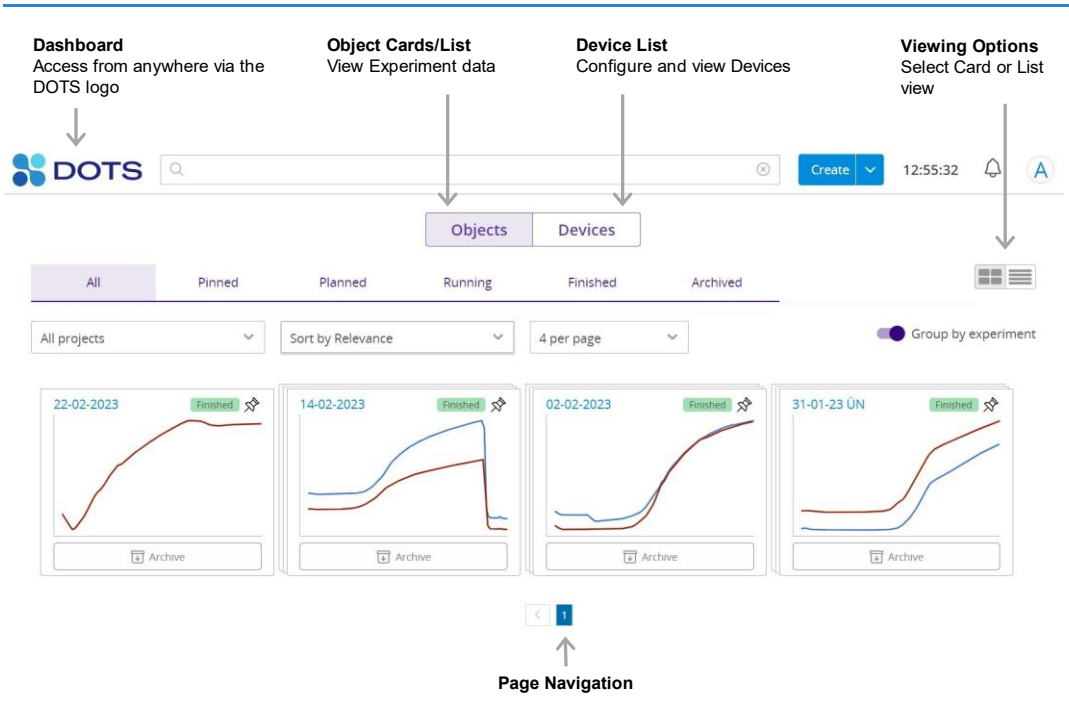


Figure 41: The DOTS Software Dashboard – an overview

Objects – Card view

The Object Cards provide a certain level of control with a compact overview of Experiment data. The cards contain graphs for a real time data preview, and quick actions that apply to all Processes within the Object (Figure 42).

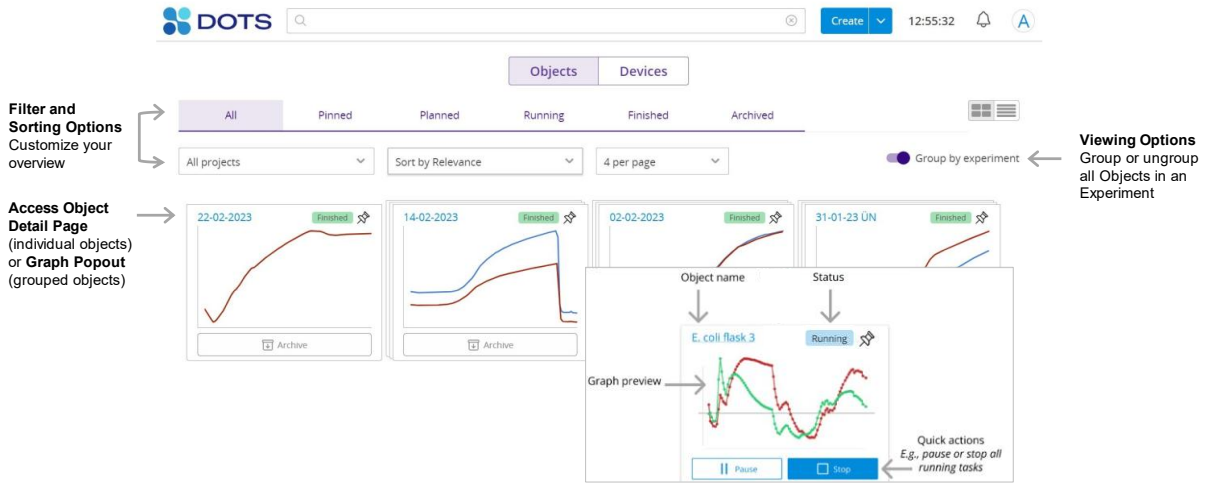


Figure 42: The Dashboard – Object Cards

Sorting Object Cards

You can filter Cards according to the run status of each Experiment (Planned, Running, Finished, Archived) using the upper tabs, and can also filter based on the Project of interest by selecting from the dropdown menu. You may also choose whether to sort your Experiment cards based on date created or date last modified. Finally, you can select how many Cards you want per page; more cards will enable you to see more data simultaneously but could result in slower Dashboard loading times.

NOTE: Archived Objects are removed from the "All" tab and appear only within the "Archived" tab.

Grouping Objects

Objects within the same Experiment are shown as one group for a simplified overview. Use the toggle "Group by Experiment" to group / ungroup Objects. With the toggle to the left, all Objects are shown as individual cards. With the toggle to the right (default), multiple Objects that are part of one Experiment (replicates or screening) will be shown as one group. Grouping works for Objects that have been created simultaneously in the Experiment Creation wizard. The grouped Experiment Card shows a graph with the primary data series for all Objects in the Experiment.

Graph preview

Real time data for each Object is displayed in a graph on each Object card. Note that the preview graph is always the graph in the first tab on the Object Detail Page. For an Object group, the preview graph will display the combined data from all Objects within an Experiment. If you want to see other data on the Dashboard, configure the first graph tab accordingly (see Graph Configuration).

The graph preview on the Dashboard is updated regularly depending on the sampling rate of the data.

Quick actions

The quick action buttons on the bottom of an Object Card **control multiple Tasks at once**. You can Start, Stop, Pause and Resume all Tasks that are in the same state. You can also archive Finished experiments (whether for single or multiple Objects). To give some examples, all running Tasks can be paused or stopped at once, all paused Tasks can be resumed at once etc. If there is a LIS Task included, LIS-specific operations are available (upload, prepare). Whenever there are several options, you can choose from a dropdown menu. For more detailed control on Task level, click on the Object Name on top of the Card to open the Object Detail Page.

If your Object contains more than one Process, the quick actions on the Dashboard are applied to Processes in a consecutive manger. To ensure that Tasks within consecutive Processes are started simultaneously, go to the Object Detail Page (Click on Object Name) and control Processes manually.

Experiment (grouped Object) options:

Click on the Experiment name to open the grouped Object pop out (Figure 43). From the pop out you can visualize labeled Object data, adjust the graph view using the in-graph controls, view the Experiment status, and perform the actions detailed in Table 7.

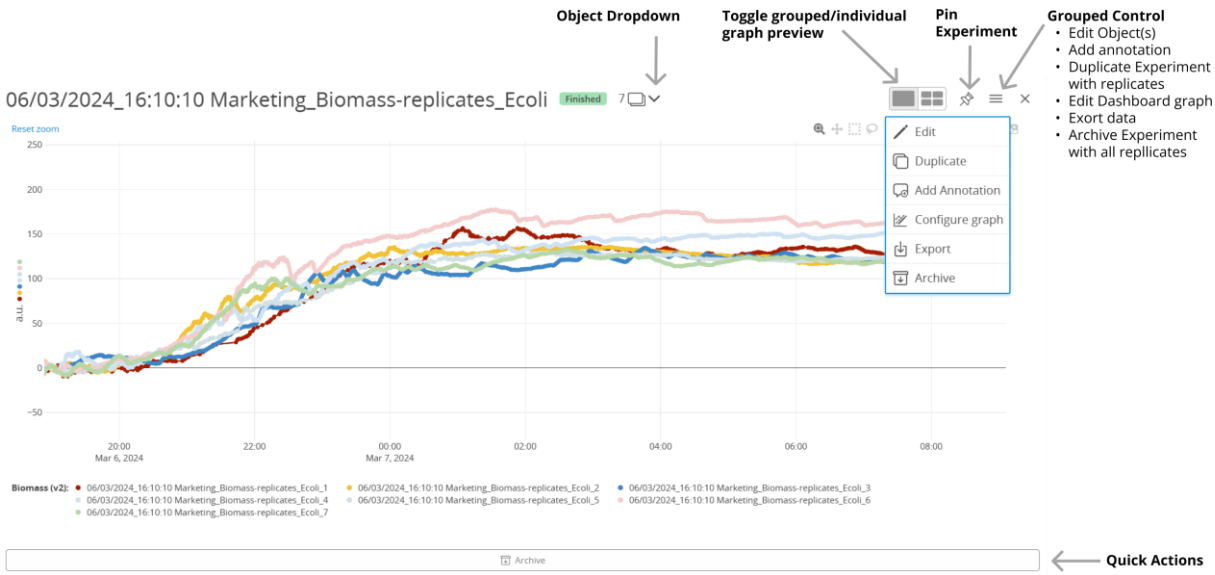
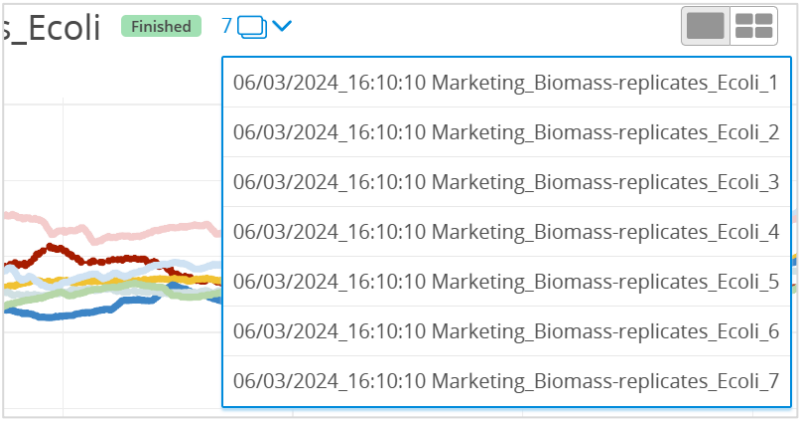


Figure 43: Grouped graph pop out. By default, the primary data series for all Objects in an Experiment group are shown.

Table 7: Grouped Object Actions

Icon	Function	Explanation
7	Grouped Object dropdown selector	Click the dropdown for a list of all Objects in the Experiment group. Click on an Object name to navigate directly to the corresponding Object Detail page. 
	Adjust view	Choose to show either a combined graph , or a separate graph for all objects.
	Pin Experiment	Pin the Experiment Card on top of the Dashboard, so it is always shown among the first Cards on the Dashboard
	Edit Experiment	Enter the Creation Wizard in Edit mode and edit Details on Experiment or individual Object level
	Duplicate Object	Duplicate the Object to create a new Experiment with the same configuration parameters and assigned Devices. Simply update the Experiment name and click through the Creation wizard.

	Graph Configuration	Configure the Dashboard graph while in the combined graph view. All features in section “Graph Configuration” can now be applied to the grouped Experiment Dashboard graph.
	Export data	Export Object data and attachments. Customize which data is exported as shown in the “Data Export” section.
	Archive Experiment	Archive the Experiment with all its replicate Objects. If the Experiment is archived, the archive icon is replaced by the unarchive icon . Click to restore the complete Experiment.

Objects – List view

The Object List provides information on the run status for each Object within an Experiment, assigned Devices, and more. You can sort Experiments and Objects by any of the column titles, and filter for keywords in every column. Use the Project filter on top of the list to show Experiments and Objects for a specific Project only.

A click on an individual Object/Replicate opens its Object Detail page, while a click on an Experiment name will open a group graph as popout.

Click on an assigned Device to open the Device Details.

Use the checkboxes to the left of the Object names to select Objects and Experiments. You can then go to Experiment Options ≡ for a combined excel export or Archiving the selection. Other options (Edit, Duplicate, Add Annotation) are not available for all Experiment states and combinations of Experiments, which makes them only available and clickable whenever the selection fits the option.

Archiving an Experiment or Object removes it from the "All" Tab of the Dashboard. Archived Experiments and Object are only visible in the "Archived" tab on the Dashboard.

An Action button is also available for combined control of all Experiments and Objects selected by activated checkboxes. The available actions (Pause, Resume, Prepare LIS etc...) depend on the selection. Hence, the combined action button may change depending on your selection. For possible actions, see section "Task Control – Action buttons".

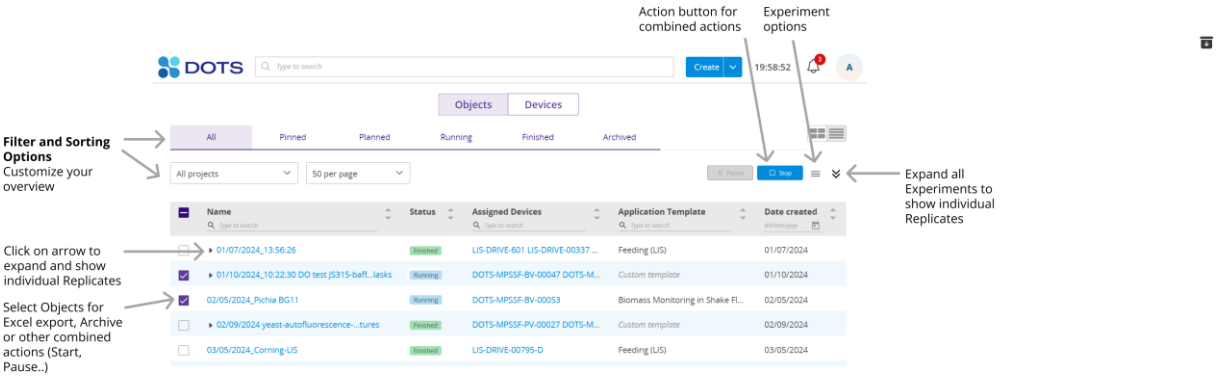


Figure 44: The Dashboard – Object List

Device list

Click on the “Devices” tab on top of the Dashboard to access the Device list, which contains all hardware that has been integrated with the DOTS Software. Connecting a Device physically (e.g., a CGQ Sensor via a CGQ Hub and USB cable) will cause the Device to automatically show as “Connected” in the list. For network devices, refer to the following section (Adding network Devices: Smart Kuhner Shaker).

If a Device is missing (not shown in the list), check your access rights (Table 5). New Devices can only be added to DOTS Teams by users with admin rights.

The Device list contains several tabs. “All” contains all DOTS Devices – use the search bars on top of each column to filter for specific Devices. The other tabs are pre-filtered lists which contain only specific Device types, such as all LIS-related Devices as shown in Figure 45.

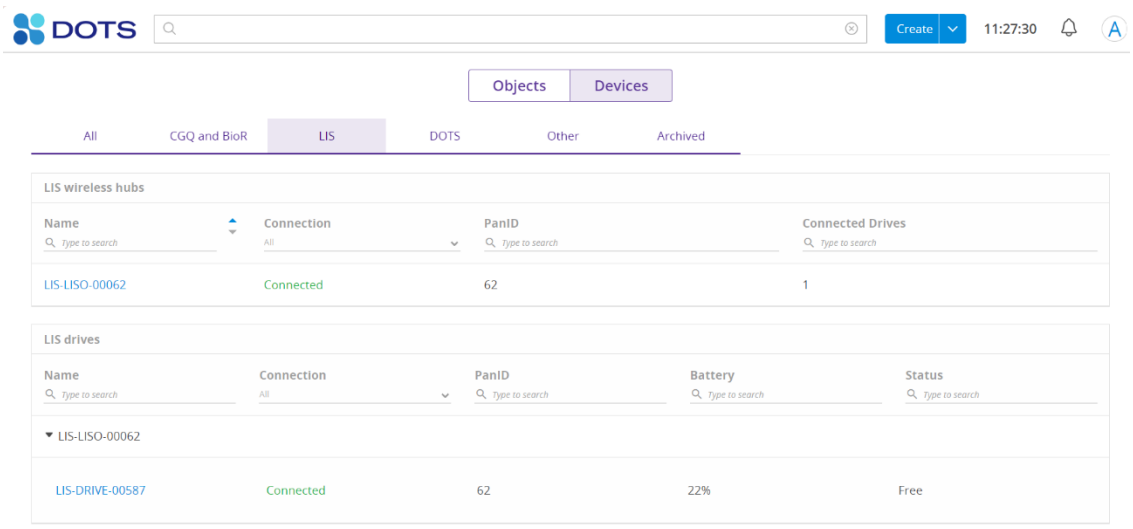


Figure 45: The Dashboard – Device list

Viewing and configuring Device details

Click on the Device name to open a pop out window with the Device Details (Figure 46). From the Device detail pop out you can:

- Edit the Device Name: Click on the edit pen next to the Device Name, enter a new name, and click Save.
- Check the Device Firmware version
- See which Teams the Device is assigned to (you can only see Teams that you are a part of) and access the Team Page (The Admin Page – Teams tab) by clicking on a Team name
- Execute Device-specific Actions (blue button)
- Perform calibrations: Calibration wizards are currently available for DOTS pH and DO Flow Cells.

Basic Device Details are available to all DOTS Users. Advanced Debugging Information and Settings, including resetting and archiving a device via the gear icon ⚙, are only available to admins.

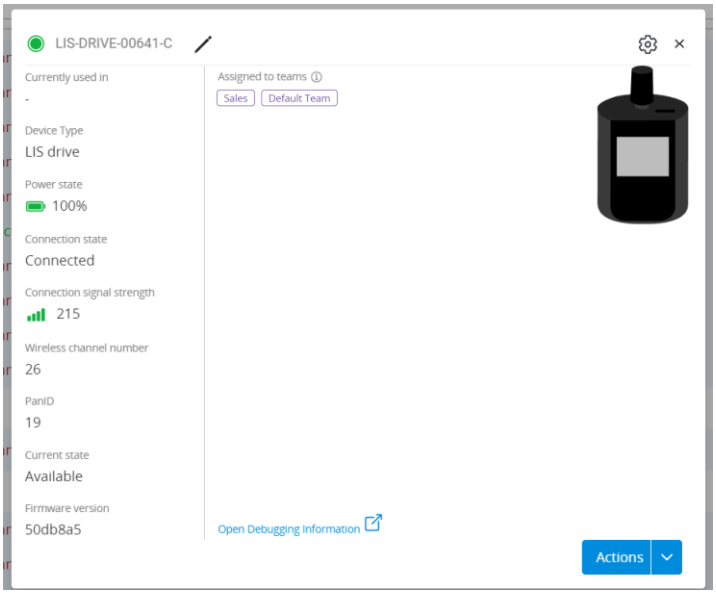


Figure 46: Device Details for a LIS Drive

Debugging information and settings for Admins

Click on “Open Debugging Information” to open a new tab with advanced debugging information. Table 8 provides an explanation of available functions within this page.

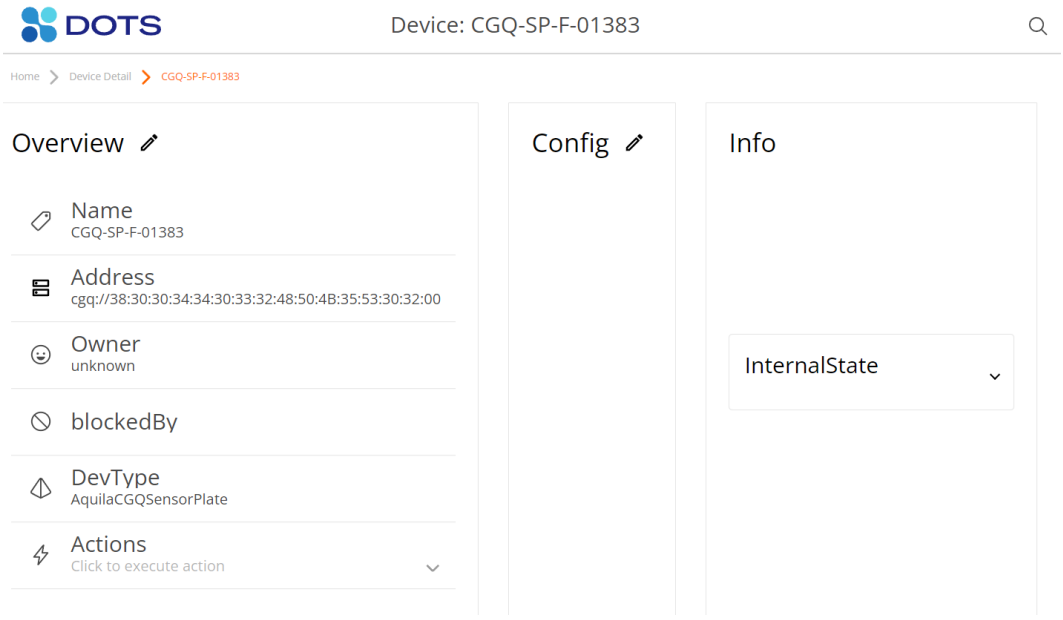


Figure 47: Advanced Device debugging information and settings (admin only)

Table 8: Explanation of Advanced Device Details (Debugging Information)

Section	Function	Explanation
Overview	Name	Name of Device. To change the name, click on the edit pen next to Overview. Enter a new Device name in the entry field “Name”, then press Enter on your keyboard or click the save icon to the right of the field.

	Address	This is the unique identifier for a specific Device.
	Calibration	*Available for the DOTS Fiber Optic Sensor only*. Click on “Create new calibration to open the Calibration Wizard.
	Owner	Currently not set.
	Blocked by	Shows corresponding Object ID if the Device is currently being used in an Experiment
	DevType	The Device type, e.g., a CGQ Sensor
	Actions	Available actions for a specific Device
Config	HandleID	HandleIDs contain status information and configuration values that are currently saved by the Device. For example, you can see the currently saved parameter set and PanID for a LIS drive. If you want to edit Device configs on this page, click on the edit pen next to Config. Contact our support team for more information.
	Add new config	For developers only. Contact our support team for more information.
Info	Internal State	Expand the list to review the following information: Timestamp Connection status Powered: true = USB powered, false = running on battery or not connected Ready: true = Device is active and can be used, false = Device cannot be used

Adding network Devices: Smart Kuhner Shaker

Network devices require communication over modbus TCP. Currently, DOTS offers integration of Kuhner shakers via a NET60 module for modbus TCP. This includes models from the Kuhner Shaker-Z/X series (ISF1-Z, LS-Z, Kelvin+, ISF1-X, ISF4-X, LT-X). Please contact your Kuhner shaker provider for information on your individual shaker setup and whether your shaker can be equipped with a NET60 module. Our application scientists provide support for connecting your smart shaker in DOTS.

Other network devices can be added in DOTS, but require implementation of respective functions by our Software Developers. Please contact our Sales Team for individual solutions.

1) Make sure that your PC with DOTS instance is in the same network as your shaker.

1) Get network IP address and port of your shaker. Your admin should provide these data.

2) Admin: Verify that smart shaker parameters are configured correctly on the NET60 module. Enter the Shaker IP address in your internet browser. The smart shaker network interface is shown (Figure 48) Access the shaker control parameters (in this example, click on “Parameter data”).

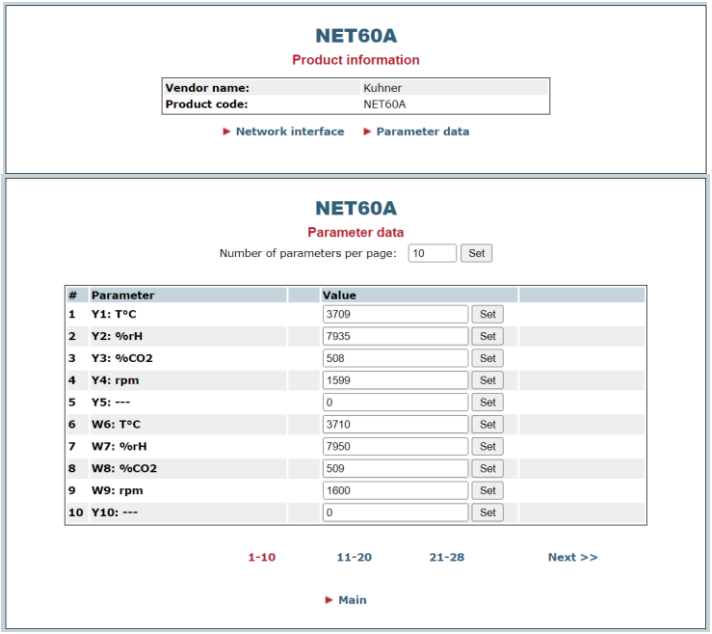
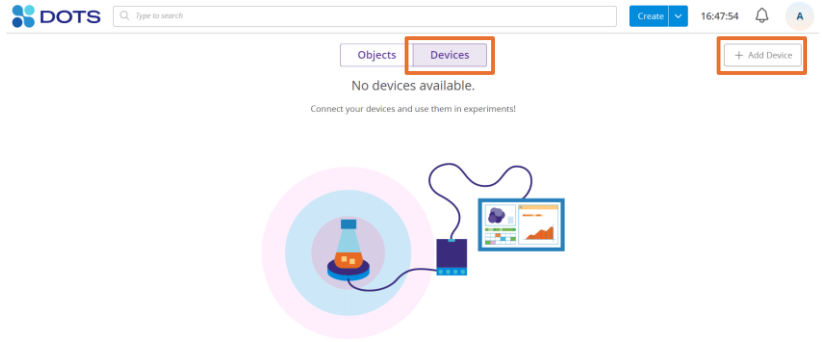


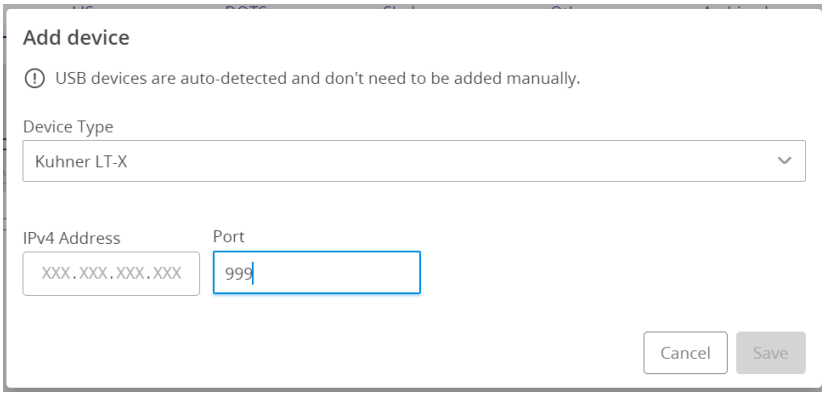
Figure 48: Example for smart shaker network interface.

Check all parameters/inputs, they must be configured the same way as shown in Table 9 below for proper communication with DOTS.

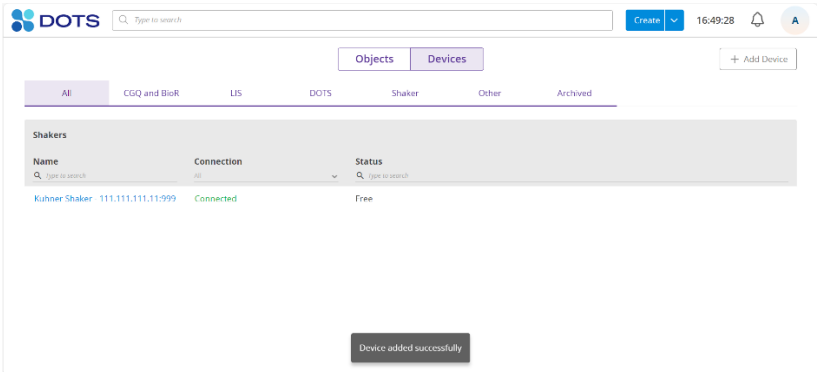
3) Admin: Add Device in DOTS. Open the DOTS Software from your network PC. Follow the steps below.



1. Log in as an Admin.
2. On the Dashboard, got to “Devices”.
3. Click on “+ Add Device” in the top right corner



4. In the popout dialog, select the Device type.
5. Enter the IPv4 address and Modbus-TCP port of your smart shaker.
6. Click “Save” on the bottom right corner of the dialog



7. The smart shaker is now visible in the Device List (Tabs “All” and “Shaker”).

Figure 49: Adding a Smart Shaker in the DOTS Software.

Table 9: Parameter configuration for smart shakers

Index	Parameter	Type	Name
1	Y1: T°C	read current value	Temperature
2	Y2: %rH	read current value	Humidity
3	Y3: %CO2	read current value	CO2
4	Y4: rpm	read current value	Shaking frequency
5	Y5: ---		Not used
6	W6: T°C	read setpoint	Temperature
7	W7: %rH	read setpoint	Humidity
8	W8: %CO2	read setpoint	CO2
9	W9: rpm	read setpoint	Shaking frequency
10	Y10: ---		Not used
11	Y11: ---		
12	Y12: ---		
13	Y13: ---		
14	Y14: ---		
15	Y15: ---		
16	Y16: ---		
17	enable	state	Channel is used
18	alarm	state	Alarm limit exceeded
19	error	state	An error occurred
20	M-status	state	Machine status (door open = 1, door closed = 0)

21	S1; T°C	write setpoint	Temperature
22	S2: %rH	write setpoint	Humidity
23	S3: %CO2	write setpoint	CO2
24	S4: rpm	write setpoint	Shaking frequency
25	S5: ---		Not used
26	S6: ---		
27	S7: ---		
28	S8: ---		

Y: read values; W: read setpoints; S: write setpoints

Smart Shaker direct controls

The Smart Shaker integration offer direct control of shaker parameters and live view of current readings. For Shaker monitoring and control in DOTS Experiments, refer to the Chapter “Configuring Experiments and Objects”.

Click on the shaker name to open the shaker’s Device Details (Figure 50). The current values of all available parameters are shown (“Readings”) and whether they are actively controlled (“Control”). The column “Machine setpoints” contains the currently applied setpoints. They can be modified either via the hardware interface (i.e., the display on the shaker), or via DOTS Software.

To send new setpoints to the shaker, activate the edit mode in the column “Software Setpoints” by clicking on the pen icon next to itAll – in this example 4 – parameters require an input. Once you have entered all Software Setpoints, click “Confirm”. You can change back to the view mode by clicking on the eye icon.

The Machine Setpoints will be updated accordingly. Be patient as it may take a while until all Setpoints are updated and displayed correctly in the Shaker Device Detail.

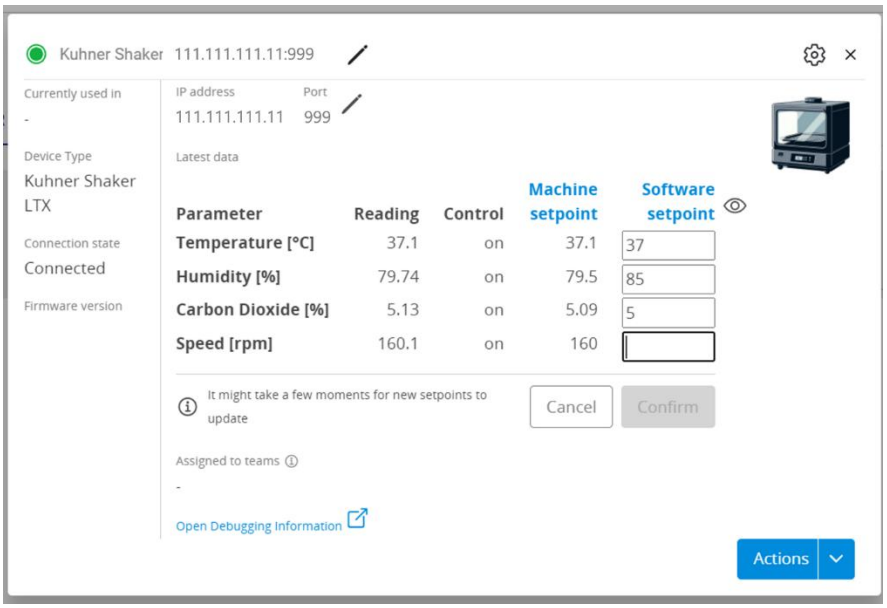


Figure 50: Smart Shaker direct controls in the Device Details.

Notification Center

The Notification Center collects all alerts and messages related to system performance and Experiment status that are automatically generated by the DOTS Software and its components. Click on the bell symbol in the menu bar to open the Notifications center (Figure 51). The red number informs you how many messages are unread. Hovering over a notification title will show the whole title in a text pop out (in case the text is truncated in the pop out).

