Instruction Guide

PHOTON SYSTEMS INSTRUMENTS

Fytotron Software Package

Please read the Guide before operating this product

Manual Version: 2025/09

www.psi.cz

The contents of this manual have been verified to correspond to the specifications of the device. However, deviations cannot be ruled out. Therefore, a complete correspondence between the manual and the real device cannot be guaranteed. The information in this manual is regularly checked, and corrections may be made in subsequent versions.

The visualizations shown in this manual are only illustrative.

This manual is an integral part of the purchase and delivery of equipment and its accessories and both Parties must abide by it.

TABLE OF CONTENTS

1 SAFETY INSTRUCTIONS

The following table lists the basic highlighted symbols used in this manual, along with the safety symbols associated with working with the equipment.

Table 1 List of Symbols

Symbol	Description
	Important information, read carefully.
	Complementary and additional information.
	Danger of electric shock

Read this manual carefully before operating the device. If you are not sure about something in the manual, contact the manufacturer for clarification.

	By accepting this device, the customer agrees to comply with the instructions provided in this guide. Always refer to the relevant manuals when operating or maintaining the Fytoscope system. Any unauthorized modification of the Fytoscope system's hardware or software is strictly prohibited without prior approval from the manufacturer. Software installation or reinstallation may only be carried out with explicit permission from PSI. Please note that the applications listed below are installed on Microsoft Windows, which requires a system restart at least once every 14 days.

	Copying or other interference in the device software without PSI permission is forbidden. These activities can also lead to loss of warranty on the device and its accessories and/or may also cause damage to health and property.

2 INTRODUCTION TO THE FYTOTRON SOFTWARE

The Fytotron software package is designed primarily for controlling growth chambers but is also compatible with a wide range of PSI devices. These include systems with customizable environmental parameters and adjustable lighting modules. Fytotron supports the control of all FytoScope growth chamber models, greenhouses with environmental and lighting control, cultivation shelves, standalone lighting panels, and other customized setups with regulated internal conditions. This section provides an overview of how to operate PSI devices using the Fytotron software.

Fytotron enables users to manage cultivation parameters either manually or automatically on a timed schedule. This allows for the creation of complex protocols that simulate diurnal cycles in light intensity and spectrum, temperature, humidity, and shelf cooling. All variables are continuously monitored, recorded, and displayed graphically.

Most of the software elements and functions are universal across all editions (protocol creation, experiment control, the way individual components are operated), but some must be customized for the specific device controlled by the particular software edition. Therefore, please note that some examples in the manual may come from different devices, but the principles should remain the same. For instance, protocol creation shares the same functions and may be demonstrated on a functional component not present in your device.

The Fytotron software is typically pre-installed on a touchscreen computer integrated into the device, its electrical control panel, or placed nearby—especially for larger systems like growth chambers. Alternatively, it may be installed on a desktop or laptop computer. The software launches automatically when the computer starts.

The Fytotron software consists of two main components: **Server** and **Client**.xx`

- **The Server** handles core device services, user management, and system alerts. It is responsible for storing and executing control protocols and logging performance data.
- **The Client** provides the graphical user interface (GUI) through which users interact with the system. All protocol management—creation, editing, activation, and visualization—is performed through the Client. Environmental data can also be viewed and exported only via the Client, although it is logged by the Server.

Importantly, once a protocol is uploaded to the Server and activated, it will continue running even if the Client is closed. However, user cannot manage the protocol in the Server. All protocol-related tasks—such as creation, starting, stopping, and visualization—must be performed via the Client application. Similarly, while the Server logs environmental data, viewing and exporting this data is only possible through the Client.

If the Client is closed after a protocol has been uploaded, the Server will continue executing the protocol as scheduled. However, to modify the protocol or access recorded data, the Client must be reopened.

	This manual is intended to be universal. Please note that your device may not include some of the modules and functionalities described in this manual.

2.1 Fytotron Control Architecture: SCC (Server-Client-Controller) Chain

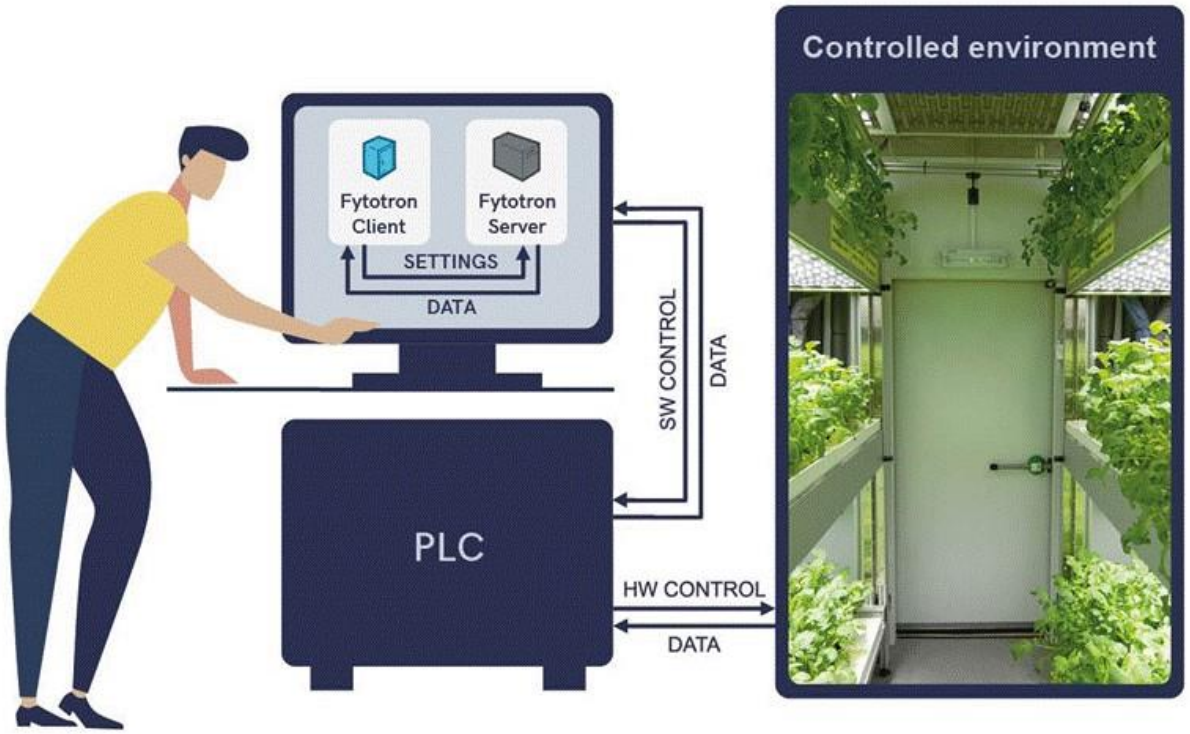


*Figure 1: Fytotron control architecture: **SCC** Server–Client–Controller Chain*

The Fytotron system is based on a control architecture known as the **SCC Chain**—**Server, Client, Controller**—which ensures structured communication and control flow.

The **Fytoscope device** is operated by a hardware controller, typically a **programmable logic controller (PLC)** or a similar unit. This controller executes commands issued by the **Fytotron Server**, which serves as the central control core of the software.

The **Client** application acts as the graphical user interface (GUI) and user-accessible extension of the Server. Through the Client, users can configure environmental parameters, create and manage automated protocols, and monitor or work with data collected from the device.

This architecture separates execution (Controller), logic management (Server), and user interaction (Client), enabling robust and flexible operation of Fytotron-controlled systems.

Disruptions in the control chain can occur due to unforeseen events. However, closing the **Client** does not interrupt the device's operation, as the **Server** continues to manage active settings and protocol execution independently. Even after a system restart, the Server is configured to launch automatically with the operating system. If the protocol includes a specified **Logic Start** time, it resumes from that point; otherwise, it restarts from the beginning.

	Please note that if the user **manually terminates** the Fytotron Server, it will not automatically restart!

In the case of a **computer shutdown**, the **PLC** retains the last received settings. However, without the Server running, the system will not proceed with scheduled actions in the protocol. For example, in a growth chamber simulating day/night cycles, if the computer is shut down while the lights are on, they will remain on continuously. The PLC does not have the authority to alter the state without receiving updated instructions from the Server.

3 Fytotron Server Application

Server application allows users to access basic device services, such as managing and modifying user accounts, setting up operator contact e-mails and phone numbers for sending information and warning messages about the device status, etc.

The Server application window consists of three tabs:

- Users
- SMTP + GSM
- Rules + Alerts

3.1 Users

The *Users* bookmark contains data about operator user accounts - account names and their permissions (see.Figure 2)

	Permissions implementation is under development and its setup does not have any impact on the user's actual permissions.

New users are added by clicking the *Add* button. *Add User* window with username and password fields is displayed (Figure 2).

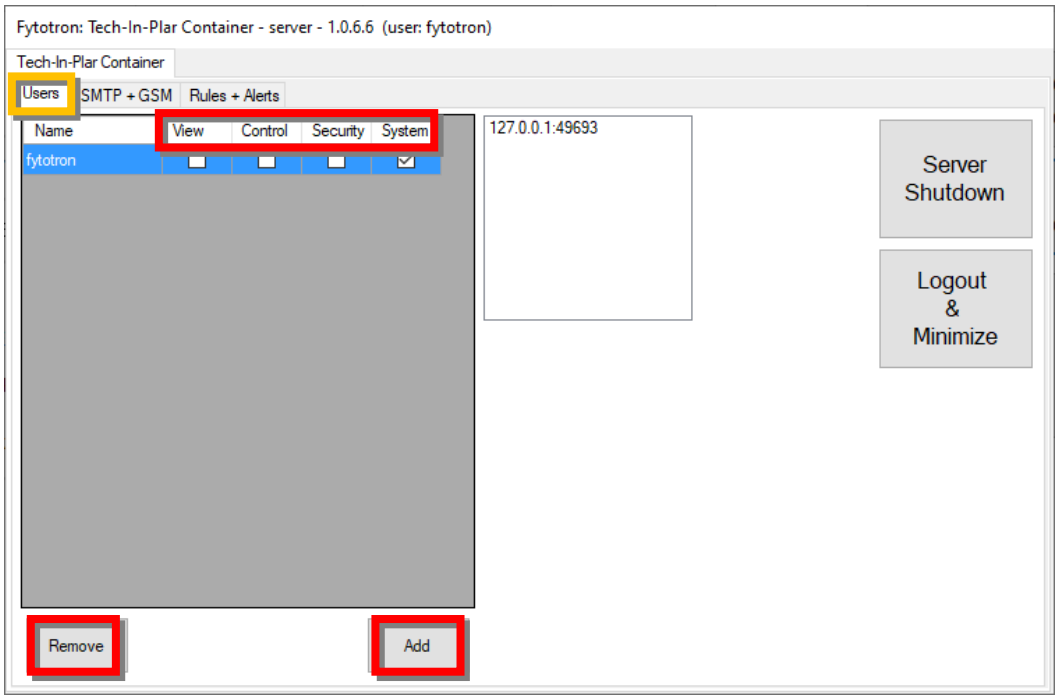


Figure 2: Users

	A few general recommendations for setting up the password: • Length of at least 6 characters. • Password should contain both large and small letters, numbers, punctuation and symbols (e.g. %, #, !). • Keep the password in a safe place and don't disclose it to anyone. It is recommended to make an official record that the user has an account with the given privileges and has set a unique password known only to him. It is then possible to link particular users with corresponding actions in case of violation of operational guidelines of the device and its accessories.

To remove a user account, select the user to remove and click the *Remove* button (Figure 2). The confirmation dialog is displayed, if accepted, user account is deleted.

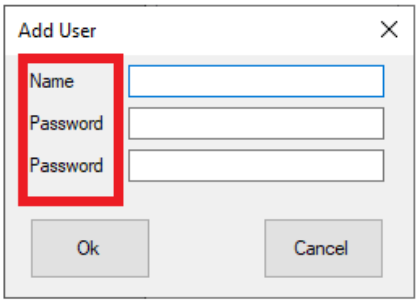
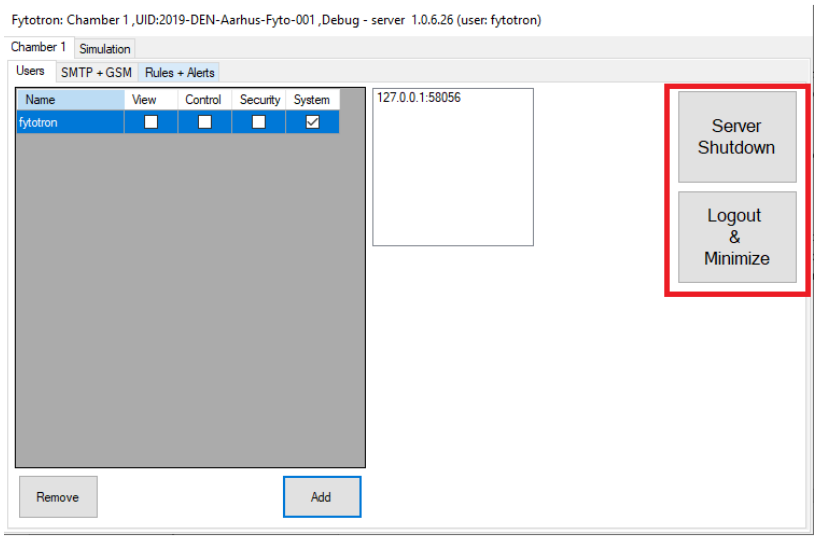


Figure 3: Adding users

	ATTENTION! Do not remove all accounts. If all accounts are removed, PSI support needs to be contacted to restore at least one valid user.



Users tab also contains *Server Shutdown* and *Logout & Minimize* buttons. *Server Shutdown* shuts down the application server, and it is subsequently not possible to log into a *Client* application. *Logout & Minimize* button logs out current user and minimizes the application to the background, which is the default state. To edit Server setup again, click the server icon in the taskbar and login.

3.2 Simple Mail Transfer Protocol (SMTP) and Global System for Mobile Communications (GSM)

SMTP + GSM Bookmark (Figure 4) contains management tools for email and SMS (text) notifications. A GSM module is not a standard component of PSI devices, therefore the text notifications may not be possible with your device. Please, check your actual configuration.

Email or phone contacts are added using the Add button and removed using the Remove button. Test buttons send email/SMS to test the functionality of the selected item

	To add or remove email address or phone number, use corresponding buttons. The deleting operation does not ask for confirmation, item is deleted immediately after pressing the button.

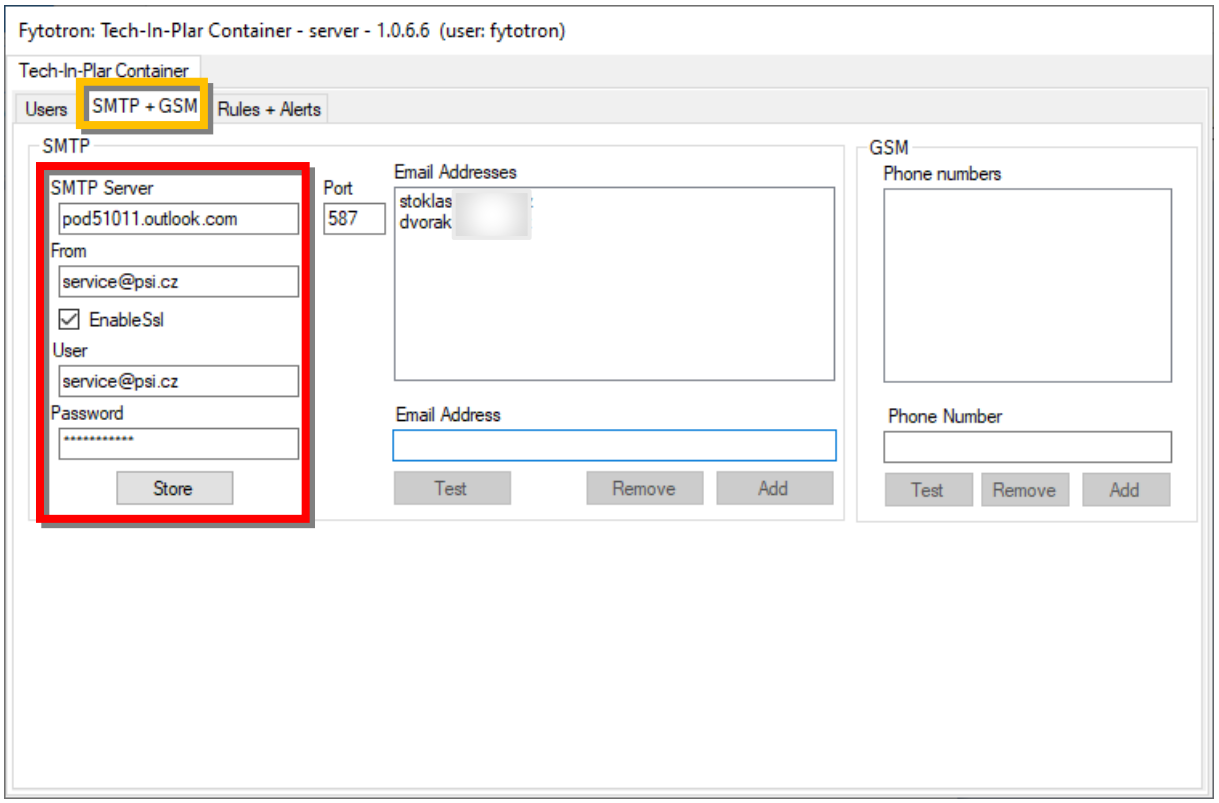


Figure 4: SMPT + GSM

	SMTP + GSM Bookmark contains also information about the SMTP Server. It is not recommended to change this setup unless you know what you are doing or you are instructed by PSI staff.

