Multi-Cultivator MC 1000 and MC 1000-OD

Instruction Manual and User's Guide for cultivation

Please read this manual before operating this product

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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 WARNINGS AND SAFETY PRECAUTIONS

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY BEFORE TURNING THE MULTI-CULTIVATOR ON:

- Remove all packaging and transport protectors before connecting the Multi-Cultivator to the power supply.
- Use only cables supplied by the manufacturer.
- Keep the device dry outside and avoid working in high humidity environment!
- The manufacturer is not responsible for any damage due to improper operation!
- Water and other liquids should only be placed in vessels designed for the purpose and according to instructions included in this manual.

GENERAL ELECTRICAL SAFETY GUIDELINES:

- Perform a routine check of the devices and their wiring.
- Replace worn or damaged cords immediately.
- Use appropriate electrical extension cords/power bars and do not overload them.
- Place the device on a flat and firm surface. Keep away from wet floors and counters.
- Avoid touching the device, socket outlets or switches if your hands are wet.
- Do not perform any alterations to the electrical parts of the device or its components.

WARNING:

The Multi-Cultivator MC 1000 is considered Class 1M* LED Product. LED radiation may be harmful to eye. Avoid direct and strongly reflected exposure. Use protective glasses.

**Class 1M: Laser and LED equipment that is safe for the naked eye under foreseeable conditions of operation. Looking directly into the source of radiation by employing optics within the beam, such as magnifying glass, telescope or microscope, can be potentially hazardous.*

2 GENERAL DESCRIPTION

Multi-Cultivator MC 1000 is a cost-effective small scale cultivation device developed for cultivation of multiple samples of algae, bacteria or cyanobacteria. An extended version of the device, Multi-Cultivator MC 1000-OD is designed to also monitor growth of cultivated organism by measuring optical density at two wavelengths of 680 nm and 720 nm under controlled environmental conditions (optional). Optical density is periodically measured at selected time intervals and the data are automatically stored in the Multi-Cultivator internal memory for transfer to PC computer at a later time. In this manual user´s guide for MC 1000-OD is presented.

Multi-Cultivator MC 1000-OD consists of 8 cultivation vessels, where up to 85 ml of suspension can be maintained under controlled temperature, light and aeration conditions. The cultivation vessels are immersed in temperature controlled water bath. Each vessel is independently illuminated by an array of cool white LEDs that generate incident irradiance up to 950 µmol/m^2/s, which is independently adjustable for each cultivation vessel in intensity, timing and modulation. Each vessel can be bubbled with air or selected gas (optional) of different flow rate through a manually adjustable valve manifold. Multi-Cultivator MC 1000-OD is supplied with a light controlling unit that supports user-defined illumination protocols, such as, flashing light or diurnal regime.

The instrument function can by enhanced by two optional accessories: Cooling Unit AC-625, which is designed for cooling of the water bath, and the PWM Pump for automatic water bath refilling as water evaporates over time. In an extended instrument version, MC 1000-OD, the suspension growth of each cultivation vessel is monitored independently by measuring its optical density.

The multi-well set-up of MC 1000-OD with controlled and adjustable light, temperature and aeration conditions is primarily suitable for small scale, multi-sample experiments. Multi-Cultivator MC 1000-OD can be used in various biotests when different light treatments of the same or different organisms need to be assessed under reproducible conditions.

MC 1000-OD is low-cost highly precise multi-well cultivation instrument for synchronous growth of algae, bacteria or cyanobacteria with a wide range of applications (i.e. toxicological and ecotoxicological testing or algae growth dynamics research where different light conditions are required).

This manual contains technical information about MC 1000-OD, description of instrumentation delivered with the device and step by step instructions for successful cultivation of a widely used test alga *Chlorella vulgaris*. The short instructional video about the set-up of MC 1000-OD is provided for demonstration purposes as part of the MC 1000-OD Cultivation kit and illustrates how to set up the MC 1000-OD and initiate the culture under standard conditions.