The notification center collects all frontend alerts. Backend alerts are written to log files (stored in a folder on the computer that runs the DOTS Software) and can be reviewed by Admins via the Admin Page (Log Viewer).

You can mark a notification as read and toggle to show only unread notifications. Alternatively, you can mark “read” notifications as “unread” to move them back to the “all” tab. If you have multiple notifications, you can quickly get an overview within the Notification Center and click “Mark all as read” to remove the red number from the bell on the Dashboard.

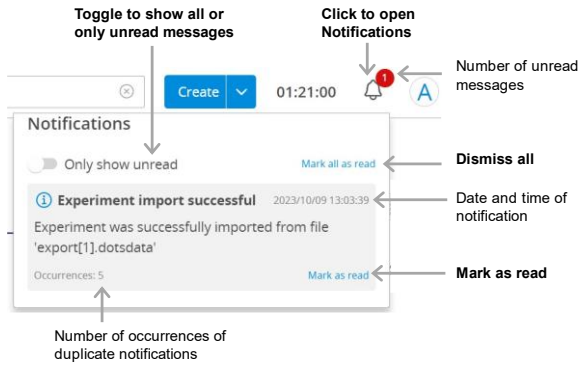


Figure 51: The Notification center

Experiment Creation wizard

In the DOTS Software, the Experiment Creation wizard guides you through the process of creating and configuring Experiments. Depending on the Application requirements, the wizard consists of only one step (compare section “Turbo Templates – Rapid Experiment Start”) or up to 6 steps for maximum customization. In the first step (Basic Settings), the bioprocess is defined by selecting an Application Template (Figure 53) or Creating a Custom Process structure (Process Structure (only for Custom Templates)). Furthermore, the number of Replicates is defined, and whether these replicates should have individually different measurement configurations. Next, the detailed measurement configurations for each Task can be adjusted for all Replicates at once (General Task Configuration), or individually for each Replicate (Individual Object Configuration). Furthermore, Graphs can be preconfigured in the Wizard (Graph Configuration), but this can also be done later at any stage of the Experiment. The wizard closes with the assignment of Devices for each Task (Device Assignment).

Use the buttons Back and Next on the bottom right to navigate through the wizard. Changes can only be saved after all required steps of the wizard are completed. After all steps are completed, you can save your defined settings to create a template specific to your process and use this template for future experiments (Complete Experiment Creation Wizard). Saved Custom Application Templates appear in the same list as preconfigured Templates, in the section “Custom Templates”.

Basic Settings

On the first page of the wizard, decide whether to use a preset **Application Template**, use a previously saved **Custom Application Template**, or create a new **Custom Experiment** from scratch. Preset Application Templates are the fastest way to start an Experiment (Figure 52). They contain preconfigured Tasks for typical Experiment setups, such as biomass monitoring for a batch cultivation in Shake Flasks.

If you want to use a template, but edit some details, click “Enable task and graph configuration”. When user inputs are required, this box will be automatically checked.

Give your Experiment a unique name, specify how many Objects will be included in the Experiment, and assign the Experiment to a Project. By default, the same settings will be applied to all Objects in an Experiment. For Experiments with multiple Objects, you can select the check box to enable configuration of Object settings on an individual basis for e.g., a screening experiment. All Basic Settings inputs are explained in Table 10.

The names of Object copies are configured automatically: Consecutive numbers are appended to the Experiment name (defined in the first step of the Wizard “Basic Settings”). Individual names can be edited by a click on the edit pen next to the Object name.

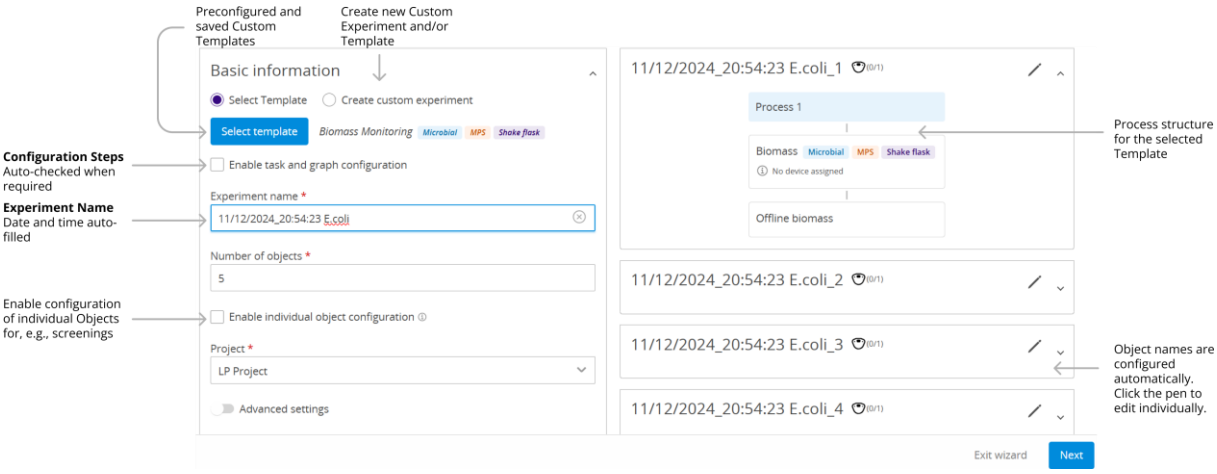


Figure 52: Experiment Creation wizard – Basic Settings

The Template list is sorted alphabetically within the categories “Favorites”, “Custom”, and “Preset Templates”. Application Template names contain colored tags with additional information that help to distinguish the Templates as shown in Figure 53. Users can add custom tags when saving a configured Experiment as new Template (see Complete Experiment Creation Wizard).

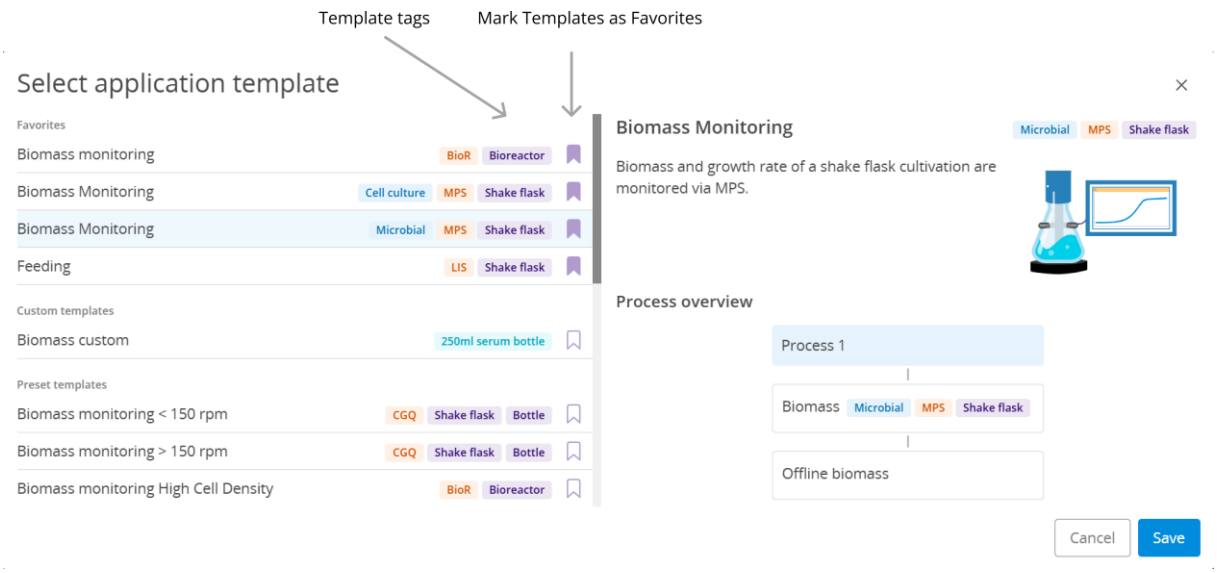


Figure 53: Application Template List. The Template names are located on the left, and tags with additional information on the right of the list (Format: [Application] [Device] [Vessel]). Selection of a Template opens a description and the Process Structure of the Template.

Table 10: Explanation of Creation wizard Step 1 - Basic Settings entries

Entry	Explanation
Enable task and graph configuration	The first entry is the choice of an Application Template. According to the selected template, a Process structure is shown in the cards on the right. Expand a card to see the Process structure of an Object. If “Configuration Step” is enabled, the Task details can be modified later in the step General Task Configuration.
Experiment name	Enter a unique name for your Experiment that can be used to search for the Experiment and Objects within the Experiment. If you create replicates for a screening (see below), Objects will automatically be assigned the Experiment name with numbers appended in ascending order beginning from 1 – on.
Number of objects	Enter the total number of Objects that you want to monitor within one Experiment. By default, the entry is one, which means only one single Object is created. Additional Objects will be exact copies of each other, e.g., technical or biological replicates with the same Processes and Tasks applied. For templates containing a LIS Device (e.g., Task: Feeding (LIS)), and for custom templates, there is the option to edit the details of individual copies in a later step (Screening Configuration) and by this, create a screening matrix.
Enable individual object configuration	Available for Experiments with multiple Objects. Check to enable configuration of process settings for each individual Object.
Project	Select a Project from the drop-down menu. Every Object must be assigned to a Project. Contact your Admin if no Projects are available.
Advanced settings	
Tag	Assign a tag: Search for a previously used tag by typing its name or create a new tag by typing in the field and pressing Enter on your keyboard. The assigned Tags appear as purple chips below. Tags help you to find and group Objects.
Relations	Relations connect Objects in a meaningful way. Available relations are Parent, Child, and Sibling.

Further explanation on relations

Relations can be defined to connect Experiments and Objects in a meaningful way. By defining relations, datasets can be interpreted on a higher level. This feature has been integrated with the current developments of artificial intelligence and machine learning in mind – with these, you will be able to analyze metadata of your Experiments and extract a new level of knowledge from your work.

Current applications could include:

- Tracking batches of chemicals and where they were used
- Tracking the origin of samples
- Tracking contaminations in a production series

Figure 54 shows one simple example of how relations could be used in Process management:

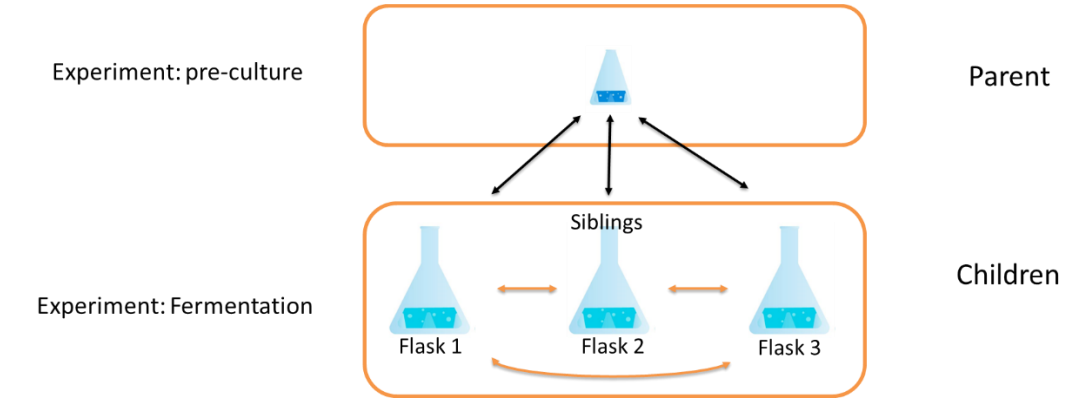


Figure 54: Example of relations between Objects

Process Structure (only for Custom Templates)

The Process structure is the heart of an Object. All types of Processes and Tasks can be prepared at this step.

The preconfigured Application Templates come with a preconfigured Process structure; only detailed Task Configurations can be changed (see section “General Task Configuration”). For custom templates, the Process Structure is set up by the user. Figure 55 shows how to set up and modify elements of the Process Structure.

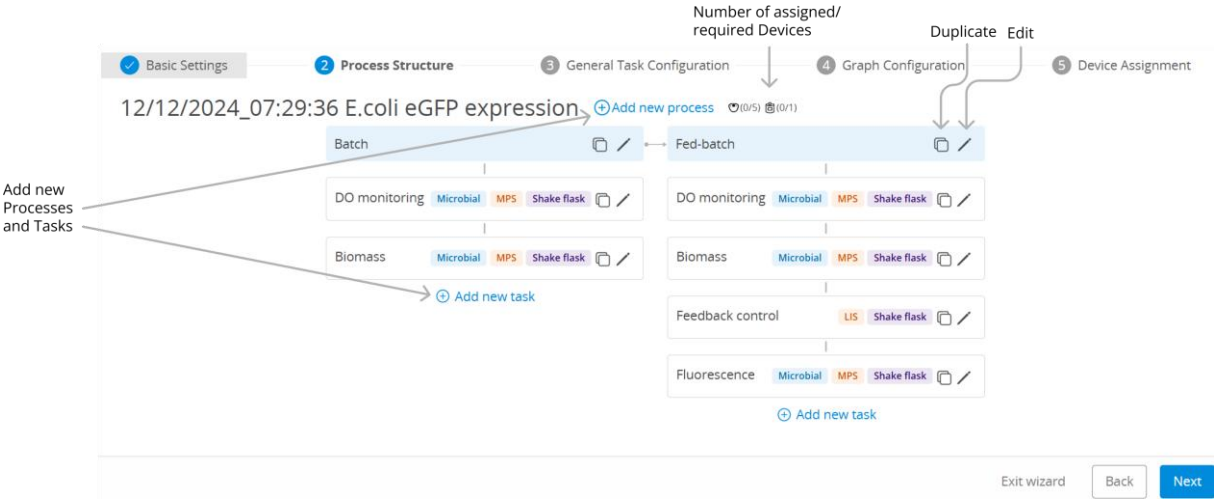


Figure 55: Experiment Creation wizard – Process Structure

In general, Tasks that are executed simultaneously (like pH and CGQ measurement in the same flask) should be grouped in one Process column. Each Process, but also each Task within the Process, can be started and controlled separately.

The visual order of Processes does not mean that they are automatically executed consecutively. If you plan a certain order for Processes, take care to start/stop them manually one after another on the Object Detail Page.

Add Processes and Tasks by clicking the buttons ⊕ Add new process and ⊕ Add new task. For a new Task, a pop out window opens (Figure 56). Select a Task base template from list on the left and enter a Task name on the right. The description on the right summarizes what this template will do. The purple chips next to the Task names furthermore indicate which device type is required for this Task.

You can create custom tags for each Task by including the tag name into the Task name using [square brackets].

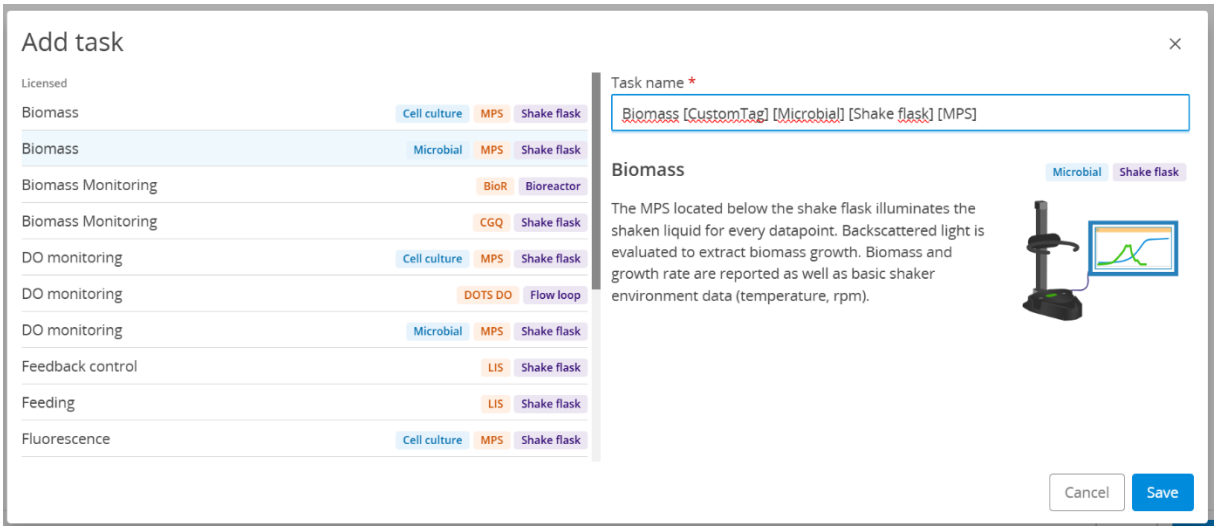


Figure 56: Adding a new Task to a Process structure

You can duplicate an existing Process with all included Tasks by clicking on the copy symbol. To modify Process names or delete a Process, click on the edit pen. The icons on the top right inform you how many Devices are assigned, and how many are required to perform all Tasks in the Experiment.

General Task Configuration

Some Tasks cannot be entirely preset and require general configuration by the user (e.g., pH and DO monitoring require an input of the Sensor Code). Inputs added during the General Task Configuration step are applied to all Objects in an Experiment. In many cases, default values are available and can be modified. Fields that require your input are marked with a red star *.

The Task that is currently selected will be highlighted in blue. If a required input field has been left blank, the relevant Process tab and Task box will be highlighted in red (Figure 58).

Hover over fields for a brief explanation on the type of entries that are expected. For more detailed explanations, refer to the chapter "Configuring Experiments and Objects"

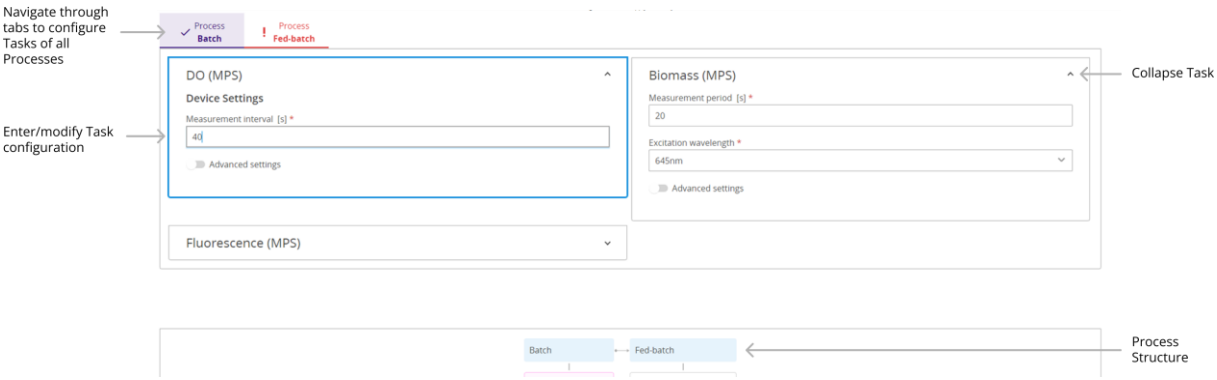


Figure 57: Experiment Creation wizard – General Task Configuration

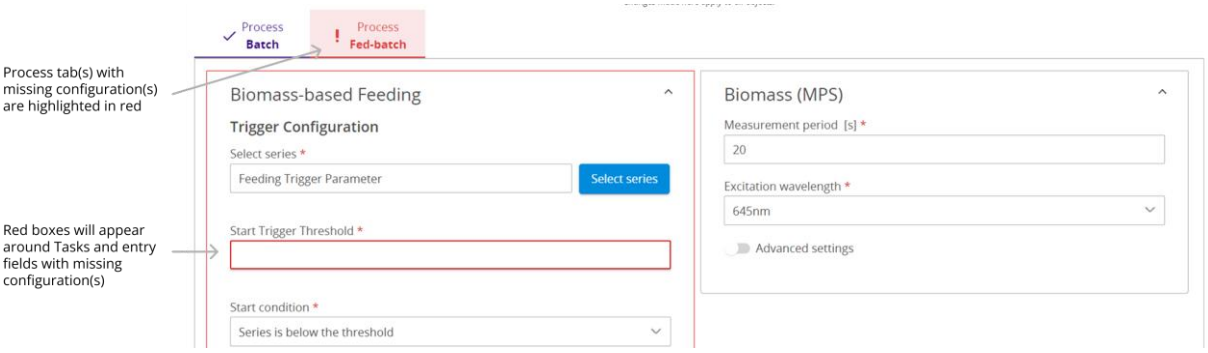


Figure 58: Experiment Creation wizard – General Task Configuration with missing inputs

The Process structure is always shown on the bottom of the page (scroll down if needed). Deleting, Adding, and Renaming Processes and Tasks is not possible for preconfigured Application Templates. If you are configuring a Custom Template, you can go back to the previous step (Process Structure) and change the Process structure there. Navigate through the tabs on the top of the page to configure all Processes (in case there are several).

Individual Object Configuration

For Experiments with multiple Objects, you can make Object-specific modifications in the “Individual object configuration” step. You must enable this extra configuration step by clicking the checkbox on the Basic Settings page of the wizard.

Click on an Object name on the right to expand the Object panel. The selected Object is highlighted by a purple frame, and the configurations for the selected Object can be edited on the left.

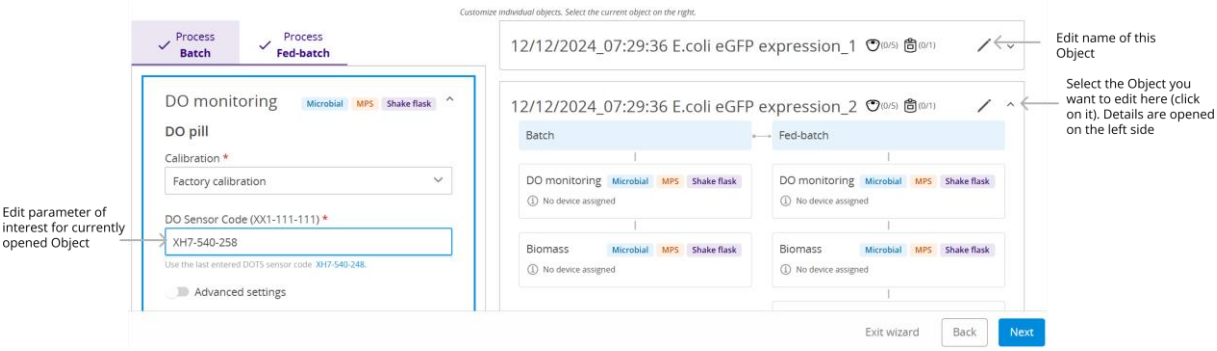


Figure 59: Experiment Creation wizard – Screening Configuration

Graph Configuration

If the “Enable task and graph configuration” checkbox is selected, users can predefine their experiment graphs. Add or remove data series, adjust axis settings, and apply calibration all during experiment setup. For additional details on graph configuration, see the section Graph Configuration Details. The graph configuration can still be modified at any time before, during, or after an experiment.

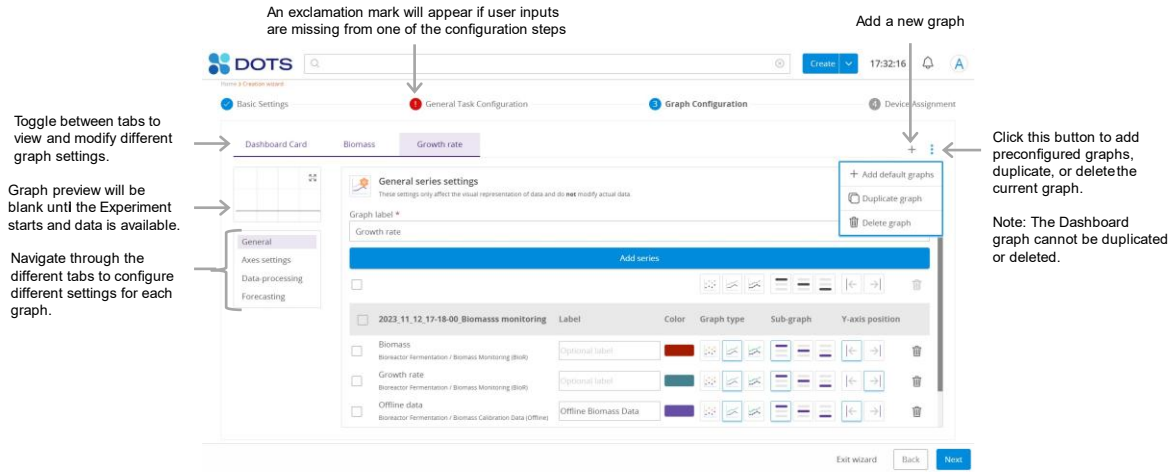


Figure 60: Experiment Creation wizard – Graph Configuration

Device Assignment

Regardless of if you are creating a new custom template or using a preconfigured Application Template, you must always assign Devices to each Task during Experiment creation. Device types that fit the Process Structure and correspond with the programmed Tasks are shown in the list on the left of the page (Figure 61). Use filters and the search bar to quickly find the Devices you need.

The Device list contains status information that might be interesting at this step in the Object Creation:

- Battery status: given in percent
- Connection status: Connected / Not connected
- Assignment status: Unassigned or assigned to x Tasks in this Experiment
- Usage status: Free (Device is available for Experiments), In Use: Device is used by a different Experiment

To see additional details for a specific Device, click on the Device name and the Device detail pop out will open (Figure 46).

The icons to the right of each Object name indicate the type and number of Devices needed for all the Tasks within the corresponding Process(es). Notice that, following the drag & drop of an appropriate Device, the numerator updates to show the number of assigned Devices. A green check mark will appear when Devices are assigned for all Tasks.

To remove a Device from a Task, or several Devices from a whole Process or Object, click on “Remove devices”.

Only admin accounts can add new Devices to the DOTS Software and assign them to Teams. Devices may be inaccessible to users with restricted access rights. Refer to Table 5 for further details.

Drag and Drop for Device Assignment

Click on and drag a device to the Object list on the right. Objects, Processes, and Tasks that correspond to the Device are framed with a dashed line. Drop the Device on any of these framed components. By dropping the Device on an Object or Process level, the Device is automatically assigned to all corresponding Tasks that match the Device type.

Figure 61: Experiment Creation wizard – Device Assignment: Drag and Drop

Auto and Batch-Assign for Devices

Auto and Batch-assign are available as an alternative means of assigning Devices to Objects/Tasks.

For Auto assignment, the software will assign the devices based on the current order of the device list on the left:

- The first device will be assigned to the first Object
- The second device will be assigned to the second Object
- …

Users do not have any manual options, but they can modify the device list by applying filters before clicking Auto assign.

For Batch assignment, users may select which devices will be automatically assigned in the resulting popout (Figure 62). There are buttons to auto assign by availability or by port (depending on the device type), or users can select specific devices from the Device list by using the checkboxes.

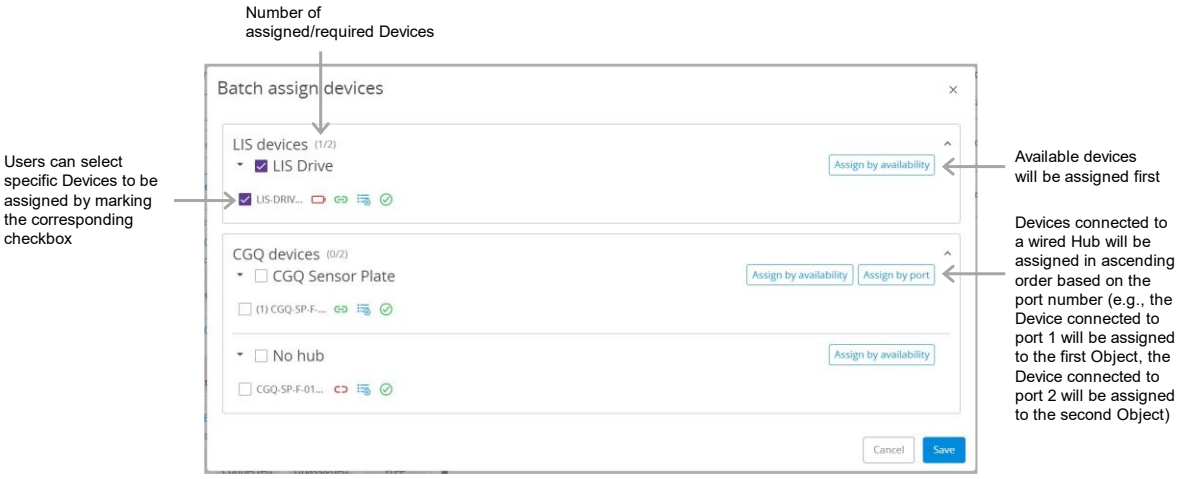


Figure 62: Experiment Creation wizard – Device Assignment: Batch assign

Complete Experiment Creation Wizard

This is the last step of the Experiment Creation wizard. You can now proceed with the available options in the bottom right of the Creation wizard:

- Save Template: Save all Task Configurations including assigned Devices as a Template. The Template will be available within the Application Template list (under “Custom Templates”) for future Experiments. You can include Custom tags for your Custom Template by including the tag into the Template name using [square brackets] (compare Figure 63 and Figure 53).
- Create and Start: Save all configurations, create the Experiment, and Start all Tasks in the first Process right away.
- Create and send to Device: Specific for Templates containing LIS Tasks. Save all configurations, create the Experiment, and upload the configuration to the LIS Drives (required prior to starting the Experiment). This action also blocks the LIS drives for any other Experiment that are planned with these Drives.
- Create: Save all configurations and create the Experiment. You can still make changes before starting the Experiment.
- *In Edit mode (Wizard entered via “Edit Experiment”)*: Update: Save all changes made to an existing Experiment.
- *In Edit mode (Wizard entered via “Edit Experiment”):* Update and Start: Save all changes, and Start all Tasks that have not yet been started in this existing Experiment.

You can create an Experiment without assigning Devices for planning purposes and assign the Devices later.

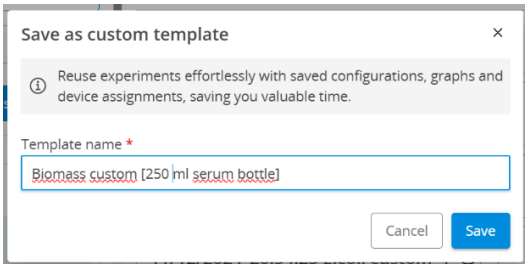


Figure 63: Saving an Experiment as Custom Application Template

After completing all steps in the Experiment Creation wizard, you will be redirected to the Object Detail Page for a single-Object Experiment, or the Dashboard for a multi-Object Experiment.

Turbo Templates – Rapid Experiment Start

Turbo templates, once configured, enable users to start an experiment in as few as three clicks. Follow the steps below to configure turbo templates for your processes.

Create and Save a Custom Template

1. From the Dashboard, click the “Create” button to prepare your Experiment.
2. Complete the Device Assignment step by assigning a Device to every measurement task within your process.
3. Click the “Save Template" button and give your custom template a name in the popout.
4. Click “Save”.

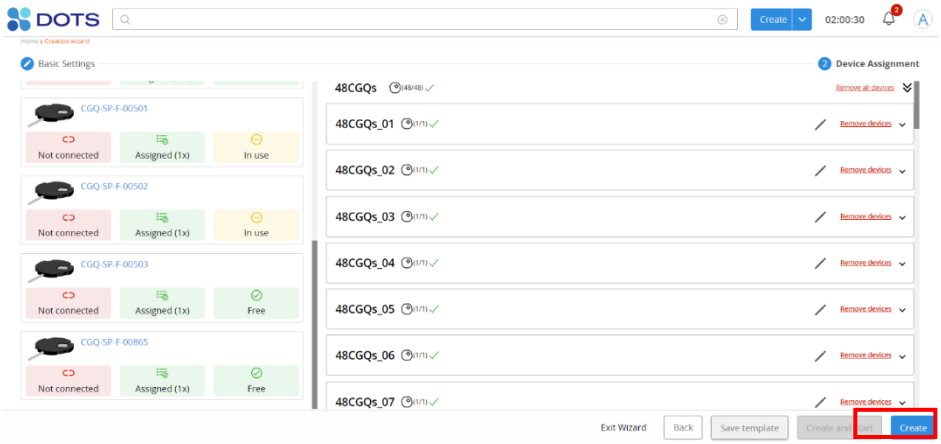


Figure 64: Create an Experiment from the Dashboard of the DOTS Software, making sure to assign devices to all tasks, and save as a custom template.