3.3 Rules and Alerts

The bookmark *Rules + Alerts* (Figure 5) contains the setup of notifications and alerts which are sent in the case of a non-standard situation or a component error occurring in the PSI device.

The column *Caption* contains individual items (functional components, systems, or processes within your device) whose status is monitored and reported in the event of a malfunction. The next two columns control if an event is reported using the corresponding messaging service (email, SMS). **A message will be sent only if the respective checkbox is ticked!** Column *State* represents current state of the item, which is further supported by visual representation in color. The color indication is complemented by a textual explanation.

- The green color indicates that the status is *Ready*.
- The yellow color means the state is *Non–present*. Valid only for the GSM and UPS modules that are not directly relevant to the device's performance.
- The red color reports *Error* state and triggers an email or text notification.

The *Time* column shows the date and time when the state of the item was last changed.

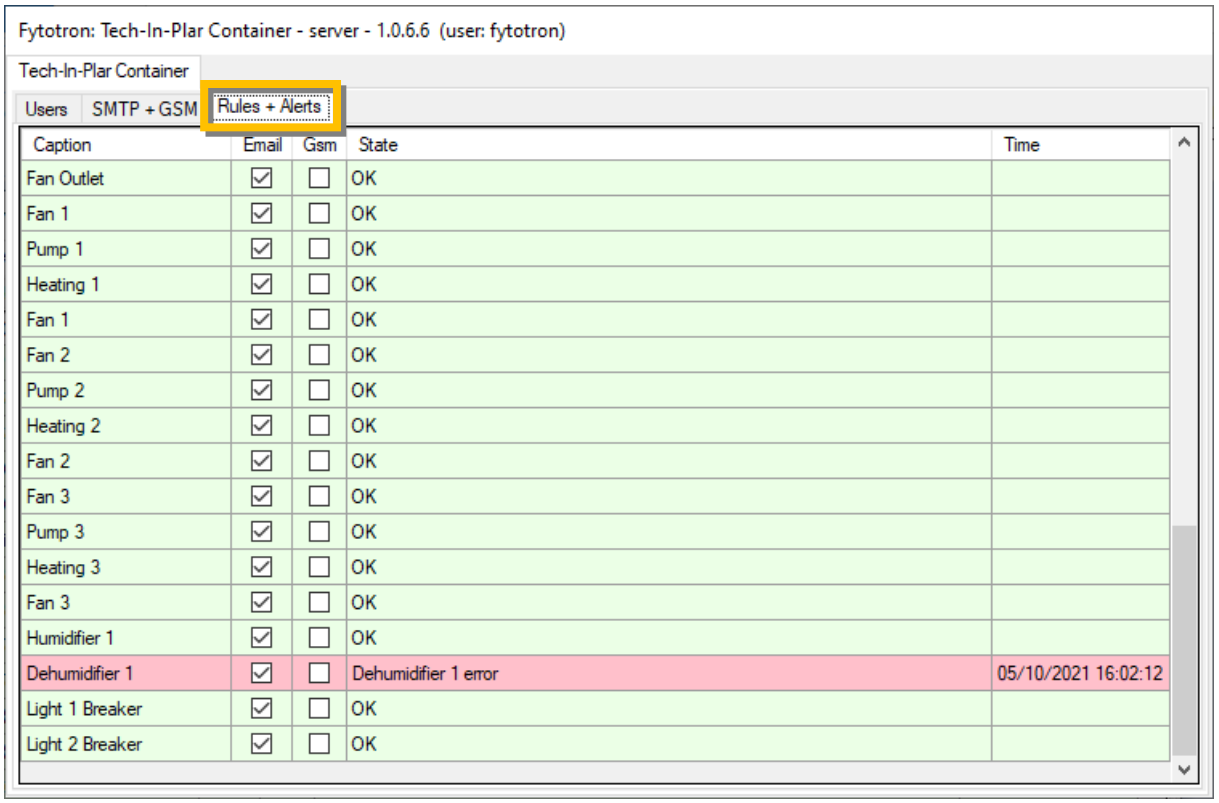


Figure 5: Rules and Alerts

	It is recommended to have all email notifications ticked (default state). SMS notifications need a respective hardware (GSM module) installed, which is not a default part of PSI devices. If there are any doubts about the caption's meaning, please contact PSI support.

3.3.1 Alert Categories

Notifications that are sent in the event of an error or abnormal situation can be categorized based on their nature. The following categories are described along with possible user solutions to the problems, if such solutions exist.

1. **Instruments and functional components status errors**

Breaker Down - Indicates that the circuit breaker for a specific electrical circuit has tripped. Open the electric control box and check if this has happened; if so, reset the breaker. Circuit breakers should be labelled, or a detailed wiring diagram should be provided. If the breaker trips again, contact PSI customer support. If an error status is shown on the Server, but the breaker is in the correct position, it may be a false alarm, which can occasionally occur due to an issue with the so-called auxiliary contact. In this case, the user can either contact PSI customer support or try manually turning the breaker off, waiting for several seconds, turning it back on, and checking if the error status in the **Server** has been reset. The following functional components are typically protected: pumps, fans (ventilators), heating circuits, lighting circuits, humidifier, and dehumidifier.

Communication Errors - If communication between system components and the PLC is disrupted for any reason, a communication error will be displayed. This mainly concerns multi-sensors and dampers in the ventilation system. In such cases, there is little the user can do, and PSI specialists should be contacted.

Internal Error - More complex components have their own internal error management systems. These include multi-sensors, humidifiers, and dehumidifiers. There are various internal error states, but only "Internal Error" without further specifications is displayed on the Server. PSI specialists are required to diagnose what exactly happened to the component and fix the error if possible. The user can at least check the functionality of the multi-sensors by looking at their display and comparing the readings with the values shown in the software.

Timeout means that the time limit for a given operation has expired. This could be, for example, a door-monitoring sensor in a growth chamber. A notification is sent if the door is left open for a longer time period, preventing contamination or unwanted intrusion.

2. **Non–standard situation**.

This type of alert notifies the user of non-standard conditions that have occurred in the device. Whether they are present on the *Rules + Alerts* tab depends on the type of device. The term includes various "**over-limit**" and "**under-limit**" warnings, such as **for temperature, humidity, and CO_2 concentration**. These indicate that the actual value of the parameter has been consistently above or below the set value. This situation can be caused by a control malfunction but can also result from a sudden change in settings. Even if the control system is operating normally, it may not be able to adjust the actual value of the environmental parameter quickly enough to match the newly set value.

It's important to consider the laws of physics; for example, in larger growth chambers full of plants grown in wet soil, rapid changes in relative humidity by tens of percentage points within minutes are not possible. Instead, such changes might take hours, which can trigger alerts. Therefore, it is better to make larger changes gradually using steps or ramps (more 4.4.3).

This type of notification is primarily informative. An exception is a prolonged over-limit temperature, which triggers an active protective event called overheating protection, as explained separately in the following paragraph.

3. **Critical errors.**

Leading to a system shutdown to protect it from damage. The first type usually listed on the *Rules + Alerts* tab is the **hardware overheat protection**. This protective feature is implemented in the event of a critical failure in the temperature control system. A relay is installed in the device to serve as a safeguard against overheating. The maximum allowable temperature (for the growth chambers usually 45 °C) is set directly on the relay. When the relay reaches this temperature, it shuts off most of the device's subsystems and heat-producing components, such as the lights and thermal regulation. The temperature is measured directly by the relay, independently of sensors or other chamber systems, in case they fail and the device starts to overheat uncontrollably.

When this error occurs, it is necessary to first wait until the temperature in the device drops approx. 5 °C below the critical temperature and then reset the device either by using the RESET button on the electrical control cabinet or by turning it off using the main switch, waiting for a while, and then turning it on again.

The second type of protection against overheating is the **software overheat event**. If there is a difference between the set temperature and the actual temperature for a longer period of time, overheat protection is triggered. When the protection is activated varies each time and depends on the specific situation. The temperature difference is being accumulated as an error value. A larger difference will activate the error sooner, and vice versa. Once the error value reaches a set threshold, overheat protection is triggered. This type of overheating protection is usually the first and only to respond. It can occur even at low temperatures if the actual temperature has been consistently higher than the set temperature.

The SW overheating protection also shuts off the lights and thermal regulation, but the reset process differs. The first step is to eliminate the cause of overheating. Then, it is needed to erase the accumulated error; otherwise, the temperature regulation will not be activated. The solution is to set the temperature value in the Client as equal to or slightly higher than the actual temperature at the moment and the error will be reset. It is recommended to pause all experiments on the **Experiment** (chapter 4.3) tab of the Client and make these temperature adjustments on the **Main** (chapter 4.2) tab. Once the overheating is reset, it is recommended to check if the lights' function and temperature regulation are working.

Lights overheat protection is relevant for devices, where the lights are placed in a separate space to minimize heat emissions into the cultivation area. In this case, the light panels have their own cooling system utilizing air, liquid, or both as a cooling medium. The protection against high temperatures is ensured by bimetal relays. If the temperature rises to a value that could damage the electronics, the bimetal uncouples and switches off the lights. After a cooldown, the relay automatically switches the lights on. In some cases, the RESET button also needs to be pushed.

If the lights overheat repeatedly, or the error cannot be reset, please contact the PSI support team. There may be a cooling fault or other problem leading to the lights not being continually operational.

Main Power Lost - This indicates that power has been lost for some reason. To send such a notification, PSI devices are equipped with a UPS (Uninterruptible Power Supply) containing a battery that can power the system for a short time, just long enough to send the notification about the power loss. If your device does not have a UPS, the device will shut down immediately upon losing power, and no notification will be sent.

CO_2 Alarm - This is an emergency sensor for CO_2 levels in the chamber. If the CO_2 concentration in the growth chamber rises to a level that is dangerous to health, this alarm is triggered. A visual warning device, and sometimes an acoustic one as well, is typically installed on-site.

Pressure Crash/Cooling Pressure Extremely Low - In the event of a loss of pressure in the cooling system due to a refrigerant leak or another malfunction, the cooling system cannot function properly, which could lead to damage and uncontrolled overheating. For this reason, a system shutdown is activated when low cooling pressure is detected.

3.3.2 Alert Relevance

If a notification of Category 1 is received, the item on the *Rules + Alerts* tab is in an error state (highlighted in red), and the error cannot be solved or reset by the user, please contact PSI customer support immediately.

The severity of reported errors is divided into two categories.

Category 1 - A serious issue that, if the user is unable to resolve, requires quick contact with PSI customer support. This category includes status errors of instruments, sensors and functional components as well as critical errors. In the case of critical problems, the system will report the error immediately. For functional components, a reaction time ranging from seconds to minutes is set.

Some components, such as multi-sensors, humidifiers, dehumidifiers, and heating units, are often installed in multiple units within the growth chambers. In these cases, if one unit fails, the others can partially compensate, so there is no need to panic. However, it is still advisable to address the issue as quickly as possible.

Category 2 - A non-urgent issue that requires action, but not immediately. However, it should not be underestimated. Over time, it may disrupt the function of the chamber or ongoing experiments. This category includes over- and under-limit humidity, under-limit temperature, as well as expired door open timeouts. The reaction time is set for several minutes to hours.

Category 3 – An informational notification indicating a normal system state or expected behavior. These messages serve for monitoring and logging purposes. While they do not signal a malfunction.

3.3.3 List of alerts

Here is a list of alerts and notifications with explanations of their significance and meaning. The list may not be exhaustive. If you are unsure of the meaning or a specific message from your device cannot be found in the list, please contact the PSI support team.

Caption	Relevance	Meaning	Solution
PLC Communication	**1**	PLC controls the hardware. No communication = no control.	Contact PSI support. Remote investigation by PSI specialist (PLC programmer).
Pressure crash	**1**	Extremely low pressure in the cooling system. **Critical error. System shutdown.**	Contact PSI support. Try to identify a leak or another malfunction in the cooling system.
Battery	**2**	Informs about the UPS battery being deteriorated.	Replace the battery. If the UPS is unable to power the messaging system, no power outage message will be sent.
Main Power	**1**	Main Power Supply lost. Message can be sent because of UPS.	Find the cause of the electricity outage.
Power supply restored	**3**	The power supply resumed	
Overheat HW	**1**	Overheat protection activated by HW relay. **Critical error. System shutdown.**	Contact PSI support. Try to find the cause of overheating. After cooling down, press the Reset button or restart the chamber.
Overheat	**1**	SW overheat protection activated by a longer period of overlimit temperature. **Critical error. System shutdown.**	Contact PSI support. Try to find the cause of overheating. Set the temperature higher than the actual temperature and wait.
Lights Overheat	**1**	Too high temperature around the lights. **Critical error. System shutdown.**	Contact PSI support. Try to find the cause of overheating.
Inlet filter	**2**	The inlet filter in the air supply is clogged	Clean the filter, or order PSI service

T. Overlimit	**1**	Temperature being +2 °C or more over the set value for more than 15 minutes and is not decreasing.	Check the environmental data. Try to alter the temperature settings. Check errors of the cooling components. If the temperature rises uncontrollably, contact PSI support. Overheat protection would be activated after some time.
T. Underlimit	**2**	Temperature being -2 °C or more under the set value for more than 15 minutes and is not increasing.	Check the environmental data. Check errors of the cooling components. Try to alter the temperature settings. If it does not help, contact PSI support.
RH Overlimir/Underlimiti	**2**	Relative humidity is more than 15 % of the set value for 1 h or more.	Check the status of humidifiers and dehumidifiers on the Rules + Alerts tab. Contact PSI support to investigate remotely.
Sensor	**1**	Environmental sensors monitoring T, Rh, CO_2 level or light intensity	Contact PSI support. In the case of chamber sensors (nr. 1 and 2), their displayed values can be checked by the user and compared with the software.
Damper Inlet/Outlet	**1**	Communication error with dampers. May affect the ventilation system.	Contact PSI support.
Fan (ventilator) circulation	**2**	Fans for inner air circulation	Check the circuit breaker. If the issue persists or the breaker is not the cause, please contact PSI technical support.
Fan (ventilator) fresh air	**2**	Fan forcing the fresh air inside	Check the circuit breaker. If the issue persists or the breaker is not the cause, please contact PSI technical support.
Fan (ventilator) lights	**2**	Fans on the intake and outtake of the lights' space	Check the circuit breaker. If the issue persists or the breaker is not the cause, please contact PSI technical support.
Breaker fans condenser (evaporator)	**1**	Fans cooling the high-pressure part of compressor circuit	Check the circuit breaker. If the issue persists or the breaker is not the cause, please contact PSI technical support.
Pump	**1**	Various pumps in the cooling system. Breaker down.	Check the breakers. Contact PSI support.
Heating	**1**	Heating unit in the heating system. Breaker down.	Check the breakers. Contact PSI support. If there are multiple units, the functional ones can compensate for the dysfunctional one to some degree.
(De)Humidifier	**1**	Breaker down or internal error. A problem with humidity regulation may arise.	Check the breakers. Contact PSI support. If there are multiple units, the functional ones can compensate for the dysfunctional one to some degree.
Humidity regulation overlimit	**2**	Humidity regulation does not fulfill the set requirements	Inspect the humidifier. If the issue remains unresolved, contact PSI support.
Humidity regulation underlimit	**2**	No water, humidifier off, dry intake air, sensor error.	Check water supply, set humidity low for 30 min then high again. If needed, reset breaker or restart chamber. Contact PSI support if issue persists.
Lights Power	**1**	Breaker down. The lights are off.	Check the breakers. Contact PSI support.
Lights off	**1**	Separately informs about lights being turned off as a result of an event, e. g. overheating	Contact PSI support.
CO2 Alarm	**1**	Dangerous concentration of CO_2 in the chamber.	Close CO_2 supply. Contact PSI support. Wait for the chamber to ventilate.
Door Open	**3**	Door open timeout. The door has been open for more than 2 minutes.	Close the door.