3 DEVICE DESCRIPTION

Standard version of the MC 1000-OD package consists of the main body of MC 1000 containing control unit, air pump, place for humidifier bottle, temperature and water control unit, water pump, water bath, main gas dispenser tube, power supply, OD measuring sensor in the extended MC 1000-OD version (Fig. 2A) and MC 1000 Cultivation Kit (Fig. 2B).

Largest part of the MC 1000-OD is the cultivation vessel composed of the temperature controlled water bath with 8 slots for the cultivation vessels and the LED panel on the back. Cultivation water bath is a flat, rectangular plastic container with the maximal capacity of 5 liters. In the cultivation vessel water is circulated by a water pump and water distributing tubing. This provides suitable and homogenous cultivation environment for the cultivation vessels. Plastic dividers in cultivation water bath separate light environment of the individual vessels. Each cultivation vessel is 3 cm in diameter and 20 cm high. The maximum culture volume held by one vessel is 100 ml, however maximal recommended volume to be used is 85 ml (**Warning**: If test cultivation vessel is filled over 85 ml excessive fluid may overflow during bubbling).

The array of light emitting diodes (LEDs) is located behind the cultivation vessels. The control unit of the MC 1000 can be used to individually set day/night regime of light conditions of varied intensities for each cultivation vessel (**Note**: Please note that some light penetration (5 % when highly illuminated slot is next to dimly illuminated one) occurs between neighboring cultivation slots because the plastic dividers between the slots are not fully light proof. See User's guide chapter on page 24 for cultivation instruction and detailed description of the MC 1000-OD Cultivation Kit.

3.1 LED LIGHTING

Equally distributed light emitting diodes in the LED panel generate a highly uniform irradiance flux that can be controlled in the range of 0-950 µmol/m^2/s.

Standard LED panel version is available:

- Cool White Light: maximum intensity up to 900 µmol/m^2/s

Two optional LED panel versions are available, spectra are shown in Fig. 1

- Warm White Light: maximum intesity up to 750 µmol/m^2/s
- Red Light: maximum intensity up to 400 µmol/m^2/s