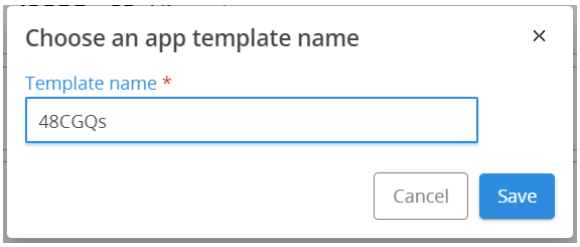
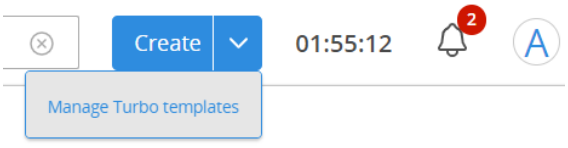


Figure 65: Save your custom template with a unique name that describes your experimental process.

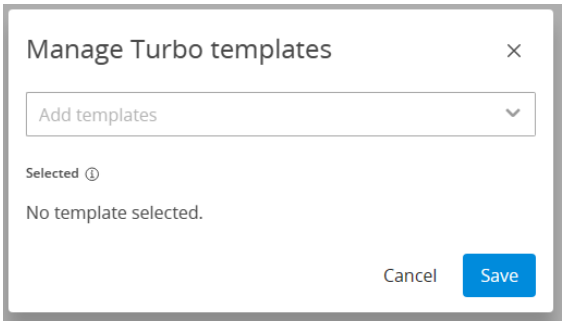
Manage Turbo Templates



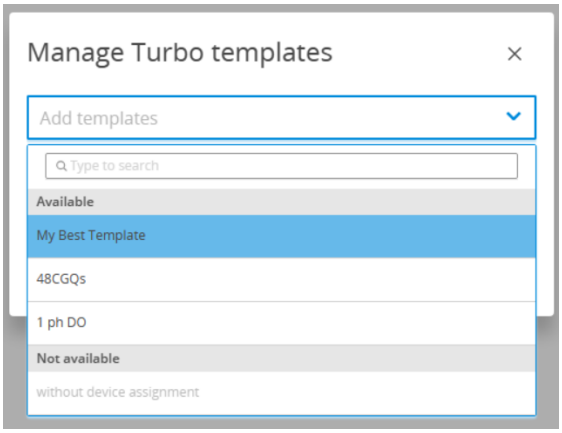
Click the dropdown arrow on the ”Create“ button.

Click ”Manage Turbo templates“

Figure 66: Manage Turbo templates

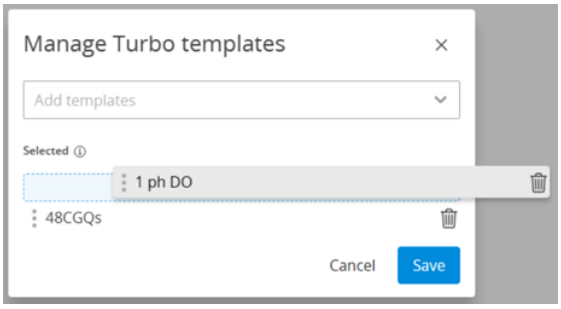


Initially, there will be no templates added to the Turbo template menu.



Open the dropdown list to select the template(s) you would like to designate as Turbo templates.

NOTE: Custom templates missing configuration information or assigned devices will be listed as ”Not available“ when adding new Turbo templates.

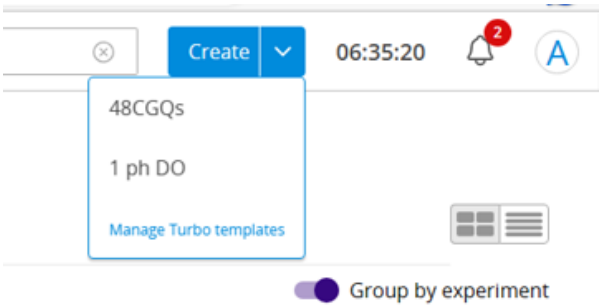


Re-order selected Turbo templates by drag and drop to adjust the dropdown menu order on the Dasbhoard.

Click ”Save“.

Figure 67: Add templates to the Turbo template menu, re-order the list, and save selections.

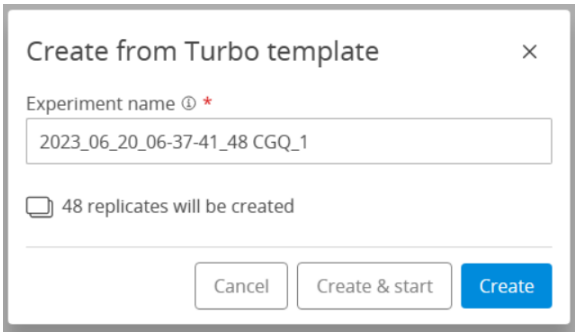
Create Experiments from Turbo Templates



Click the dropdown arrow on the ”Create“ button.

Select your preconfigured Turbo template from the list.

Figure 68: Select a Turbo template to start an Experiment

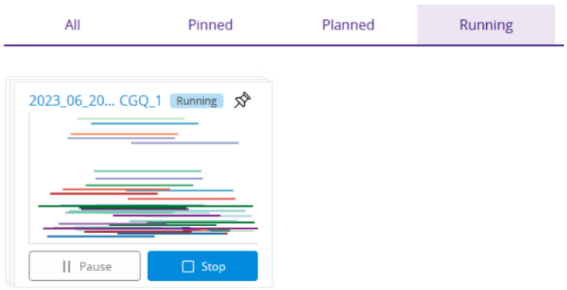


Adjust the Experiment name, if desired.

NOTE: A default experiment name is given that includes the date, time, and name of the selected Turbo template.

Click ”Create“ to simply prepare the Experiment or ”Create & Start“ to start monitoring right away.

Figure 69: Confirm the Experiment name and create your Experiment



The created Experiment will appear on the Dashboard, either under the ”Running“ tab if ”Create & Start“ was clicked or under the ”Planned“ tab if ”Create“ was clicked.

Figure 70: Created Experiments will appear on the Dashboard

Object Detail Page

Every Object can be monitored and controlled from the Object Detail Page. The page includes basic information on the Experiment, customizable graphs for real time data visualization, a Process overview with run status of and action buttons for each Task, trackable annotations, and additional options.

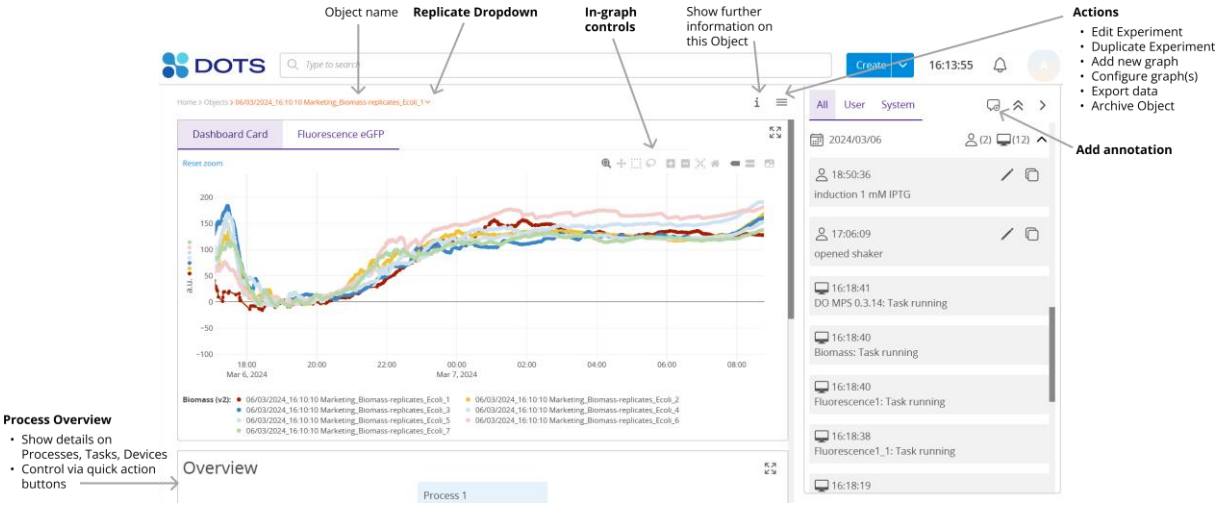


Figure 71: Object Detail Page – an overview

Navigating between grouped Objects

Easily navigate between Objects grouped into the same Experiment via the grouped Object dropdown selector linked to the Object name breadcrumb. The Object name corresponding to the current detail page will be greyed out.

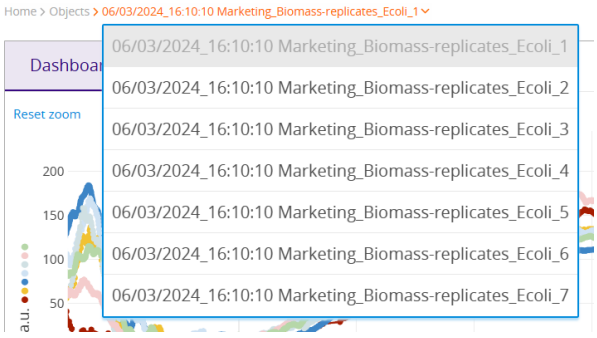


Figure 72: Grouped Object dropdown selector – breadcrumb on the Object Detail page

Basic Information

Clicking on the Basic Information button i opens a pop out that shows the Name of the Object, the Project to which the Object is assigned, the date and time when the Experiment was created and last modified, and which user created / modified the Experiment. Any Tags assigned to the Object during Experiment creation are also listed and, if the Object is one of several in a grouped Experiment, the related Objects will also be listed as shown in Figure 73.

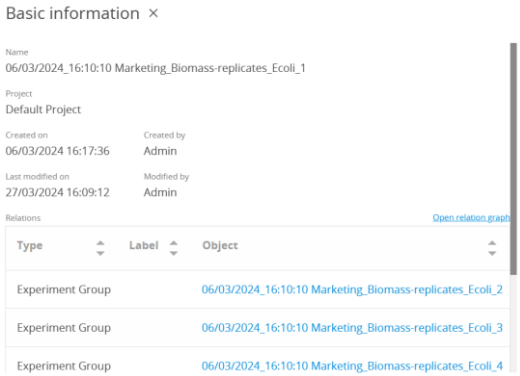


Figure 73: Object Detail Page – Basic information pop out

Process Overview

The Overview section of the Object Detail Page combines monitoring and control. Clicking on a Process, Task, or Device name in the Process Overview opens a pop out window with detailed information on these components. The details shown in a pop out depends on what is selected. A Device detail pop out will include connection status, Device type, and the Device name (see Figure 46). A Task detail pop out will include configuration parameters, assigned Devices, and start / stop times of the Task (Figure 74). Individual Tasks can be controlled via action buttons located within the Task boxes.

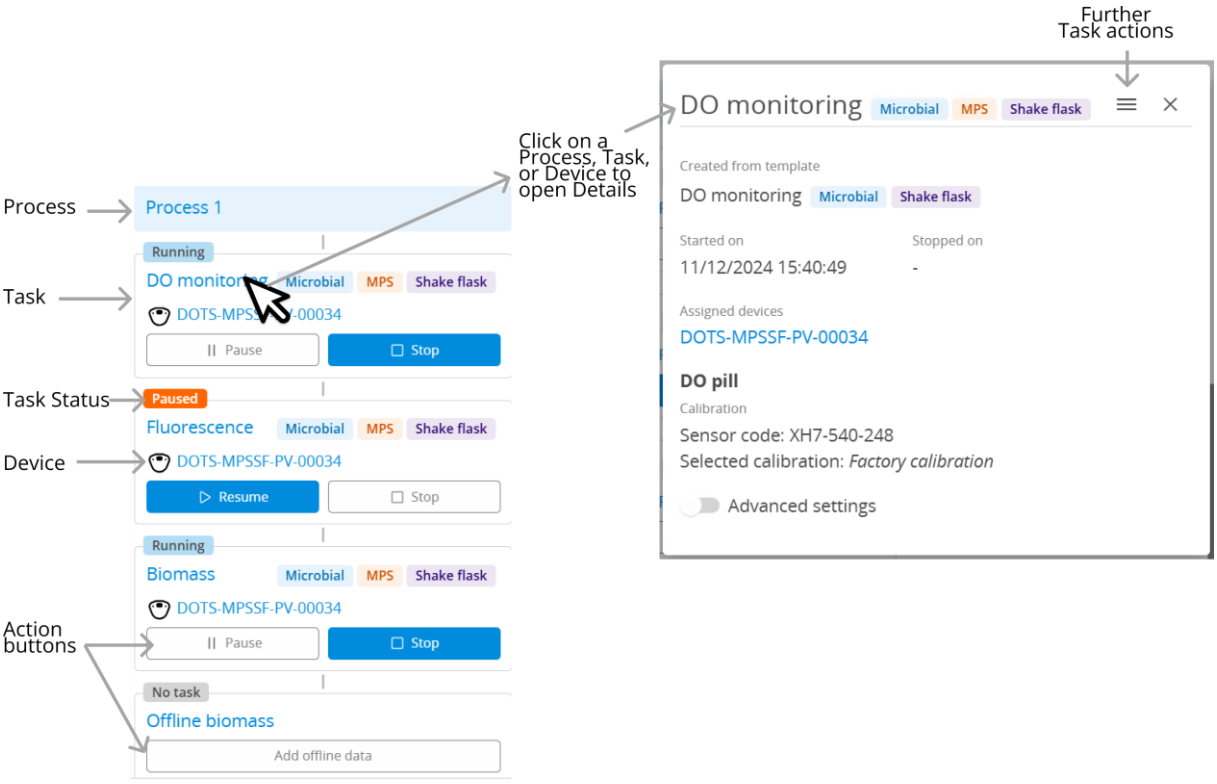


Figure 74: Object Detail Page – Process Overview section and Task detail pop out.

Task Detail: Further Task actions

Available further Task actions depend on the Task state (Figure 75).

All Tasks can be duplicated directly on the Object Detail Page. This creates a copy only in this Replicate. To create Task copies for all replicates in an Experiment, Edit the whole Experiment (Figure 71). While creating a Task copy on the Object Detail Page, the Task name will automatically be appended with the word “Copy”, you can adjust the name (Figure 76). Then click “Save” or “Save and Start” from the dropdown menu to create the new Task, or create and start the Task right away. Consider that some Devices, like LIS Drives, can only handle one Task at a time, so make sure to stop the previous Task on such a Device before starting a new Task on the same Device.

While a Task (copy) has not been started yet, you can adjust the Task details and settings by clicking on the edit pen that appears on top of the respective Task detail popout,

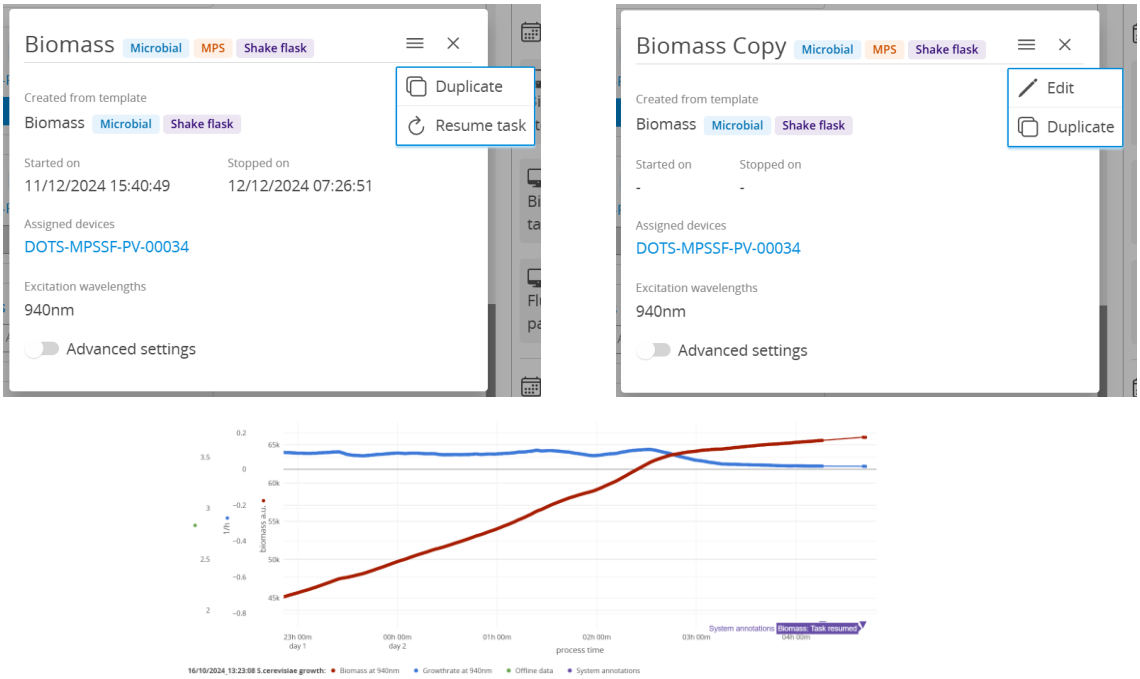


Figure 75: Task Details – Further actions. All Tasks can be duplicated directly on the Object Detail page. Stopped Tasks can be resumed (top left). Tasks parameters can be edited in case the Task has not yet been started (top right). An example for a resumed Task is shown on the bottom screenshot.

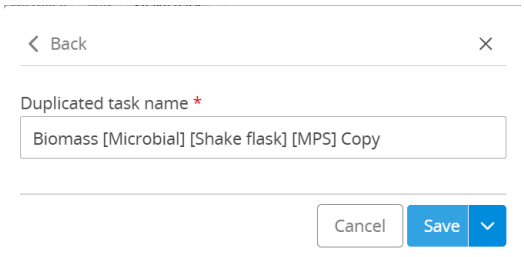


Figure 76: Object Detail Page – Duplicating a Task: Tags of the Task are represented in square brackets.

Only for Tasks that **do not contain a LIS action**: If a Task has been stopped, the “Resume Task” option becomes available (Figure 75, top right). This Resume action will create a system annotation (“Task resumed”) and append data to the previous data series of this Task ((Figure 75, bottom).

Task Control – Action buttons

Action buttons located within each Task box can be used to control Tasks individually from the Object Detail Page. Available action buttons change depending on the run status of the Task, which is indicated by a colored chip next to the task name (Table 11). Note that there are additional action buttons for LIS-specific Tasks (Table 12) since the LIS requires the additional Upload and Prepare steps during setup. Refer to the LIS User Guide for more detailed information on LIS operation.

Table 11: Task status and possible control actions

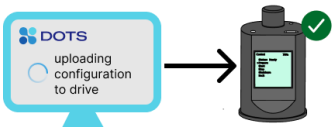
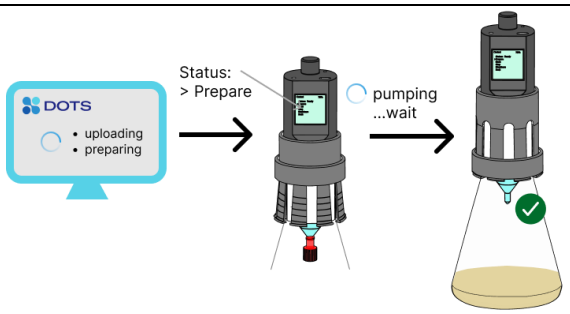
Status chip	Task Status	Possible actions
Planned ⚠	Planned, not ready	*Edit Task (Further Task actions on Task Detail popout)*
Planned	Planned, ready	Start *Edit Task (Further Task actions on Task Detail popout)*
Running	Running	Pause Stop
Paused	Paused	Resume Stop
Finished	Finished	*Resume Task (Further Task actions on Task Detail popout) : Not for LIS Tasks* Archive
Finished ⚠	Finished, error	Archive Click on the Task or Device for error details

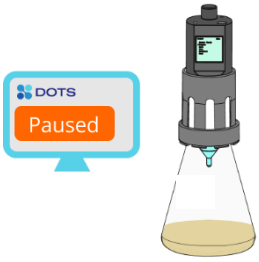
Table 12: LIS-specific actions and resulting status chips

The workflow to **start** a LIS-Drive always comprises three actions, which are executed in this order:

1. Upload
2. Prepare
3. Start

If any of the three actions is clicked, DOTS Software automatically includes all previous actions in case they have not been executed manually. That means, you can click start and the Drive will be automatically uploaded, prepared, and the started.

Action	Explanation	Status after successful execution
Upload	 Upload the Task configuration to the LIS Drive (this will block the Drive for any other Experiments, i.e., it cannot be started from other Experiments and the Task Details can no longer be edited).	Uploaded
Prepare	 The LIS Drive is prepared to equilibrate the pump to ambient pressure. This step ensures that liquid will be held inside the LIS Cartridge.	Prepared

Start		Start the automated feeding Task.	Running
Pause / Resume		Pause the automated feeding Task. When Resuming the Task, select whether to resume the feed profile with a delay – start back up where the task left off, or without a delay – catch up to where the task would have been without a pause (see Figure 77).	Paused
Stop	Stop all actions of the LIS Drive. The pump will turn off completely and any remaining liquid will slowly drop out of the Cartridge. We recommend stopping the Task only after the assembled LIS has been removed from the Experiment flask. Stopping the Drive is necessary to unblock the Device and make it available for use in other Experiments.		Finished

Once a Task containing LIS actions is stopped it cannot be restarted. If you just want to stop the measurement temporarily, use the Pause / Resume actions instead of the Stop action.

In case a Task containing LIS actions has been accidentally stopped, you can straightforward copy the Task on the Object Detail Page. Remember to adjust the cartridge volume to what is left in the cartridge at that moment by accessing the Task Edit mode. After that, you can proceed to start the Task copy (Figure 74, Figure 76). Add the required Task data to your graphs to continue live data monitoring.

LIS Pause & Resume Feature

Unlike the CGQ or pH and DO sensors which simply resume measuring after being paused, a LIS task requires user selection of how feeding should be resumed. The "Resume **without** delay" option causes the feed profile to resume as if no pause occurred, visualized by a jump on the graph following the pause period as the Drive "catches up" to the preset feeding profile. The "Resume **with** delay" option causes the feed profile to resume right where it left off, resulting in a plateau on the graph for the duration of the pause before the Drive begins feeding again (Figure 77).

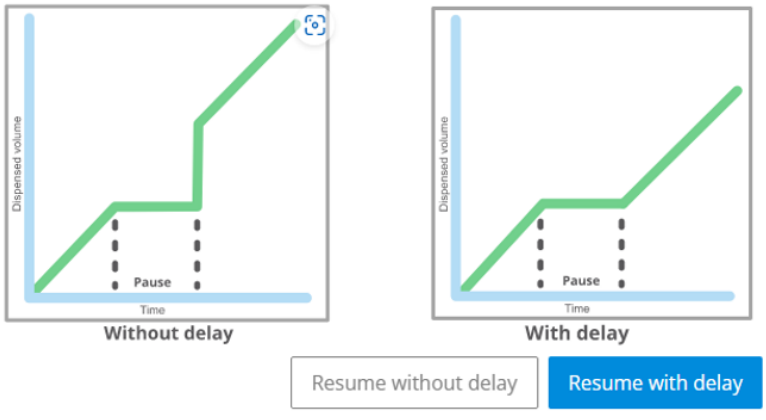


Figure 77: Different options for resuming a paused LIS Task

Annotations

Annotations are useful for tracking critical events during an Experiment and logging Object-specific notes. Refer to Table 13 for a description of available functions within the Annotations section on the Object Detail Page (Figure 71).

Table 13: Functions for Annotations

Icon	Function	Explanation
All User System	Annotation Tabs	Click on the respective tab to show all annotations or only annotations created by user or system.
	Add new annotation	Click on the + symbol to add a new annotation. Modify the time point if desired and enter your message. Pictures and other files can be added by drag & drop or by clicking the “Select files” button. Click “Save”.
	Expand annotations	Expand / collapse all annotations by clicking the double expand symbol. Individual annotations can be expanded / collapsed by clicking on the annotation or the single dropdown symbol.
	Origin of annotation	User annotations are displayed with the user symbol and the username. System annotations, such as errors during a run, are displayed with the system symbol .
	Edit annotation	Annotations can be edited or deleted by clicking on the edit pen symbol. Click “Save” after you have made your changes.
	Duplicate annotation	Annotations, i.e., their plain text content including attached files, can be duplicated by clicking on the copy icon. Just the timestamp will differ. Use this function to annotate recurring actions, like a sampling event.

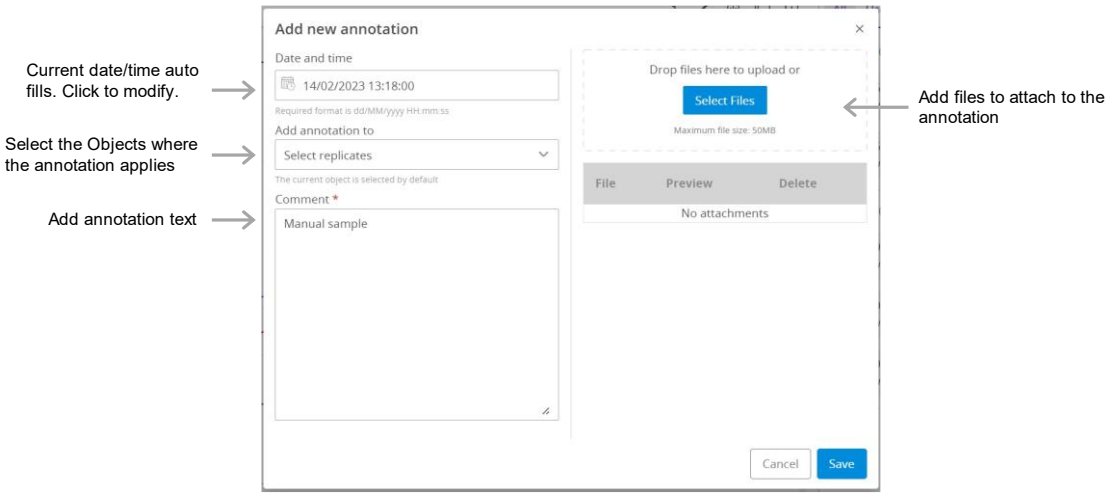


Figure 78: Object Detail Page – Adding new annotations

Annotations can be added to an Object at any time with automatically generated, editable timestamps, and visualized by adding the “Annotations” series to graphs in the “General” graph configuration tab. Each annotation will be represented by a small arrow on the time axis. Hover over an arrow for details on the corresponding annotation (Figure 79).

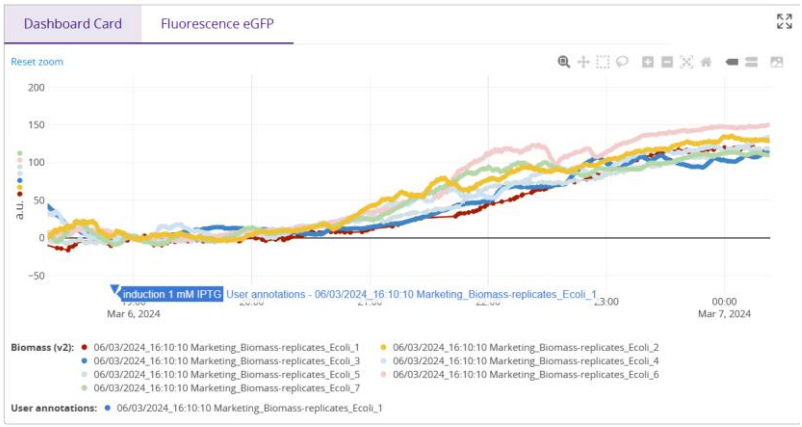


Figure 79: Annotations visualized in a graph

Actions

Additional actions relevant to the entire Object are available in the upper right corner of the Object Detail page.

Table 14: Available Object Actions

Icon	Function	Explanation
	Edit Object	Opens the Experiment Creation wizard for the Object. Changes cannot be applied while the Object Tasks are running.
	Duplicate Object	Duplicate the Object to create a new Experiment with the same configuration parameters and assigned Devices. Simply update the Experiment name and click through the Creation wizard.
	New graph	Enter the Graph Configuration and configure a new graph
	Configure Graph	Enter the Graph Configuration and configure the shown graph
	Export data	Export Object data and attachments. Customize which data is exported as shown in the “Data Export” section.
	Archive Object (Unarchive)	Archive the Object. Archived Objects will not appear in the “All” Tab on the Dashboard, but can be found in the “Archived” Tab only. Deletion of an Object is not possible. If the Object is archived, the archive icon is replaced by the unarchive icon . Click to restore the Object,

Graphs

The first graph on the Object Detail Page will always be shown on Object Cards for the Dashboard data preview. Navigate between the tabs on top of the graph to switch between your configured graphs. If you want different data to be shown as a preview on the Dashboard, configure the first graph accordingly (it is currently not possible to change the order of the graph tabs).

Data are visualized with 1000 points per data series for performance reasons. When zooming into the graph, data are automatically reloaded accordingly to show more detail.

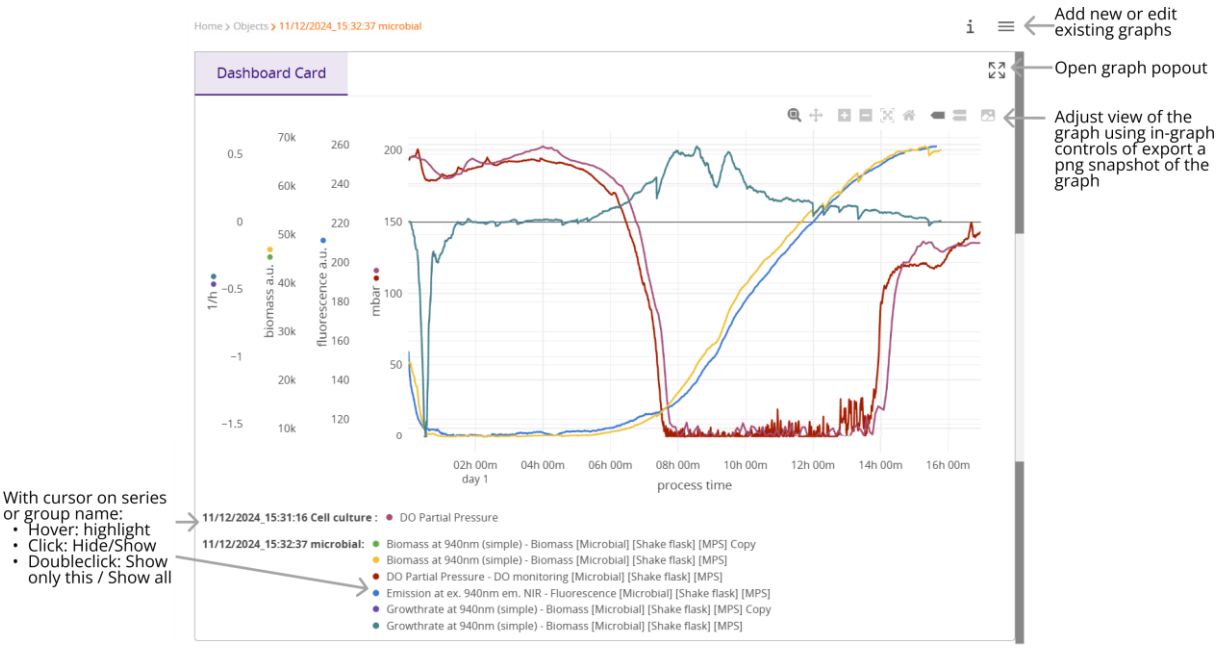


Figure 80: Object Detail Page – Graphical overview

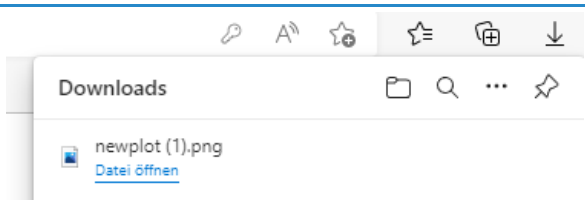
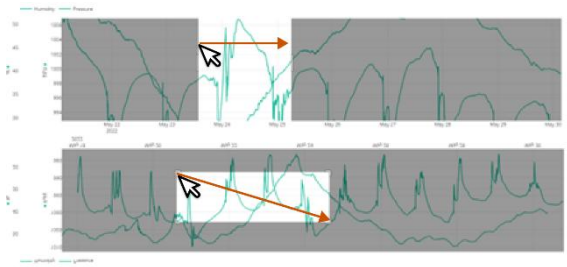
At least one graph must be configured before data can be visualized.

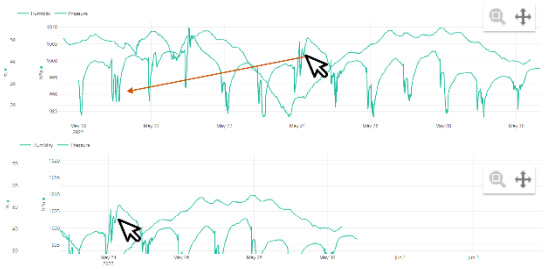
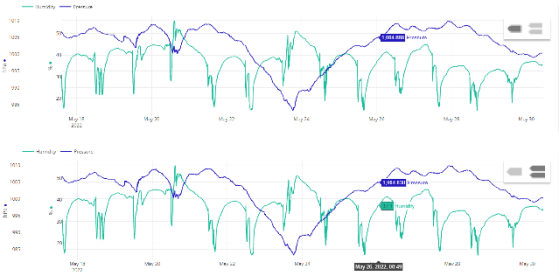
Live data is updated whenever a new data point is available.