Agregat - internal	**1**	Device became unresponsive	Check the display of the cooling unit, take a photo, and send any visible error messages to PSI support.
Agregat communication error	**2**	Lost communication with the device.	Check if the unit is running. If not, contact PSI support.
Cooling water (temperature)	**2**	Too high temperature of the cooling liquid. May lead to problems with temperature regulation. If the water temperature is above 20 °C.	See also other cooling alerts + support
Cooling water pressure extremely low	**1**	Failure of cooling because of low pressure	Please contact support.
Cooling water pressure low	**2**	Warning of low pressure, cooling still operational	Please contact support.
Damper inlet/outlet	**2**	Dampers for air supply regulation	Please contact support.
GSM present	**3**	Informs about the presence of the GSM module for sending SMS	
Heating circulation	**1**	Error in the heating circuit	Check the breakers. Contact PSI support.
Heating sensor	**2**	Monitors the temperature of the heating module	Please contact support.
High pressure sensor	**2**	HW relay monitoring pressure in the high-pressure section of the cooling circuit behind the compressor. It must not be too high – error.	Please contact support.
Low pressure sensor	**2**	HW relay monitoring pressure in the low-pressure section of the cooling circuit before the compressor. It must not be too low – error	Please contact support.
Overheating (HW, SW)	**1**	Overheating protection activated. Lights and temperature regulation shut off.	Needs reset, check cooling system, contact support.
Pump lights	**1**	Pumps in the lights' cooling circuit (if cooled by water)	Check the breakers. Contact PSI support.
Sensor fresh air	**2**	Reads parameters for the fresh air supply regulation	Please contact support.
Sensor lights ventilation	**1**	Used for lights ventilation regulation	Please contact support.
Suction/Condensation pressure	**1**	Pressure in the compressor circuit	Please contact support.

4 FYTOTRON CLIENT APPLICATION

The Client application allows for the creation of settings, data visualization, data export, and other control elements of your device.

When the *Client* application is started, the initial device selection dialog window is displayed (Figure 6). Logon window appears only at the moment when there is more than one device installed. Otherwise, the automatic selection is made and the dialog is skipped.

	Functions *Add*, *Edit,* and *Delete* should be only used by trained personnel with the approval of PSI. Self-made changes in the setup may corrupt the communication and disable device control.

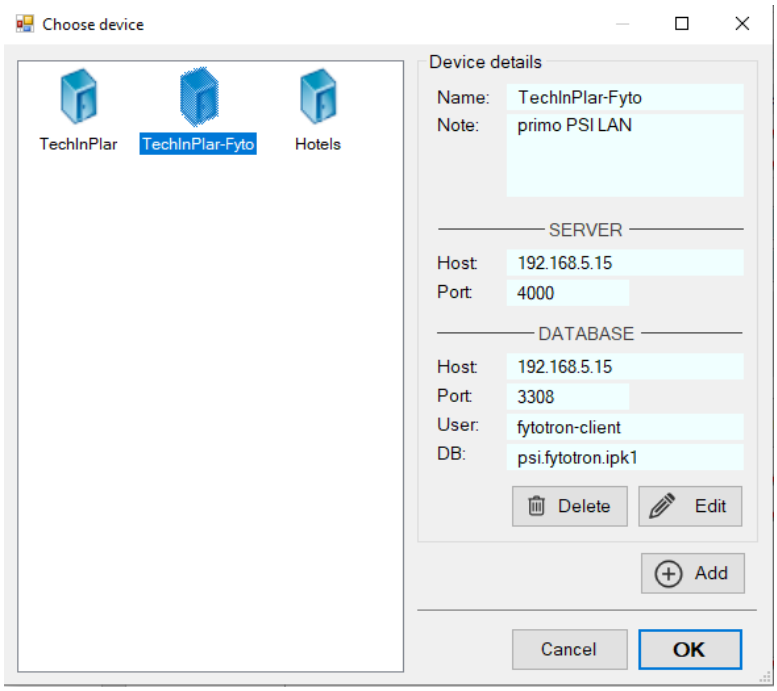


Figure 6: Login

To log in, click on the particular device icon and press Enter / Click the *OK* button (Figure 6)

After selecting the device and press OK, *AUTHENTICATION* screen is displayed (**Chyba! N enalezen zdroj odkazů.**). This screen contains three areas:

- CONTROL SERVERj
- AUTHENTICATION SERVER
- AUTHENTICATION

IP address, and current server state are shown in the *Control Server* area.

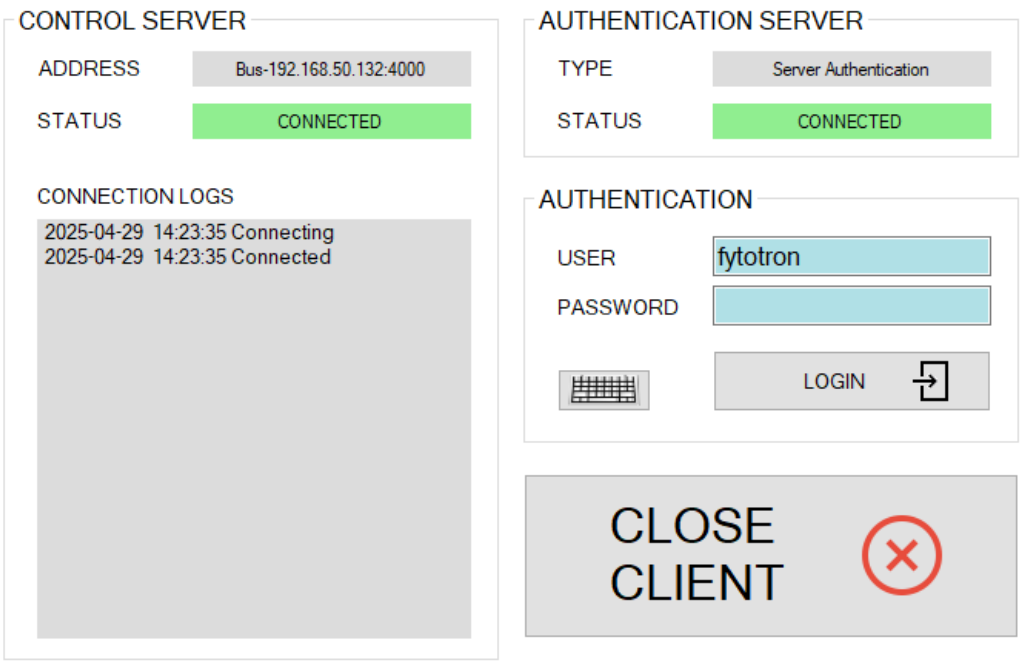


Figure 7: Authentication

	If the *State* box shows *Disconnected* message, the Server application is not running and must be started before logging in the Client.

Authentication area contains fields for user credentials and Login button. On the left side, the on-screen keyboard toggle button is located. (Figure 8).

Figure 8: On Screen Keyboard

After filling in the required information, click *Login* button. Credentials are checked and if valid, confirmation message is displayed (Figure 9)

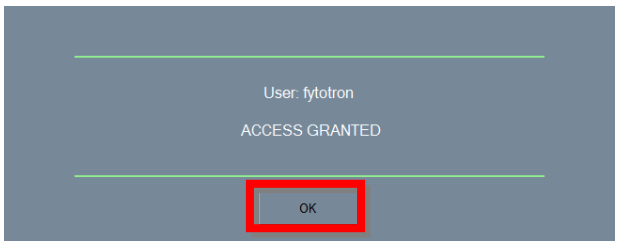


Figure 9 Successful Login into the Client Application

The last option is the *Close Client* button. Clicking this button closes the login window.

4.1 Screen Description

Client program is functionally divided into several tabs:

- **Main tab** – provides an overview of the current state and allows manual adjustment of parameters (only constant values, no planning or programming), also displays a simple graph of recent environmental data
- **Experiment tab** – provides tools for protocol state monitoring and control
- **Protocol Editor tab** – provides tools for generating protocols, i.e. instructions for simulating complicated growth conditions from simple day / night cycle with constant temperature and humidity to complicated diurnal waveforms of all parameters
- **Data Viewer tab** – displays complex graph and provides tools for recorded data export
- **Controls** – informs about power consumption, actual input power and customized features, e.g. cooling water temperature, cooling fans speed etc.
- **Service** – displays information about the connection to the server and allows control of the client window
- **Authentication** – manages user sessions

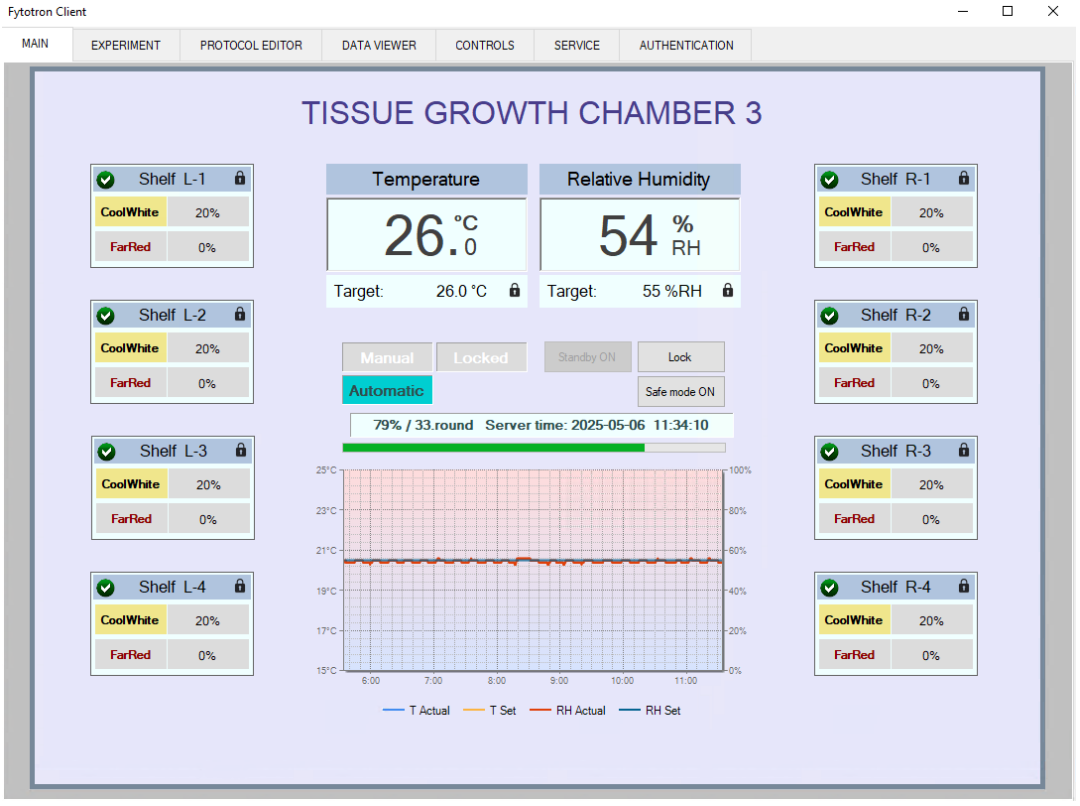


Figure 10 Fytotron Client

4.2 Main

The **Main** tab displays an overview of device controls (Figure 11). This represents target and current values for temperature, relative humidity, and CO_2 concentration. Additionally, it may include manual control of lighting channels and their intensity, as well as the control of hydroponics or the irrigation system. The graph shows recent values of temperature and humidity. Informational and control buttons are also present, along with a *status bar* informing about a connection to the server and about experimental progress, if there is an experiment running.

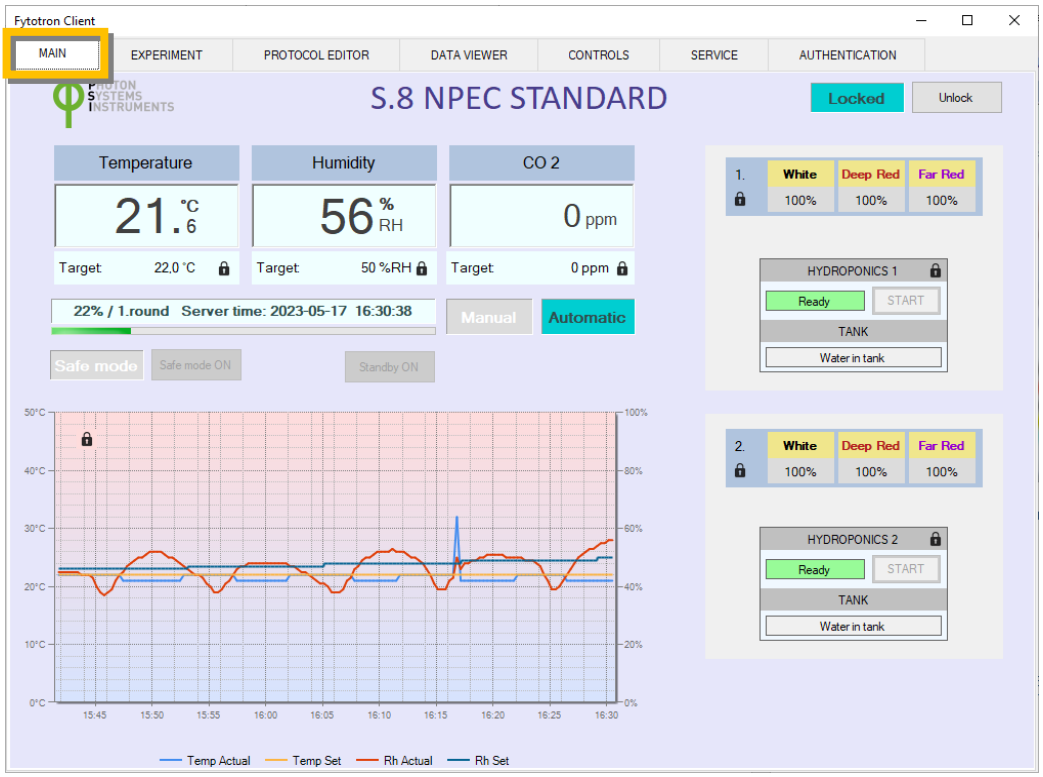


Figure 11 Main tab in a typical growth chamber

	The appearance of this tab is highly customized based on the product specifications. Some modules are not present in all types of PSI products, depending on individual setup – e. g. hydroponics/watering and CO_2 control. **Please consider the actual disposition of your device when reading this manual.**

4.2.1 Mode of operation

The application can operate in **Manual** or **Automatic** mode (Figure 12). Manual mode allows a direct change of the target temperature and humidity alongside the light and hydroponics control in the **Main** tab. Automatic mode controls the parameters by using predefined protocols. The automatic mode is activated via the **Experiment** tab. When active, the controls in the **Main** tab are locked and cannot be manually changed.

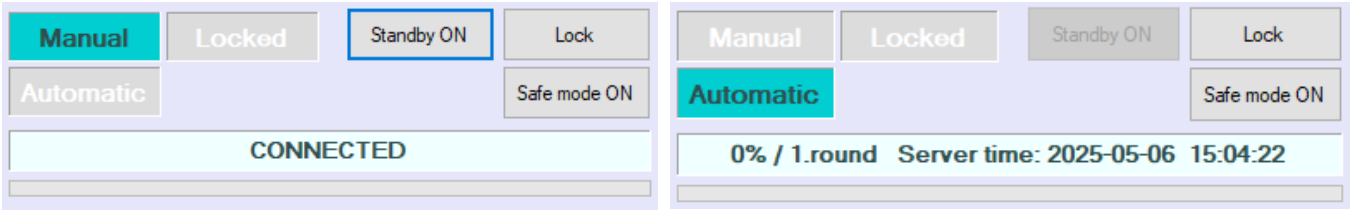


Figure 12 Mode of operation

Standby button (Figure 13, left) turns the whole device into the standby mode, where the lights, temperature and humidity control are turned off. Overheating protection is active. Energy consumption of the device is lowered, while it can be easily switched on again to full operation mode. Standby mode can only be activated if no experiment is currently running.

Safe mode (Figure 13, right) is used to dim the lights to prevent eyesight damage in the case the operator needs to enter the illuminated area.

Lock button locks application controls to avoid unwanted operation (Figure 13). To unlock the controls, it is necessary to re-enter the credentials.