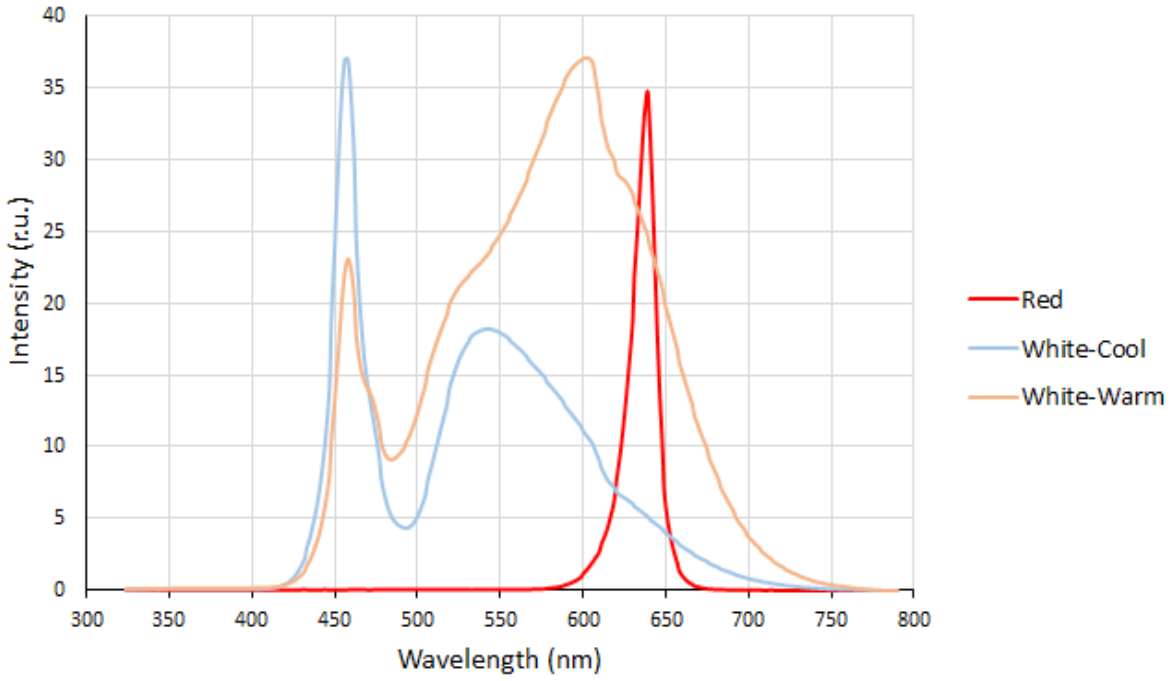


Fig. 1 LED spectra of Multi-Cultivator MC 1000

3.2 COMPONENTS OF MC 1000 AND MC 1000-OD

Standard MC 1000-OD components delivered to the customer and the view of the final MC 1000-OD set-up are shown in Fig. 2.

Note: Check the contents of the package and compare it with enclosed standard package list (see below).

3.2.1 LIST OF STANDARD MC 1000 OR MC 1000-OD COMPONENTS

1. Power supply with the power cord.
2. Main body of the MC 1000 consisting of:
    - Water bath
    - Water pump with voltage changer
    - Cooling and heating unit
    - Water level sensor
    - Temperature sensor
    - Air pump
    - Control unit
    - Main gas dispenser tube with manifolds