In-graph controls

Short term changes to the graph appearance – like scaling, zooming, etc. – are available via the row of icons on the top right of the graph and some other features through directly clicking on the graph. Refer to Table 15 for details on these features.

Table 15: In-graph viewing options

Icon	Function	Explanation
	Take a screenshot of the current graph display. Direct download as .png file	
	While enabled, zoom over a custom area of the graph by clicking and holding while scrolling over the area of interest on the graph. Double-click to zoom back out.	

	While enabled, shift the visible area of the graph while maintaining the scale of the axes. Click and hold while moving the cursor. Tip: By **default**, zooming is selected.	
	Select an area of the graph with a box or custom lasso shape. Double-click to remove the selection.	
	Zoom in and out (one step per click) Tip: Double click on the graph to zoom out completely and reset the axes.	
	Autoscale axes to fit all data into the graph	
	Reset axes to original configuration	
	Show data of the series that is closest to the current cursor location. Show data of all series at the current cursor location. Tip: By **default**, is selected.	

Adjusting axes on the graph

Use your mouse curser to adjust the axis limits directly on the graphs in the Object Detail page.

- Hover the cursor over each axis until an arrow appears. Click and hold the arrow to move axes vertically or horizontally.
- Hover the cursor at the corners of the axes labels until a diagonal arrow appears. Click and hold to scale the graphical display.
- Click at the corners of the axes to highlight a hidden field. Type in a value to set custom axis limits.

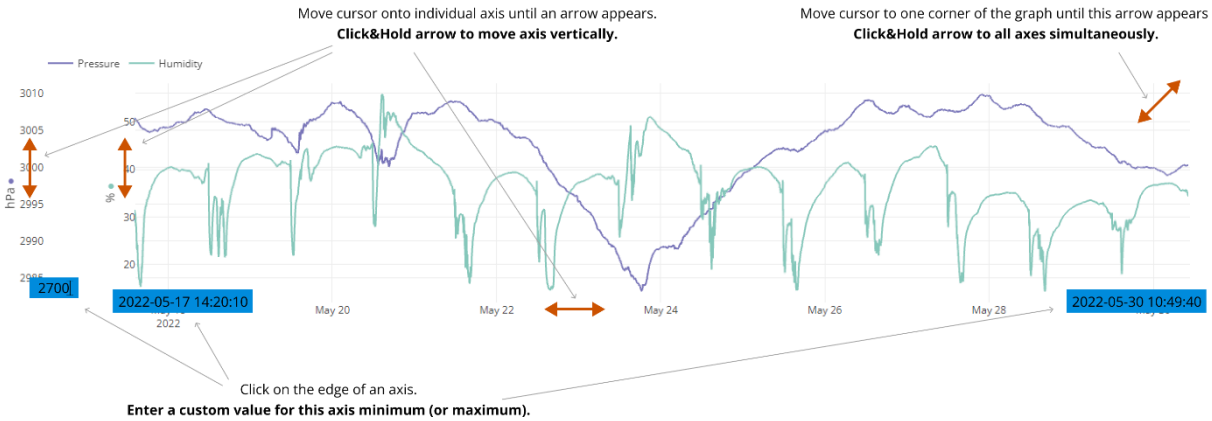


Figure 81: In-graph controls – Temporary adjustment of axes

Graph Configuration Details

If you created your Experiment with a preconfigured Application Template, there will be several preconfigured graphs for each Object. All configurations can be modified, and new graphs can be added. If you used a custom template during Experiment creation, you will need to configure all graphs for real time data visualization. This configuration can happen during experiment creation or after the experiment has started.

Click on the edit pen in the top right corner of the graph header to open the graph configuration pop out (Figure 82). The window will open in the “General” tab for configuration of general series settings. Use the menu on the left to navigate to “Axes settings” and “Data processing” tabs for additional configuration options. Regardless of which tab is open, you can always add a new graph, add default graphs, duplicate the current graph, or delete the current graph. When duplicating a graph, you will automatically be switched to the tab for the newly created, duplicate graph.

The small preview graph in the top left corner will give you an idea of how your settings will affect the graph. You can enlarge and minimize the preview graph by clicking on the respective icons.

Use the checkboxes to the left of the series’ names to quickly apply settings to multiple series. Settings in the first row of the list (in every tab) apply to all selected series.

The graph configuration can be saved as soon as all mandatory fields (marked with a red star *) are filled.

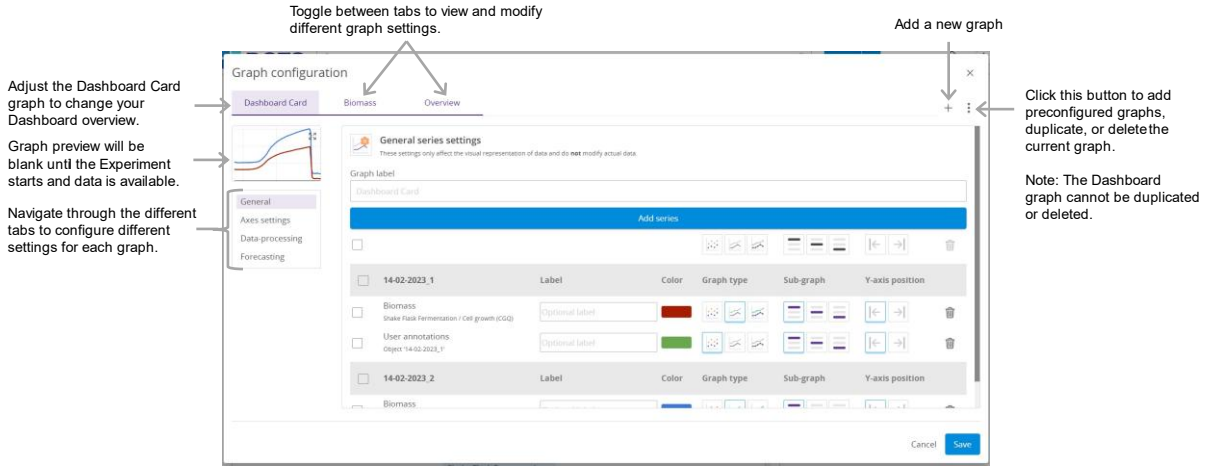


Figure 82: Graph configuration window – General tab

General series settings

You can enter and modify graph labels, select which series will be present on graphs, and configure general settings for each series on the “General” graph configuration tab.

When adding new graphs, make sure to enter a fitting name in the Graph label field since the name is used to search for existing graphs and load them into other graphs for comparison.

To add series to a graph, click the “Add series” button and select the series from the popout. Click “Load other Objects” to add data from other Experiments. Apart from data series, you can also add Annotations that will be displayed as arrows on the time axis. Once series are selected, a series list with various configurations will appear. The small text below the series name indicates to which Process / Task the series belongs (Figure 83).

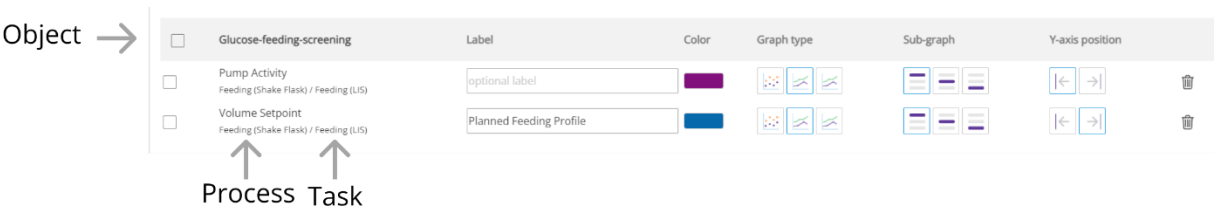
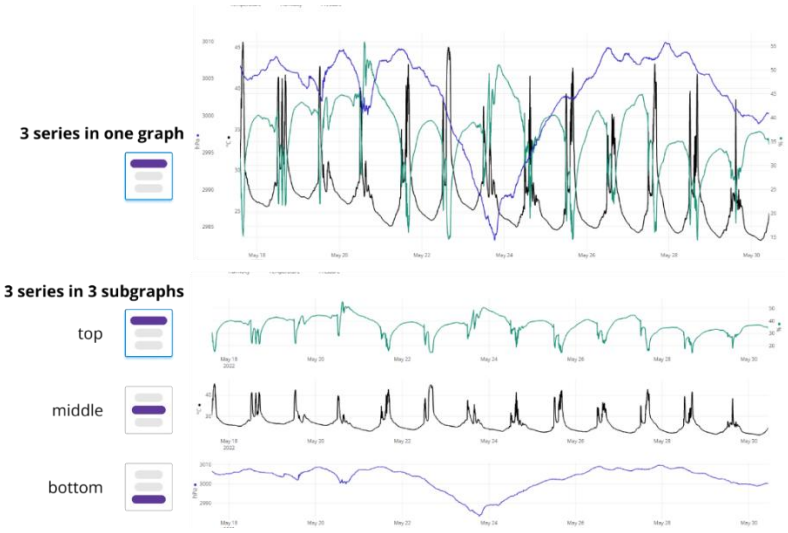
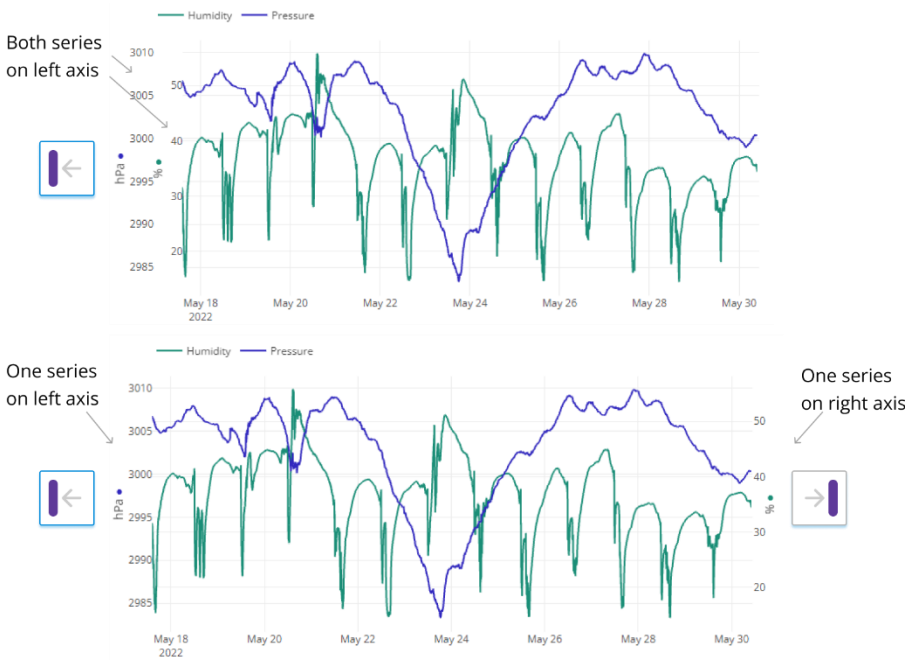


Figure 83: General series settings – List of series

Table 16: Configuring general series settings

Category	Icon	Explanation
Label	-	Enter an alternative name for the series, which be shown in the graph header. If no name is entered the series name will be used as the label.
Color		Click on the icon to open a list of optional colors and select.
Graph type		Scatter plot (markers only)
		Line graph (default for 2D data with a time axis and a value axis)
		Lines and markers (info on hover with or without markers)
Sub-graph		It is possible to distribute series data on up to 3 subgraphs (virtual rows) within one graph tab. Select the row (top, middle, or bottom) on which the series should be displayed. If the same subgraph is active for all series, all series data will be displayed on the same graph and will fill the Graph section on the Object Detail Page. 
Y-axis position		Position of the y-axis for the selected series. Select the left or right side of the graph. Series that have the same type of data (e.g., two temperature series) will automatically share the same axis the when the same y-axis position is selected for both series.



Delete		Deletes the series from the graph.

Axes settings

In the Axes settings graph configuration tab, the format and range of the y and x-axes can be configured, and offsets applied.

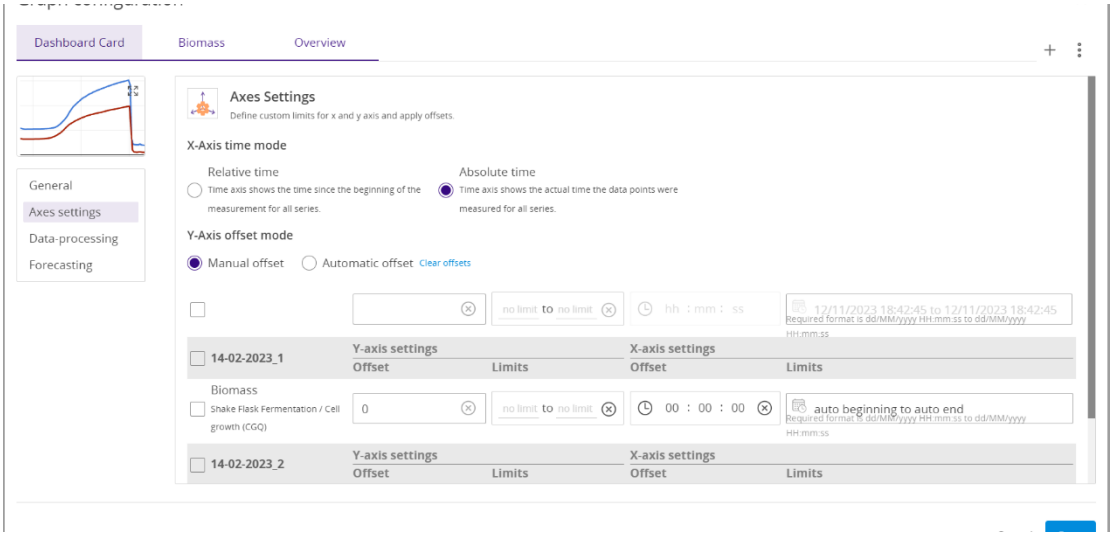
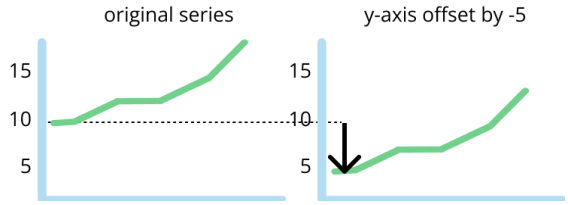
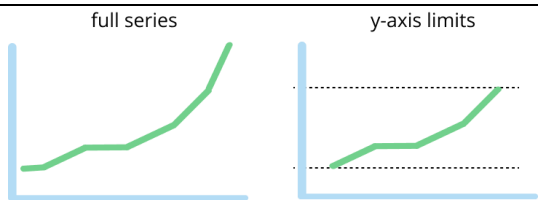
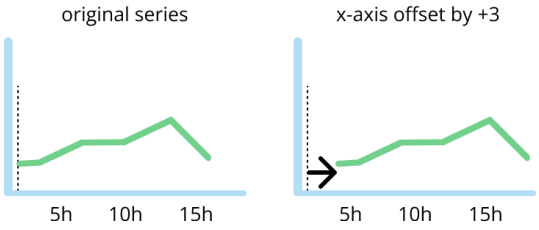
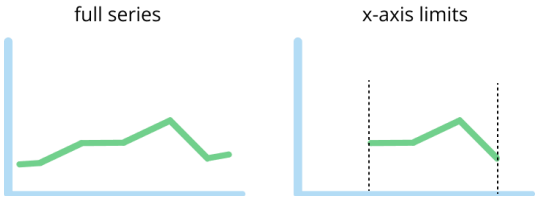


Figure 84: Graph configuration window – Axes settings tab

By default, no offsets are applied (**Manual offset** selected under Y-Axis offset mode and all offsets are set to zero). You can apply custom offsets for all axes (time and value axes) by filling in the entry fields in the lower series table. Refer to Table 17 to see how different axes settings affect your data series presentation.

Table 17: Configuring X and Y-Axis settings

Axes setting	Effect on data series presentation
Y-axis offset Move series along the y-axis by a specified value. This allows you to correct for, e.g., physical sensor offsets like a background signal.	
Y-axis limits Enter a minimum and / or maximum value to manually define axis limits. Only data within these limits will be displayed.	
X-axis offset Move series along the x-axis (time axis) by a specified value.	
X-axis limits Enter a minimum and / or maximum value to manually define axis limits. Only data within these limits will be displayed This setting can be used to trim data to remove initial instabilities from the real-time graph during the remainder of the process run.	

X-Axis time mode

Define whether the time axis (x-axis) should be displayed using relative or absolute time.

- Absolute time [default]: Show the actual date and time (based on computer settings) that each data point was recorded
- Relative time: Show time as duration of Experiment with the time of start = time point zero. If two Tasks within the same Process are started at different time points, this will be reflected in the relative time display.

Y-Axis offset mode

Define whether y-axis offset should be manually or automatically applied. Automatic offsets can be applied when all series of the graph share the same axis and contain the same type of data - e.g., all are “temperature” series.

With “Automatic offset” selected, all series will be automatically aligned to bring them as close together as possible on the y-axis (Figure 85). You can apply the auto offset based on all data, or refine the offset by specifying advanced options (move the toggle to “show advanced options for calculating offsets”):

- Custom time range: Series will be aligned based only on the data in this time range
- Target value: In the given time range, series will be moved as close as possible to the specified target value

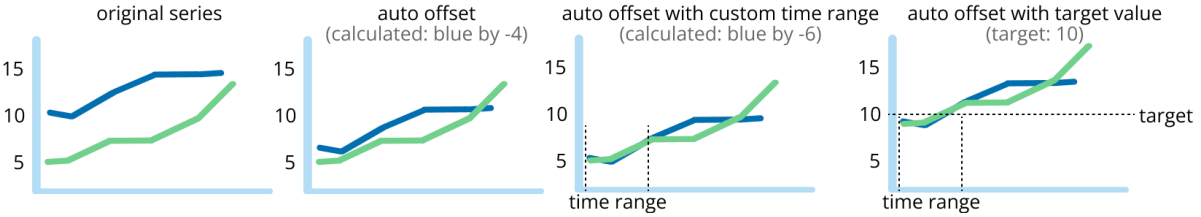


Figure 85: Applying automatic y-axis offsets with different control options

Please note that automatic offsets remain in the graph configuration once they have been calculated. You must click on “Clear offsets” to remove calculated offsets if you do not want to apply them any longer. The calculated offsets can be reviewed in the individual entry fields of each series (entry field “Y-axis settings” – “Offsets”).

Data Processing

In the Data-processing graph configuration tab, you can apply different data processors including calibrations and offsets. To apply a calibration, select the type of calibration curve (CGQ default calibration or One-Point/Two-Point calibration) and choose the relevant offline series.

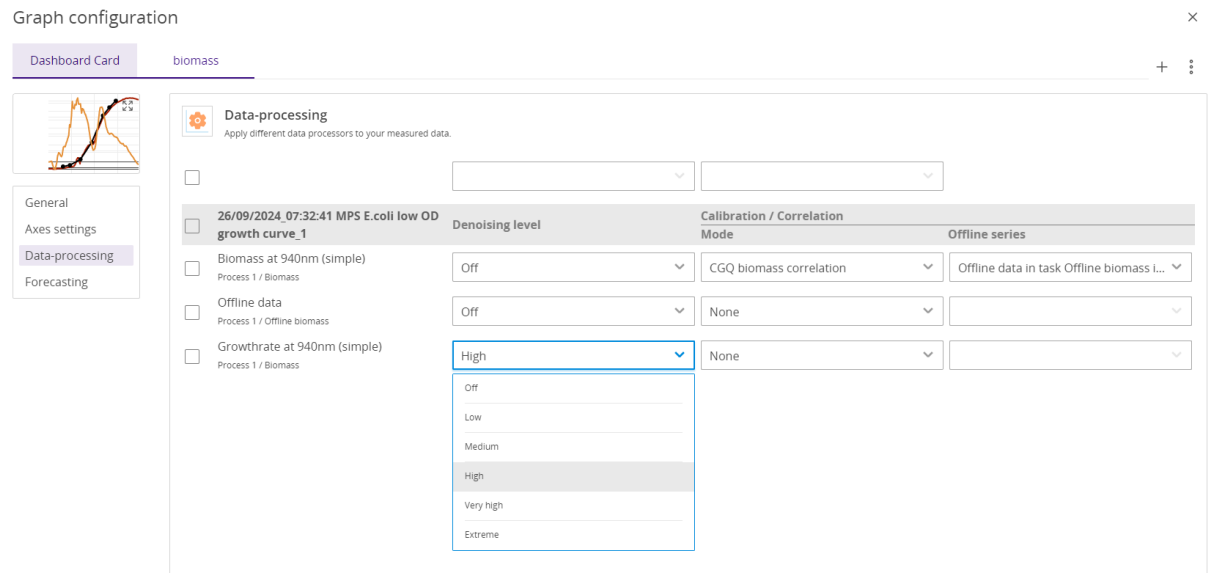


Figure 86: Graph configuration window – Data-processing tab

Table 18: Configuring Data-processing settings

Category	Explanation
Denoising level	Use this function to reduce noise in your raw data. Choose the desired level of denoising from the dropdown menu. The small graph on the top left helps to decide for a useful level of denoising for your specific data.
Calibration / Correlation: Mode	Select the type of calibration curve (either a One-Point/Two-Point calibration or a CGQ default calibration) from the dropdown list. This option will be disabled if no offline data has been recorded. For the calculation, timestamps of offline datapoints must lie within the range of online datapoints from the first to the last online datapoint.
Calibration / Correlation: Offline data series	Offline data series contain manually corrected and external input data (see “Task: Offline Monitoring” for more information). CGQ calibrations and pH offsets require an input of manually collected data to apply a calibration / offset.

Explanation on the denoising method

The DOTS Software uses exponential smoothing for denoising data series. The smoothing factor, alpha, sets the exponential rate at which the influence of older data points on the smoothing decays – the smaller the alpha value, the stronger the denoising. Alpha is dependent on the time since the last data point with alpha = (1-exp(deltaT/tau)).

Table 19: Current alpha values for each level of denoising

Denoising level	Tau value
Off	-
Low	70s
Medium	200s
High	330s
Very high	3300s
Extreme	33000s

Forecasting

In the Forecasting graph configuration tab, you can forecast what future data may look like (Figure 87). Define the time span (prior to the latest datapoint) that will be considered to calculate the data forecast. The same time span will be added to the last datapoint as a forecast.

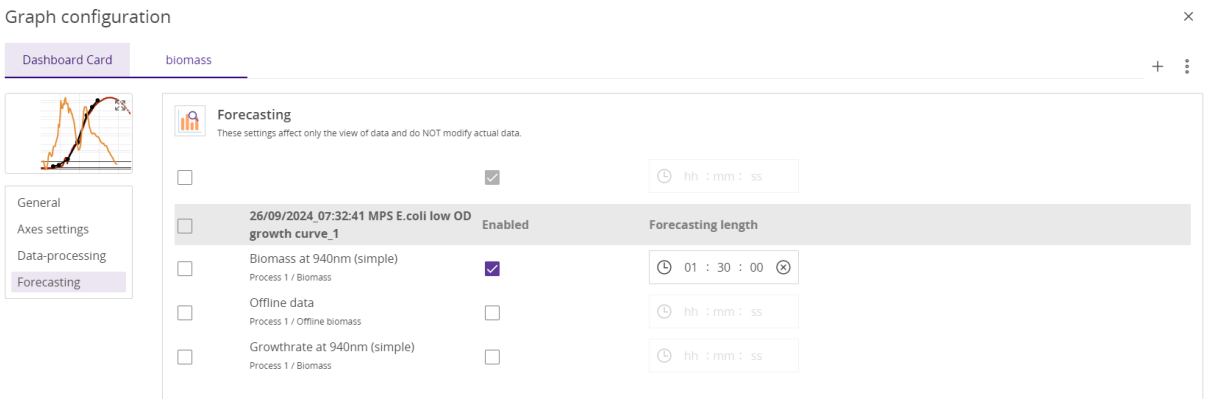


Figure 87: Graph configuration window – Data-processing tab

Data Export and Import

Exporting data from the DOTS Software

A customizable data export is now available within the DOTS Software. Click the download button from the grouped Object card, the Object list, or the Object detail page and select the type of export from the resulting popout (Figure 88, Figure 89). The different types of export are detailed in Table 20.

Select to decrease data density for Experiments with a high number of recorded measurements. Specify over which interval of time the data should be reduced, and the average of all data points within each interval will be reported as a single point.

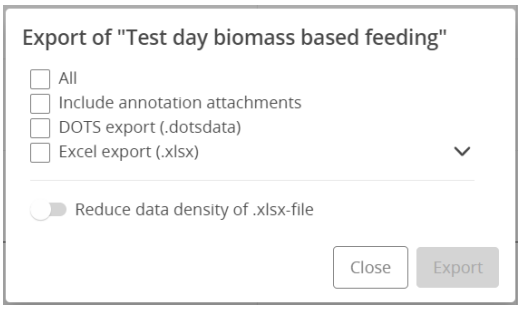


Figure 88: Data export popout – Dashboard

When exporting data from the detail page of a grouped Object, you will have the option to select data from all Objects within the Experiment group. Simply turn the toggle on and expand the dropdown Excel list to view and select additional Object data.

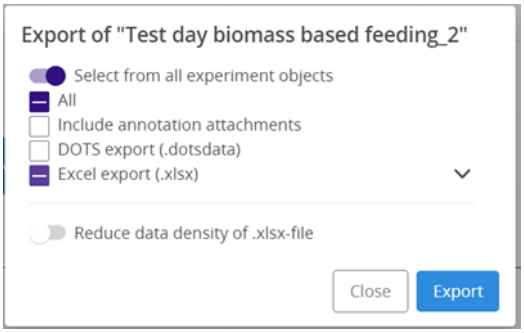


Figure 89: Data export popout - Object detail page of a grouped Object

Table 20: Data export customization options

Option	Explanation
All	Export all data for the entire Experiment. The created zip file will include attachments, a DOTS data export, and .xlsx files for each Object and the Dashboard Graph data.
Include annotation attachments	Export attachments associated with annotations for all Objects in the Experiment group.
DOTS export (.dotsdata)	Export a DOTS data file for the Experiment that can be imported into another instance of DOTS.
Excel export (.xlsx)	Export Excel file(s) for Experiment data. The default Excel export will include all data. Click the arrow and select data types from the expanded list to customize which data is included in the Excel export (Figure 90). Data types include: Raw data Dashboard graph data Object-specific data A separate .xlsx file will be generated for each Object and will include the Raw data and Dashboard Card data (if selected). An individual excel workbook will be exported if just the Dashboard Card data or individual Graph data are selected.

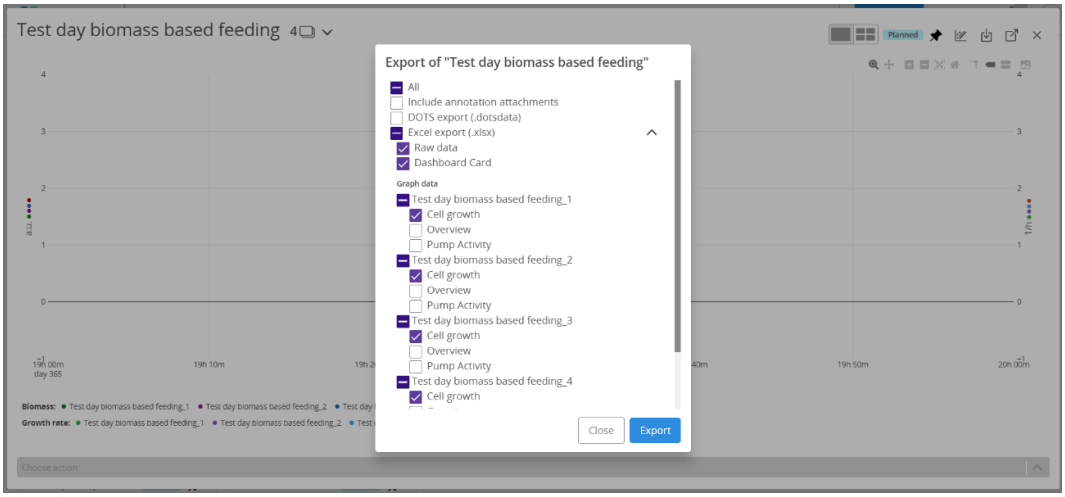


Figure 90: Dashboard data export pop out – expanded view. Customize which data is exported by checking the boxes next to series of interest.

Importing a DOTS data file

DOTS data files are exported as part of a .zip data file. Unzip the file before importing the DOTS data file into a new instance of DOTS. Click on “Experiment import” from the user icon in the top right corner of the software. On the import dialog, specify which Team will have access to the data and to which Project the data is relevant (Figure 91). Then, select the .dotsdata file(s) and click import. Once the import is completed, you will receive a notification as shown in Figure 92.

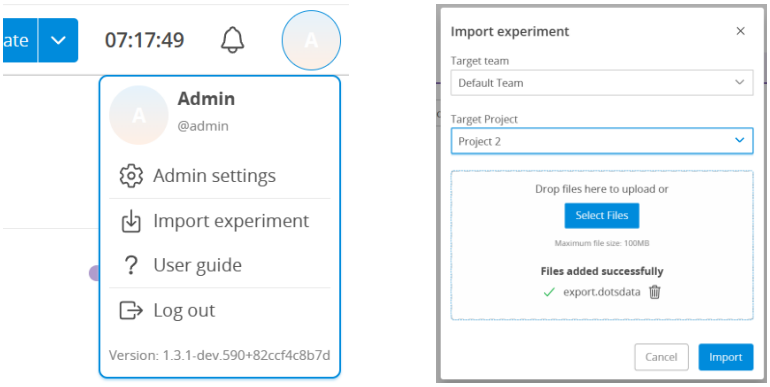


Figure 91: Navigating to the Experiment import (left) and import dialog (right)

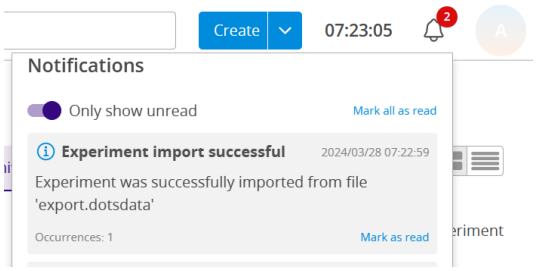


Figure 92: Successful Experiment import notification

Configuring Experiments and Objects

The workflows to create and configure Experiments are explained in the chapter “Experiment Creation wizard”. The first step is to select an Application Template for your specific experiment setup.

Using Application Templates

The Application Template contains all measurement configurations. An overview of the preconfigured Application Templates available in DOTS can be found in Table 1. The structure and contents of each Application Template are explained in the following section sections. Detailed information on Task configuration is given in section “Configuring Tasks” on pp. 83.

Some Task Templates, such as Smart Feeding and Shaker Control, are only accessible via Custom Application Templates. Such Templates are designed for advanced experiment setups or require combination with other Tasks’ (online) data.

The workflow to set up a Custom Application Templates, is included in the instructions on pp. 9. Both preconfigured and Custom Application Templates can be saved for later use (p.52), including the assigned Devices (see section “Turbo Templates – Rapid Experiment Start”).

Application Templates: Biomass monitoring / Biomass Monitoring High Cell Density [BioR]

What it does: These two templates are used for Biomass monitoring in bioreactors using the CGQ BioR Sensor. Choose “Biomass monitoring” or “Biomass Monitoring High Cell Density” according to your expected cell density (see Table 35). Both applications are based on the same Task template but come with different configurations. For the High Cell Density template, the BioR Sensor is configured to use a different wavelength to illuminate the culture. Whether you should use the normal or high cell density template is highly dependent on your type of strain and media. Please perform test Experiments or contact our application specialists for details.

Enable the “Configuration Step” in Basic Settings of the Creation wizard to view or modify Task Configuration Details.

Steps in Creation Wizard: Basic Settings, (optional: General Task Configuration), Device Assignment

Process Structure: One Process “Bioreactor Fermentation” is created. It contains the configuration for the CGQ BioR Sensor measurement “Biomass Monitoring (BioR)” and an offline data Task “OD600 Calibration Data (offline)”. The Task “Biomass Monitoring (BioR)” can be started, paused, and stopped from the Dashboard or Object Detail Page. The Task “OD600 Calibration Data (offline)” can be used to add manually recorded biomass data for calibration or documentation purposes. Simply click the “Add offline data” action button to add a new data point.