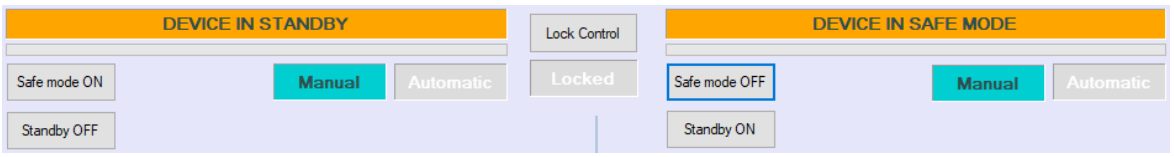


Figure 13 Standby mode (left), Safe mode (right)

4.2.2 TEMPERATURE, HUMIDITY AND CO_2

Actual temperature, *humidity* and CO_2 concentration are displayed in the Main window (), along with the target values. These values can be manually changed by clicking on the corresponding blue target value label. A dialog window will appear. Values cannot be changed if a protocol is running (Automatic mode) or if the screen is locked. In these cases, the target values display a symbol of a lock:

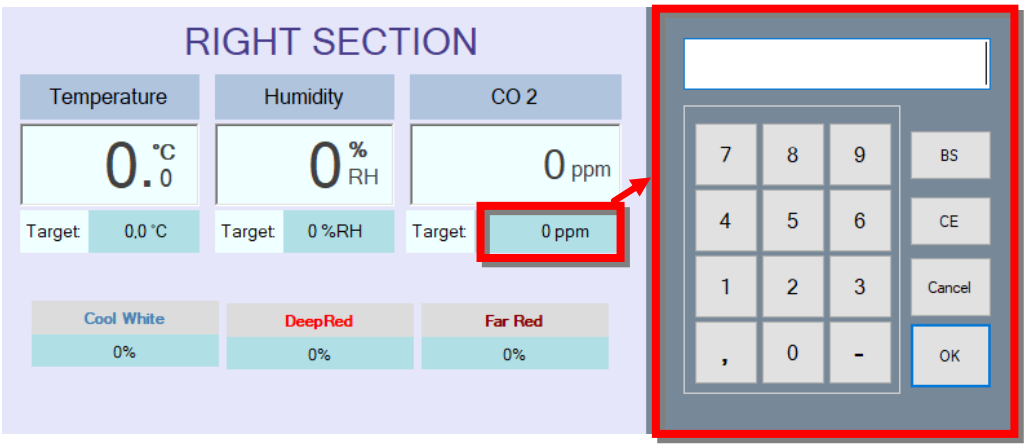


Figure 14 Temperature and humidity settings

4.2.3 LIGHTS

Light control shares some principles with the control of environmental parameters described previously. The number, placement, and components of light controls reflect actual chamber dispositions.

Light intensity is displayed in percent of maximal intensity and can be manually changed by clicking on the intensity value label (light blue colour). The light is turned on and off by clicking the light's name label. If the light is off, the label is grey, if it is on, the label turns yellow. Intensity cannot be changed and the light cannot be turned on/off if a protocol is running (*Automatic mode*) or if the screen is locked (Figure 15, right side). In these cases, the target values display a symbol of a lock.

	Please note that the lights can be turned on and off only by clicking on the label with the name of the respective light. The set percentages of intensity alone will not turn on the light. An exception is when the intensity is set to 0%, in which case the light will, of course, not illuminate.

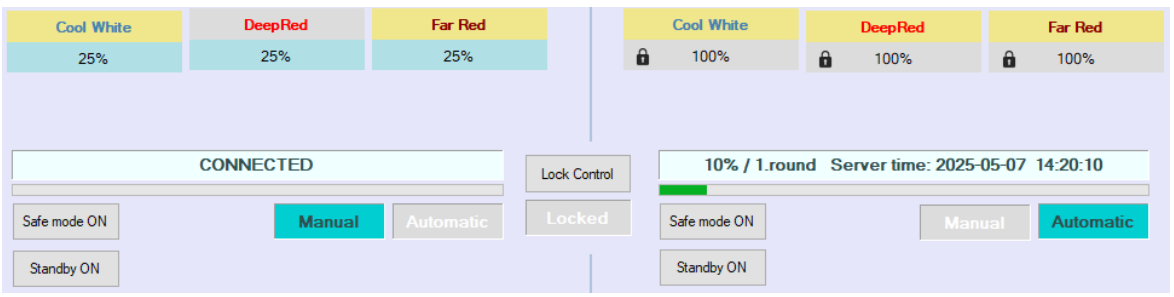


Figure 15 Examples of light-control panels, with the protocol running shown on the right

4.2.4 FEEDBACK-CONTROLLED LIGHTS

In some devices, a special light control, called feedback control, is implemented. The solution is primarily employed in greenhouses, where, in the case of low natural light, artificial lighting is used to supplement it.

The desired light intensity is set in the relevant software window. Inside the cultivation area, a light intensity meter is placed. Based on the measured data, the electric current flowing through the LED diodes is regulated to achieve the user's desired light intensity. The intensity is expressed not in percentages but directly in units used for Photosynthetic Photon Flux Density (PPFD), $\mu mol \cdot m^{-2} \cdot s^{-1}$ (abbreviated as µE).

If the light panels have multiple channels of different colours, their intensity cannot be adjusted directly but proportionally. The ratio is a dimensionless number that ranges from 0 to 100. For instance, if there are 4 light channels and their ratio is set to 100:100:100:100, it equals as 1:1:1:1. If the ratio is set to 30:30:30:3, the last light channel contributes ten times less to the overall artificial lighting than the other three (the same as ratio 10:10:10:1).

Figure 16

4.2.5 WATERING SYSTEM AND HYDROPONICS

PSI cultivation chambers can also include an automatic watering system of various design, ranging from simple flood irrigation of plants grown in regular soil or substrate to complex systems enabling hydroponic cultivation in various modes (ebb and flow, nutrient film technique, etc.). Always check your system's current setup.

Examples of watering controls are shown in Figure 17:

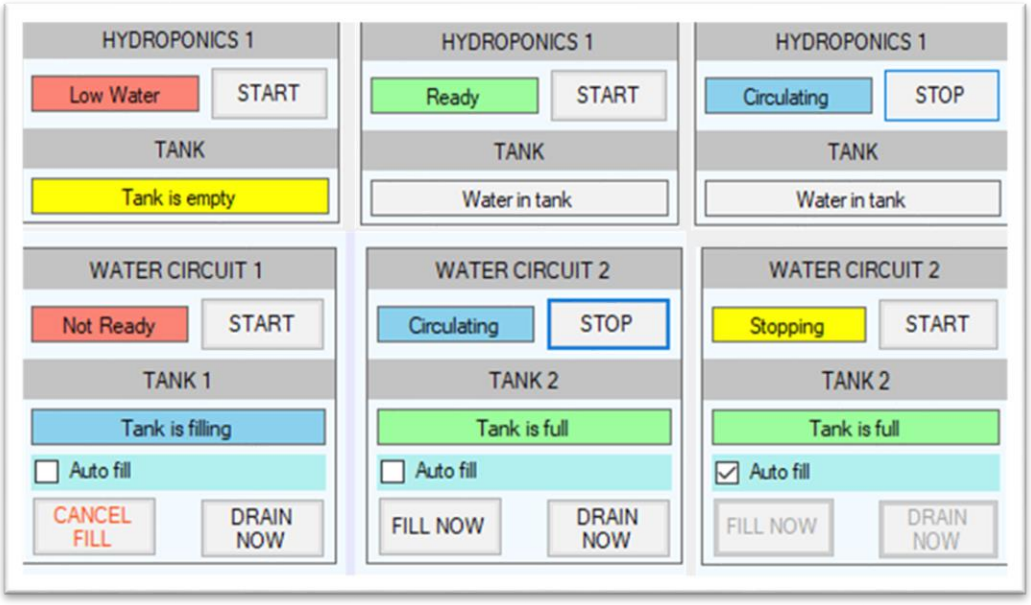


Figure 17 Watering and Hydroponics - software control example

The information label determines, if circulation is ready or not, depending on the amount of water/medium detected by sensors in the tank. If the water pump is running, the information label will report, that the medium is *Circulating*.

Start button turns on the water pump and its label changes to *Stop*. After turning off, the *Stopping* phase may be activated for several minutes. During this phase, medium is pumped back into the tank. In systems that do not contain a reverse pump, the water or medium drains freely due to gravity through an open valve to the reservoir tank.

In some systems, machine filling or draining of reservoir tanks is enabled, also in automatic mode. *Fill now* button manually starts to fill the reservoir tank from water supply. If the *Auto fill* box is checked and the reservoir is not full, automatic filling will occur after the *Stopping* phase of circulation is finished.

Drain now activates emptying of the tank. **It may require that the valves on the respective pipeline must be manually switched to *DRAIN* position.** This allows the draining of the hydroponic medium into the sewerage or a waste container.

	The circulation cannot be turned on if there is no medium in the tank, the *Stopping* phase is active or the tank is filling.

4.2.6 CHART

Some software versions also include an informative chart on the **Main** tab, providing users with a quick overview of recent developments in environmental parameters. The Y-axis displays values of individual variables measured over time, while the X-axis represents the time (Figure 18). By clicking on the chart, a dialogue box opens, allowing users to select displayed parameters and scale the chart (Figure 19).

Figure 18 Chart on the Main tab

Figure 19 Chart settings

4.3 EXPERIMENT

Experiment tab (Figure 20)is used to manage and view the current experiment – an automatic mode of software control. The protocols can be loaded and created on the **Protocol Editor** tab, as described in a respective chapter (more in 4.4).

	The protocol created in Protocol Editor or loaded from local storage must be saved to *Server actual* first to appear on the Experiment tab (see 4.4.1).

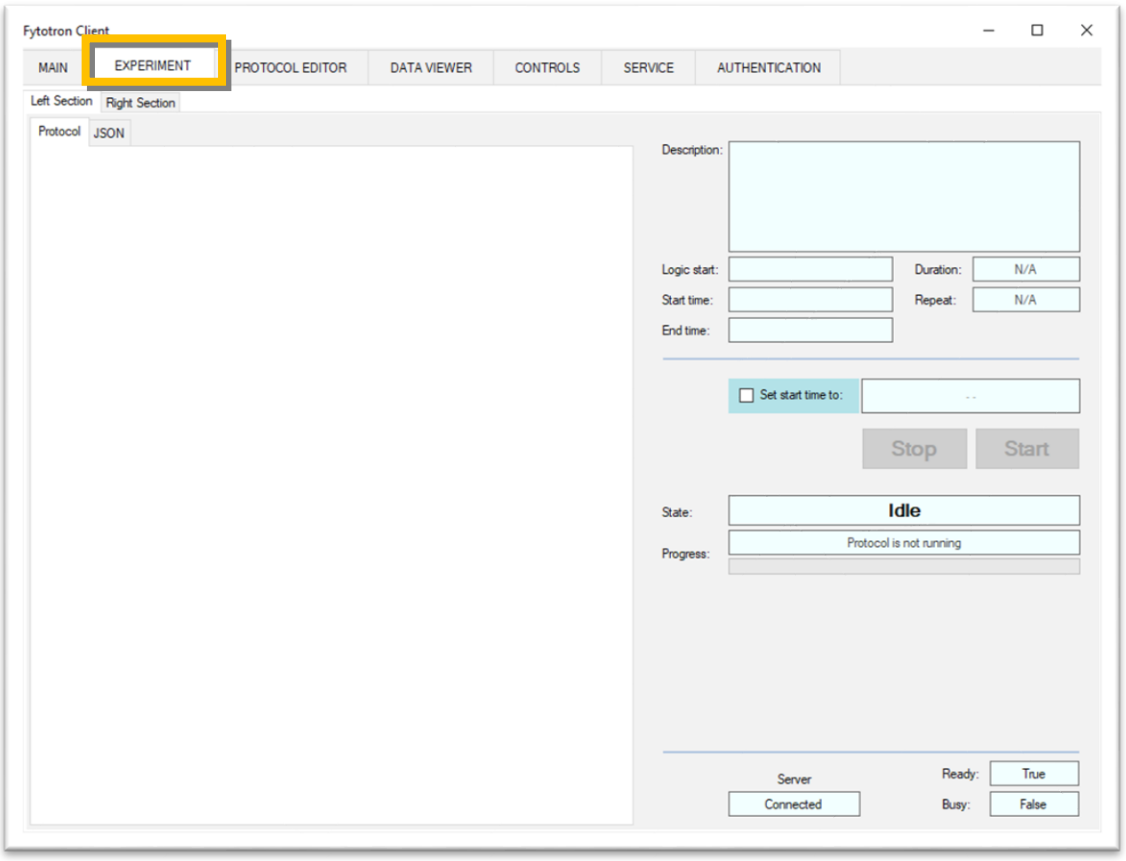


Figure 20 Experiment (blank)

4.3.1 INFORMATION ABOUT THE EXPERIMENT

The left side of window (Figure 21) contains information about the currently loaded protocol and its progress. It can be divided into sub-tabs representing controllable units composed of *Variable Groups* (see 4.4.2), if there are more than one. The division and layout of device control into individual compartments depend on the specific design and arrangement of the device. This division allows for separate and completely independent control and management of protocols in each functional component.

	The blue color indicates which phase of the protocol is currently active. The green bar displays current phase's progress.

The bookmark *JSON* shows text version of the protocol in the JSON language.

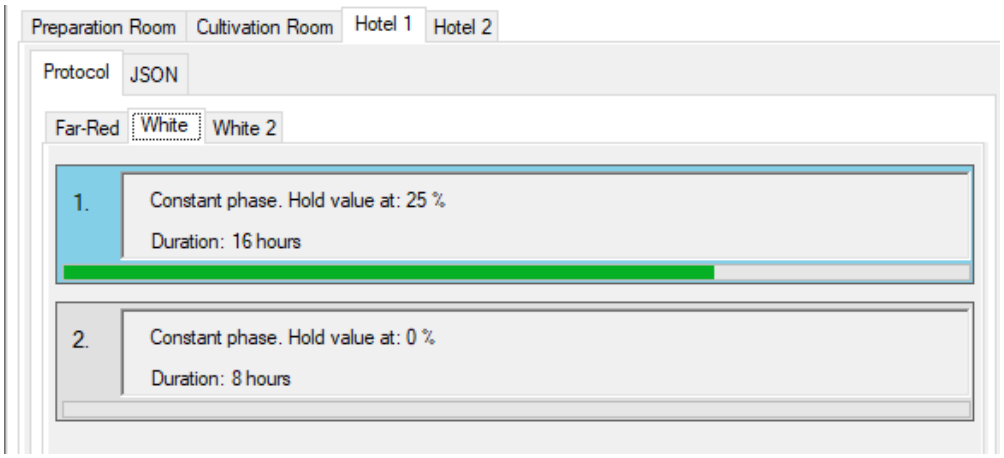


Figure 21 Phase Progress

Information about the beginning, end, duration and the number of repetitions of the protocol is displayed in the upper right part of the window (Figure 22).

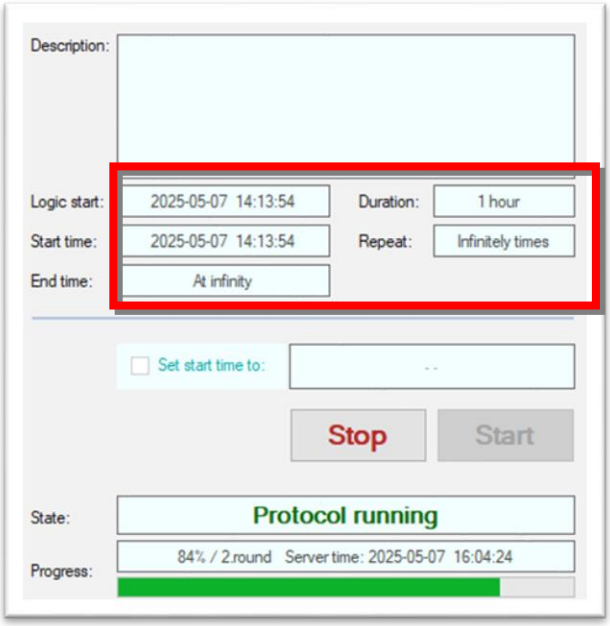


Figure 22 Experiment Information

Current state and progress of the experiment and control buttons are displayed in the bottom right part of the window. Protocol start can be postponed to a specific date and time (Figure 23).

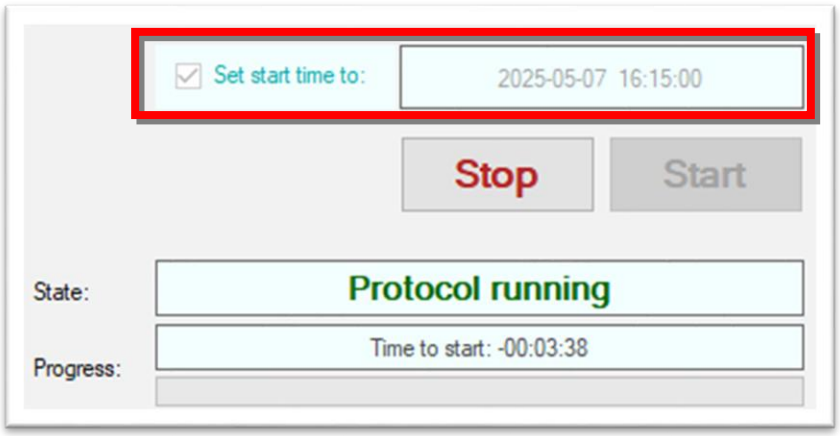


Figure 23 Experiment controls

4.4 Protocol Editor

Protocol Editor tab contains controls allowing to create new or edit existing protocols independently for all compartments. These protocols can, among other things, simulate regularly recurring natural events, like the alternation of day and night.