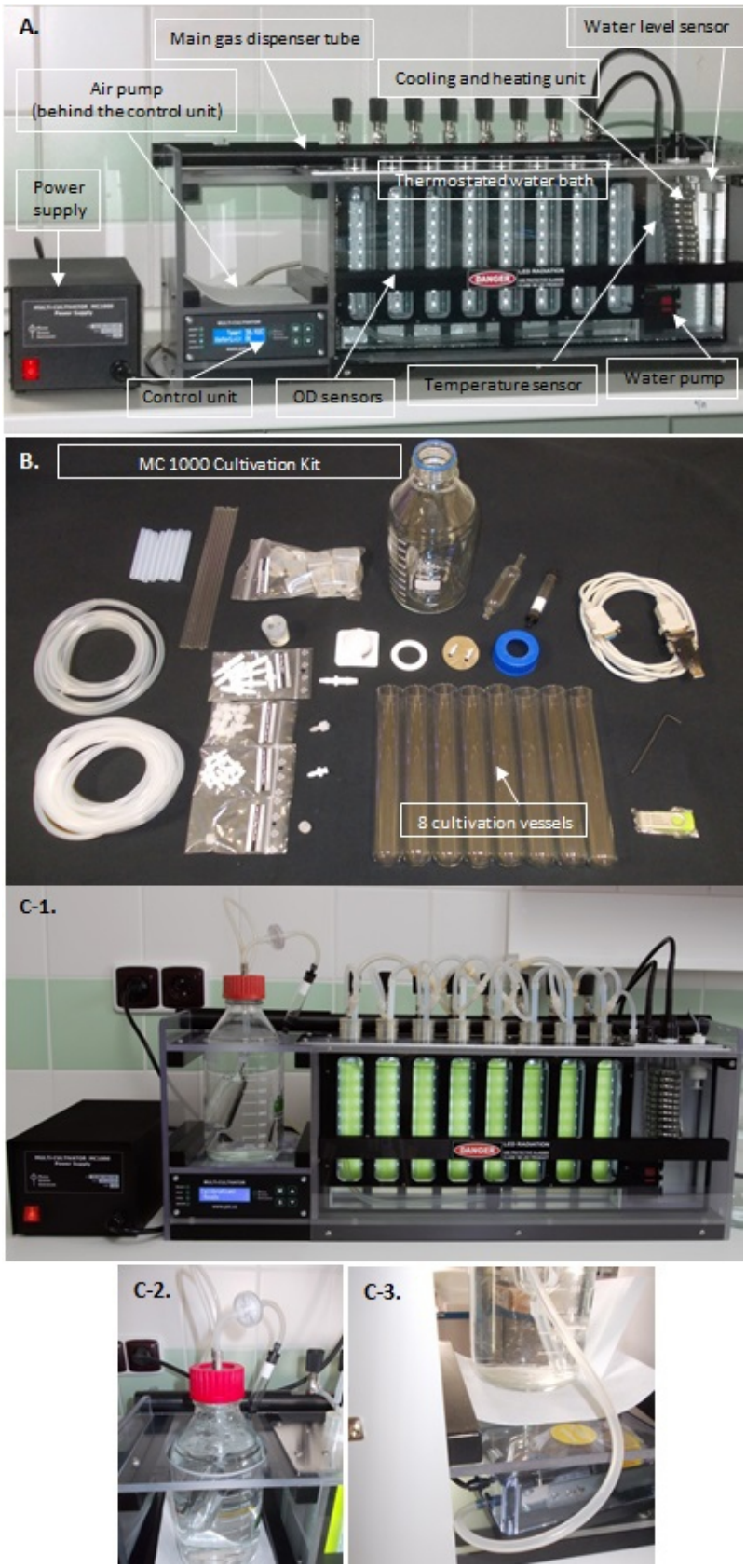


Fig. 2 Components of the MC 1000-OD device. A) Front view of the MC 1000-OD. B) Components of the MC 1000 Cultivation Kit. C-1) View of fully assembled and operating MC 1000-OD device. C-2) detail of humidifier bottle set-up is shown. C-3) Detail of air pump connection is shown.

3. Cultivation Kit for set up of 8 cultivation tubes (For the complete list of cultivation kit components see Table 1. on page 24) and protective glasses.
4. Optical density sensors for each cultivation vessel (MC 1000-OD only).
5. Gas Connection Module for establishing the connection between the Multi-Cultivator and an external Gas Mixing System such as GMS 150 or an air pump. This module is required if the gas supply to the MC 1000 is not via the air pump which is provide with the Multi-Cultivator.
6. USB Flash Disc with ODView Software for downloading stored OD and temperature measurements (MC 1000-OD only) and with ControlDeviceCenter Software for light calibration or firmware upgrade.
7. Serial cable with USB adapter for data transfer or firmware upgrade (MC 1000-OD only).
8. DVD with demonstration video User´s Guide for Cultivation of Algae and Cyanobacteria in MC 1000-OD.
9. Instruction Manual and User's Guide for cultivation.

3.2.2 OPTIONAL ACCESORIES/COMPONENTS

1. Cooling Unit AC-625 including plastic tubes, power cord and control cable for cooling the water bath below ambient temperature (down to 15 °C).

   Note: MC 1000-OD device itself does not have temperature regulator built-in that would allow regulate the temperature in water-bath below the ambient temperature. If high light intensities are used, please be aware that the water bath temperature will increase even above the ambient room temperature.

   MC 1000-OD built-in temperature regulator allows only to warm up the temperature inside the water bath.
2. PWM Pump including plastic tubes and plastic connectors for automatic control of water level in the water bath.
3. Gas Mixing System GMS 150 or an air pump including parker tubing and connectors for control gas concentrations in the MC 1000.
4. Spare Part Kit.
5. Set of 10 Three-Ways Sampling Valves for sterile culture sampling during cultivation.

3.3 DESCRIPTION OF THE MULTI-CULTIVATOR CONTROL UNIT FRONT PANEL

The device is controlled via front panel of the control unit with 4 LED lights on the left and 4 control keys on the right (Fig. 3).