Table 21: Process Structure for Application Templates: Biomass monitoring / Biomass Monitoring High Cell Density [BioR]

Task	Based on Task Template	Devices
Biomass Monitoring (BioR)	Task: Biomass Monitoring in Bioreactor (BioR)	CGQ BioR Sensor
Biomass Calibration Data (Offline)	Task: Manual Monitoring (Offline Device)	Input required: Two offline values are required to calculate a calibrated OD curve from a Biomass signal. If offline values are only included for documentation purposes, more than two offline values can be stored in this OD600 data series.

Calibration: Calibration of CGQ data is performed during an Experiment. Refer to section “CGQ Calibration” to learn more.

Application Templates: Biomass / Fluorescence / DO Monitoring [Cell culture] [MPS]

What it does: These templates configure the MPS (Multiparameter Sensor) to measure Biomass, Fluorescence, and/or DO (dissolved oxygen) in a shake flask. Biomass is monitored in all MPS Application Templates. If you wish to measure all three parameters at once, choose the Application Template "DO and Fluorescence Monitoring for cell culture (MPS)".

Additional Components: DO Monitoring by the MPS requires the addition of a DO Sensor Pill into the flask.

Steps in Creation Wizard: Basic Settings, General Task Configuration (optional for Biomass only), Device Assignment

Process Structure: One Process is created. In all cases, it contains the configuration for Biomass and an offline data Task "Offline biomass", which can be used to correlate the MPS Biomass signal with offline Biomass measurements or add data for documentation purposes (e.g., OD_{600}, cell dry weight). Simply click the "Add offline data" action button to add a new data point. The Fluorescence and DO Templates contain, in addition to Biomass, a respective Task that configures the MPS to measure either Fluorescence or DO by reading out the signal from a DO Sensor Pill inside the flask. All Tasks can be started, paused, and stopped simultaneously from the Dashboard or Object Detail Page.

Table 22: Process Structure for Application Templates: Biomass / Fluorescence / DO Monitoring [Cell culture] [MPS]

Task	Based on Task Template	Devices
DO	Task: DO monitoring [Cell culture] (MPS)	MPS + DO Sensor Pill (single use, sterile, added inside flask) Input required: DO Sensor Pill calibration code (on package)
Fluorescence	Task: Fluorescence [Cell culture] (MPS)	MPS
Biomass	Task: Biomass [Cell culture] (MPS)	MPS
Offline biomass	Task: Offline Monitoring	No device required. Using this Task to add manually collected offline data is optional. Offline data can be used to correlate biomass with MPS Biomass readings.

Correlating MPS Biomass signal with offline collected biomass data: Access the graph configuration and navigate to "Data Processing" as explained in detail in the section "Data Processing".

Application Templates: Biomass / Fluorescence / DO Monitoring [Microbial] [MPS]

What it does: These templates configure the MPS (Multiparameter Sensor) to measure Biomass, Fluorescence, and/or DO (dissolved oxygen) in a shake flask. Biomass is monitored in all MPS Application Templates. If you wish to measure all three parameters at once, choose the Application Template "DO and Fluorescence Monitoring for microbial (MPS)".

Additional Components: DO Monitoring by the MPS requires the addition of a DO Sensor Pill into the flask.

Steps in Creation Wizard: Basic Settings, General Task Configuration (optional for Biomass only), Device Assignment

Process Structure: One Process is created. In all cases, it contains the configuration for Biomass and an offline data Task "Offline biomass", which can be used to correlate the MPS Biomass signal with offline Biomass measurements or add data for documentation purposes (e.g., OD_{600}, cell dry weight). Simply click the "Add offline data" action button to add a new data point. The Fluorescence and DO Templates contain, in addition to Biomass, a respective Task that configures the MPS to measure either Fluorescence or DO by reading out the signal from a DO Sensor Pill inside the flask. All Tasks can be started, paused, and stopped simultaneously from the Dashboard or Object Detail Page.

Table 23: Process Structure for Application Templates: Biomass / Fluorescence / DO Monitoring [Microbial] [MPS]

Task	Based on Task Template	Devices
DO	Task: DO [Microbial] (MPS)	MPS + DO Sensor Pill (single use, sterile, added inside flask) Input required: DO Sensor Pill calibration code (on package)
Fluorescence	Task: Fluorescence [Microbial] (MPS)	MPS

Biomass	Task: Biomass [Microbial] (MPS)	MPS
Offline biomass	Task: Offline Monitoring	No device required. Using this Task to add manually collected offline data is optional. Offline data can be used to correlate biomass with MPS Biomass readings.

Correlating MPS Biomass signal with offline collected biomass data: Access the graph configuration and navigate to “Data Processing” as explained in detail in the section “Data Processing”.

Application Templates: Biomass monitoring > / < 150 rpm [CGQ]

What it does: These two templates are used for Biomass monitoring in Shake Flasks using the CGQ Sensor. Select "> 150 rpm" or "< 150 rpm" according to your planned shaking speed. Both applications are based on the same Task template but come with different configurations. The CGQ sensor can automatically pause and resume a measurement based on shaking speed (rpm). This feature is used to remove artifacts from the CGQ backscatter data, which can be caused by, e.g., opening the shaker. However, this rpm-based measurement control is only reliable above 150 rpm. Thus, it is active for the template "> 150 rpm" and inactive for the template "< 150 rpm".

Make sure to choose the correct template according to your shaking speed. The CGQ Sensor will not measure any data if the template > 150 rpm is chosen and the shaking speed falls below 150 rpm.

Enable the "Configuration Step" in Basic Settings of the Creation Wizard to view or modify Task Configuration Details.

Steps in Creation Wizard: Basic Settings, (optional: General Task Configuration), Device Assignment

Process Structure: One Process "Shake Flask Fermentation" is created. It contains the configuration for the CGQ Sensor measurement "Cell Growth (CGQ)" and an offline data Task "OD600 (offline)". The Task "Cell Growth (CGQ) can be started, paused, and stopped from the Dashboard or Object Detail Page. The Task "OD600 (offline)" can be used to add manually recorded biomass data for calibration or documentation purposes. Simply click the "Add offline data" action button to add a new data point.

Table 24: Process Structure for Application Templates: Biomass monitoring > / < 150 rpm [CGQ]

Task	Based on Task Template	Devices
Cell Growth (CGQ)	Task: Biomass Monitoring in Shake Flask (CGQ)	CGQ Sensor
Offline Biomass Data	Task: Manual Monitoring (Offline Device)	Input required: Two offline values are required to calculate a calibrated OD curve from a Biomass signal. If offline values are only included for documentation purposes, more than two offline values can be stored in this OD600 data series.

Calibration: Calibration of CGQ data is performed during an Experiment. Refer to section "CGQ Calibration" learn more.

Application Template: Biomass-based Feeding [LIS+CGQ]

What it does: This template combines the CGQ Sensor and the LIS system functionalities for trigger-based feeding in shake flasks. It uses live biomass data, generated by a CGQ Sensor, to trigger feeding of a liquid, executed by a LIS Drive, into a shake flask. Once the trigger condition is met (Biomass as Backscatter or growth rate, both absolute values), the individually defined feeding profile starts.

The “Configuration Step” is always enabled since you must define the type of liquid and the feeding profile as well as the feeding trigger (Biomass or growth rate threshold).

Steps in the Wizard: Basic Settings, General Task Configuration, Device Assignment

Process Structure: One Process “Biomass based Feeding” is created. It contains the configurations for the LIS Drive “Feeding (LIS)” and the CGQ Sensor “Biomass Monitoring (CGQ)”, as well as an offline data series for manually recorded OD_{600} values “Offline Biomass Data”. The LIS workflow is different from usual Tasks. The available Actions on the Dashboard and Object Detail Page are “Upload LIS”, “Prepare LIS”, and “Start LIS”. See Table 12 for detailed explanations on the LIS workflow. The Task “Cell Growth (CGQ) can be started, paused, and stopped from the Dashboard or Object Detail Page. The Task “Offline Biomass Data” can be used to add manually recorded biomass data for calibration or documentation purposes. Simply click the “Add offline data” action button to add a new data point.

Table 25: Process Structure for Application Template: Biomass-based Feeding [LIS+CGQ]

Task	Based on Task Template	Devices
Feeding (LIS)	Task: Feeding (LIS) (only profile based Feeding available)	LIS Drive
Biomass Monitoring (CGQ)	Task: Biomass Monitoring in Bioreactor (BioR)	CGQ BioR Sensor
Offline Biomass Data	Task: Manual Monitoring (Offline Device)	Input required: Two offline values are required to calculate a calibrated OD curve from a Biomass signal. If offline values are only included for documentation purposes, more than two offline values can be stored in this OD600 data series.

Calibration: Calibration of CGQ data is performed during an Experiment. Refer to section “CGQ Calibration” to learn more.

Application Templates: pH and/or DO Monitoring [DOTS pHDO] [Flow Loop]

What it does: These templates configure the DOTS Fiber Optic Sensor to use the DOTS Flow Cell pH, DOTS Flow Cell DO, or both simultaneously, to measure pH and/or dissolved oxygen in a flow loop of, e.g., your bioreactor. Choose one out of the three templates (pH & DO, pH, DO) according to the connected type(s) of Flow Cells and the type of Fiber Optic Sensor (Dual Channel or Single Channel pH or DO).

The “Configuration Step” is always enabled for Flow Loop templates since you must enter the Sensor code of the Flow Cells. This code enables the DOTS Software to configure the Fiber Optic Sensor correctly according to the connected type of Flow Cell.

Steps in Creation Wizard: Basic Settings, General Task Configuration, Device Assignment

Process Structure: One Process “Cell Culture” is created. It contains the configuration for pH monitoring, DO monitoring, or both, according to the selected Template. For Processes with a “pH Monitoring” Task, an offline data Task “pH Data (offline)”. The pH and DO Monitoring Tasks can be started, paused, and stopped from the Dashboard or Object Detail Page. The Task “pH Data (offline)” can be used to add manually recorded pH data for offsetting or documentation purposes. Simply click the “Add offline data” action button to add a new data point.

Table 26: Process Structure for Application Templates: pH and/or DO Monitoring [DOTS pHDO] [Flow Loop]

Task	Based on Task Template	Devices
pH Monitoring	Task: pH Monitoring (DOTS)	DOTS Sensor with connected pH flow cell. Input required: Sensor Code (on package)
DO Monitoring	Task: DO Monitoring (DOTS)	DOTS Sensor with connected DO flow cell. Input required: Sensor Code (on package)
pH Data (offline)	Task: Manual Monitoring (Offline Device)	Input required: An offline pH value is required to correctly offset the optical pH measurement at the start of an Experiment. If offline values are only included for documentation purposes, more than one offline value can be stored in this offline data series.

Calibration: Calibration of the DOTS Fiber Optic Sensor is performed prior to an Experiment. Please refer to the section “DOTS pH & DO Calibration” to learn more.

Application Template: DO-based Feeding (with Fluorescence monitoring) [LIS+MPS]

What it does: These templates configure the MPS (Multiparameter Sensor) to measure Biomass and DO (dissolved oxygen) in a shake flask. Fluorescence is additionally measured in the Template "…with Fluorescence monitoring…". The DO signal is used in a feedback loop that triggers a LIS Feed whenever the DO exceeds a user-defined DO threshold (e.g., 100 mbar DO Partial Pressure). Hence, a feed is applied that caters to the requirements of the culture in the flask.

Additional Components: DO Monitoring by the MPS requires the addition of a DO Sensor Pill into the flask.

Steps in Creation Wizard: Basic Settings, General Task Configuration, Device Assignment

Process Structure: One Process is created. In all cases, it contains the configuration for Biomass and DO and an offline data Task "Offline biomass", which can be used to correlate the MPS Biomass signal with offline Biomass measurements or add data for documentation purposes (e.g., OD_{600}, cell dry weight). Simply click the "Add offline data" action button to add a new data point. The Fluorescence and DO Templates contain, in addition to Biomass, a respective Task that configures the MPS to measure either Fluorescence or DO by reading out the signal from a DO Sensor Pill inside the flask. The Task "Feedback control" contains the PID controller that triggers the LIS Feed. It is connected to the Task "DO" since it uses the DO data for feedback control. Choose between "DO Partial Pressure" or "DO Percent" for the feedback control. All Tasks can be started, paused, and stopped simultaneously from the Dashboard or Object Detail Page. The available Actions for the Feedback control Task on the Dashboard and Object Detail Page are "Upload LIS", "Prepare LIS", and "Start LIS". See Table 12 for detailed explanations on the LIS workflow.

To prevent an unwanted Feed during the batch phase of your culture, make sure to set a proper Start Condition for to activate the Feedback Control (LIS) at the right time.

In a typical DO based Feeding experiment, the culture starts with a high DO, which decreases while cells start to grow, and later increases again when the batch substrate is depleted. A useful start condition for the DO-based Feedback Control is "DO ≤ Target DO", or, for even more robust condition "If continuously for the last … minutes, DO ≤ Target DO". This Start Condition makes sure that no feeding will occur while batch substrate is still available for the culture.

Table 27: Process Structure for Application Template: DO-based Feeding (with Fluorescence monitoring) [LIS+MPS]

Task	Based on Task Template	Devices
DO monitoring	Task: DO (MPS)	MPS + DO Sensor Pill (single use, sterile, added inside flask) Input required: DO Sensor Pill calibration code (on package)
Feedback control	Task: Feeding [LIS]	LIS
Biomass	Task: Biomass (MPS)	MPS
Offline biomass	Task: Offline Monitoring	No device required. Using this Task to add manually collected offline data is optional. Offline data can be used to correlate biomass with MPS Biomass readings.
Fluorescence	Task: Fluorescence (MPS)	MPS

Correlating MPS Biomass signal with offline collected biomass data: Access the graph configuration and navigate to "Data Processing" as explained in detail in the section "Data Processing".

Application Template: Feeding [LIS]

What it does: This template configures the LIS drive to execute a defined Feeding Profile. The liquid in the LIS cartridge is pumped into a Shake Flask.

The “Configuration Step” is always enabled since you must define the type of liquid and the feeding profile.

Steps in the Wizard: Basic Settings, General Task Configuration, Device Assignment

Process Structure: One Process “Feeding (Shake Flask)” is created. It contains the Task “Feeding (LIS)” which defines the Feeding Strategy and the correct configuration of the LIS drive according to the liquid in the LIS cartridge. The LIS workflow is different from usual Tasks. The available Actions on the Dashboard and Object Detail Page are “Upload LIS”, “Prepare LIS”, and “Start LIS”. See Table 12 for detailed explanations on the LIS workflow.

Table 28: Process Structure for Application Template: Feeding [LIS]

Task	Based on Task Template	Devices
Feeding (LIS)	Task: Feeding (LIS) (only Profile based feeding available)	LIS Drive

Configuring Tasks

All hardware is controlled via the Tasks within an Object Structure. The DOTS Software works with several Task Templates that directly access the available functions of the hardware. All details of the Tasks can be adjusted. For detailed information on the hardware technology, refer to the respective Hardware User Guides.

Some hardware can handle multiple Tasks. For example, the MPS (Multiparameter Sensor) can measure several settings for Biomass detection, Fluorescence at different wavelengths, and dissolved oxygen on one Device. However, measurements are always executed one after another, never simultaneously. For this reason, some scheduled measurement timepoints may be delayed. This happens when the Device is busy with one measurement while another measurement is already scheduled. Certain user settings may provoke visible deviations from the scheduled measurement timepoints. These include a large number of Tasks on the same Device, or prolonged measurements (e.g., long acquisition times for Fluorescence monitoring). Hence, the measurement interval of all tasks is titled as “minimum measurement interval”, indicating that longer intervals may be observed.

If more than one Task is running on the same Device (especially MPS), scheduled measurement timepoints may be delayed.

Table 29: Task Templates available in the DOTS Software

Task template	Hardware
Biomass [Cell Culture] [MPS]	MPS
Biomass [Microbial] [MPS]	MPS
Biomass Monitoring [BioR]	CGQ BioR
Biomass Monitoring [CGQ]	CGQ
DO Monitoring [DOTS DO] [Flow Loop]	DOTS Flow Cell DO
DO monitoring [Cell culture] [MPS]	MPS + DO Sensor Pill
DO monitoring [Microbial] [MPS]	MPS + DO Sensor Pill
Feeding [LIS]	LIS
Fluorescence [Cell Culture] [MPS]	MPS
Fluorescence [Microbial] [MPS]	MPS
Notification Trigger[1]	None This Task is used to configure notifications (e-mail, DOTS Software Dashboard, DOTS Software internal notification system) based on user-specified triggers (e.g., certain growth rate reached). It works in combination with the Task type that contains the data used for the trigger.
Offline Monitoring	None / your own specific hardware
pH Monitoring [DOTS pH] [Flow Loop]	DOTS Flow Cell pH
Shaker control [Shaker] [1]	Smart Shaker capable of modbus TCP (via NET60 module)
Shaker monitoring [Shaker] [1]	Smart Shaker capable of modbus TCP (via NET60 module)

CGQ: Cell Growth Quantifier, LIS: Liquid Injection System, DO: Dissolved Oxygen, MPS: Multiparameter Sensor

1 These Templates are only available via the Custom Application Template workflow (but the configuration can be done once and saved under Custom Templates, see: Complete Experiment Creation Wizard).

Task: Biomass [Cell culture] [MPS]

What it does: The MPS performs biomass monitoring in shake flasks.

Required Devices: MPS

Table 30: Main output data from Task: Biomass [Cell culture] [MPS]

Output	Explanation	Remarks
Biomass	Backscattered light intensity [a.u.] (suspended biomass)	Backscatter signal can be converted to TCD (total cell density) and/or VCD (viable cell density) values if two offline values are provided (see CGQ and MPS Biomass Correlation with offline data). Calibration is available after the measurement is finished.
Growth rate	Growth rate of monitored culture	Calculated from backscatter data

Table 31: Configurable parameters for Task: Biomass [Cell culture] [MPS]

Parameter	Default settings	Explanation
Excitation wavelength	940 nm	Peak wavelength of the LED that is used to illuminate the biomass for backscatter (Biomass) measurements
Advanced settings	Hidden	Advanced settings are configurable for advanced users. Toggle “On” to view and edit.
Acquisition time [s]	6 seconds	The time used to complete one measurement (datapoint). The shake flask liquid is illuminated during the specified acquisition time. A higher acquisition time can increase the lower detection limit but may also increase noise.
Selected bin	30	Relates to the position within the circle that the flask liquid travels during shaking. Depending on the process parameters (among others: flask type, flask size, flask filling volume, shaking speed), the optimal bin for robust measurements may shift from the default value. The raw data contains measurements for all bins and can be processed in hindsight. Please contact our application scientists for post-processing and identifying optimal bins for your experiment setup.
Measurement type	Near	Position and type of the photodiode used to capture backscattered light. The raw data contains measurements for all photodiodes and can be processed in hindsight. Please contact our application scientists for post-processing and identifying optimal photodiodes for your experiment setup.
Min. measurement interval [min]	5 minutes	The time between two measurements (datapoints). Possible minimum: 1 minute.

Task: Biomass [Microbial] [MPS]

What it does: The MPS performs biomass monitoring in shake flasks.

Required Devices: MPS

Table 32: Main output data from Task: Biomass [Microbial] [MPS]

Output	Explanation	Remarks
Biomass	Backscattered light intensity [a.u.] (suspended biomass)	Backscatter signal can be converted to OD600 values if two offline values are provided (see CGQ and MPS Biomass Correlation with offline data). Calibration is available after the measurement is finished.
Growth rate	Growth rate of monitored culture	Calculated from backscatter data

Table 33: Configurable parameters for Task: Biomass [Microbial] [MPS]

Parameter	Default settings	Explanation
Excitation wavelength	940 nm	Peak wavelength of the LED that is used to illuminate the biomass for backscatter (Biomass) measurements
Advanced settings	Hidden	Advanced settings are configurable for advanced users. Toggle “On” to view and edit.
Min. measurement interval [s]	20 seconds	The time between two measurements (datapoints). Enter a value in seconds. For short Experiment durations, short measurement intervals are recommended (possible minimum: 10 seconds).
Acquisition time [s]	6 seconds	The time used to complete one measurement (datapoint). The shake flask liquid is illuminated during the specified acquisition time. A higher acquisition time can increase the lower detection limit but may also increase noise.

Task: Biomass Monitoring [BioR]

What it does: The CGQ BioR Sensor performs biomass monitoring in bioreactor vessels.

Required Devices: CGQ BioR Sensor, CGQ Hub

Table 34: Main output data from Task: Biomass Monitoring [BioR]

Output	Explanation	Remarks
Biomass	Backscattered light intensity [a.u.] (suspended biomass)	Backscatter signal can be converted to OD600 values if two offline values are provided (see CGQ Calibration). Calibration is available after the measurement is finished.
Growth rate	Growth rate of monitored culture	Calculated from backscatter data

Table 35: Configurable parameters for Task: Biomass Monitoring [BioR]

Parameter	Default settings	Explanation
Standard Cultivation / High Cell Density Cultivation	Standard Cultivation	The CGQ BioR is capable of measuring in an OD600 range of 0.5-300 (up to approx. 150 g/L) – depending on your process. However, low and high cell densities require different sensitivity modes for accurate results. There is a great variety between organisms and bioprocesses, so we cannot give standard recommendations for when to use which sensitivity mode. If your expected OD600 is in a range of above 100, you will for sure need the High Cell Density Cultivation mode. For other cases, run a test Experiment or contact our support Team – we are always happy to assist you!
Advanced settings		
Min. measurement interval [s]	20 seconds	The time between two measurements (datapoints). Enter a value in seconds. For short Experiment durations, short measurement intervals are recommended. General recommendation: 5-30 seconds per datapoint.

Task: Biomass Monitoring [CGQ]

What it does: The CGQ Sensor performs biomass monitoring in shake flasks.

Required Devices: CGQ Sensor, CGQ Hub

Table 36: Main output data from Task: Biomass Monitoring [CGQ]

Output	Explanation	Remarks
Biomass	Backscattered light intensity [a.u.] (suspended biomass)	Backscatter signal can be converted to OD600 values if two offline values are provided (see CGQ and MPS Biomass Correlation with offline data). Calibration is available after the measurement is finished.
Growth rate	Growth rate of monitored culture	Calculated from backscatter data

Table 37: Configurable parameters for Task: Biomass Monitoring [CGQ]

Parameter	Default settings	Explanation
LED position	Position 3 – Outer LED	The measurement can be performed from one of the 3 LED positions on the CGQ sensor (refer to the CGQ hardware manual for details). The standard LED position used in the DOTS Software is the outermost Position 3, as it most often creates best results. However, based on your experiment, changing the position may be beneficial, especially if sub-optimal filling volumes or baffled flasks are used or foam is formed in the cultivation. Feel free to contact our support team.
Automatically pause / resume measurement based on RPM	> 150 rpm: On < 150 rpm: Off	Changes in shaking speed, especially stopping the shaking, even for a short period of time (for example, while opening the shaker to take a sample) can lead to artifacts in the backscatter signal (since the liquid stops moving). The CGQ sensor recognizes short-term changes of the shaking speed [rpm] and will not record data for shaking speeds < 150 rpm. Turn this function off for shaking speeds < 150 rpm since the sensor cannot properly recognize this type of event for low shaking speeds (the Sensor will not even start measuring).
Advanced settings		
Min. measurement interval [s]	20 seconds	The time between two measurements (datapoints). Enter a value in seconds. For short Experiment durations, short measurement intervals are recommended. General recommendation: 5-30 seconds per datapoint.

Task: DO Monitoring [DOTS DO] [Flow Loop]

What it does: Monitor the dissolved oxygen (DO) of a liquid passing through a DOTS Flow Cell within a flow loop.

Required Devices: DOTS Fiber Optic Sensor with fiber optic cable(s)

Additional components: DOTS Flow Cell – DO, Pt100 Temperature Sensor (optional)

Table 38: Main output data from Task: DO Monitoring [DOTS DO] [Flow Loop]

Output	Explanation	Remarks
DO Percent	Dissolved oxygen (percent of full saturation) of liquid passing through the DOTS Flow Cell	DO [%] is calculated based on either a Factory calibration (via the Flow Cell Sensor code) or a Custom calibration (must be generated prior to Experiment setup) and is capped between 0-100% DO.
DO Partial Pressure	Dissolved oxygen (absolute partial pressure units) of liquid passing through the DOTS Flow Cell	DO [mbar] measurements always reported in absolute units. This output is useful for still being able to visualize changing DO in case the %DO goes above or below the saturated point or 0-point, and becomes capped.
Pt100 Temperature	Real time temperature measurements read by a connected Pt100 Temperature Sensor, regardless of which channel (pH or DO) the sensor is connected to	An optional output for when temperature is not controlled. Measured at the location of the Pt100 sensor, and not within the flow loop. If temperature is known and tightly controlled, a “Manual” value may be entered in °C and this output would not be available.

Table 39: Configurable parameters for Task: DO Monitoring [DOTS DO] [Flow Loop]

Parameter	Default settings	Explanation
Flow Cell Settings		
Calibration	Factory calibration	Select Factory calibration or a calibration file that has been previously recorded and saved. Refer to section “DOTS Fiber Optic Sensor calibration wizard” for detailed instructions on how to generate and save a custom calibration file.
DO Sensor Code	Requires user input	Enter the Sensor code listed on the outside of the DOTS Flow Cell package. This code will auto-fill if a custom calibration file is selected for the “Calibration” parameter. Format: XX1-999-111
Temperature Source	Pt100	For non-temperature-controlled environments, a Pt100 temperature sensor must be connected to the DOTS Fiber Optic Sensor to compensate for temperature fluctuations. If temperature is known and tightly controlled, select “Manual” for the Temperature Source and input the temperature in °C in the resulting “Manual Temperature [°C]” field.
Advanced settings	Hidden	Advanced settings are configurable for advanced users. Toggle “On” to view and edit.
Min. measurement interval [s]	20 seconds	The time between two measurements (datapoints). Enter a value in seconds. For short Experiment durations, short measurement intervals are recommended. Do not go below 5 second measurement intervals.
Pressure Source	Ambient	Measured inside sensor housing to compensate for fluctuations in atmospheric pressure. If pressure within the flow loop is known and tightly controlled, select “Manual” for the Pressure Source and input the Manual Sample Pressure in mbar units.

Salinity of solution [g/L]	Physiological (5-15 g/L)	Solution salinity is used to calculate accurate DO measurements. If salinity is known to greatly differ from the physiological range, select “Custom” and input the Custom salinity of solution in g/L.

Task: DO monitoring [Cell culture] (MPS)

What it does: The MPS measures DO (dissolved oxygen) in shake flasks by reading the signal from a DO Sensor Pill circulating in the shake flask liquid. The DO Sensor Pill must circulate with the liquid. Details for appropriate process conditions are given in the MPS and DO Sensor Pill User Guide.

Required Devices: MPS

Additional components: DO Sensor Pill

Table 40: Main output data from Task: DO monitoring [Cell culture] (MPS)

Output	Explanation	Remarks
DO Partial Pressure	Dissolved oxygen (absolute partial pressure units) of liquid inside the shake flask	DO [mbar] measurements are calculated within the DOTS Software and always reported in absolute units. This output is useful for still being able to visualize changing DO in case the %DO goes above or below the saturated point or 0-point, respectively, and becomes capped.
DO Percent	Dissolved oxygen (percent of full saturation) of liquid inside the shake flask	DO [%] is calculated based on the Factory calibration (via the DO Sensor Pill calibration code) and is capped between 0-100% DO.

Table 41: Configurable parameters for Task: DO monitoring [Cell culture] (MPS)

Parameter	Default settings	Explanation
DO Pill		
Calibration	Factory calibration	DO Sensor Pills come factory calibrated and do not require user calibration for typical applications. For further explanations, refer to the MPS and DO Sensor Pill User Guide.
DO Sensor Code (XX1-111-111)	Requires user input	The calibration code can be found on the package of each DO Sensor Pill. The calibration code ensures the correct transformation of DO raw data (DO dPhi) to processed data “DO Partial Pressure” and “DO Percent”. The raw data cannot be transformed in hindsight, please make sure to always enter the correct calibration code prior to experiment start.
Advanced Settings: DO Pill	Hidden	Advanced settings are configurable for advanced users. Toggle “On” to view and edit.
Salinity of solution [g/L]	Physiological [5-15 g/L]	Solution salinity is used to calculate accurate DO measurements. If salinity is known to greatly differ from the physiological range, select “Custom” and input the Custom salinity of solution in g/L. Note that DO Sensor Pills do not work well in absence of salts (desalted water).
Advance Settings: Device Settings	Hidden	Advanced settings are configurable for advanced users. Toggle “On” to view and edit.
Temperature Source	Ambient	For non-temperature-controlled environments, the temperature sensor integrated in the MPS compensates the DO signal for temperature fluctuations. If temperature is known, constant, and tightly controlled, you can select “Manual” for the Temperature Source and input the temperature in °C in the resulting “Manual Temperature [°C]” field.
Min. measurement interval [min]	5 minutes	The time between two measurements (datapoints). Possible minimum: 1 minute.

Task: DO monitoring [Microbial] (MPS)

What it does: The MPS measures DO (dissolved oxygen) in shake flasks by reading the signal from a DO Sensor Pill circulating in the shake flask liquid. The DO Sensor Pill must circulate with the liquid. Details for appropriate process conditions are given in the MPS and DO Sensor Pill User Guide.

Required Devices: MPS

Additional components: DO Sensor Pill

Table 42: Main output data from Task Task: DO monitoring [Microbial] (MPS)

Output	Explanation	Remarks
DO Partial Pressure	Dissolved oxygen (absolute partial pressure units) of liquid inside the shake flask	DO [mbar] measurements are calculated within the DOTS Software and always reported in absolute units. This output is useful for still being able to visualize changing DO in case the %DO goes above or below the saturated point or 0-point, respectively, and becomes capped.
DO Percent	Dissolved oxygen (percent of full saturation) of liquid inside the shake flask	DO [%] is calculated based on the Factory calibration (via the DO Sensor Pill calibration code) and is capped between 0-100% DO.

Table 43: Configurable parameters for Task: DO monitoring [Microbial] (MPS)

Parameter	Default settings	Explanation
DO Pill		
Calibration	Factory calibration	DO Sensor Pills come factory calibrated and do not require user calibration for typical applications. For further explanations, refer to the MPS and DO Sensor Pill User Guide.
DO Sensor Code (XX1-111-111)	Requires user input	The calibration code can be found on the package of each DO Sensor Pill. The calibration code ensures the correct transformation of DO raw data (DO dPhi) to processed data “DO Partial Pressure” and “DO Percent”. The raw data cannot be transformed in hindsight, please make sure to always enter the correct calibration code prior to experiment start.
Advanced Settings: Device Settings	Hidden	Advanced settings are configurable for advanced users. Toggle “On” to view and edit.
Min. measurement interval [s]	20 seconds	The time between two measurements (datapoints). Enter a value in seconds. For short Experiment durations, short measurement intervals are recommended (possible minimum: 10 seconds).
Temperature Source	Ambient	For non-temperature-controlled environments, the temperature sensor integrated in the MPS compensates the DO signal for temperature fluctuations. If temperature is known, constant, and tightly controlled, you can select “Manual” for the Temperature Source and input the temperature in °C in the resulting “Manual Temperature [°C]” field.
Advanced Settings: DO Pill	Hidden	Advanced settings are configurable for advanced users. Toggle “On” to view and edit.
Salinity of solution [g/L]	Physiological [5-15 g/L]	Solution salinity is used to calculate accurate DO measurements. If salinity is known to greatly differ from the physiological range, select “Custom” and input the Custom salinity of solution in g/L. Note that DO Sensor Pills do not work well in absence of salts (desalted water).

Task: Feeding [LIS]

What it does: Feeding a liquid into a shake flask, optionally controlled by external triggers and/or a Feedback loop. With “Profile based Feeding” enabled, a pre-defined Feeding profile is started (Figure 93). With “Feedback control” enabled, a live data source is utilized to control the Feeding. Both Profile Based Feeding and Feedback control can be used individually or combined – if combined, the Profile Based Feeding preceeds the Feedback control. For both Feeding types, various triggers, e.g., a certain growth rate or DO value, can be used to define a smart start and/or stop condition for the Feed. An annotation is created when the start or stop trigger condition is reached. You can also visualize the reached trigger by selecting the data series “(Profile/Feedback) Start trigger condition reached” in the Graph configuration (Figure 95).