4.4.1 Creating, saving and loading the protocols

In the upper right part of the window (Figure 24) is placed a dropdown menu where the particular compartment can be selected, if there are more than one in the device. Protocol file group contains buttons for protocol creating, saving and loading. After pressing the *New* button, a dialog window with the selection of controlled parameters for the new protocol appears. *Load* and *Save* buttons are used for handling the protocols on the local disk or on the server (Figure 25). On the server, only one protocol for each compartment can be saved at a time. Only a protocol saved to the server can be controlled in the Experiment tab, as described before.

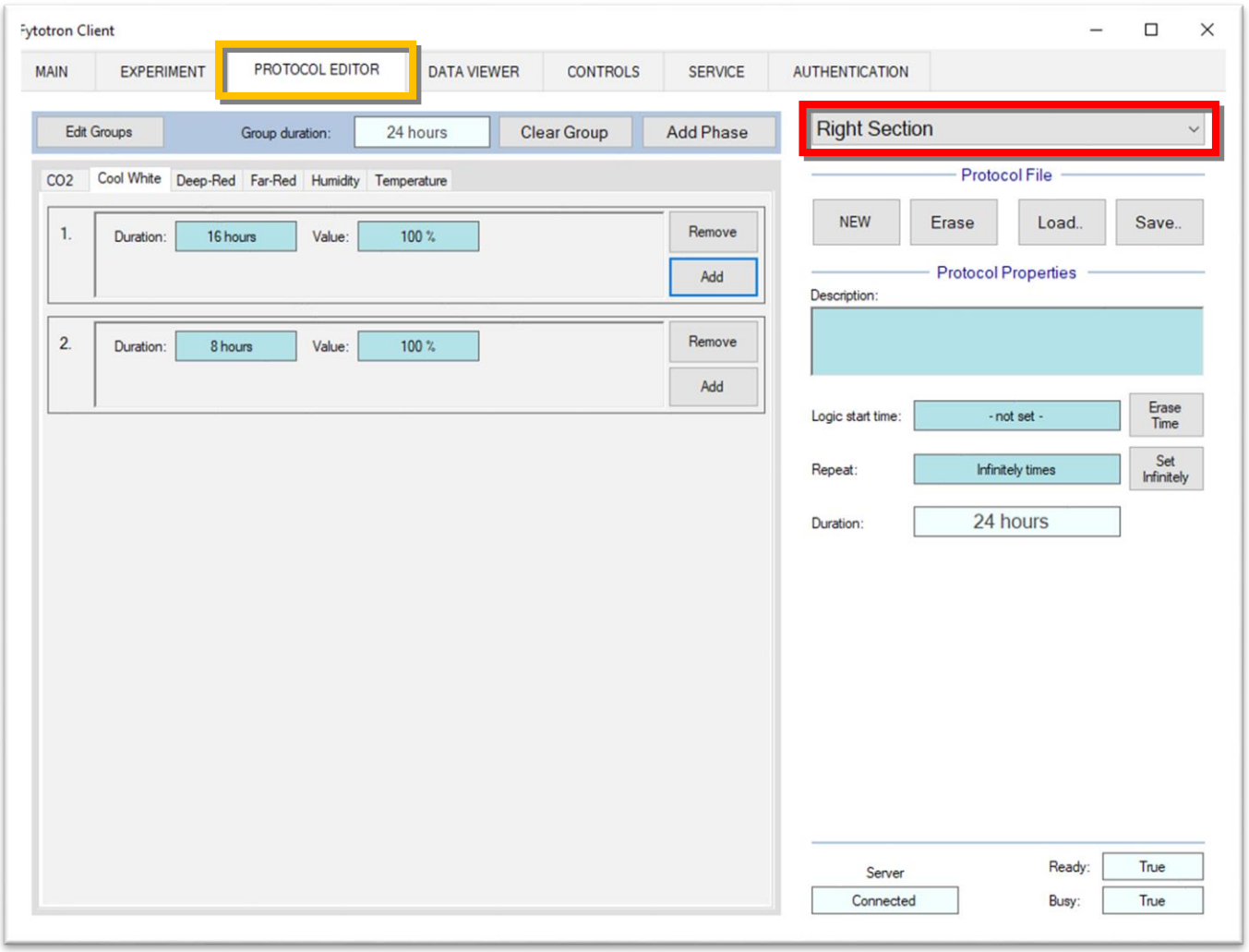


Figure 24 Protocol Editor with the compartment selection expanded

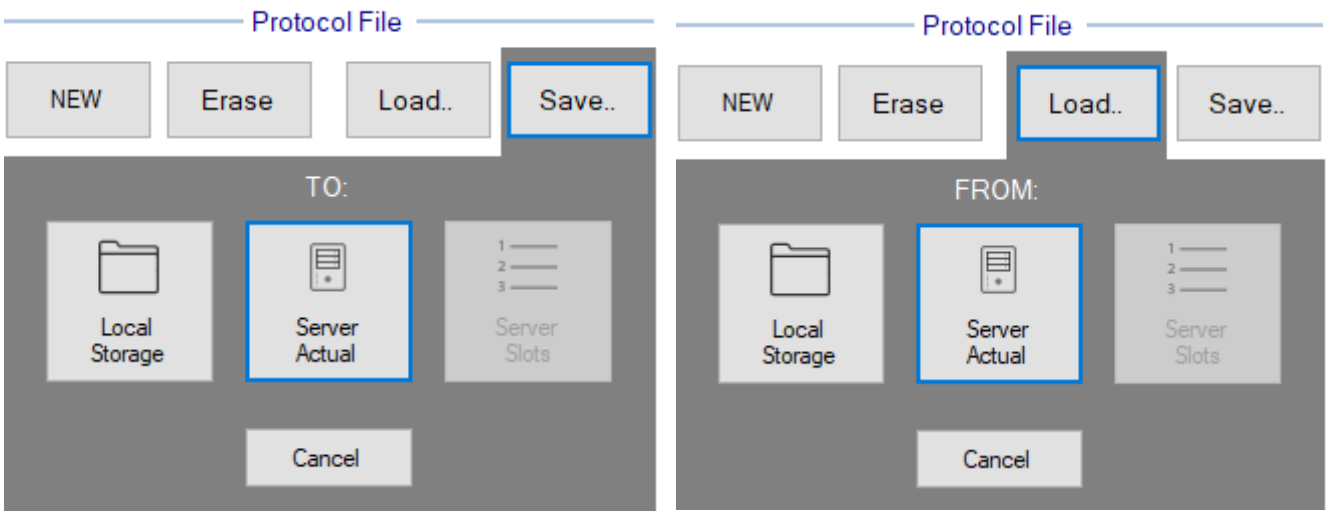


Figure 25 Saving and Loading the Protocol

Clicking on *New* will open a dialog window called *Protocol Variables Management*. When editing an existing protocol, this window can be accessed by clicking the *Edit Groups* button in the top left corner of the software window (Figure 24).

4.4.2 PROTOCOL VARIABLES MANAGEMENT

A *Variable* is a term used in Fytotron Client terminology to refer to the smallest controllable parameter unit of the device. Some parameters include only one variable, such as in a single cultivation chamber where temperature and relative humidity have one variable each. Multiple variables are often present in the case of lighting settings, which are based on the device's configuration. Common growth chambers may contain multiple light shelves or panels, each of which can be controlled individually. In the Protocol Editor, each of these individually controllable units is represented as a separate variable. Variable types associate controllable units of the same properties. Light channels of different colors usually are of separate types – White lights ≠ Red lights etc.

Variables of the same type are managed together in *Groups*. A group has to contain at least one variable. By default, variables of the same type are merged into a single group. Each group is represented by one tab, which displays all variables that it contains. Groups are the base units in the protocols; each group can have different sequence of phases in protocol and thus can be controlled separately (Figure 26).

Turned around, each variable, which is desired to be controlled by the protocol, must be contained in a group

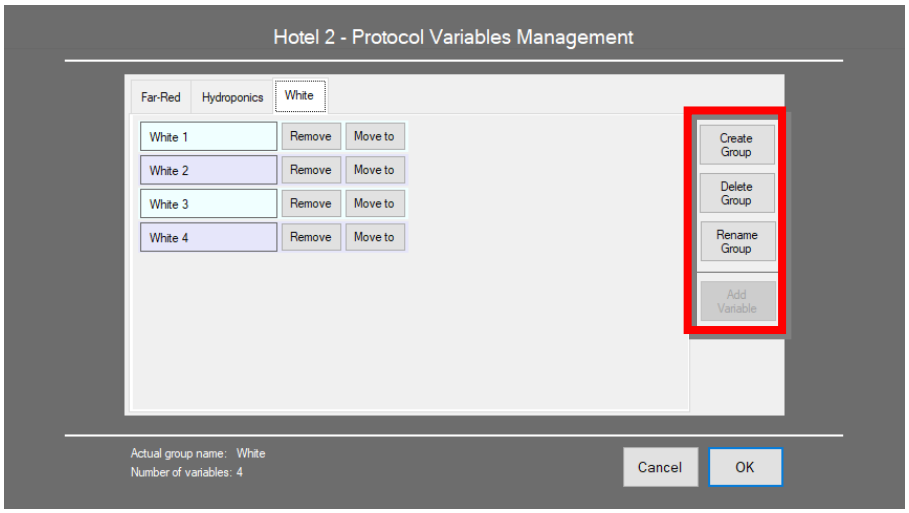


Figure 26 Group variables

In the right part of the window are buttons for the whole group operations - *Create* for new group, *Delete for removing the group and Rename for changing group's name.*

In the example (Figure 26) is shown, that in the compartment called Hotel 2 are four light shelves with two light channels (colors) each, white and far-red. Light channels are projected in the software as variable types White and Far-Red. Each of them has four units (Variables), that represent respective light channel on one cultivation shelf. They can be grouped together, as shown in the example, or be divided into up to four groups. **For each group, a different automatic protocol can be created**. Group examples in this case would be:

- 1 group with 4 variables
- 2 groups, 2 + 2 variables or 1 + 3 variables
- 3 groups, 1 + 1 + 2
- 4 groups, 1 variable in each

Add Variable button is used to add variables to the current group. If the group already contains all variables of the same type as the current group, the button is disabled. When pressed, a list of available variables is displayed (Figure 27).

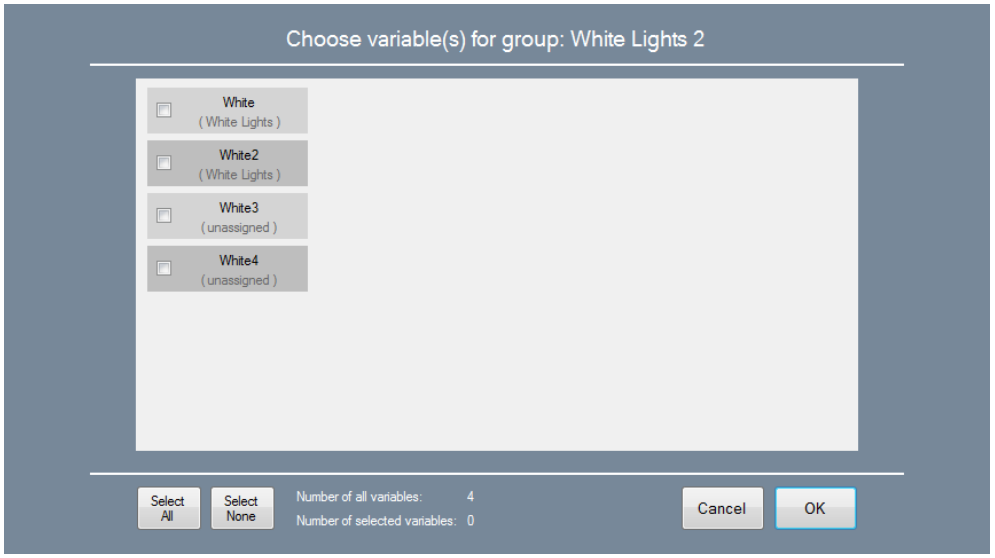


Figure 27 Variable assignment

Variables are assigned to a current group if their checkbox is ticked. Both free and already assigned variables can be selected, if a variable is already assigned to some group, it is moved to the current one. Selection is confirmed by the OK button.

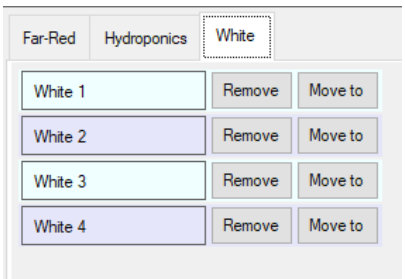


Figure 28 Moving and removing variables

Each variable in a group is carrying two buttons (Figure 28). *Remove* button removes the variable from the group, thus it becomes unassigned. It is either available for assignment to another group, or if it remains unassigned, it will not be controlled by the automatic protocol. *Move* button is used to directly assign a variable to another group of the same type.

To create a new group, press the *Create group button*. In the dialog box (Figure 29) select the type of the group (this determines which variables can be assigned to a group) and enter a name for the group.

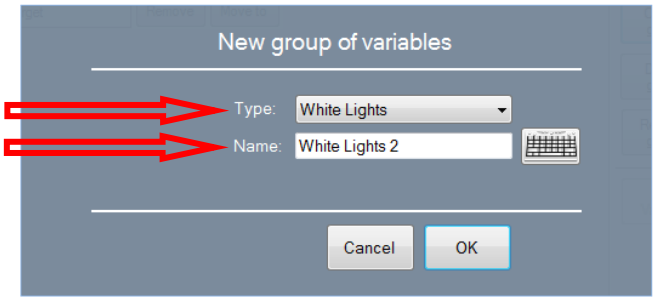


Figure 29 New Group

Newly created group has no assigned parameters, use the *Add Variable* button to add some.

After the variables management is finished, click the OK button and the window will be closed.

4.4.3 Protocol Phases

The protocol phase represents the configuration of a group of variables over a specific time interval. The shortest duration of a phase is typically limited to 1 minute. The Fytotron Client offers several types of phases. The simplest one is constant, where a constant value is maintained throughout the entire phase duration. Another option is a ramp, which represents a linear change in parameters between the initial and final values. The third type is a periodically oscillating phase - a sinusoid. The last option, which is only functional for lights, is the simulation of natural lighting conditions of a cloudy sky - Cloudy Day Phase. There is also a possibility to create custom phase profiles and import them using a .csv file.

Add phase button (Figure 30) is used for adding phase at the beginning of the protocol. To add phase after an existing phase, the Add button on the phase visualization box is used. After pressing one of the add buttons, the Add Phase dialog box appears (Figure 31).

Figure 30 Add Phase button

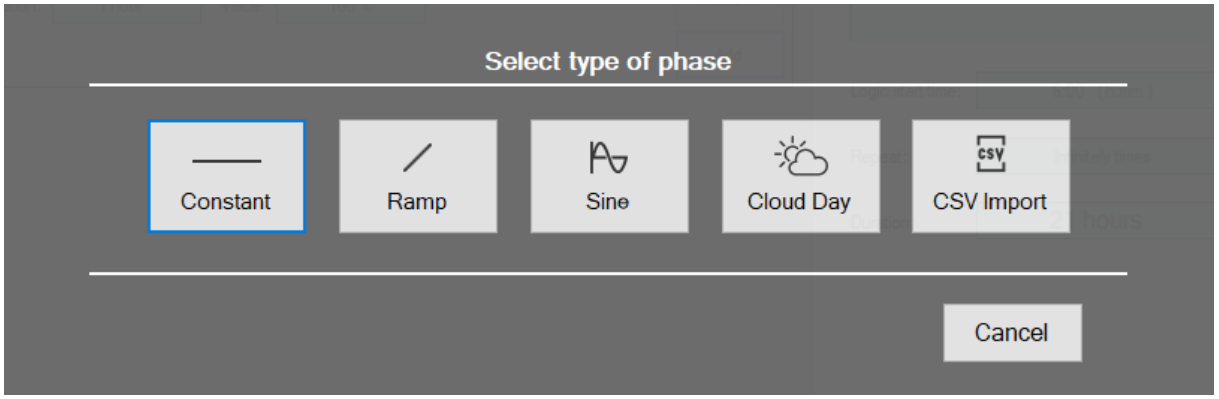


Figure 31 New Phase of Protocol

Constant option creates phase that maintains constant value of the variable (Figure 32), while the *Ramp* option creates a phase with linear variable transition from Start to End value. Phases have *Duration* parameter, specifying the time duration of the phase. Parameters are changed by clicking on the blue field. The duration of all phases created for one group of variables is summed up and visualized as *Group duration* (Figure 30).