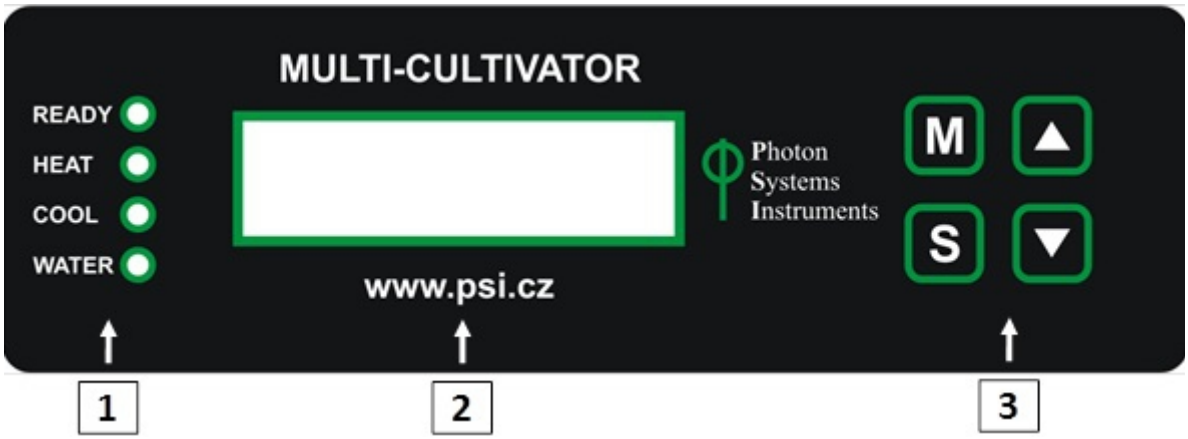


Fig. 3 Multi-Cultivator front panel. 1) Four LED indicators. 2) Two line display. 3) Four control keys.

3.3.1 1. LED INDICATORS

Green LED indicator **READY** is lighting when the current temperature is equal to target temperature.

Orange LED indicator **HEAT** is lighting when the heater turns on in the cultivation vessel.

Blue LED indicator **COOL** is lighting when the cooling spiral is cooling water in the cultivation vessel when the AC-625 Cooling Unit is operating. **Note:** Without Cooling Unit AC-625 the minimal temperature in the MC 1000 will correspond to surrounding room temperature.

Red LED indicator **WATER** is lighting when the water level in the cultivation vessel drops under required level.

3.3.2 2. MAIN DISPLAY

The functions as shown in the main display are controlled via the main keys as described below.

3.3.3 3. MAIN KEYS

[M]: Used to move back in the menu tree or to exit the menu.

[S]: Used to move forward in the menu tree, to save the selection, or to turn ON/OFF.

[↑]: Used to move up in the menu or to add value.

[↓]: Used to move down in the menu or to subtract value.

See page 37 of this Manual for more information on Multi-Cultivator control.

3.4 DESCRIPTION OF THE MULTI-CULTIVATOR REAR PANEL

The rear panel houses connectors for all connecting cables (Fig. 4).

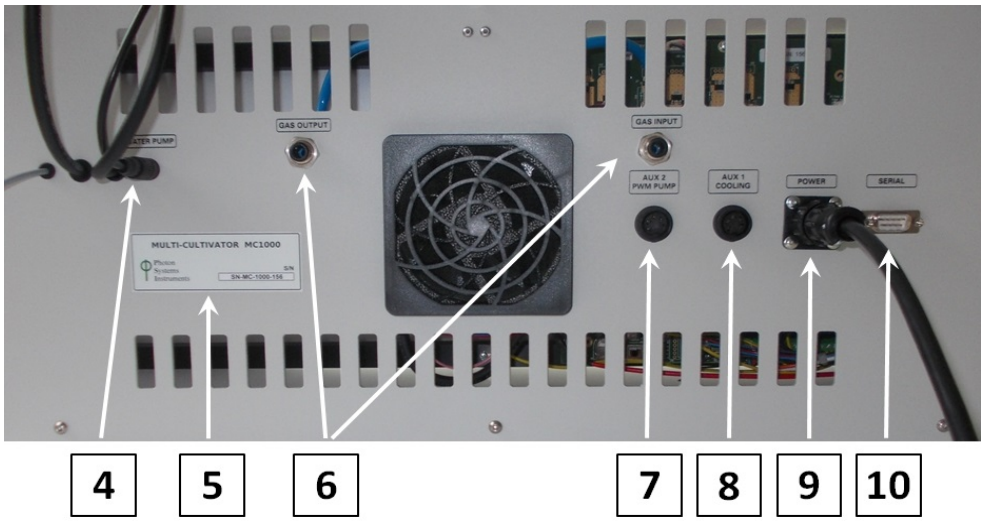


Fig. 4 Multi-Cultivator rear panel. 4) Water pump connector with water pump cable. 5) Multi-Cultivator MC 1000 label with serial number. 6) Gas Output and Gas Input for the Gas Mixing System. 7) AUX2 connector for PWM Pump. 8) AUX1 connector for AC-625 Cooling unit. 9) Power supply connector. 10) Firmware communication connector.