If a „Feedback control“ is enabled, this Task must be combined with a Task “DO (MPS)” (or other Task that contains live dtaa for the Feedback loop). However, manual addition of the Task “DO (MPS)” is only required when setting up a Custom Application

Required Devices: LIS Drive, LIS Coordinator, Device for external trigger (MPS, CGQ Sensor, DOTS Flow Cell pH, or DOTS Flow Cell DO)

Additional components: LIS Cartridge, filter, Luer plug, syringe, and blunt end needle

Table 44: Main output data from Task: Feeding [LIS]

Output	Explanation	Remarks
Volume Dispensed	How much of the liquid is fed into the shake flask over time	Actual dispensed volume (may differ from the planned Feeding Profile)
Feeding Start	An annotation is automatically created when the trigger condition is met and feeding starts	Select the series “Annotations” in the Graph configuration to see the Feeding Start Annotation. Alternatively, select the series “(Profile/Feedback) Start trigger condition reached” in the Graph configuration to visualize the start and stop triggers for the Feeding.
Pump activity	Degree of activity of the pump	Pump activity is required to keep the liquid in the LIS Cartridge while no dispensing is taking place. High pump activities (> 5%) can indicate a problem with the LIS drive/cartridge assembly. Please note: Not every value > 5% is automatically a problem. Contact our support team for assistance.

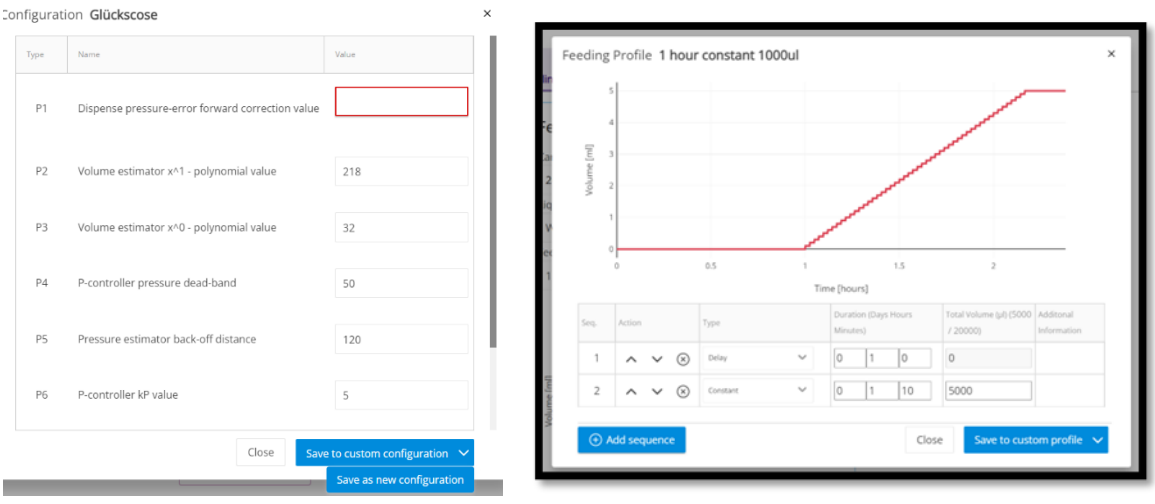


Figure 93: Editing a LIS parameter set (left) and defining a LIS Feeding profile (right).

Table 45: Configurable parameters for Task: Feeding [LIS]

Parameter	Default settings	Explanation
Feeding configuration		
Cartridge filling volume [µl]	Requires user input	Volume of liquid filled in the LIS Cartridge. Recommended: 3000-20,000 µL (3-20 mL) Maximum.: 25,000 µL (25 mL) Try to always have a minimum of 3000 µL (3 mL) left in your Cartridge, even after the last feeding step.
Liquid type (Parameter set)	Requires user input	Select the type of liquid that will be used, to apply the correct parameter set to the LIS Drives. It is important to choose the correct parameter set, otherwise liquid might spill, or incorrect amounts will be dispensed. Frequently used liquid types are available but contact our support team (p. 68) for application-specific parameter sets. To customize a parameter set, click on the edit pen symbol, and modify the values in the pop out window (Figure 93, left). On the bottom left, save the created parameter set only to this Object (Click “Save to custom configuration”) or save for later use (Click “Save as new configuration” in the dropdown list).
Profile based feeding		
Profile based feeding enabled	Disabled If enabled: Requires user input	Create a custom profile or load/edit an existing one (saved profiles appear in the dropdown list). Feeding profiles are generated by one or multiple feeding sequences (see Table 46 for details). Please note that any new entry is only accepted after you have left the entry field (click somewhere else on the pop out window or hit Enter on your keyboard). A preview graph shows how the liquid will be fed over time. A flat line at the end of the Profile indicates that the remaining liquid will be kept in the Cartridge. On the bottom left, save the created profile only to this Object (“Save to custom profile” or save it for later use by using the dropdown arrow to access “Save as new profile” (Figure 93, right).
Start condition for profile	Disabled	Define a condition that will trigger the predefined LIS Feed Profile. This could be configured as a duration, or a growth rate threshold. The start conditions can be configured with the same logic as the .
Stop condition for profile	Disabled	Define a condition that will stop the LIS Feed completely Task runs into “Finished” state). This could be configured as a duration, or a growth rate threshold. The stop conditions can be configured with the same logic as the .
Feedback control		
Feedback control enabled	Disabled If enabled: Requires user input	
Start condition for feedback control	Disabled	Define a condition that will trigger the predefined LIS Feed Profile. This could be configured as a duration, or a growth rate threshold.

		The start conditions can be configured with the same logic as the .
Stop condition for feedback control	Disabled	Define a condition that will stop the LIS Feed completely Task runs into “Finished” state). This could be configured as a duration, or a growth rate threshold. The stop conditions can be configured with the same logic as the .
Measured parameter	Requires user input	Select a data series that you would like to base your feedback loop on (e.g., DO Partial Pressure or DO Percent). These data series come from a separate Task (e.g., DO [MPS]) that must be configured along with the “Feeding” Task”, as shown in Figure 94.
Target value [unit]	Requires user input	Enter a value between 0 and 100 % of the expected value range (e.g. for DO: zero to air saturation (0-210 mbar)). The PID controller will not achieve that this target value is held at that level, but it will trigger a feed whenever the target is exceeded. The closer to the lower or upper DO limit, the sooner or later – respectively – a Feed will be triggered. The overall reaction time and applied feed rate, however, depend greatly on the PID parameter settings and maximum flow rate.
Maximum feed rate [µl/h]	Requires user input	This feed rate will never be exceeded. The PID controller calculates feed rates relative to the set maximum feed rate, i.e., the value entered at maximum feed rate will influence the calculations of the PID controller and hence the feedback loop outcome.
Advanced settings: PID controller configuration		
Process gain [%_signal/%_feed]	-2	Expected change of target signal [%] in response to change in feed rate [%]. Increase, e.g., to -0.2, for a faster Feedback loop. The input is positive for a positive correlation of target value and feed rate, i.e., whenever a feed will make the target value rise. It is negative for a negative correlation, i.e., whenever a feed will make the target value decrease – hence, the input is negative for DO-based Feedback control using DO Partial Pressure or DO Percent data series.
Dead time [s]	20	Expected lag time until the measured signal shows a first reaction to a feed rate change. Increase if the PID controller reacts too fast and to reduce risk of overshooting.
Time constant tau (expected signal stabilization time) [s]	15	Expectation how fast the measured signal will stabilize at a new value after a feed rate change (in fact, how fast 63 % of the new value are reached). Increase if the PID controller reacts too strongly.

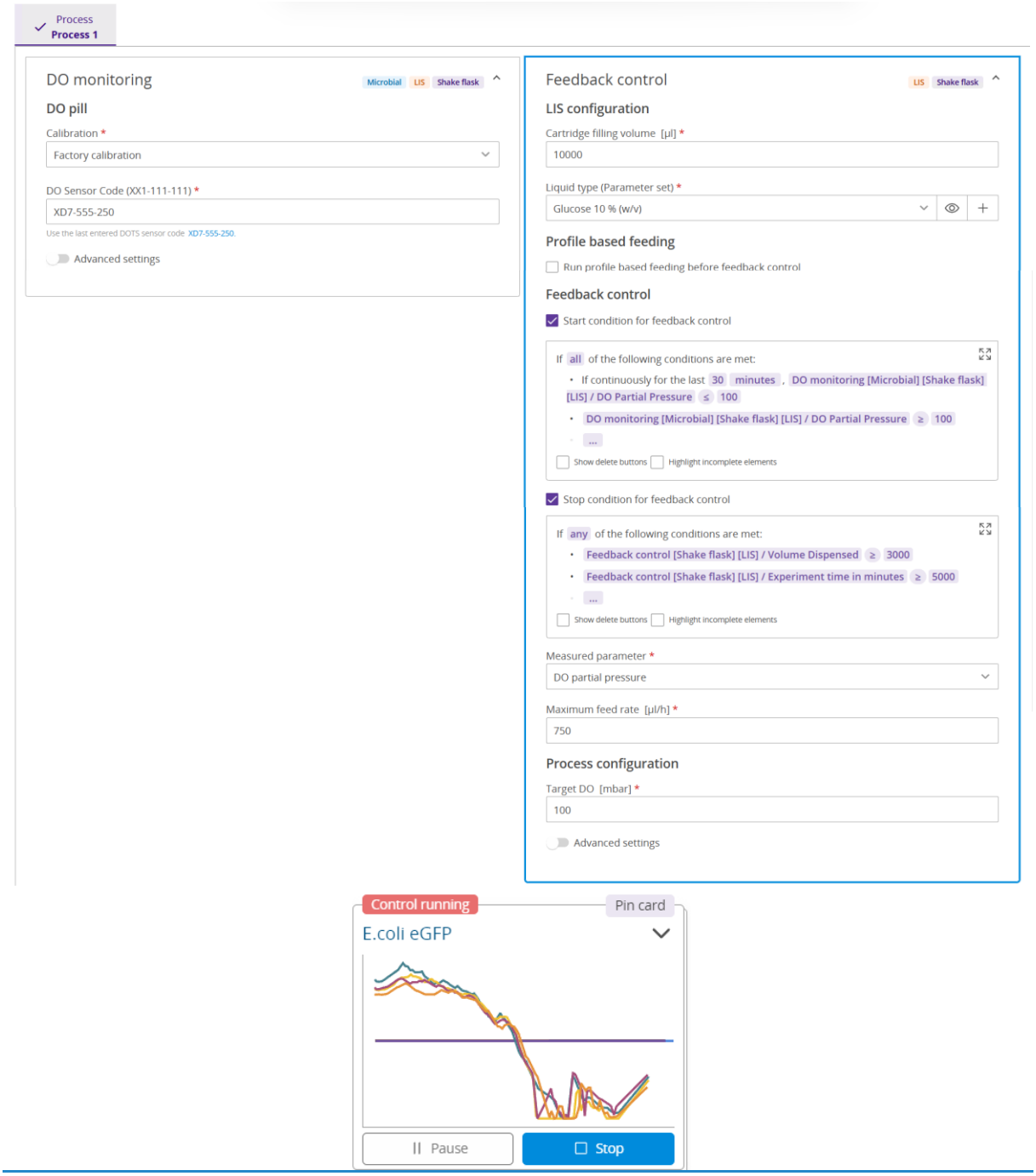


Figure 94: Creation wizard: General Task Configuration – Selecting the DO data series for the DO based feedback control and configuring Task details. In this example, the Start condition checks that the DO was low once and then starts to rise again - which means that the batch phase of the culture is over. Hence, no feed will be applied during batch growth on the initial substrate. Once the start condition has been reached, a badge "Control running" on the Dashboard Card will indicate that the Feedback control is now active.

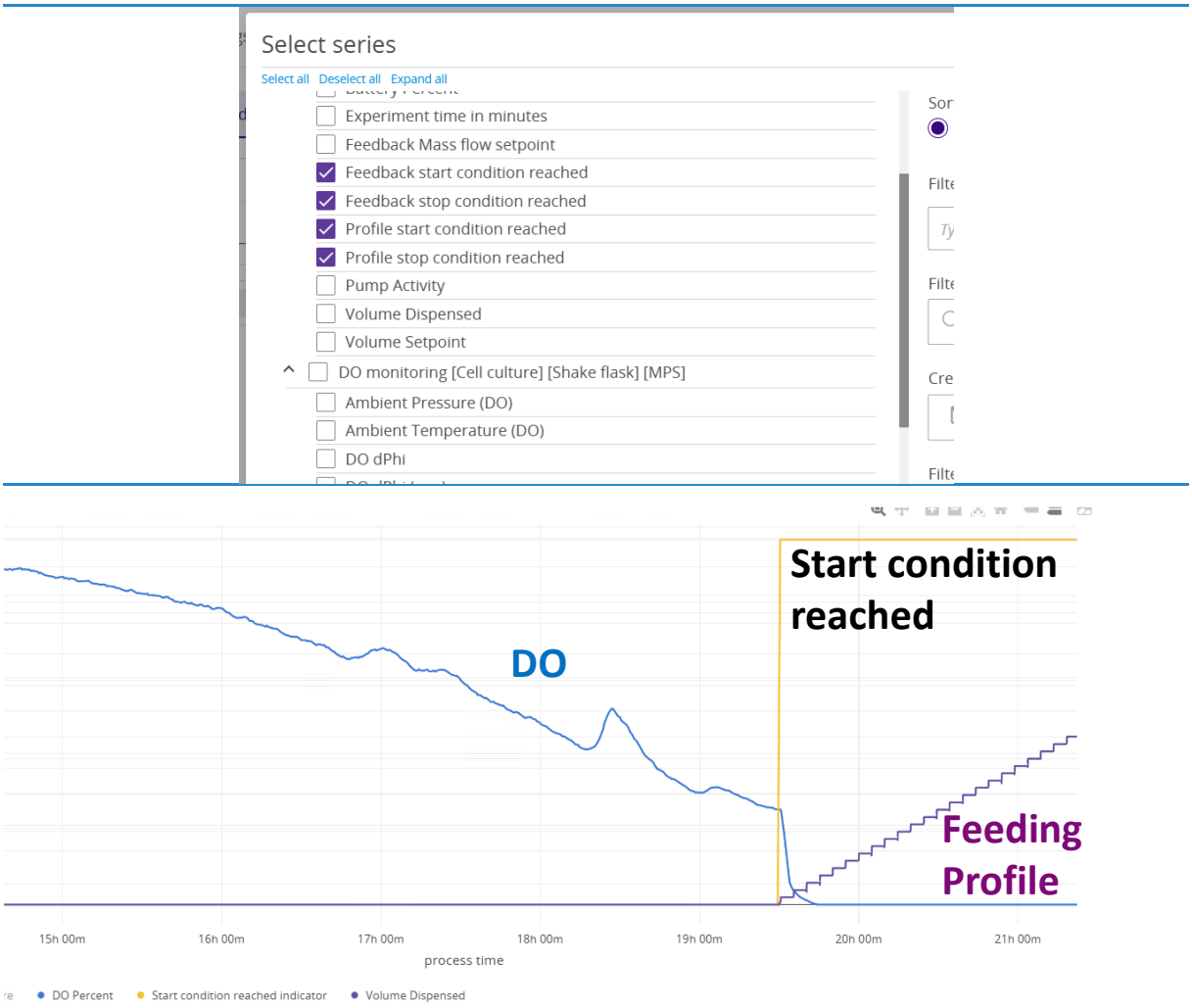


Figure 95: Output data for a Smart Feeding (LIS) Task. Top: Graph configuration, series selector: The selected series visualize the start and stop triggers. Bottom: Graph with start condition reached series. The yellow line jumping from 0 to 1 represents the "Start condition reached indicator". Once the start condition was triggered (in this case, by the DO signal), the Feeding Profile starts.

LIS Feeding Sequences

Note the technical limitations of the LIS Drive: It can dispense a minimum drop size of approx. 100 µL, and perform a maximum dispense rate of 1 mL/min – if the specified rate is greater, the volume will be dispensed as fast as possible but may take longer than you intend.

The LIS feeding sequences in Table 46 can be used to generate a custom LIS Feeding profile. All Feedings sequences can be combined freely. The sequences are applied in the order of the list, from top to bottom. Use the up / down arrows left of the sequence names to move them up or down in the list.

Please note that any new entry is only accepted after you have left the entry field (click somewhere else on the pop-out window or hit Enter on your keyboard).

Table 46: LIS Feeding sequences

Sequence	Explanation
Delay	No feeding action for the specified duration.
Single Shot	The defined volume is dispensed in one single shot (with 1 ml/min feed rate).

Multi-Shot	The defined total volume is distributed over the defined total time and dispensed in the defined number of repetitions.
Constant	The defined total volume is dispensed with a constant speed over the defined total time. Technically, the feeding is performed in volume steps as small as possible to obtain a near-constant profile.
Exponential	The defined volume is dispensed according to the specified exponential function.

Task: Fluorescence [Cell culture] [MPS]

What it does: The MPS measures Fluorescence at user defined excitation (LED) and emission wavelengths in shake flasks. For details on available LED and detection wavelengths, and guidelines on optimizing fluorescence detection, refer to the MPS User Guide.

Required Devices: MPS

Table 47: Main output data from Task: Fluorescence [Cell culture] [MPS]

Output	Explanation	Remarks
Emission at xxx nm	Fluorescence intensity measured at the selected wavelength(s)	Fluorescence intensities at all user-selected emission wavelengths are smoothed and reported as Emission at the respective wavelength. For all non-selected emission wavelengths, raw data are recorded anyway and are available via excel exports. An exception is the data processing mode “high sensitivity”, which records only up to 5 wavelengths higher than each user-selected excitation wavelength.

Table 48: Configurable parameters for Task: Fluorescence [Cell culture] [MPS]

Parameter	Default settings	Explanation
Excitation and emission wavelengths	Requires user input	Select the LED with the peak wavelength that should be used to excite your fluorophore(s). The row containing emission wavelengths that can be paired with your selected excitation LED wavelength is highlighted (Figure 96). Select for which emission wavelength(s) fluorescence intensitie(s) should be reported. If more than the specified wavelengths are required after the experiment is finished, the data of all wavelengths are still available as raw data via excel exports (all emission wavelengths are always recorded for a specific excitation wavelength, but only the selected ones are processed). Note that each excitation wavelength is a separate measurement for the MPS. On the one hand, that means that only selected excitation wavelengths are actually used for measurements. Make sure to select all required excitation wavelengths. On the other hand, this means that for each additional excitation wavelength, the total Fluorescence measurement will take longer – to be specific, each the MPS is measuring the duration of one acquisition time for each excitation wavelength. In contrast, the measurement is not prolonged by selecting multiple emission wavelengths.
Advanced settings	Hidden	
Spectrometer integration time [ms]	100 milliseconds	The duration of one sequence during which fluorescence light is captured. The MPS records as many sequences as required to complete the total acquisition time. The integration time influences how detection is aligned with the liquid movement during shaking. The default integration time is optimized for eGFP detection. For fluorophores with higher excitation/emission wavelengths, lower quantum yield, and generally low concentrations, different integrations times may result in better detection. Refer to the MPS User Guide for instructions.
Acquisition time [s]	30 seconds	The time used to complete one measurement (datapoint). The shake flask liquid is illuminated during the specified acquisition time. The default acquisition time is optimized for eGFP detection. For fluorophores with higher excitation/emission wavelengths, lower quantum yield, and generally low concentrations, choose higher acquisition times. Refer to the MPS User Guide for instructions.
Data processing mode	None	In addition to the standard mode (“None”), DOTS now offers a “High sensitivity” mode for fluorescence measurements. This mode is

		recommended for low concentrated and low light-emitting fluorophores (e.g., low quantum yield like mCherry).
Selected bin	30	Relates to the position within the circle that the flask liquid travels during shaking. Depending on the process parameters (among others: flask type, flask size, flask filling volume, shaking speed), the optimal bin for robust measurements may shift from the default value. The raw data contains measurements for all bins and can be processed in hindsight. Please contact our application scientists for post-processing and identifying optimal bins for your experiment setup.
Min. measurement interval [min]	5 minutes	The time between two measurements (datapoints). Possible minimum: 1 minute. Be aware that the measurement interval will be at least as large as the acquisition time.

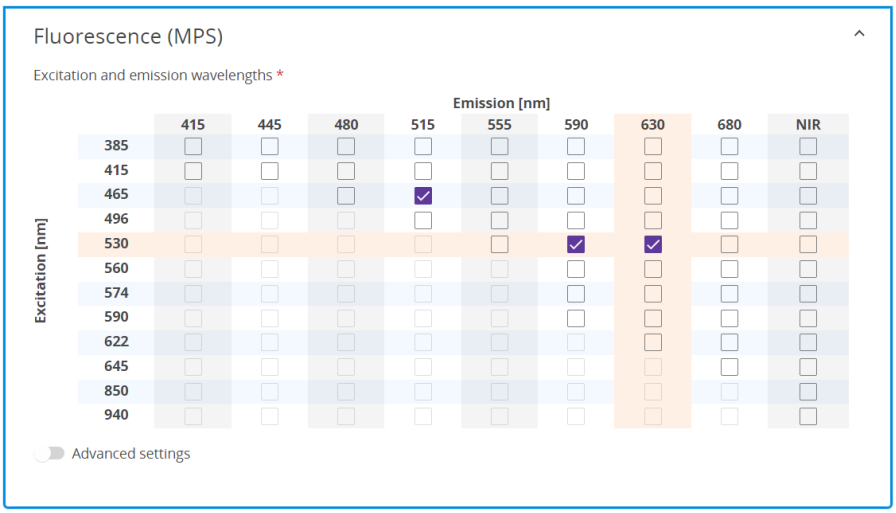


Figure 96: Selecting excitation/emission wavelength pairs in the Tasks "Fluorescence [cell culture] (MPS)" and "Fluorescence [Microbial] (MPS)".

Task: Fluorescence [Microbial] [MPS]

What it does: The MPS measures Fluorescence at user defined excitation (LED) and emission wavelengths in shake flasks. For details on available LED and detection wavelengths, and guidelines on optimizing fluorescence detection, refer to the MPS User Guide.

Required Devices: MPS

Table 49: Main output data from Task: Fluorescence [Microbial] [MPS]

Output	Explanation	Remarks
Emission at xxx nm	Fluorescence intensity measured at the selected wavelength(s)	Fluorescence intensities at all user-selected emission wavelengths are smoothed and reported as Emission at the respective wavelength. For all non-selected emission wavelengths, raw data are recorded anyway and are available via excel exports. An exception is the data processing mode “high sensitivity”, which records only up to 5 wavelengths higher than each user-selected excitation wavelength.

Table 50: Configurable parameters for Task: Fluorescence [Microbial] [MPS]

Parameter	Default settings	Explanation
Excitation and emission wavelengths	Requires user input	Select the LED with the peak wavelength that should be used to excite your fluorophore(s). The row containing emission wavelengths that can be paired with your selected excitation LED wavelength is highlighted (Figure 96). Select for which emission wavelength(s) fluorescence intensitie(s) should be reported. If more than the specified wavelengths are required after the experiment is finished, the data of all wavelengths are still available as raw data via excel exports (all emission wavelengths are always recorded for a specific excitation wavelength, but only the selected ones are processed). Note that each excitation wavelength is a separate measurement for the MPS. On the one hand, that means that only selected excitation wavelengths are actually used for measurements. Make sure to select all required excitation wavelengths. On the other hand, this means that for each additional excitation wavelength, the total Fluorescence measurement will take longer – to be specific, each the MPS is measuring the duration of one acquisition time for each excitation wavelength. In contrast, the measurement is not prolonged by selecting multiple emission wavelengths.
Advanced settings	Hidden	
Min. measurement interval [s]	60 seconds	The time between two measurements (datapoints). Enter a value in seconds. For short Experiment durations, short measurement intervals are recommended (possible minimum: 10 seconds, but be aware that the measurement interval will be at least as large as the acquisition time).
Spectrometer integration time [ms]	100 milliseconds	The duration of one sequence during which fluorescence light is captured. The MPS records as many sequences as required to complete the total acquisition time. The integration time influences how detection is aligned with the liquid movement during shaking. The default integration time is optimized for eGFP detection. For fluorophores with higher excitation/emission wavelengths, lower quantum yield, and generally low concentrations, different integrations times may result in better detection. Refer to the MPS User Guide for instructions.
Acquisition time [s]	30 seconds	The time used to complete one measurement (datapoint). The shake flask liquid is illuminated during the specified acquisition time. The default acquisition time is optimized for eGFP detection. For fluorophores with higher excitation/emission wavelengths, lower quantum yield, and generally low

		concentrations, choose higher acquisition times. Refer to the MPS User Guide for instructions.
Data processing mode	None	In addition to the standard mode (“None”), DOTS now offers a “High sensitivity” mode for fluorescence measurements. This mode is recommended for low concentrated and low light-emitting fluorophores (e.g., low quantum yield like mCherry).

Task: Notification trigger

The Notification Trigger Task is only available if you create a Custom Application Template. Add a new Task in the Step “Process Structure” of the Experiment Creation wizard, then select “Notification Trigger” from the dropdown menu (compare Figure 56). Notifications can be received via the Notifcation center and/or via e-mail. Active notifications are also visible on the DOTS Software Dashboard.

To receive notifications via e-mail, e-mail settings and user e-mail addresses need to be configured by an admin account.

Required devices: None specifically for the Task, but any Device required for the Task that generates data for a Notification trigger.

How to use:

1) Configure e-mail settings for DOTS (requires admin account). See The Admin Page – System settings tab

2) Add e-mail addresses for DOTS users (requires admin account). See The Admin Page – Users tab

3) Task “Notification trigger”: Set trigger conditions, configure channels for notification, and notification texts (Figure 97**).**

3.1) Set trigger conditions. The very first line is preconfigured to combine all trigger conditions below this line: Various trigger conditions can be combined with and AND or OR logic (If all/any of the following conditions are met). Select “all” or “any”. If there is only one trigger condition, select “all”.

Each line specifies a) one trigger conditions or b) another AND/OR logic for all sub-lines. Select “… ≥/≤…” to configure a trigger condition. See Table 51 below for explanations on the line configuration and the input fields for trigger conditions.

A trigger contains a data series, a threshold, and information whether the series should reach values below or above the threshold to trigger a notification (select ≥ or ≤ between the two input fields …). For each trigger input left and right of the smaller/greater sign, select an input by clicking on the … field. A list opens that allows you to select the type of input (see below “Input fields for trigger conditions” in the table below).

Our Application Scientists can support you in setting up a good trigger logic for your experiment.

Table 51: Input options for Task: Notification trigger

Input options	Explanation
Line configuration	
… ≤ …	Value of left input shall be smaller than value of right input
… ≥ …	Value of left input shall be greater than value of right input
If all/any of the following conditions are true:…	Analogous to the very first line, create another line that combines all trigger conditions below this line, in the specified AND or OR logic (“all” or “any”).
If continuously for the last X minutes,…	Triggers when the condition behing this sentence is true for the user-specified amount of time [minutes]. Any outlier that does not meet the condition will reset the time counter.
Input fields for trigger conditions	
Series…	Opens the series selector. You can choose from any data series from Tasks inside the same Object where the Trigger logic is configured. For timeout triggers, the “Experiment time in minutes” can be selected as data series underneath the Task “Trigger logic” in the Series Selector. Note that the “Experiment time in minutes” counts from the start timepoint of the first online data series (i.e., offline data are not considered).
Constant…	Enter a number in the resulting input field.
Minimum of…	Combine with “Series” or “Constant”.

Maximum of…	Combine with “Series” or “Constant”.
Absolute value of…	Combine with “series”.
Mathematical operators	Mathematical operations can be used to connect or process input data (addition (+), subtraction (-), multiplication (*), division (/), squaring (^{2})).

Checking the “Highlight incomplete elements” will underline all missing inputs.

3.2) Configure channels for notifications. Under “Notify”, select users or whole teams that should receive the notification. Decide whether the DOTS Notification center and/or e-mails should be used to notify these users by checking the respective checkboxes. A warning appears in case not all selected users (also inside a team) have specified e-mail addresses.

3.3) Configure notification texts. Use the input field “Include personal message” to add a text to the automatic notification that appears in the DOTS notification center and/or is sent out as e-mail. Under “Dashboard status”, configure the text that will be shown on the Experiment Dashboard card and the Trigger logic Tasks on the Object Detail page. Select a short one or two word text. If more than one different notifications are triggered at the same time, the text will show “Triggered”, and details are shown on hover. Stop the notification trigger Task on the Object Detail Page to remove the badge.

Example. In the example below (Figure 97), the user wants to be notified 1) when the culture starts growing, so the user can manually add induction agent, and 2) as soon as the culture stops growing, to sample for offline analysis and harvest a produced protein. For this purpose, the series “growth rate” is used. For trigger 1), the notification trigger is setup straightforward by defining a growth rate threshold. For trigger 2), a second condition is required since the growth rate will be low both at the start and end of culture growth. The second trigger can be either a biomass (backscatter) value higher than the inoculation value (i.e., make sure biomass has grown) or a timeout, which is set to the – in this case – known time range that the culture needs to start growing. Once the conditions are met, the user will receive notifications in DOTS (Figure 98) and, if configured, per e-mail (Figure 99).

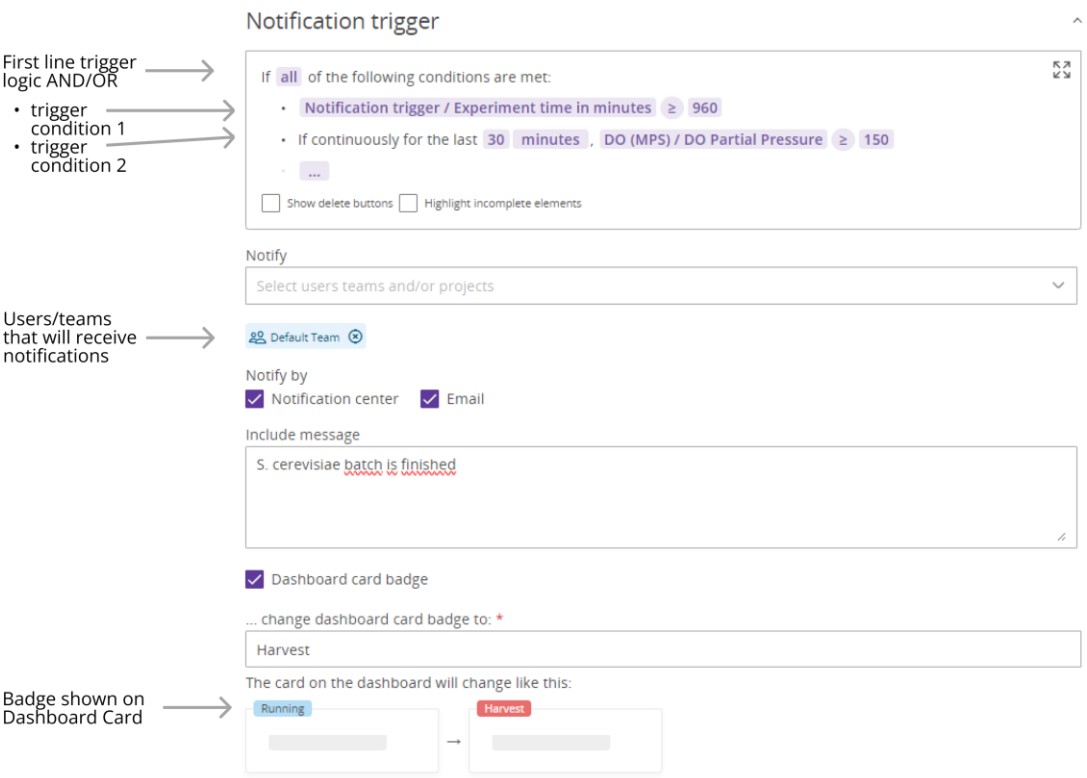


Figure 97: Notification trigger: Configure triggers, notification channels, and notification texts

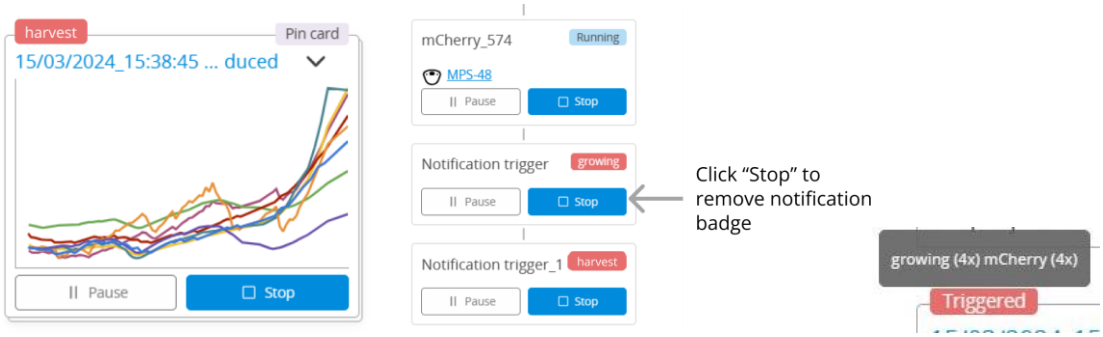


Figure 98: Notification trigger: Notifications shown as badges on Dashboard Card (left) and Tasks on Object detail page (center), and badge “Triggered” in case several different notifications are triggered at the same time, with details shown on hover (right)

A notification for your experiment: 15/03/2024_15:38:45 mCherry-induced **was triggered on** 03/04/2024 18:37:44 MESZ
Affected Replicate: 15/03/2024_15:38:45 mCherry-induced_1
Triggered Logic:
If any of the following conditions are met:

* Series Biomass (MPS) / Estimated growthrate ≤ 0.1
* Series Notification trigger / Experiment time in minutes ≥ 240

Value of trigger parameters:
Notification trigger / Experiment time in minutes: 104,5
Biomass (MPS) / Estimated growthrate: 0,08

Notification details: your stuff stops growing!