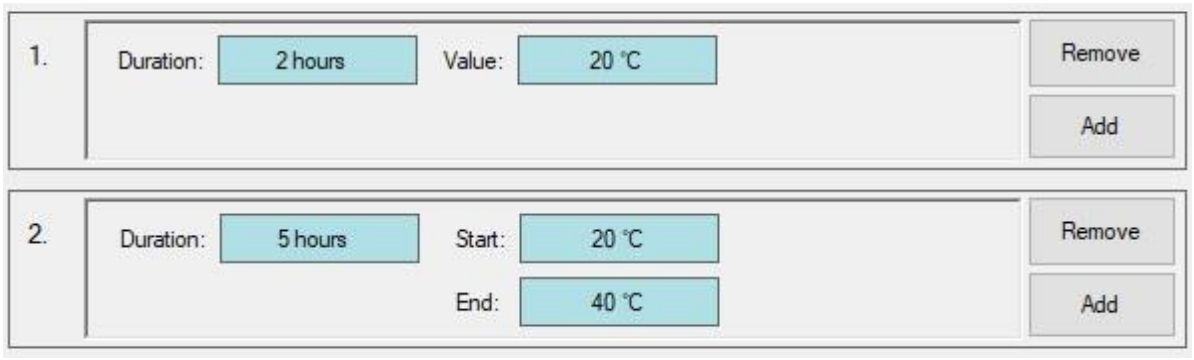


Figure 32 Constant and Ramp phase example

Sine option creates periodically oscillating phase – a sine wave (Figure 33). *Duration* parameter stays the same as before – defines phase time duration. Other parameters define function's maximum and minimum (per cents for light intensity or relative humidity, °C for temperature), period and offset. *Offset* determines the time shift of function's maximum against the time of phase start.

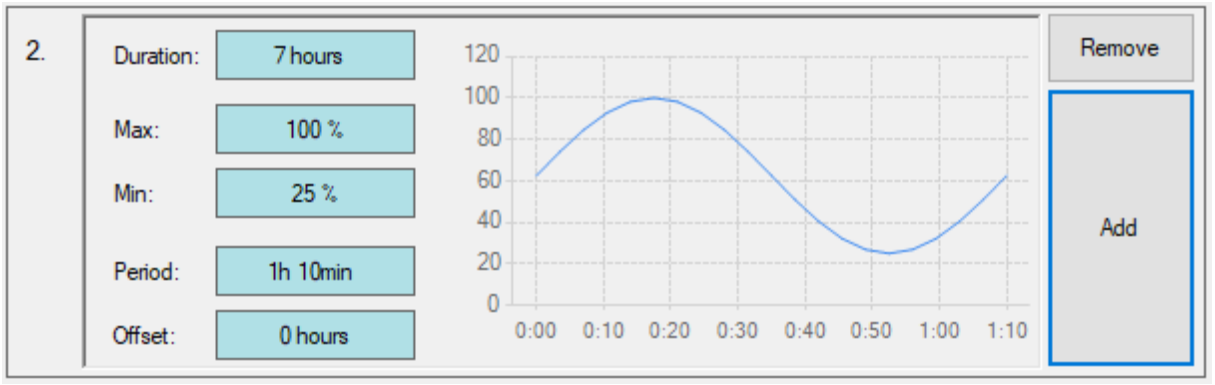


Figure 33 Sine Phase

Cloudy Day (**Chyba! Nenalezen zdroj odkazů.**) is an option of light control simulating natural outside conditions of cloudy sky, when the l ight intensity is not constant, but changes and fluctuates with the sun's position and clouds' passing. *Amplitude* describes function's mean maximum (up to 100 %). *Offset* shifts the curve upwards (0 % - no shift, 100 % maximum shift). *Cloud Attenuation* function sets how the "clouds" dim the light (0 – complete shadow, 0.5 – light intensity lowered to half, 1 – intensity not affected by the cloud's passing). *Cloud Density* specifies the frequency of cloud occurrence (0 – 100, no clouds – completely overcast). *Cloud Position* simulates the position of the clouds in the sky (0 – zenith, 100 – horizon). *Cloud Duration* defines the duration of one cloud's passing (in seconds), with a variability *Cloud Duration Variability* (also in seconds). *Fluctuation* parameters create fluctuating effect of the curve. It is recommended to validate the generated light curve with the use of light data loggers to ensure proper simulation of natural lighting conditions.

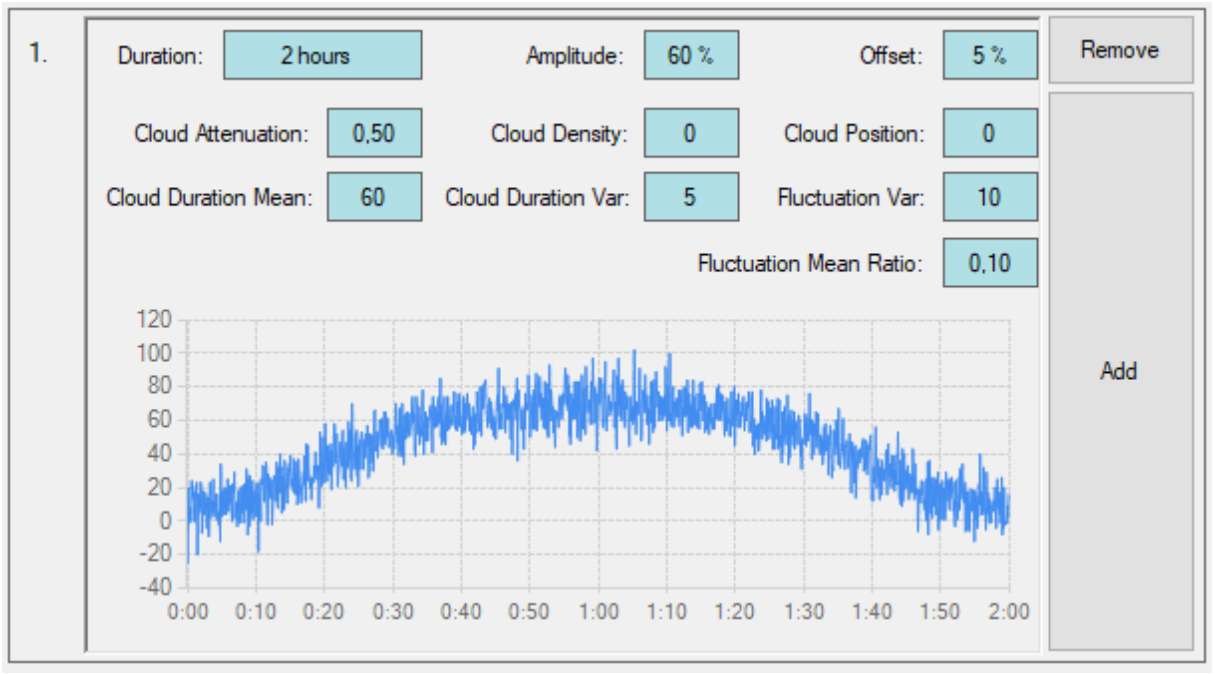


Figure 34 Cloudy Day

A protocol can be created by importing data from a CSV file using the *CSV Import* button. The file must contain exactly two columns without a header (Figure 35). The first column defines the duration of each phase in seconds (positive whole numbers), and the second column specifies the target value (an integer or decimal number). Columns must be separated by a comma, and decimal points must use a dot. The CSV file can be easily prepared in Excel. Export the resulting two-column selection as a CSV file. This method allows precise modeling of faster dynamics with fine time resolution, for example to achieve more dynamic light control or to simulate cloud transitions or to define longer and more complex protocols spanning multiple days (Figure 36).

Time [h]	Time [min]	Time [s]	Temperature [°C]
10	600	36000	30.0
5	300	18000	20.0
12	720	43200	15.0
5	300	18000	30.0
10	600	36000	20.0
1	60	3600	21.5
5	300	18000	22.0

Figure 35 Preparing CSV data for protocol import in Excel

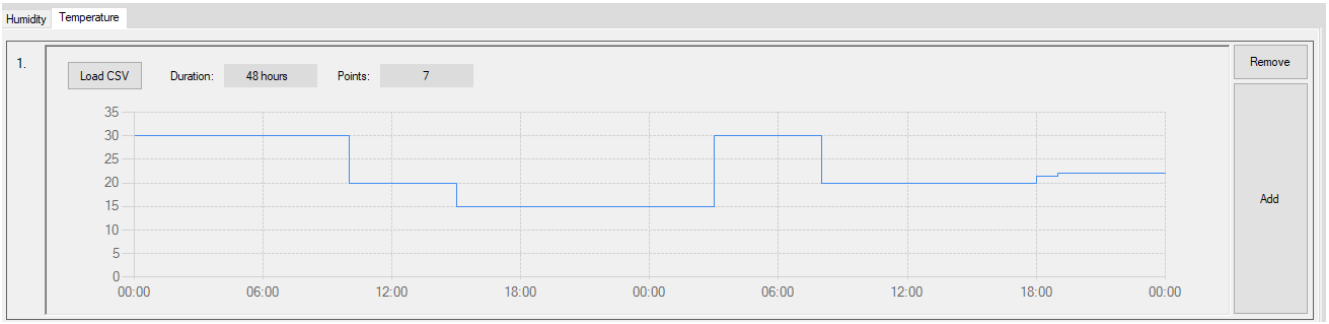


Figure 36 Example of a temperature protocol imported via CSV

	In some cases, not all phase types are available to use. A good example is the automatic watering system, which only allows the use of a constant on/off phase (Figure 37).

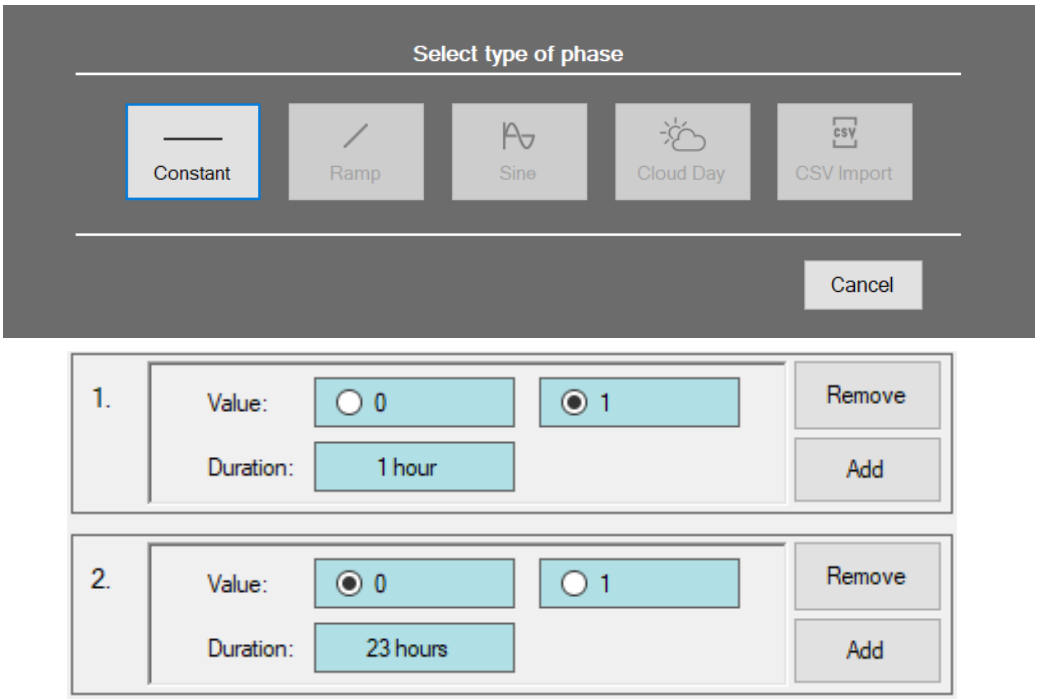


Figure 37 Limited options for the hydroponics control

4.4.4 PROTOCOL PROPERTIES

Controls for editing the protocol properties are located in the right part of the window (Figure 39). Here can be set the *Protocol description, a Logic start time and the number of repetitions of the whole protocol*

Logic start time specifies the start time of the protocol in range from 0:00 to 23:59. If the value is set by clicking the blue field, the position in the protocol is immediately recalculated at the protocol start, so it seems it was started at the *Logic start time*. *Erase Time* button clears the value (Figure 38).

	Logic start time is useful for editing the protocol parameters during the protocol execution. If the time is set, stop the protocol, edit parameters and run it again. Protocol resumes the execution in the correct position.

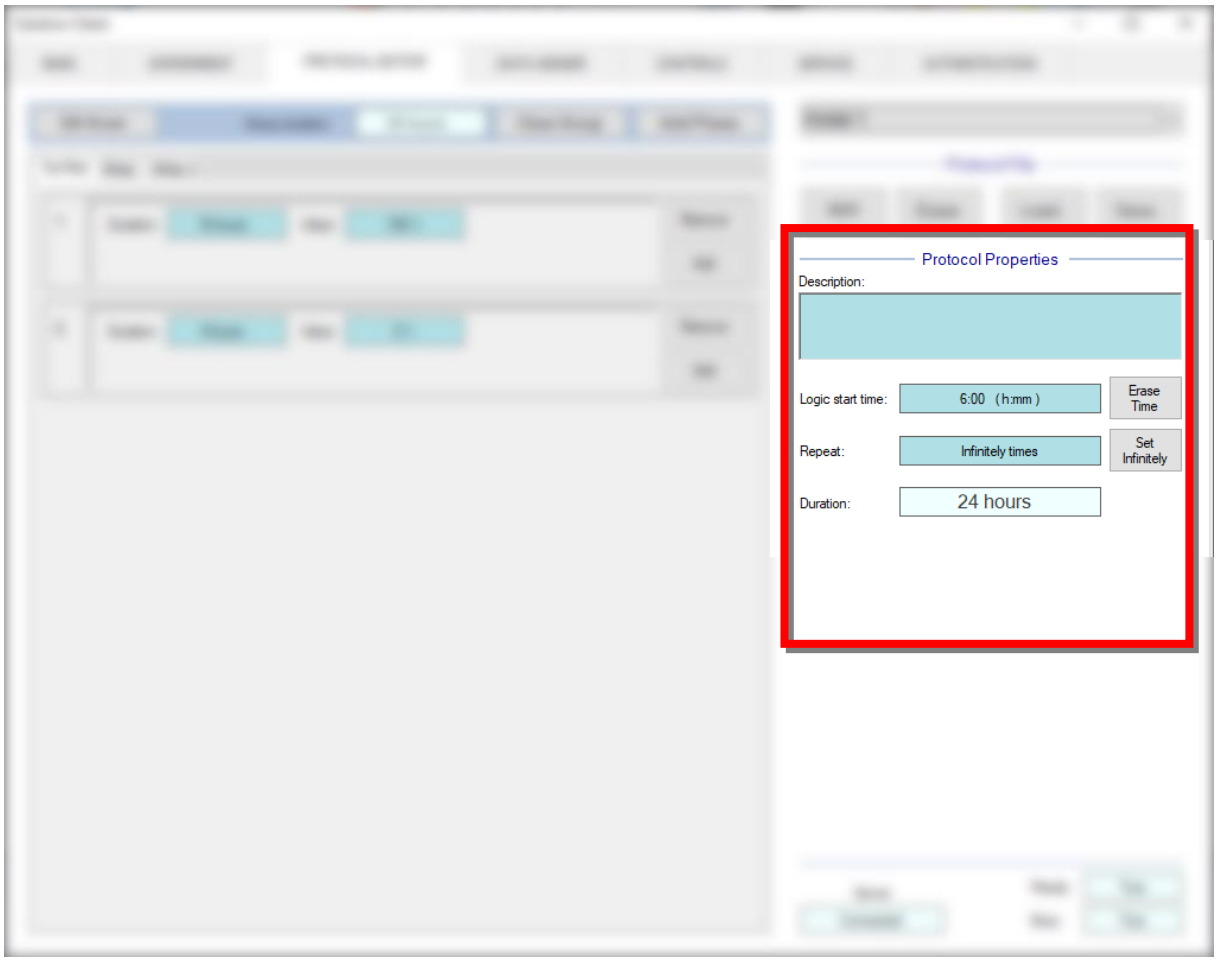


Figure 39 Protocol properties

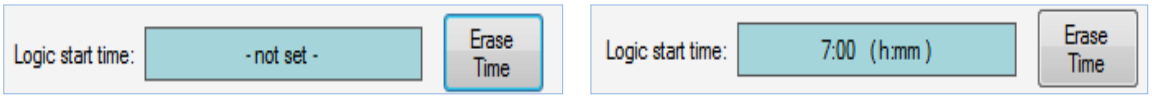


Figure 38 Logic Start Time

Repeat sets the number of repetitions of protocol (Figure 40). The minimum value is one repetition and the maximum value is infinite. *Set Infinitely* button sets the number of repeats to infinity, protocol is then repeated in a never-ending loop.

Figure 40 Repeating the protocol

Protocol duration shows duration of the entire protocol based on the longest Group Duration. **The duration of all variable groups should be the same** in the correctly defined protocol, and therefore equal to the *Protocol duration*. Length may however differ during the protocol building process. This is visualized in the Group duration value and the colour of the field is highlighted orange if the Group Duration is shorter than the Protocol Duration (Figure 41).