3.4.1 4. CONNECTION FOR THE WATER PUMP

Power cable for water pump should be plugged into the water pump connector (Fig. 4-4) prior to switching MC 1000 device ON.

3.4.2 5. IDENTIFICATION LABEL WITH SERIAL NUMBER

Each Multi-Cultivator MC 1000 produced has a serial number label that corresponds with the serial number of the power supply unit provided together with the MC 1000 main body. Prior to switching MC 1000 device ON make sure that the serial number of the Multi-Cultivator is the same as the serial number on the power supply (Fig. 5).

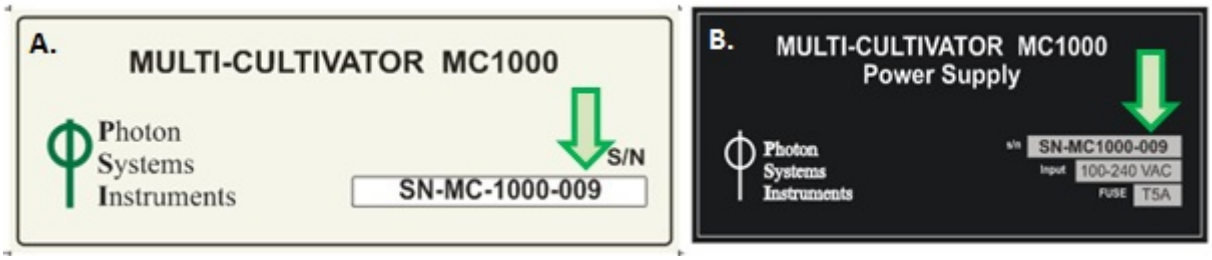


Fig. 5 A) Label from the MC 1000. B) Label from the Power Supply of the MC 1000. Note the same serial number.

Warning: Damage can occur when the power supply is incompatible with the MC 1000 device.

3.4.3 6. GAS OUTPUT AND GAS INPUT FOR THE GAS MIXING SYSTEM

Please note that the Gas Mixing System (GMS 150) is not included with the standard MC 1000 device. See page 21 for detail instructions for use of the Gas Mixing System.

3.4.4 7. AUX2 CONNECTOR FOR THE PWM PUMP CABLE

Please note that the PWM Pump is not part of standard MC 1000 device. See page 19 for detail instructions for use of the PWM Pump.

3.4.5 8. AUX1 CONNECTOR FOR THE AC-625 COOLING UNIT

Please note that the Cooling Unit AC-625 is not included with the standard MC 1000 device. See page 16 for detail instructions for use of the device.

3.4.6 9. POWER SUPPLY CONNECTOR

3.4.7 10. SERIAL COMMUNICATION CONNECTOR

USB connector with serial communication cable is provided as part of the MC 1000-OD package for connecting the MC 1000-OD with the computer via serial communication connector. This connection has to be made for OD and temperature data download to a PC or for any firmware updates.

4 INSTALLATION

4.1 DEVICE INSTALLATION

To install the device properly, it is necessary to follow the proper sequence of the assembly instructions as described below:

- Multi-Cultivator should be placed on a flat, firm and dry surface.
- Make sure that the power supply is switched OFF.
- Using the provided power cord connect the MC 1000 with the power supply. Plug the power cord of the power supply (the thickest cable) into the round connector on the rear side of the Multi-Cultivator labeled POWER (Fig. 6A).