Figure 99: Notification trigger: E-mail notification sent out by DOTS.

Task: Offline Monitoring

What it does: To increase data reliability, online monitoring is frequently supported by manual monitoring with established offline devices. Also, online monitoring might not be available for your specific parameter of interest. Use the Task “Manual Monitoring” to add any data recorded outside the DOTS Software. The data is stored in an offline data series, which is handled just as any online data series by the DOTS Software. The offline series can also be used to calibrate or correlate output from various Devices, like CGQ sensors, or offset certain data series, like the online pH data.

Required Devices: Your own external hardware

How to use: Go to the Object Detail Page of the Object for which you are collecting offline data. In the Process Overview, look for the offline Task and click the “Add offline data” button. In the pop out, add your datapoints and the respective time points when the datapoints were recorded. If you want to apply the current time, just click “now” in the calendar time picker. You can add more than one datapoint at a time – Just click on “Add new entry” to open another entry field (Figure 100).

Offline values can be added anytime regardless of the status of the Object (Running, planned, idle, or stopped).

The entered data appears as a list in the Details of the Manual Monitoring Task (click on the Task to view the Task details pop out). In the list, you can edit / delete existing entries by clicking on the edit pen / trash can icons next to an entry.

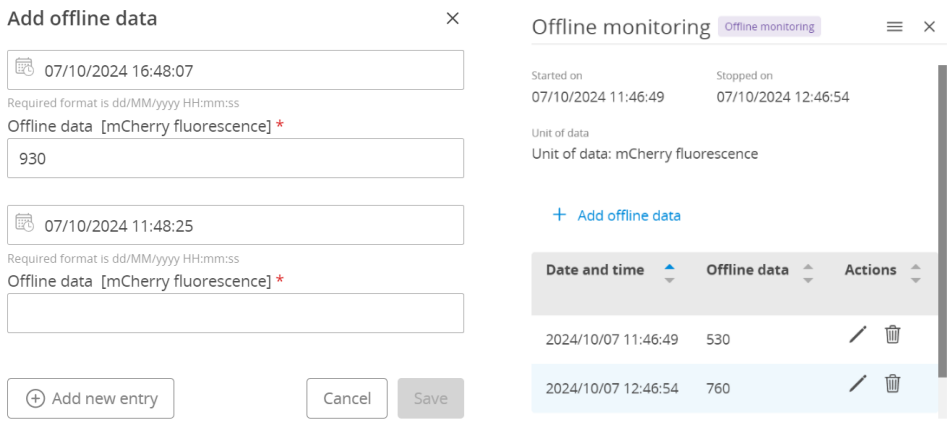


Figure 100: Adding offline values to an Offline Monitoring Task (left) and a list of offline values in Task Details (right).

Table 52: Configurable parameters for Task: Offline Monitoring

Parameter	Default settings	Explanation
Unit of data	User input required	Enter the unit of measured offline data, e.g. “OD600 a.u.”

Task: pH Monitoring [DOTS DO] [Flow Loop]

What it does: Monitor the dissolved oxygen (pH) of a liquid passing through a DOTS Flow Cell within a flow loop.

Required Devices: DOTS Fiber Optic Sensor with fiber optic cable(s)

Additional components: DOTS Flow Cell – pH, Pt100 Temperature Sensor (optional)

Table 53: Main output data from Task: pH Monitoring [DOTS DO] [Flow Loop]

Output	Explanation	Remarks
pH	pH of liquid passing through the DOTS Flow Cell	pH is calculated based on either a Factory calibration (via the Flow Cell Sensor code) or a Custom calibration (must be generated prior to Experiment setup) and is capped within the Flow Cell measurement range (5-7 pH, 6-8 pH, or 7-9 pH). Measurements outside of the measurement range will return a constant value of -2.0 or approximately 11.3 pH.
Pt100 Temperature	Real time temperature measurements read by a connected Pt100 Temperature Sensor, regardless of which channel (pH or DO) the sensor is connected to	An optional output for when temperature is not controlled. Measured at the location of the Pt100 sensor, and not within the flow loop. If temperature is known and tightly controlled, a “Manual” value may be entered in °C for the Temperature source and this output would not be available.

Table 54: Configurable parameters for Task: pH Monitoring [DOTS DO] [Flow Loop]

Parameter	Default settings	Explanation
Flow Cell Settings		
Calibration	Factory calibration	Select Factory calibration or a calibration file that has been previously recorded and saved. Refer to section “DOTS Fiber Optic Sensor calibration wizard” for detailed instructions on how to generate and save a custom calibration file.
pH Sensor Code (XXX1-111-111)	Requires user input	Enter the Sensor code listed on the outside of the DOTS Flow Cell package. This code will auto-fill if a custom calibration file is selected for the “Calibration” parameter.
Device Settings		
Temperature Source	Pt100	For non-temperature-controlled environments, a Pt100 temperature sensor must be connected to the DOTS Fiber Optic Sensor to compensate for temperature fluctuations. If temperature is known and tightly controlled, select “Manual” for the Temperature Source and input the temperature in °C in the resulting “Manual Temperature [°C]” field.
Advanced settings	Hidden	Advanced settings are configurable for advanced users. Toggle “On” to view and edit.

Min. measurement interval [s]	20 seconds	The time between two measurements (datapoints). Enter a value in seconds. For short Experiment durations, short measurement intervals are recommended. Do not go below 5 second measurement intervals.
Salinity of solution [g/L]	Physiological (5-15 g/L)	Solution salinity is used to calculate accurate pH measurements. If salinity is known to greatly differ from the physiological range, select “Custom” and input the Custom salinity of solution in g/L.

Task: Shaker control [Shaker]

The Shaker control (Shaker) Task is only available if you create a Custom Application Template. Add a new Task in the Step “Process Structure” of the Experiment Creation wizard, then select “Shaker control (Shaker)” from the dropdown menu (compare Figure 56).

What it does: Controls various parameters of a smart shaker via network connection. A profile with start and stop conditions can be configured for one or several parameters.

Required devices: Smart shaker with NET60 modul for modbus TCP communication. For details on how to connect your smart shaker to DOTS Software, see Adding network Devices: Smart Kuhner Shaker.

How to use:

The entries below the headers “Start condition” and “Stop condition” are optional. The configuration of such conditions uses the same logic builder than the task “Notification Trigger”.
Under “Shaker Configuration”, load a saved profile from the dropdown list or create a custom profile clicking on “Edit shaking profile”.

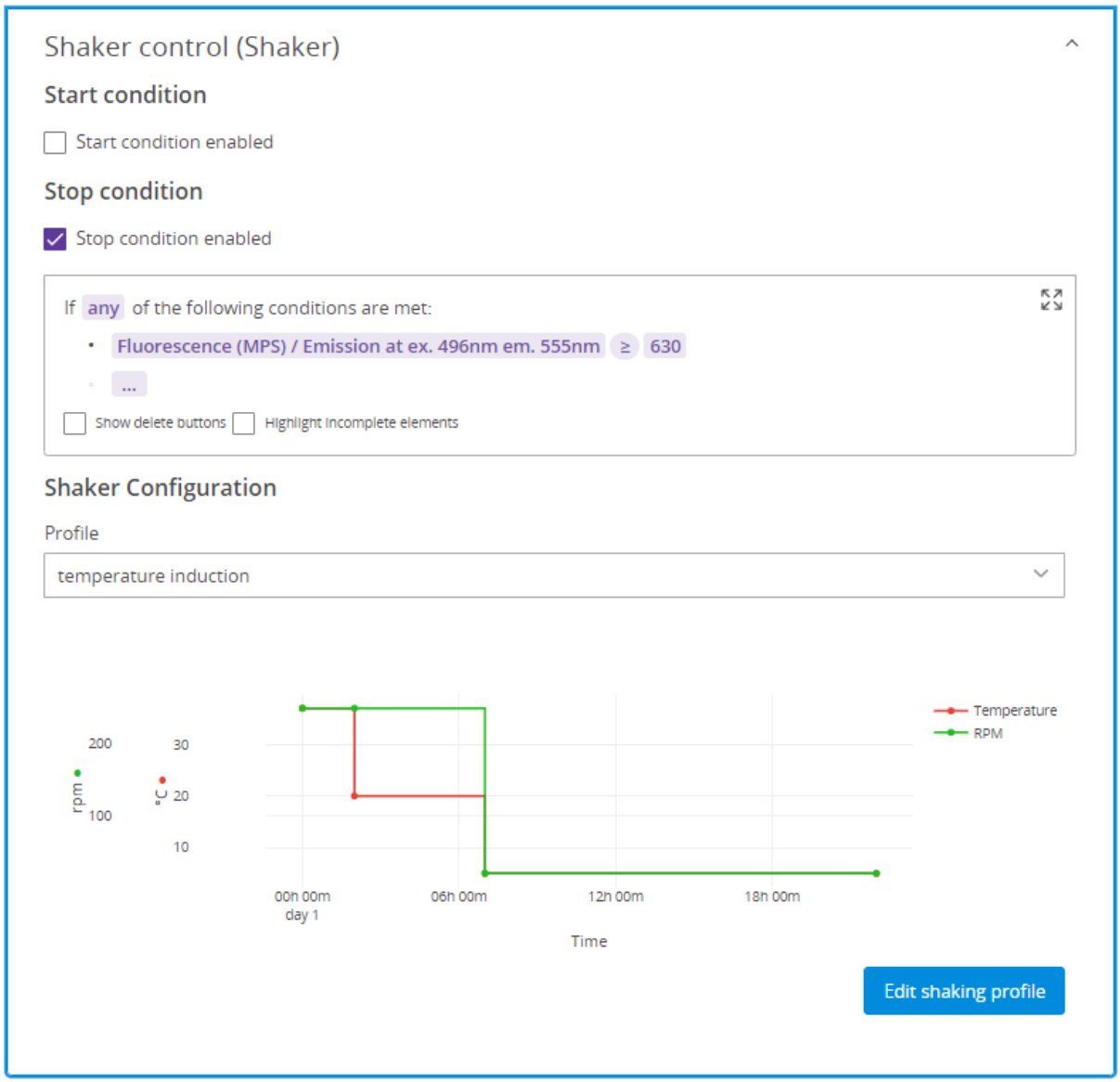


Figure 101: Task Configuration: Shaker control, Task configuration.

The shaker profile configuration opens in a popout. Select the features to control by activating the respective checkboxes. The example in Figure 102 actively controls the shaker temperature and the shaking speed (RPM), while humidity and CO2 are not actively controlled. All parameters will be monitored in DOTS, also the ones that are not actively controlled.

The checkbox selection configures the first sequence (grey box). Set the initial parameter values and a hold (wait) time. To add further lines, use the buttons “Add part” (adds one line) or “Add sequence” (adds another block with all actively controlled parameters). The type of parameter in a line can be changed using the dropdown menu of each line. The line order can be modified by drag&dop using the = icon the beginning of each line.

The configured shaker profile is visualized in the top graph. Click on the legend entries to view only specific parameters (see In-graph controls).

Save the shaker profile by clicking on “Apply profile” or use the dropdown from the button to save the profile in DOTS. You will be asked to enter a name for your profile. Saved shaker profiles are available via the dropdown menu under “Shaker configuration” in the Task Configuration (Figure 101, see selected profile “temperature induction”).

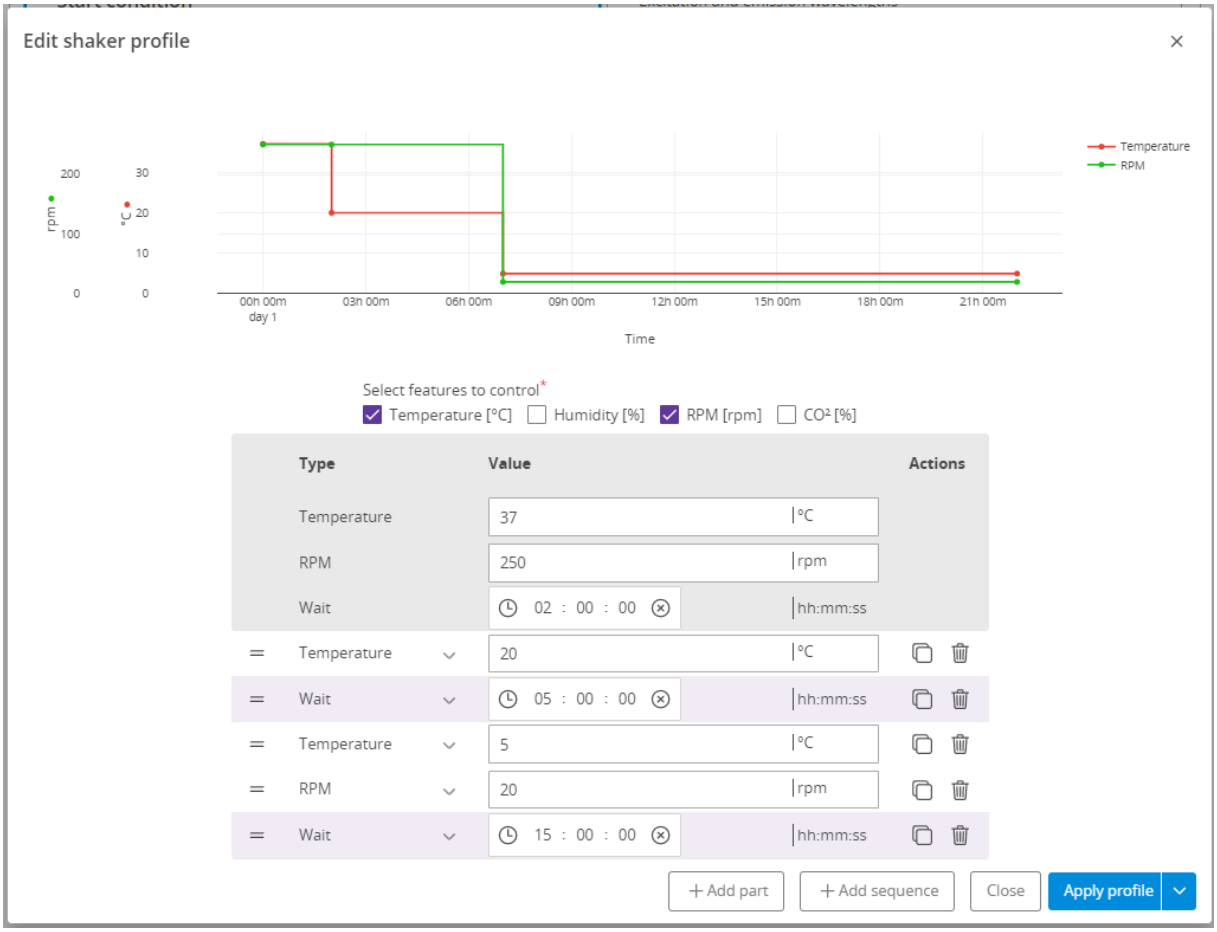


Figure 102: Task Configuration: Shaker control, profile configuration.

Table 55: Main output data from Task: Shaker control [Shaker]

Output	Explanation
Carbon Dioxide measurement	CO2 concentration inside the shaker
Humidity measurement	Relative humidity [%] inside the shaker

Temperature measurement	Temperature inside the shaker
Door open indicator	Indicates shaker door state. 0 = shaker door closed, 1 = shaker door open.

Table 56: Configurable parameters for Task: Shaker control [Shaker]

Parameter	Default settings	Explanation
Start condition enabled	Activated	If activated, the configured trigger logic is applied to start of the shaker profile.
Stop condition enabled	Deactivated	If activated, the configured trigger logic is applied to stop of the shaker profile.
Shaker Configuration: Profile	Custom	Configure a custom shaker profile or load a saved profile from the list.

Task: Shaker monitoring [Shaker]

The Shaker monitoring (Shaker) Task is only available if you create a Custom Application Template. Add a new Task in the Step “Process Structure” of the Experiment Creation wizard, then select “Shaker monitoring (Shaker)” from the dropdown menu (compare Figure 56).

What it does: Monitors various parameters of a smart shaker via network connection.

Required devices: Smart shaker with NET60 modul for modbus TCP communication. For instructions on how to connect your smart shaker to DOTS Software, see Adding network Devices: Smart Kuhner Shaker.

How to use:

This Tasks requires no input. Choose the data series to display in the Graph Configuration.

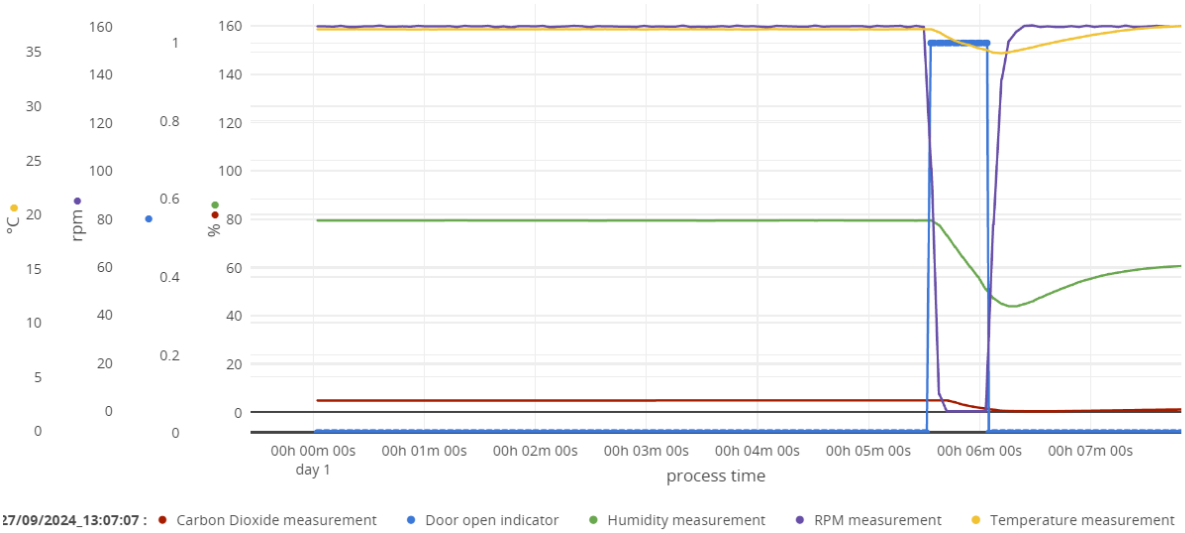


Figure 103: Task “Shaker monitoring”: Example data. Door open indicator 0 = closed, 1 = open

Table 57: Main output data from Task: Shaker monitoring [Shaker]

Output	Explanation
Carbon Dioxide measurement	CO2 concentration inside the shaker
Humidity measurement	Relative humidity [%] inside the shaker
Temperature measurement	Temperature inside the shaker.
Door open indicator	Indicates shaker door state. 0 = shaker door closed, 1 = shaker door open.

Device-specific background parameters that are always recorded

Most SBI Devices record certain background data that provide information on the general status of the Device and environment. Although these data are not explicitly shown in the Application Templates and Task details, they are always recorded.

The background data are available as data series that can be loaded into graphs and included in Excel exports of Objects.

Table 58: Background data of MPS that is always recorded

Output	Explanation	Remarks
Temperature	Ambient temperature [°C]	Measured inside sensor housing. The CGQ sensor needs time to equilibrate to the shaker temperature. We recommend to equilibrate ~ 30 min prior to use.
Shaking frequency	Shaking frequency [rpm]	Measured rpm when installed on a shaking tray.

Table 59: Background data of CGQ Sensors that is always recorded

Output	Explanation	Remarks
Temperature	Ambient temperature [°C]	Measured inside sensor housing. The CGQ sensor needs time to equilibrate to the shaker temperature. We recommend to equilibrate ~ 30 min prior to use.
Shaking frequency	Shaking frequency [rpm]	Measured rpm when installed on a shaking tray.

Table 60: Background data of CGQ BioR Sensors that is always recorded

Output	Explanation	Remarks
Temperature	Ambient temperature [°C]	Measured inside sensor housing. The BioR does not measure temperature inside the bioreactor (vessel).

Table 61: Background data of LIS Drives that is always recorded

Output	Explanation	Remarks
Battery State	Battery State = 1: charging Battery State = 0: not charging, battery is in use	Recorded apart from the Task data, recorded only once per LIS drive that is used in the Object
Battery percentage	Battery Charge given as % of a full charge	Recorded apart from the Task data, recorded only once per LIS drive that is used in the Object

Table 62: Background data of DOTS Fiber Optic Sensors that is always recorded

Output	Explanation	Remarks
Ambient Pressure	Ambient pressure [mbar]	Measured inside sensor housing. The DOTS Fiber Optic Sensor does not measure pressure inside the flow loop. Recorded for correction of DO measurements.
Humidity	Relative humidity [%]	Measured inside sensor housing. The DOTS Fiber Optic Sensor does not measure humidity inside the flow loop. Not displayed, recorded in the background, and used exclusively for data Processing.

Calibration and Correlations with offline data

CGQ and MPS Biomass Correlation with offline data

DOTS Software offers general correlation files that can be used to convert Backscatter data from a CGQ Sensor, BioR Sensor, or MPS into OD600 values (or other biomass-related offline data, such as cell dry weight [g/L]). The correlation relies on a typical batch growth (comprising lag, acceleration, exponential, deceleration, stationary phase). Owing to varying backscatter properties between organisms, growth phases, and even individual flasks (see CGQ and MPS User Guides), the Biomass correlation file cannot be applied directly (just as it is not possible to generally convert OD600 to cell dry weight values). You must record at least two offline OD600 values for each individual flask. Store these offline values in a Task: Offline Monitoring. These offline Tasks are already included in Application Templates for CGQ Sensors (Shake Flasks), BioR Sensors (Bioreactors), and MPS (Shake Flasks).

We recommend sampling the OD_{600} of your culture prior to starting the measurement (Start OD) and right after finishing the measurement (End OD). This way, you will not interfere with the automatic measurement by the CGQ, BioR Sensors, and MPS.

Biomass correlation is applied in the Graph configuration tool (see section “Data Processing”). Go to the tab “Data Processing” as shown in Figure 104. Select the Biomass correlation for each “Biomass” series that you want to correlate with offline values. In the column “Offline Series”, select the offline data series in which you have stored the (two or more) manual OD_{600} offline values.

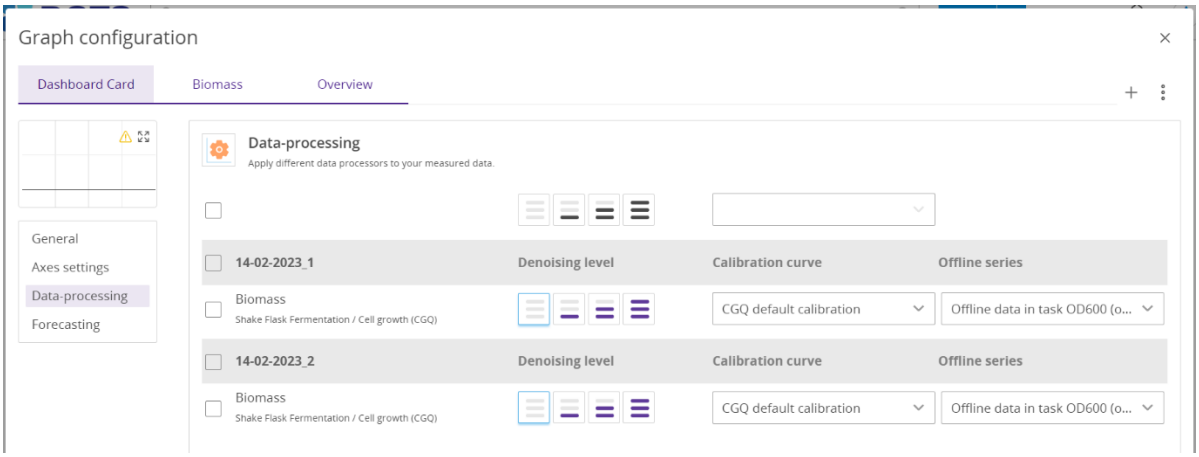


Figure 104: Applying CGQ correlation using default correlation file and manually recorded offline data

Correlated Biomass signals are a good approximation for OD_{600} values, but do not replace manual OD_{600} values for use cases that require highly accurate OD_{600} data.

The CGQ default calibration only applies to data measured with CGQ sensors, for MPS, use the linear correlation in combination with 2 offline valies.

DOTS pH & DO Calibration

DOTS Fiber Optic Sensors can be calibrated via the pH & DO Calibration wizard within the DOTS Software. Each calibration is valid for all DOTS Flow Cells within the same batch, i.e., all flow cells with the same Sensor Code. Refer to the DOTS Flow Cells User Guide for detailed explanations on when to perform a pH calibration and when to perform a DO calibration.

The Calibration Wizard is accessible via the Device Details pop out (Figure 105). Click on the DOTS Sensor to which your Flow Cell for pH / DO is connected to open the corresponding pop out and click on the blue “Batch Calibration” button.

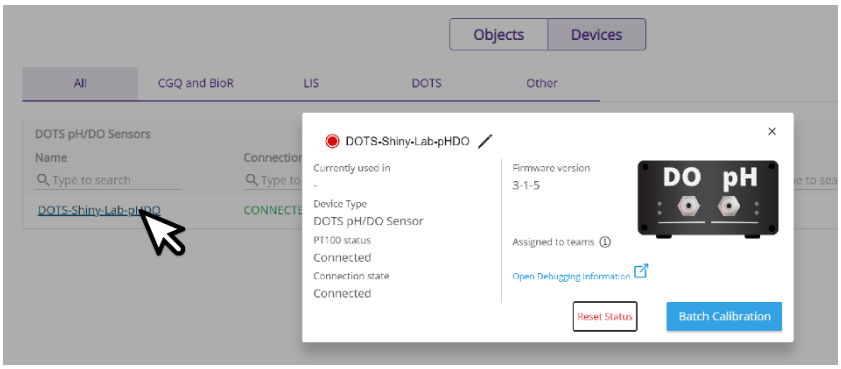


Figure 105: The pH & DO Calibration wizard is accessible via the DOTS Fiber Optic Sensor Device Details pop out

Enter the Sensor Code (located on the outside of the Flow Cell package) in the “Sensor code” field of the Basic Info panel (Figure 106). The DOTS Software recognizes either a pH (format: XXX1-111-111) or DO (format: XX1-111-111) Sensor Code and automatically opens the corresponding calibration parameters.

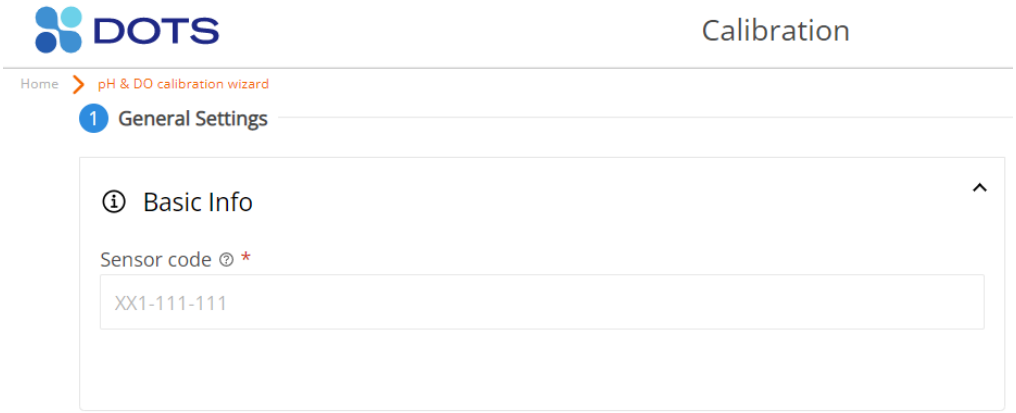


Figure 106: Enter the correct Sensor code for either a pH or DO flow cell, depending on the type of calibration you would like to perform

In case you have lost the package, you can use the code of another Flow Cell from the same batch.

DO Calibration – General Settings

Basic Info

All DO calibrations require a 0-point and Saturated point calibration step. After inputting a Sensor code for a DOTS Flow Cell – DO, you will be prompted to select the anticipated oxygen concentration in the gas phase that will most accurately reflect the experimental conditions – this oxygen concentration should be maintained during the Saturated point calibration step to account for your specific experimental parameters. Refer to the Table 63 below for information on which Oxygen Concentration to select.

Table 63: Oxygen Concentration in Gas Phase calibration options

Option	Explanation
Ambient Oxygen (21%)	Select if you will be running your flow system in an ambient environment with normal oxygenation

Pure Oxygen (100%)	Select if you will be gassing your flow system with pure oxygen during your experiment
Custom	Select if you will be tightly controlling the oxygen concentration within your flow system at a specific oxygen concentration. If selected, input the target oxygen concentration in %.

Calibration Settings

Configure the required calibration parameters in the General Settings tab of the Calibration wizard.

Table 64: Calibration Settings of the DO Calibration wizard

Parameter	Default settings	Explanation
Temperature	Pt100 Temperature Sensor	For non-temperature-controlled environments, a Pt100 temperature sensor must be connected to the DOTS Fiber Optic Sensor to compensate for temperature fluctuations. If temperature is known and tightly controlled, select “Manual Temperature” and input the temperature in °C in the resulting “Manual Temperature [°C]” field.
Salinity	Requires user input	Solution salinity is used to calculate accurate DO measurements. If salinity is known to greatly differ from the physiological range, select “Custom” and input the known salinity in g/L of the culture media or experimental liquid.
Device for calibration	Requires user input	Select the DOTS Fiber Optic Sensor that will be used for the calibration and your Process from the dropdown list

DO Calibration – Setup & Run

After configuring all parameters in the General Settings tap of the Calibration wizard, click the “Next” button in the bottom right corner of the screen to start the calibration process (Figure 107).

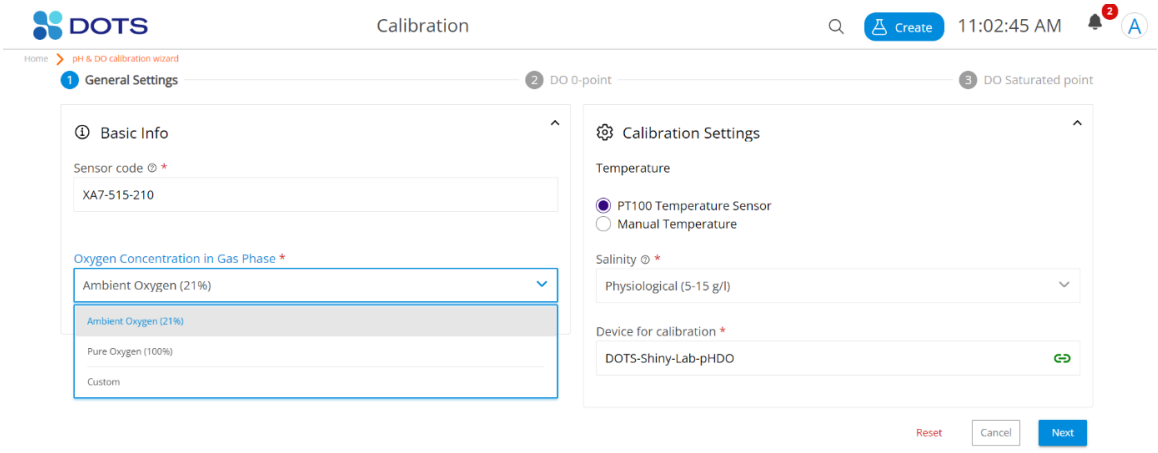


Figure 107: DO Calibration – General Settings tab with configured parameters

DO 0-point Calibration Step

Prepare a 0% DO solution and saturate a DOTS Flow Cell – DO with the solution using one of the methods described below.