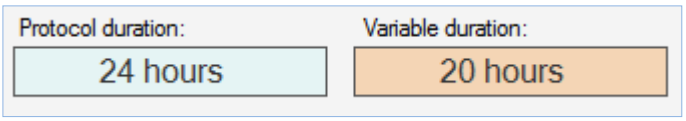


Figure 41 Protocol and Group duration

If the protocol contains only one V*ariable Group* (e. g. temperature), *Protocol duration* is always equal to the *Group duration*. If it contains more components, *Protocol duration* shows the longest of component durations and *Group duration* shows value for the currently edited *Variable Group*.

Clear *and* Clear all buttons are used for removing currently selected or all phases of the current protocol component. Single phases can be also removed using Remove button on the phase visualization box.

4.4.5 PROTOCOL EXAMPLES

Example #1 - Simple day-night cycle

The first example shows how to set simple day-night cycle, with a protocol controlling only white lights. The light intensity is 80% from 7:00 to 6:00 p.m. and darkness for the rest of the day (Figure 42).

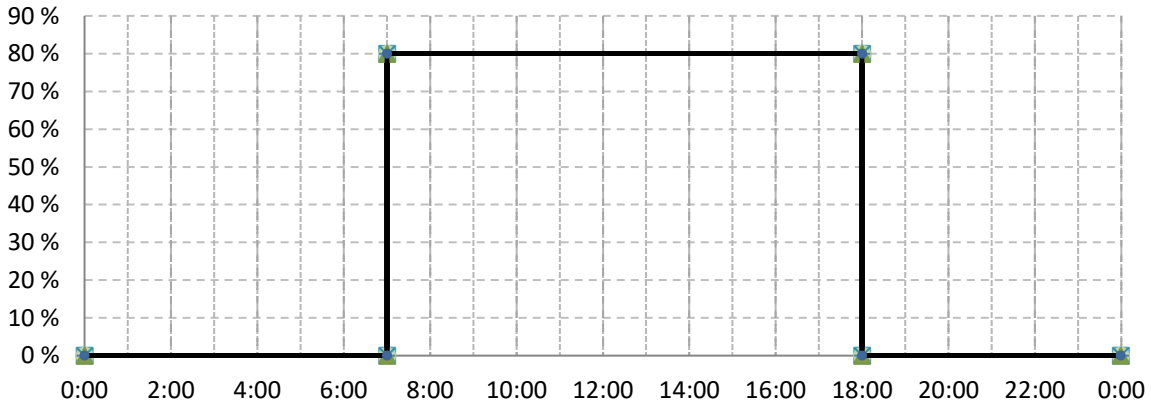


Figure 42 Simple Day-Night Protocol

Create a new protocol by pressing the *New Protocol* button. A dialog box for selecting the regulated variables appears. Select only the White Lights group, remove others if present, and click on OK. The White Light group tab is created. The easiest way how to create light curve on the picture is to use three constant phases. The first phase is set from midnight to 7:00. The duration is therefore 7 hours, light intensity 0 %. The second phase with an intensity of 80 % starts at 7:00 and ends at 18:00, the duration is thus 11 hours. The last phase duration is 6 hours and intensity 0 %.

Table 2 List of Phases for Example #1

	Phase type	Settings	Time	Duration
1.	Constant	0 %	0:00 - 07:00	7 h
2.	Constant	80 %	07:00 - 18:00	11 h
3.	Constant	0 %	18:00 - 00:00	6 h

Insert the first phase by clicking *Add Phase* button, and select the *Constant* type. New phase with default values is inserted into the *White Lights* tab. Set the Value and Duration fields to values listed in the Table 2 clicking corresponding blue fields. Add the second and third phase by clicking the Add button on the previous phase box, and fill in the values from Table 2.

Next, set *Logic start time* to midnight (0:00) and *Repeat* to infinity. Now the protocol is set. To run it, first upload it to the server by clicking the *Send to Server* button, and then start it using Start button from the *Experiment control tab.* The system starts the execution of the protocol in a time corresponding with the current real-world time.

TIP: If the protocol duration is 24 hours, the first and the last phase are the same type with the same values (except duration), one phase creation can be spared by using the *Logic Start feature.* The procedure is demonstrated using the Example #1 above. Protocol is not built from the scratch, just modified. First, remove either the first or last phase (the first in this example) by clicking the respective Remove button. The remaining phases of the protocol are automatically renumbered. Extend the originally third, now second phase Duration by the length corresponding to the deleted phase. In our case, the second phase has length of 13 hours (Figure 43).

Table 3 List of Phases for Modified Example #1

	Phase type	Settings	Time	Duration
1.	Constant	80 %	07:00 - 18:00	11 h
2.	Constant	0 %	18:00 -07:00	13 h

To finish the setup, modify the *Logic start time to 7:00. This causes the protocol to start at 7:00 real-world time with 11 hours of light, followed by 13 hours of darkness.*

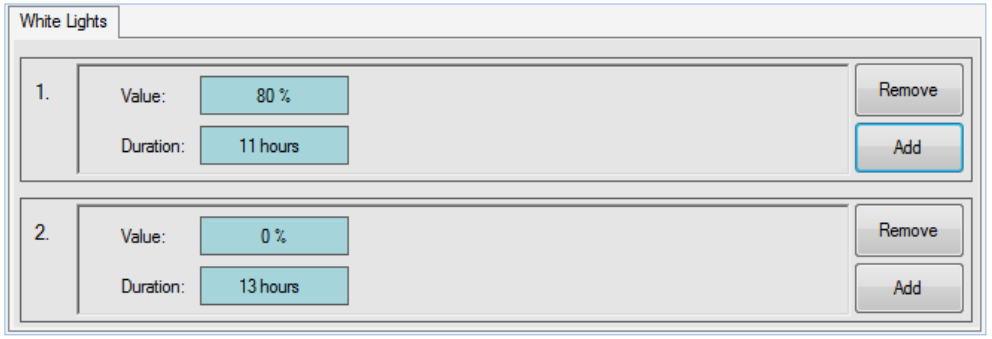


Figure 43 Phases for Modified Example #1

The output light curve is therefore identical to the curve from Example #1 programmed using 3 phases (Figure 44).

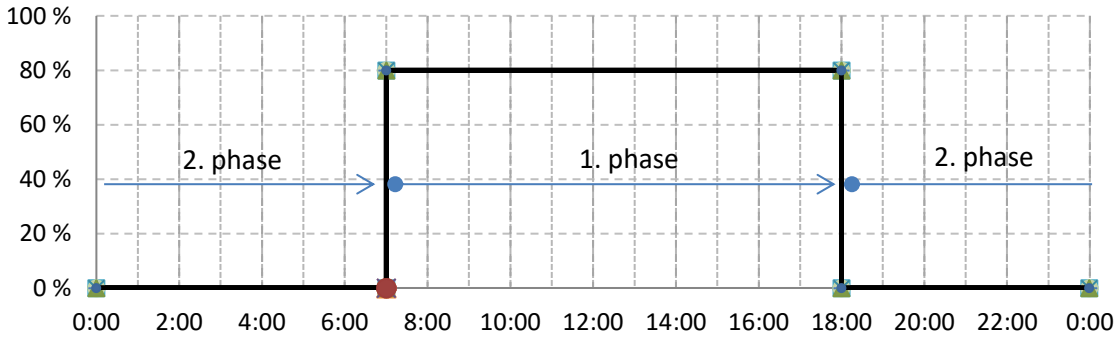


Figure 44 Phases for Modified Example #1 with the Logic start time marked in red

Example #2 - Temperature regulation with ramps

The second example shows how to program temperature day-night cycle with dusk/dawn-like temperature transitions (Figure 45).

Create the protocol the same way as for Example #1, but select the Temperature variable group this time.

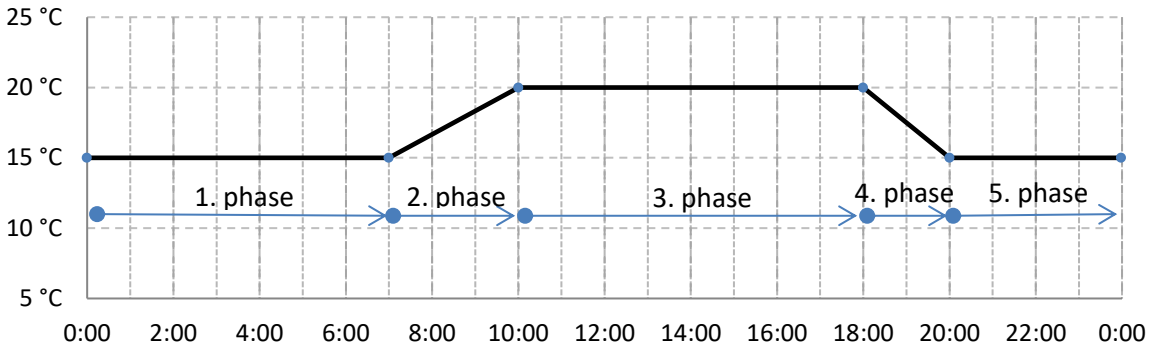


Figure 45 Phases for Example #2

The waveform can be divided into five phases - constant phase 15 °C, rising phase 15 to 20 °C, constant phase 20 °C, descending phase 20 to 15 °C and constant phase 15 °C. The first and the last phase have the same value, therefore the first phase can be omitted while extending the duration of the last phase. The *Logic start* time is set to 7:00.

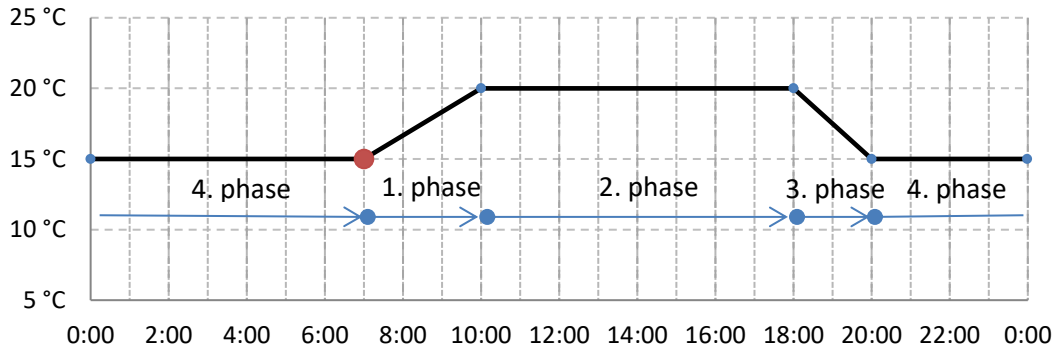


Figure 46 Phases for Modified Example #2 with the Logic start time marked in red

Table 4 List of Phases for Example #2

	Phase type	Settings	Time	Duration
1.	Ramp	15 - 20 °C	7:00 - 10:00	3 h
2.	Constant	20 °C	10:00 - 18:00	8 h
3.	Ramp	20 - 15 °C	18:00 - 20:00	2 h
4.	Constant	15 °C	20:00 - 07:00	11 h

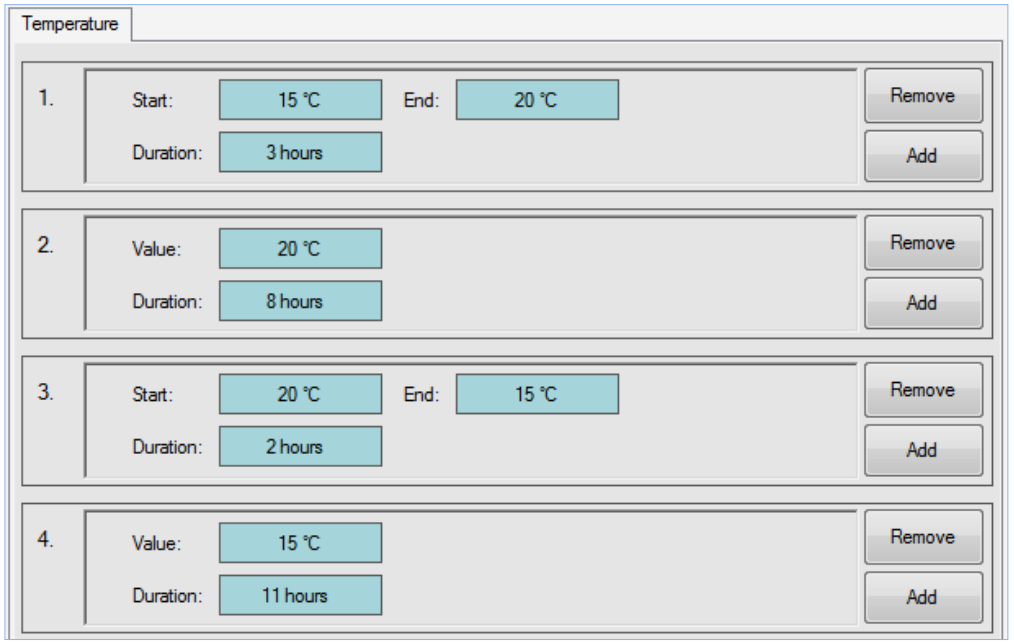


Figure 47 Graphical View of Phases for Example #2

Example #3 - Complex Waveforms

The system allows entering almost any combination of constant and ramp stages. Few more waveforms with a description of phases follow.

Waveform #1, Logic start time 6:00

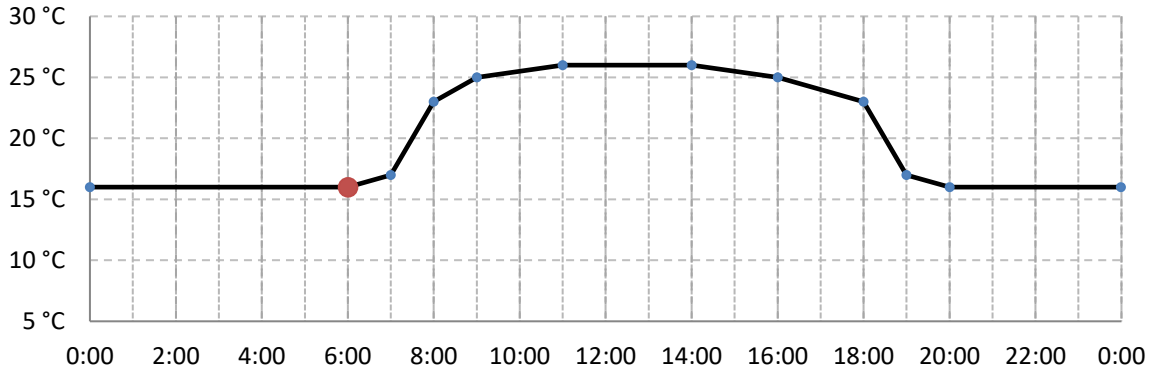


Figure 48 Complex Waveforms #1

Table 5 List of Phases for Waveform #1

	Phase type	Settings	Time	Duration
1.	Ramp	16 - 17 °C	06:00 - 07:00	1 h
2.	Ramp	17 - 23 °C	07:00 - 08:00	1 h
3.	Ramp	23 - 25 °C	08:00 - 09:00	1 h
4.	Ramp	25 - 26 °C	09:00 - 11:00	2 h
5.	Constant	26 °C	11:00 - 14:00	3 h
6.	Ramp	26 - 25 °C	14:00 - 16:00	2 h
7.	Ramp	25 - 23 °C	16:00 - 18:00	2 h
8.	Ramp	23 - 17 °C	18:00 - 19:00	1 h
9.	Ramp	17 - 16 °C	19:00 - 20:00	1 h
10.	Constant	16 °C	20:00 - 06:00	10 h

Waveform #2, Logic start time 6:00

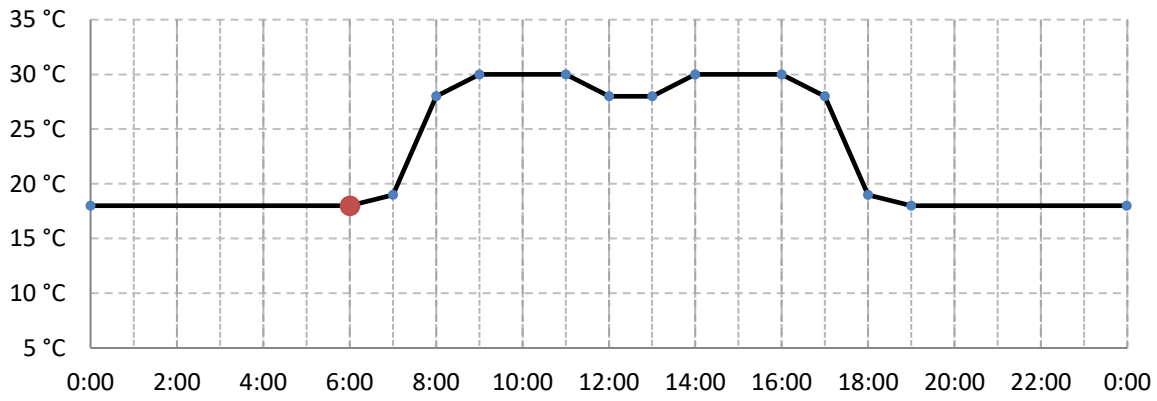


Figure 49 Complex Waveforms #2

Table 6 List of phases for waveform #2

	Phase type	Settings	Time	Duration
1.	Ramp	18 - 19 °C	06:00 - 07:00	1 h
2.	Ramp	19 - 28 °C	07:00 - 08:00	1 h
3.	Ramp	28 - 30 °C	08:00 - 09:00	1 h
4.	Constant	30 °C	09:00 - 11:00	2 h
5.	Ramp	30 - 28 °C	11:00 - 12:00	1 h
6.	Constant	28 °C	12:00 - 13:00	1 h
7.	Ramp	28 - 30 °C	13:00 - 14:00	1 h
8.	Constant	30 °C	14:00 - 16:00	2 h
9.	Ramp	30 - 28 °C	16:00 - 17:00	1 h
10.	Ramp	28 - 19 °C	17:00 - 18:00	1 h
11.	Ramp	19 - 18 °C	18:00 - 19:00	1 h
12.	Constant	18 °C	19:00 - 06:00	11 h

Waveform #3 is independent of time of day - *Logic start* time is not set. This type of protocol does not necessarily take 24 hours. Time on the X axis in this case does not represent the time of the day but the duration of the protocol.