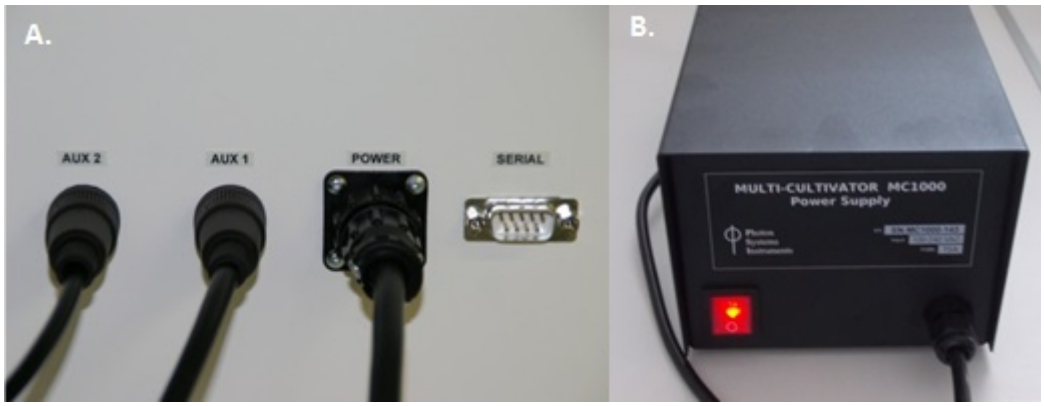


Fig. 6 Rear side of the MC 1000 with the POWER connecter where power supply cord is plugged. B) Power supply device.

- Connect the power supply (Fig. 6B) to a 110/230 V outlet.
- Plug the voltage changer of the water pump (Fig. 4-4A) into the water pump connecter (Fig. 4-4B) in the rear side of the MC 1000.
- Switch ON the power supply.
- **Optional:** Place the power cord from Cooling Unit AC-625 and the PWM pump into an electrical outlet. **Important:** Let AC-625 unit stand in upright position for **at least 12 hours before plugging it into power supply!** See below page 16 for detail instructions.
- To set up the MC 1000 for the cultivation of algae and cyanobacteria follow the instructions provided in next chapter on page 24.

4.2 LIGHT CALIBRATION

Lights of each manufactured MC 1000 device are factory calibrated. Lights are calibrated for different light intensities equivalent to 1, 2, 3, 5, 10, 15, 20, 25, 50, 70, 90 and 100 % output of the LED lights. The results of the light calibration with the calibration coefficients are included in a calibration list and provided to the customer together with the

purchased device unit.

In case the customer requires re-calibration or the firmware version was changed (please note that in this case light calibration values are lost) the following steps should be followed:

- Fill the water bath with distilled water to the top.
- Place cultivation vessel filled with distilled water in slot 1 (first slot form the left side of the MC 1000 = Light 1).
- Turn on the Multi-Cultivator and connect it to the computer via serial cable. Open ControlDeviceCenter from delivered USB flash disc and find the device via button “Detect”.
- Place the light measuring sensor inside the cultivation vessel at a fixed depth in the center of the vessel. **Please note, we use spherical light sensor for the calibration.**
- Write a desired light output (for example “100 %”) down in the first window in Calibration >> Displayed Light >> Light 1 >> New Calibration.
- Activate the Light 1 with click to the second window. Write a relevant acquired light intensity down in the second window (without using the units).
- Use button “Add” to continue with next light intensity of Light 1.
- After finishing of Light 1 calibration use button “Save to Device” to save the calibration coefficients and curve for Light 1. Please note, after calibration saving only calibration coefficients and calibration curve without raw calibration data will be displayed in sheet “Calibration”.
- Follow the same protocol to calibrate all the other lights ensuring that the light measuring sensor is placed at the same height and in the center of every cultivation vessel.
- **Note:** For optimal calibration performance, proceed with the calibration in dark room where no external light sources can influence the measurement.
- **Note**: Please note that when all lights are operating, light intensity measured in individual slots will be higher due to the penetration of some light from the neighboring slots.

Calibration coefficients (either provided by manufacturer or calculated by customer) can be changed and replaced (sheet “Calibration”). It is recommended to save the customized calibration coefficients for different calibration curves in separate file because once the coefficients are overwritten and saved in ControlDeviceCenter they aren’t accessible anymore.

5 ACCESSORIES/OPTIONAL COMPONENTS

The function of the Multi-Cultivator MC 1000 may be enhanced by adding three optional accessories – Cooling Unit AC-625 (Fig. 7A), PWM Pump (Fig. 7B) and Gas Mixing System (Fig. 7C).