- **SBI Cal Caps**: Prepare a 0% DO solution using the SBI Cal Caps (as explained in the DOTS Flow Cells user guide) and, using a syringe with Luer fitting, flush a DOTS Flow Cell – DO with the solution. Make sure to use a flow cell from the same batch (i.e., with the same Sensor code) as the flow cell that will be used during your experiment. Circulate the

0% solution through the flow cell in a closed system, or recap the flow cell with the 0% DO solution inside to ensure 0% DO is maintained during the calibration,

- **Degassing**: Assemble your flow system (as explained in the DOTS Flow Cells user guide) and purge the system of oxygen using nitrogen (or similar) gas. Circulate the deoxygenated culture media through your system to fully saturate the DO flow cell.

The capsules and powdered contents are not sterile. Any solutions prepared using the capsules must be passed through a sterile filter to maintain sterility of the flow cells and flow system during calibration.

Connect the DOTS Fiber Optic Sensor DO channel to a flow cell in either preparation. Follow the onscreen instructions to perform the 0-point calibration step of the DO Calibration wizard (Figure 108).

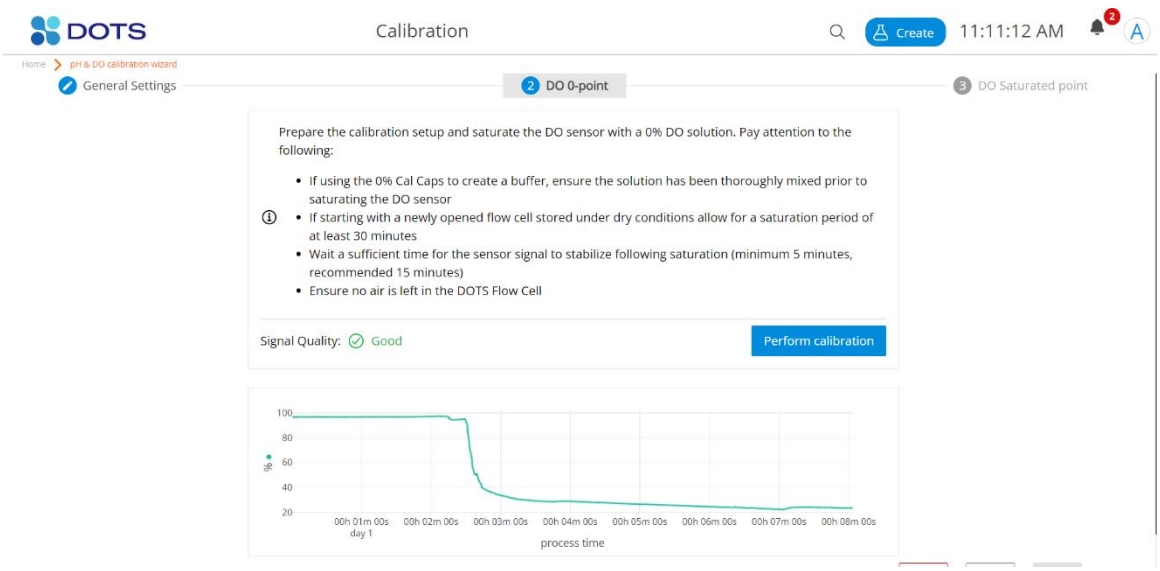


Figure 108: DO Calibration – 0-point calibration step

After allowing sufficient time for the sensor signal to stabilize (visualized on the real time calibration graph), click “Perform calibration” and wait until Calibration Success is reported (Figure 109). Then click “Next” to move to the DO Saturated point calibration step.

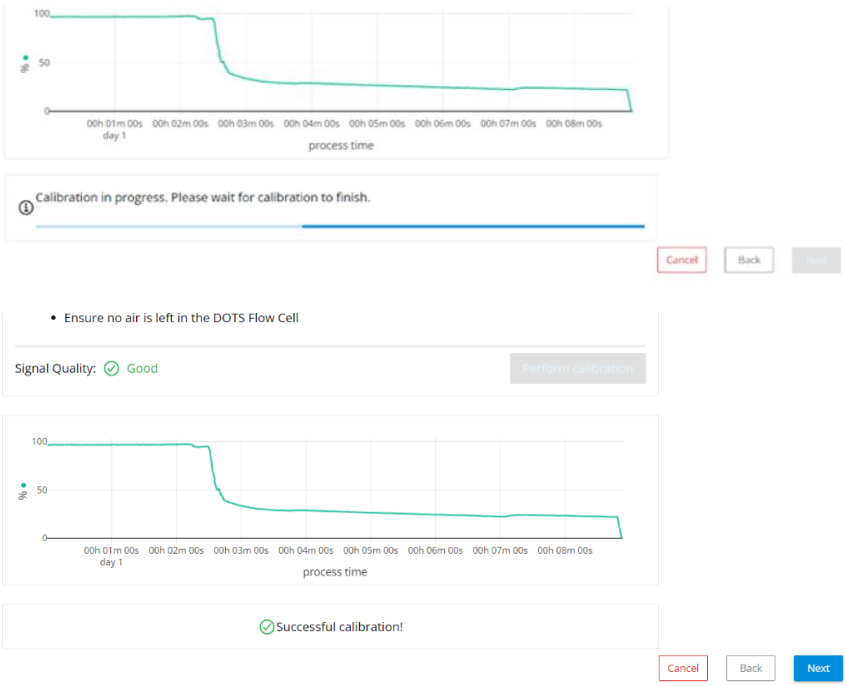


Figure 109: DO Calibration – Performing the 0-point calibration step (top) and calibration success (bottom)

Do not click "Perform calibration" until the sensor signal has stabilized. Performing the calibration before the signal has stabilized may result in inaccurate calibration curves.

If you click "Perform calibration" before allowing the sensor signal to stabilize, cancel the calibration by clicking the "Cancel" button on the bottom of the page. Then start a new calibration.

DO Saturated point Calibration Step

Prepare for the Saturated point calibration step using one of the methods described below.

- **Bench**: Thoroughly rinse the flow cell (with DI water) that was saturated with the 0% DO Cal Caps solution, and fill / circulate with an oxygen-saturated solution. Use either DI water or the culture media that will be used during your Process.
- **Integrated**: Re-oxygenate your assembled flow system and maintain normal experimental conditions during the Saturated point calibration step. Make sure to maintain the gas phase concentration level that was specified during General Settings configuration.

Connect the DOTS Fiber Optic Sensor DO channel to either preparation of flow cell. We recommend using an integrated flow cell that has been equilibrated to normal experimental conditions to achieve the most accurate saturated point measurement.

Follow the onscreen instructions and perform the Saturated point calibration step of the DO Calibration wizard. After this point has been successfully calibrated, click the "Finish" button on the bottom of the page (Figure 110).

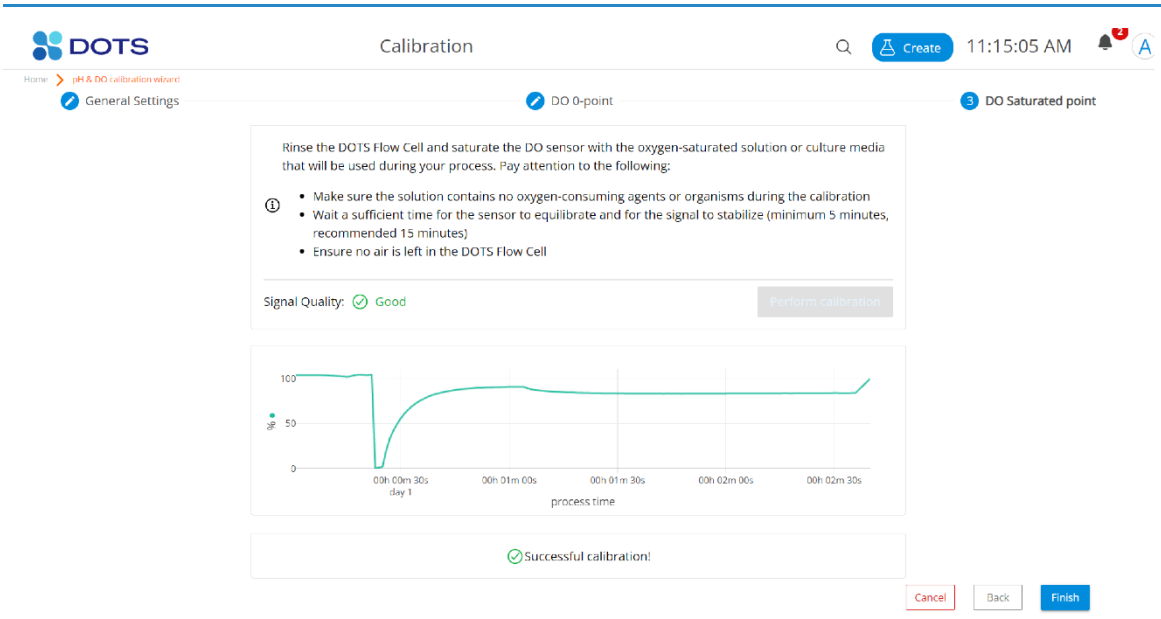


Figure 110: DO Calibration – Successful Saturated point calibration

Do not click "Perform calibration" until the sensor signal has stabilized. Performing the calibration before the signal has stabilized may result in inaccurate calibration curves.

If you click "Perform calibration" before allowing the sensor signal to stabilize, cancel the calibration by clicking the "Cancel" button on the bottom of the page. Then start a new calibration.

Enter a unique name and description for the calibration file (Figure 111). Include information like media type, saturated oxygen concentration, or whether you used the 0% DO Cal Caps. Click the "Save and Close" button. The calibration file will be stored within the DOTS Software database and can be selected when creating an Experiment with a DO monitoring Task.

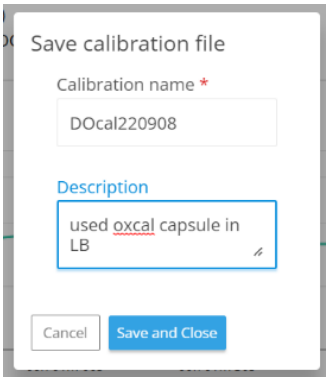


Figure 111: DO Calibration – Saving the calibration file

pH Calibration – General Settings

Basic Info

After inputting a Sensor code for a DOTS Flow Cell – pH, you will be prompted to select whether you want to perform a 2-point or 3-point calibration (Figure 112). Both require an acidic pH and basic pH calibration point, for which we recommend the use of the DOTS Cal Caps for mixing of the appropriate calibration solutions (see DOTS Flow Cells user guide). The 3-point calibration includes a pKa calibration point, which requires a third solution with a pH in the working range of the DOTS Flow Cell (e.g., for a flow cell with range 6-8 pH, use a pH 7 solution). Please prepare your own calibration solution for the pKa calibration point.

Default pH values (pH 2 for the Acidic point and pH 11 for the Basic point) that correspond to the DOTS Cal Cap solutions are auto filled in the Calibration wizard. If using your own buffers (not recommended) edit the Acidic pH and Basic pH values in the entry fields. Also input the pH value of the pKa solution for a 3-point calibration.

If preparing your own calibration solutions, keep in mind that the Acidic pH solution must be < 3 pH and the Basic pH solution must be > 10 pH.

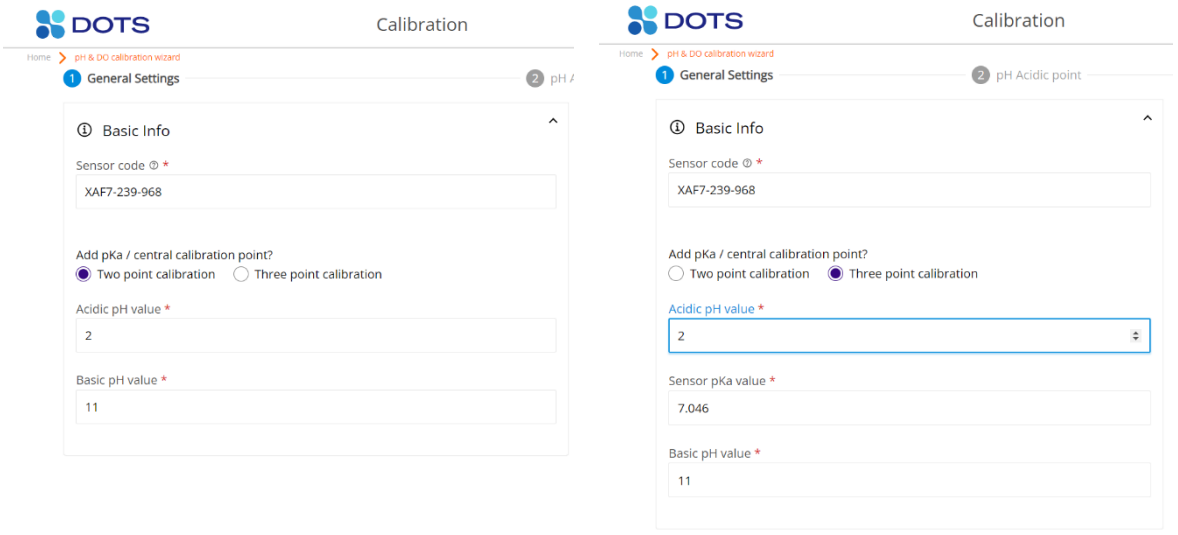


Figure 112: pH Calibration – Basic Info for a Two-point (left) and Three-point (right) calibration

Calibration Settings

Configure the required calibration parameters in the General Settings tab of the Calibration wizard.

Table 65: Calibration Settings of the pH Calibration wizard

Parameter	Default settings	Explanation
Temperature	Pt100 Temperature Sensor	For non-temperature-controlled environments, a Pt100 temperature sensor must be connected to the DOTS Fiber Optic Sensor to compensate for temperature fluctuations. If temperature is known and tightly controlled, select “Manual Temperature” and input the temperature in °C in the resulting “Manual Temperature [°C]” field.
Salinity	Requires user input	Solution salinity is used to calculate accurate pH measurements. If salinity is known to greatly differ from the physiological range, select “Custom” and input the known salinity in g/L of the culture media or experimental liquid.
Device for calibration	Requires user input	Select the DOTS Fiber Optic Sensor that will be used for the calibration and your Process from the dropdown list

pH Calibration – Setup & Run

After configuring all parameters in the General Settings tap of the Calibration wizard, click the “Next” button in the bottom right corner of the screen to start the calibration process.

pH acidic point Calibration Step

Prepare an acidic solution using the pH 2 SBI Cal Caps (as explained in the DOTS Flow Cells user guide) and, using a syringe with Luer fitting, flush a DOTS Flow Cell – pH with the solution. Make sure to use a flow cell from the same batch (i.e., with the same Sensor code) as the flow cell(s) that will be used during your experiment. Circulate the acidic solution through the flow cell in a closed system or recap the flow cell with the pH 2 solution inside to allow the sensor to fully saturate.

The capsules and powdered contents are not sterile. Any solutions prepared using the capsules must be passed through a sterile filter to maintain sterility of the flow cells and flow system during calibration.

Connect the DOTS Fiber Optic Sensor pH channel to the prepared flow cell. Follow the onscreen instructions to perform the Acidic point calibration step of the pH Calibration wizard (Figure 113).

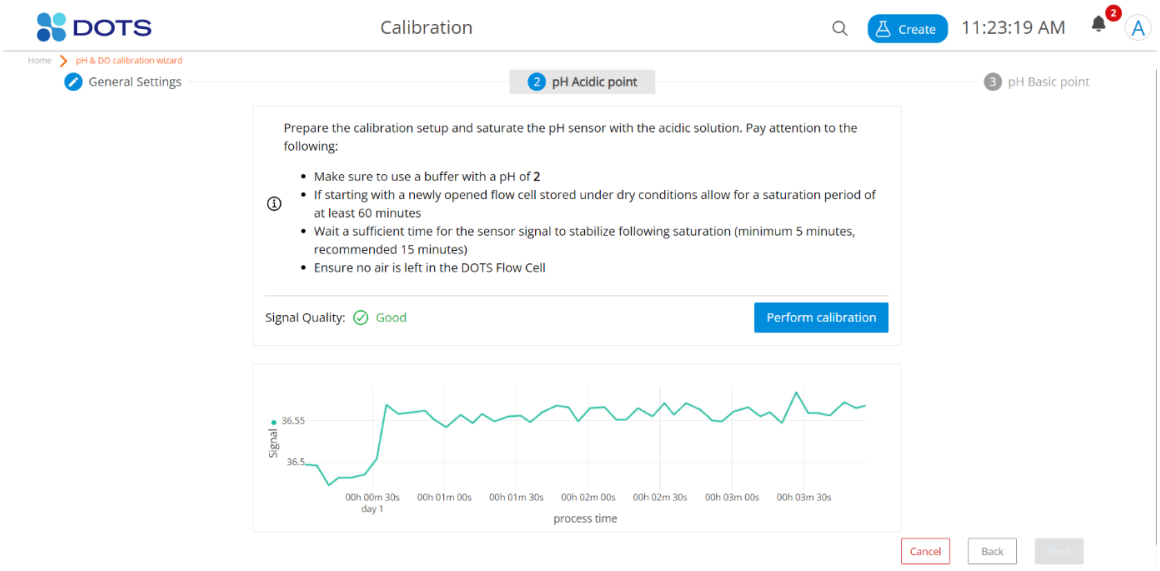


Figure 113: pH Calibration – Acidic point calibration step

After allowing sufficient time for the sensor signal to stabilize (visualized on the real time calibration graph), click “Perform calibration” and wait until Calibration Success is reported (Figure 114). Then click “Next” to move to the Basic point (2-point calibration) or pKa point (3-point calibration) calibration step.

Note that the real time pH calibration graph displays the sensor dPhi value vs the absolute pH value. This is because the highly acidic and basic solutions required for proper calibration of the pH sensors are outside the measurement range of the flow cells. The dPhi value is used so that a stable sensor signal can be visualized when the sensor is equilibrated and ready to be calibrated.

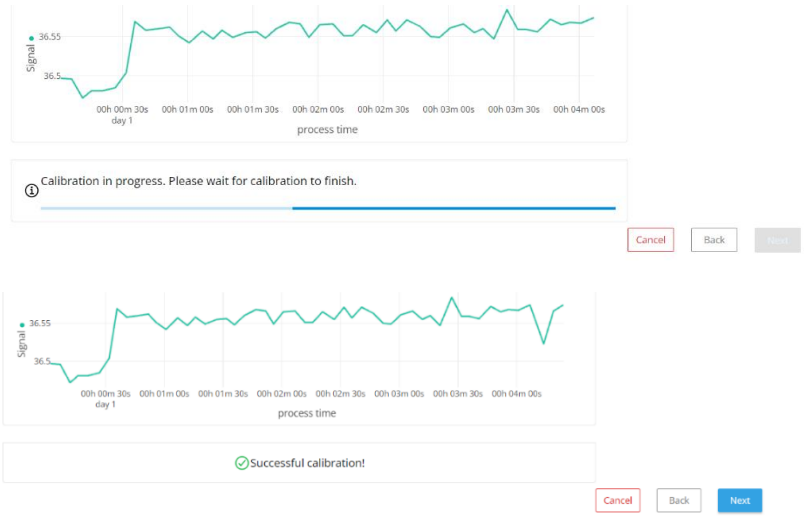


Figure 114: pH Calibration – Performing the Acidic point calibration step (top) and calibration success (bottom)

Do not click “Perform calibration” until the sensor signal has stabilized. Performing the calibration before the signal has stabilized may result in inaccurate calibration curves.

If you click “Perform calibration” before allowing the sensor signal to stabilize, cancel the calibration by clicking the “Cancel” button on the bottom of the page. Then start a new calibration.

pH pKa point Calibration Step – only for 3-point calibrations

Thoroughly rinse (with DI water) the flow cell used for the Acidic calibration point. Prepare a solution with the same pH as the pKa of the calibration flow cell – we recommend using a solution with pH equal to the midpoint of the flow cell measurement range. Flush the flow cell with the pKa solution and either circulate within a closed system or recap the flow cell with the pka solution inside to allow the sensor to fully saturate.

Follow the onscreen instructions to perform the pKa point calibration step, then click “Next” to move to the Basic point calibration step.

pH basic point Calibration Step

Thoroughly rinse (with DI water) the flow cell used for the Acidic or pKa calibration point. Prepare a basic solution using the pH 11 SBI Cal Caps (as explained in the DOTS Flow Cells user guide) and, using a syringe with Luer fitting, flush the basic solution through the rinsed calibration flow cell. Circulate the basic solution through the flow cell in a closed system or recap the flow cell with the pH 11 solution inside to allow the sensor to fully saturate.

The capsules and powdered contents are not sterile. Any solutions prepared using the capsules must be passed through a sterile filter to maintain sterility of the flow cells and flow system during calibration.

Follow the onscreen instructions to perform the Basic point calibration step of the pH Calibration wizard. After this point has been successfully calibrated, click the “Finish” button on the bottom of the page (Figure 115).

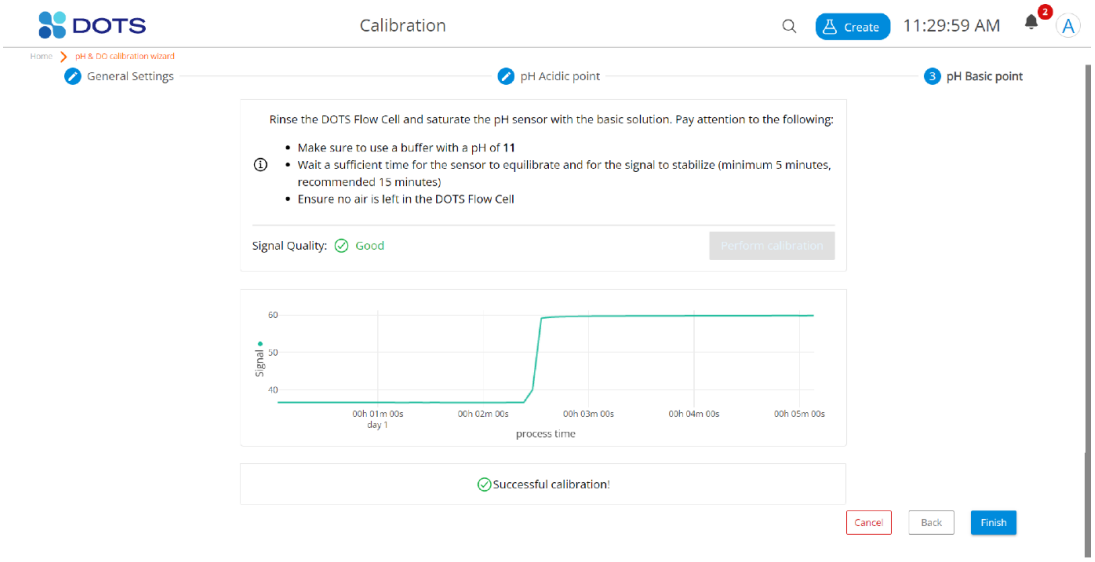


Figure 115: pH Calibration – Successful Basic point calibration

Do not click "Perform calibration" until the sensor signal has stabilized. Performing the calibration before the signal has stabilized may result in inaccurate calibration curves.

If you click "Perform calibration" before allowing the sensor signal to stabilize, cancel the calibration by clicking the "Cancel" button on the bottom of the page. Then start a new calibration.

Enter a unique name and description for the calibration file (Figure 116). Include information like date and time of the calibration and whether you included the optional pKa calibration point. Click the "Save and Close" button. The calibration file will be stored within the DOTS Software database and can be selected when creating an Experiment with a pH monitoring Task.

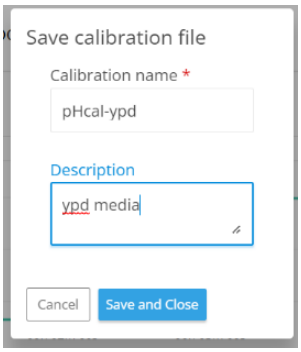


Figure 116: pH Calibration – Saving the calibration file

DOTS pH Offset

Optical pH sensors offer high accuracy and precision when monitoring changing pH of a solution. However, the initial absolute pH measured and reported by the DOTS Software may slightly deviate from the true pH value of the solution. For this reason, we recommend all users to apply a one-point offset at the start of a pH monitoring Task.

Sample the pH of your culture media before starting your experiment and store the offline data in a manual monitoring Task. This type of Task will be automatically included in the Process structure of any Application Template that includes pH monitoring. Log the manual pH measurement after allowing the flow cells to equilibrate to the culture solution so that the sensor signal will be stable, and the correct linear offset will be applied to the dataset.

Go to the “Data Processing” tab within the Graph configuration tool and select the “Linear Correlation” curve to be applied to your pH series. Select the offline data series to which you have stored your manual pH value(s) (Figure 117). Click “Save” to apply the offset.

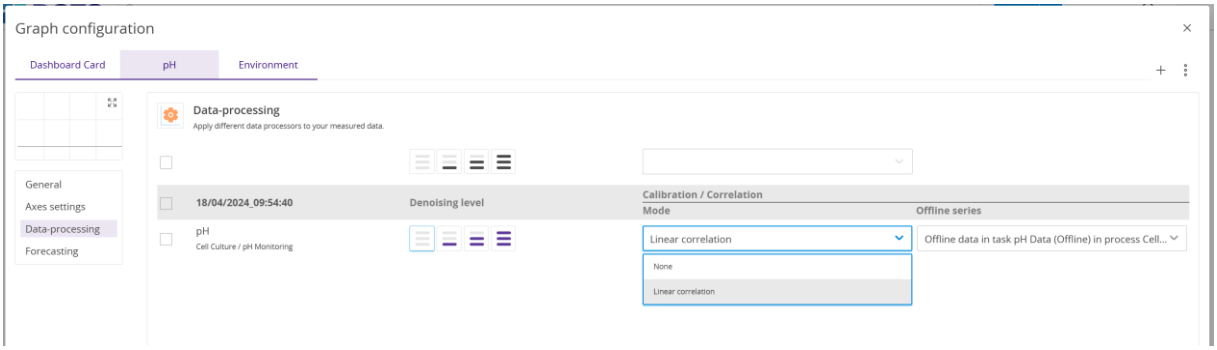


Figure 117: Applying a one-point pH offset

Troubleshooting

The DOTS system tray icon can be used to check the status of the backend, view log files, and start/stop/restart the backend server. Expand the tray area via the upright arrow ^ if you can't see the DOTS icon and right-click the icon to access the full menu (Figure 118). Menu options are explained in detail in Table 66 below.

This only works for computers that have the DOTS Software installed – if you work on a different computer (i.e., you access DOTS via your local network), ask your admin for assistance.

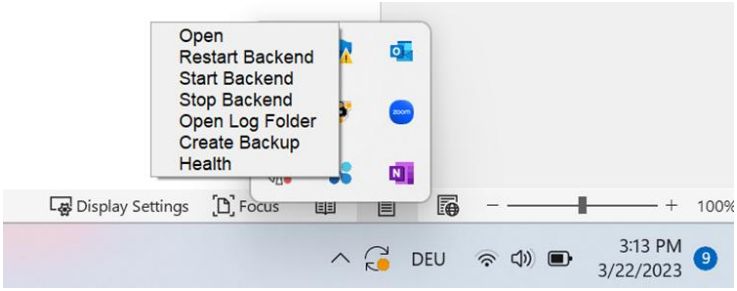


Figure 118: Options available via the DOTS system tray icon

Table 66: DOTS system tray icon – menu options and explanations

Function	Explanation
Open	Opens a browser window with the DOTS Software frontend / user interface.
Restart Backend	Restarts the backend of the DOTS Software (in case the server has stopped).
Start Backend	Starts the backend of the DOTS Software (not required to start the Software in general, but in case the server has stopped).
Stop Backend	Stops the backend of DOTS Software. This will stop all running Experiments!
Open Log Folder	Opens the location in your local browser where the DOTS Software stores log files (C:\ProgramData\DOTS\log). If you experience a problem with the DOTS Software, these files must be sent to our support team for troubleshooting.
Create Backup	Creates a backup of all data within the current DOTS Software installation. This file can later be used to restore the DOTS Software.
Health	Shows the status of the different backend services in DOTS Software. Click on Health to open the status of all services.

Analyze and report problems

If a serious error occurs, send all log files to our support team. Open the log folder (via the system tray icon as shown above or go to C:\ProgramData\DOTS\log). Select all files and folders, right click, and select "Send to" → "Compressed (zipped) folder". The generated .zip file can be sent to our service team by e-mail.

Refer to Table 67 below for solutions to potential problems. Contact our support team for any questions not addressed in this guide.

Table 67: Potential problems and solutions

Question	Solution
I can't find a specific Object	Check if the Object has been Archived. Archived Objects are only visible on the "Archived" tab on the Dashboard. Check if the Project Filter on the Dashboard is active and only showing Objects within the selected Project. Remove or change the Project Filter accordingly Check with your Team Leader / Admin to see if the Object was assigned to a Project that you don't have access to and ask to be assigned to that Project as a Member.
I can't see any data for my Object, or I want to see different data	For CGQ and MPS: Check if the shaker is running at the minimum shaking speed required for the Device / Task configuration (refer to hardware user guides). Note that the CGQ has a feature to turn off measurements at low rpm, this might be switched on. The Object has not been started, or there was an error when starting the Object. No graphs have been configured. Load default graphs (if available) or configure custom graphs on the Object Detail Page. Only the first graph on the Object Detail Page is shown on the Dashboard. Configure the first graph according to the data you want to see previewed on the Dashboard.
I can't find a Device that I want to use	Check if any filter options are applied to the Device List that you are viewing, and remove these filters. Check with your Admin to see if the Device has been added to the DOTS Software and assigned to your Team.
I cannot use a Device because it is blocked ("in use"), and I cannot unblock it	Devices can only be released from an Object while it is not archived. Check if the Object that "uses" your Device is archived. In this case, unarchive the Object, then reset the Device (only possible for admin accounts, see p. 39). Alternatively (e.g., if you do not have admin access), you can manually reset the Device by, e.g., pressing a button. For hard reset options, refer to the respective hardware user manual.
Correlation/Calibration with my offline data won't work	Check if all offline data lie within the time range of the online data. The calibration is not possible in general if the trends of offline and online data differ too much. Try removing certain datapoints that may be outliers / or coincide with online data outliers.

Abbreviations

Abbreviation	Name
a.u.	Arbitrary unit
LED	Light emitting diode
DO	Dissolved oxygen

DOTS Software Definitions and Symbols

Name / Symbol	Definition
Bioprocess Logic	
Device	Any piece of hardware connected to / used by the DOTS Software
Task	The smallest user-controlled element.

	Contains all required Device configurations to perform a specific measurement or action (e.g., Feeding).
Process	A bioprocess or one stage of a bioprocess. Contains one or several Tasks.
Object	Any object (e.g., a shake flask, bioreactor, or flow loop) that you monitor and/or perform actions on using the DOTS Software and Devices.
Experiment	The process within the DOTS Software where you configure Processes and Tasks to monitor or act upon Objects of interest using Devices.
Team & Project Management	
Team	Teams contain Projects, Devices, and Objects/Experiments. These can all be accessed by any User that is assigned to the Team.
(Team) Leader	A User assigned to a specific Team with Project management rights.
(Team) Member	Any User assigned to a specific Team.
Project	Admins can create Projects and assign them to different Teams. Every Object is assigned to one Project during Experiment creation.
(Project) Editor	A User that can create and edit Objects and Experiments within the assigned Project.
(Project) Viewer	A User that can view Objects and Experiments and download data within the assigned Project.
Admin	A User with maximum rights in the DOTS Software. Can create Teams and Projects, assign Users to different Teams with different access rights, and add and assign Devices to different Teams in the DOTS Software.
LIS Control	
	Upload Task configuration to a LIS drive
	Start LIS Task
	Prepare LIS Drive pump
Devices	
	CGQ BioR Sensor
	CGQ Sensor
	LIS Wireless Hub
	LIS Drive
	MPS (Multiparameter Sensor)
	DOTS Dual Channel Fiber Optic Sensor – pH & DO
	DOTS Single Chanel Fiber Optic Sensor – pH
	DOTS Single Chanel Fiber Optic Sensor – DO
	Smart Shaker

Other	
	Export data
	Archive Object/Experiment
	Unarchive Object/Experiment
	Configure Graph
	Add Annotation

Contact

Website	www.scientificbio.com	
Newsletter subscription	https://www.scientificbio.com/subscription-center	
	Information on new Software versions, Device firmware updates, new products	
Email	insights@scientificbio.com	
Headquarters	SBI North America	SBI Europe Represented by: aquila biolabs GmbH
	201 Penn Center Blvd Pittsburgh, PA 15235, USA	Arnold-Sommerfeld-Ring 2 52499 Baesweiler, Germany
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