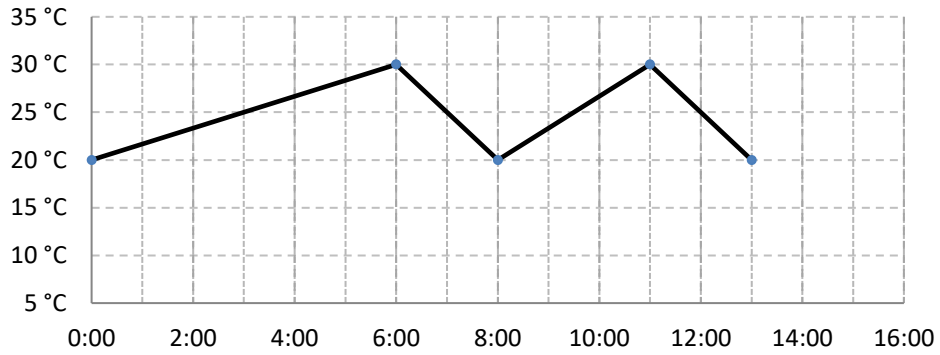


Figure 50 Example of the process without Logic start setup

Table 7 List of phases for waveform #3

	Phase type	Settings	Duration
1.	Ramp	20 - 30 °C	6 h
2.	Ramp	30 - 20 °C	2 h
3.	Ramp	20 - 30 °C	3 h
4.	Ramp	30 - 20 °C	2 h

4.5 DATA VIEWER

The Data Viewer tab (Figure 51) is used to display the recorded data in a graph. The graph shows one day at a time, day selection can be done by clicking in the box and selecting a date in the calendar view or by scrolling the days using two buttons on the sides of the window with the date. Displayed parameters are selected in the menu right of the graph. The chart can also be saved as an image, or the data can be exported in a .csv file format.

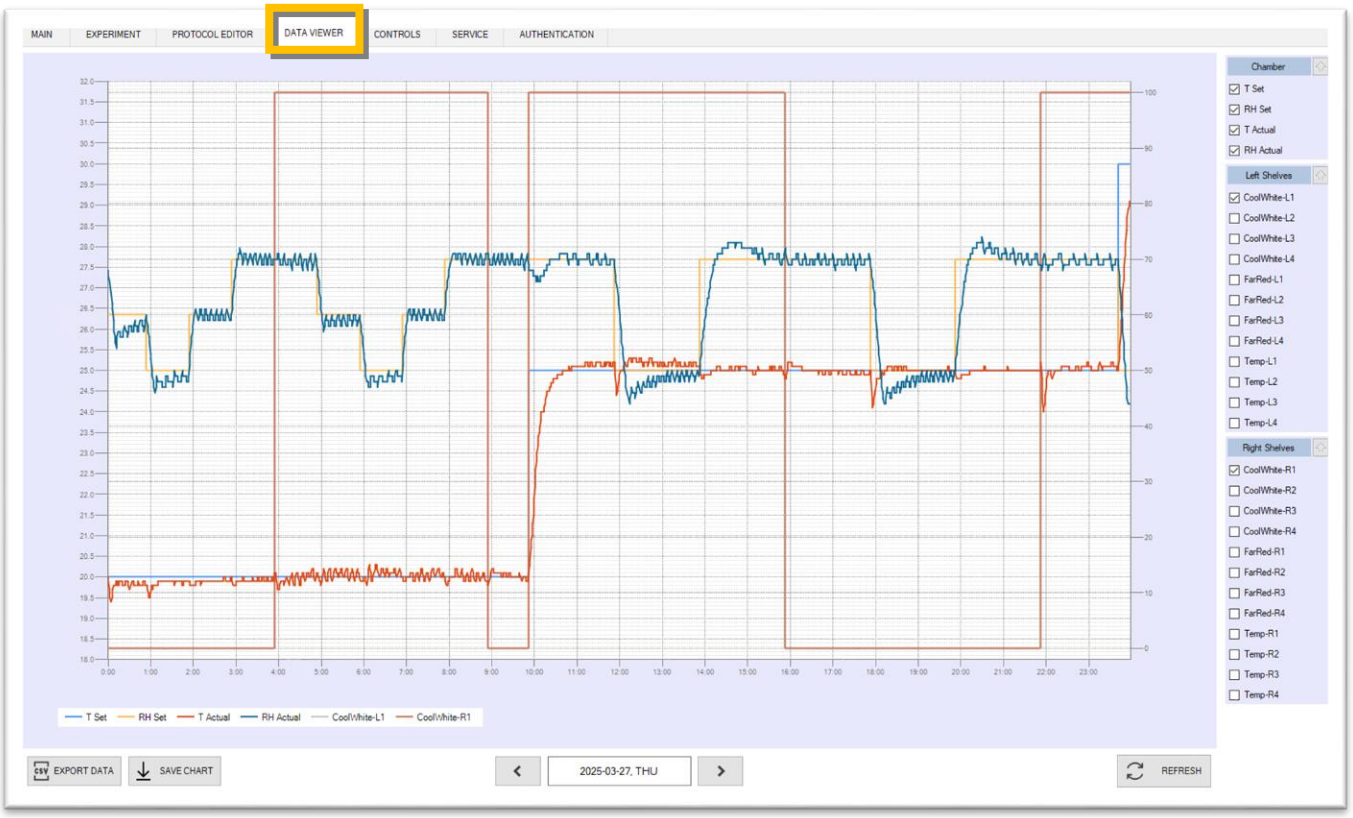


Figure 51 Data Viewer

4.6 CONTROLS

The *Controls* tab (Figure 52) contains various information or settings that are highly customizable for each customer. Information about the energy consumption, outside device temperature, coolant temperature. In this tab, it is also possible to control the offset of cooled shelves, if such a feature is included in the installation.

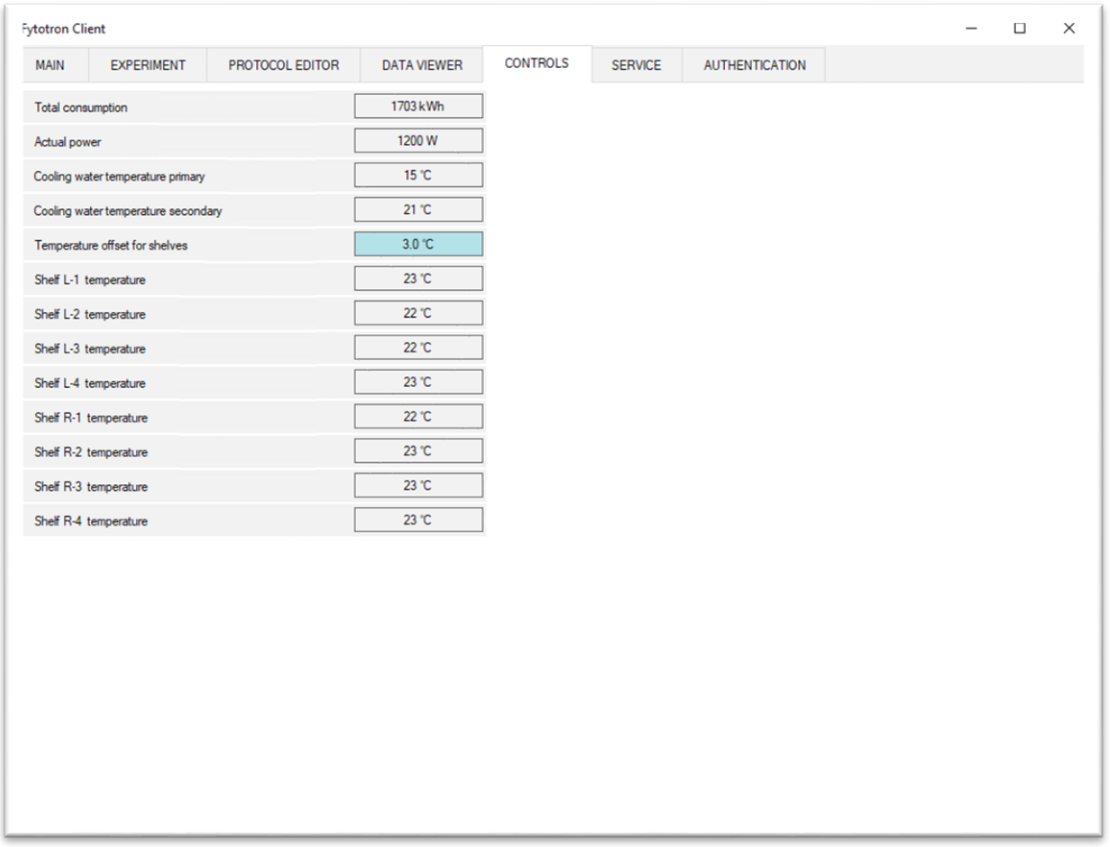


Figure 52 Controls Tab

4.6.1 REGULATION MODES IN REACH-IN CHAMBERS

The FytoScope Reach-In growth chambers allow users to switch between control modes on the Controls tab (Figure 53).

Normal indicates the standard mode, which is more energy-efficient but has less precise control, particularly regarding humidity.

Precise T+Rh mode is more energy-intensive but offers very precise control of both variables, although the controllable range for relative humidity is approximately 40 - 60%.

Users can switch between modes regardless of whether an experiment is running or not. The change is made immediately at the PLC level. Mode switching cannot be automated and must always be done manually.

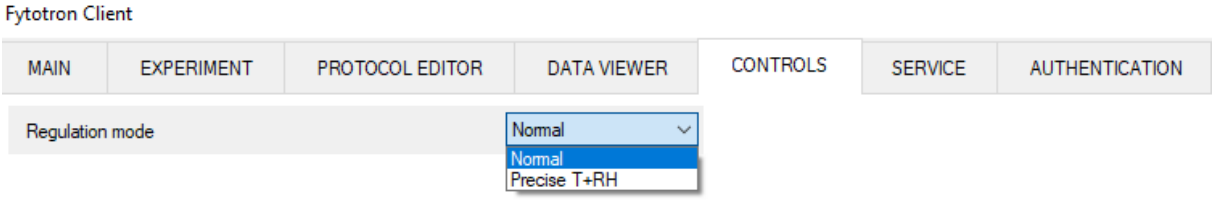


Figure 53 Regulation modes in RI chambers

4.7 SERVICE

The Service tab (Figure 54) displays basic status information about the server connection and controls for the application window. The *Minimize* button hides the application window to the taskbar, the *Maximize* button expands the application window to full screen. *Add* and *Remove Border* buttons display and hide the border around the application window. *Close Client* button closes the Client application.

	Closing the Client application does not influence the execution of the current protocol uploaded to the Server.

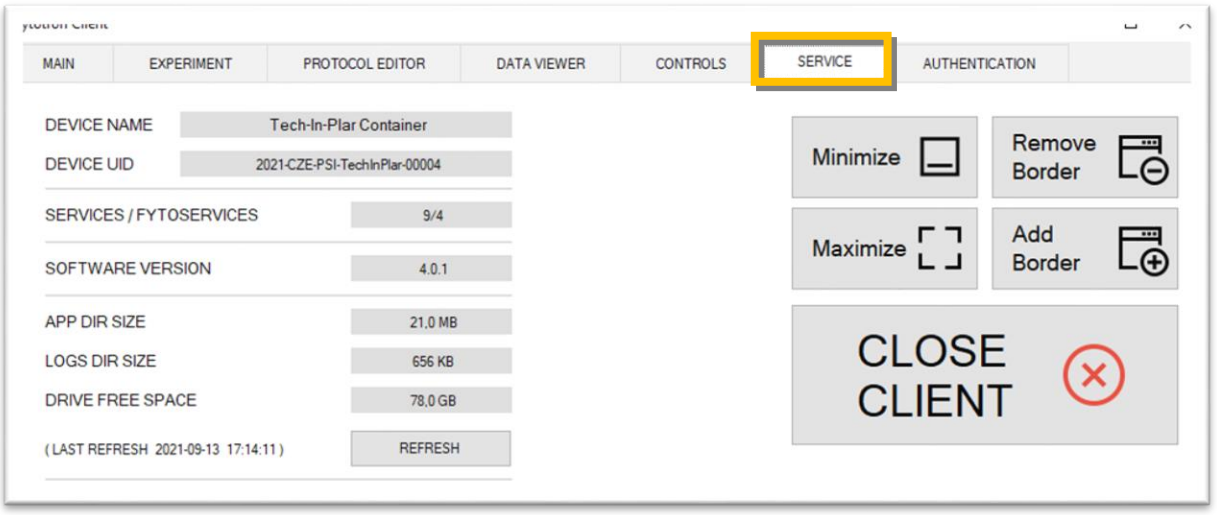


Figure 54 Service

4.8 AUTHENTICATION

The Authentication tab (Figure 55) serves as the gateway for user logon and logoff procedures. Users are prompted to input their username and password for authentication. When a user is successfully logged in, the button caption displays Logout and functions as a logoff command. Conversely, if no user is logged in, the button caption switches to Login and serves as the entry point for user logon.

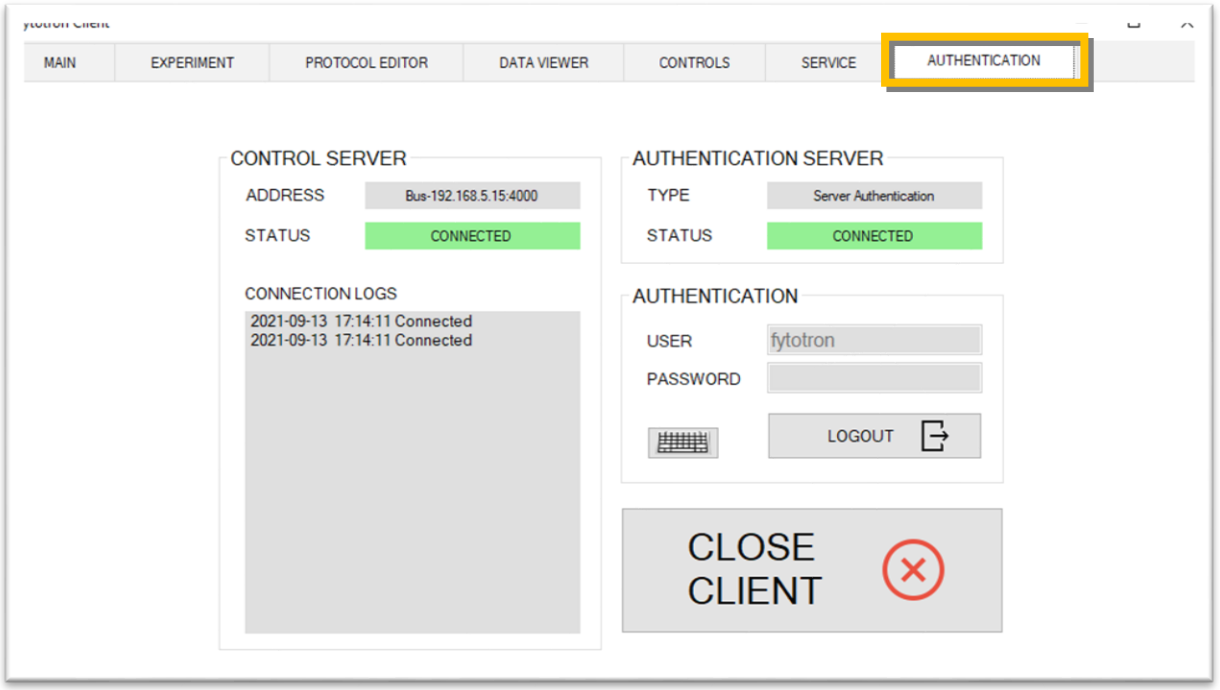


Figure 55 Authentication

5 LIST OF FIGURES

6 LIST OF TABLES