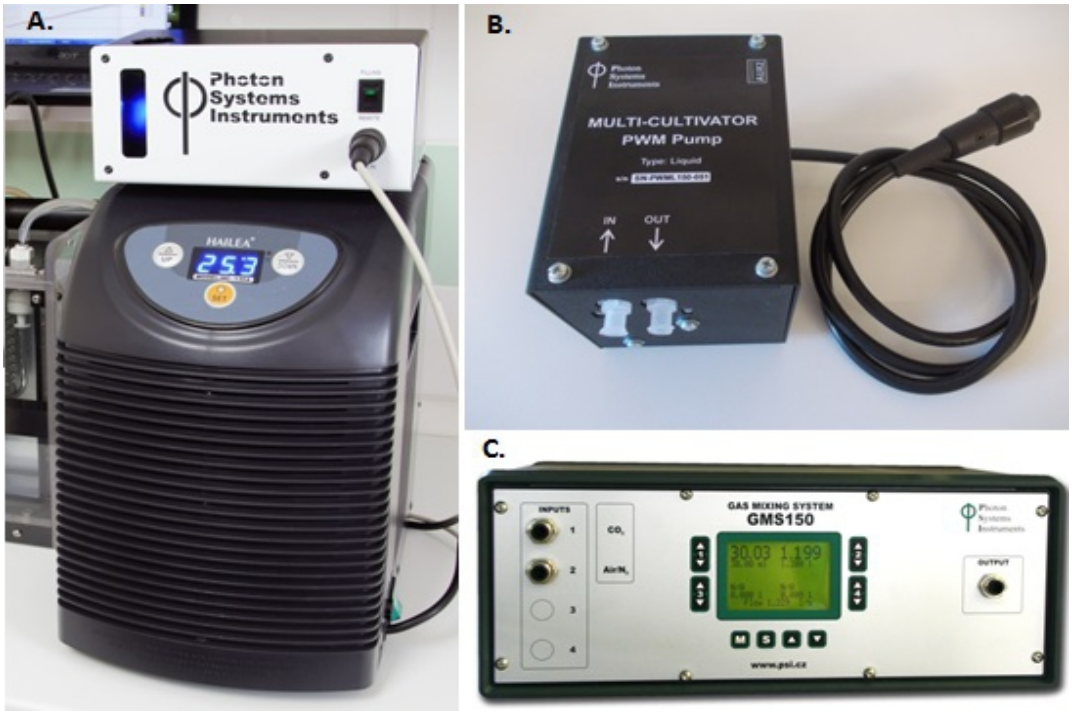


Fig. 7 A) Cooling Unit AC-625. B) PWM Pump. C) Gas Mixing System.

5.1 COOLING UNIT AC-625

Additional Cooling Unit AC-625 is designed to regulate temperature of water in the water bath down to 15 °C with resolution of ± 1 °C. This device is valuable primarily when high light intensities are required for cultivations in room temperature conditions as some heating of the water bath will occur from the high output of the LED lights.

Cooling Unit AC-625 enables reduction of temperature in the water bath as compared to the ambient air temperature. At laboratory temperature of 22 °C, the temperature of water in the water bath can be lowered down to 15 °C.

5.1.1 COOLING UNIT AC-625 EQUIPMENT

Cooling Unit AC-625 package consists of:

- AC-625 water pump (Fig. 8A)
- Hailea HC-130A water chiller
- One piece of power cable
- One piece of AUX cable
- One piece of elastic silicon tube 8/6 mm – 5 m length
- One piece of 110V/220 V AC converter (optional)

5.1.2 INSTALLATION

Please refer to following steps for the device installation:

1. Place the Cooling Unit AC-625 on a flat, firm and dry surface! Let it stand in upright position for at least **12 hours before plugging it into power supply!**

2. To connect the water pump with water chiller place two circular rubber seals (Fig. 8A right side) around the outlets on the top of the Hailea water chiller first (Fig. 8B). After that put the water pump on the top of the water chiller (Fig. 8C) and place the other two seals around the outlets of Hailea water chiller (Fig. 8D). Finally, fix the water pump to the water chiller with screws (Fig. 8D-F).

3. Plug the AC-625 water pump connector into the **AUX1** output on the rear panel of the MC 1000 (Fig. 8G-H). This connection maintains the powering of the pump and controls its function in remote mode (MC 1000 controls the circulation of the water in water cooling circuit).

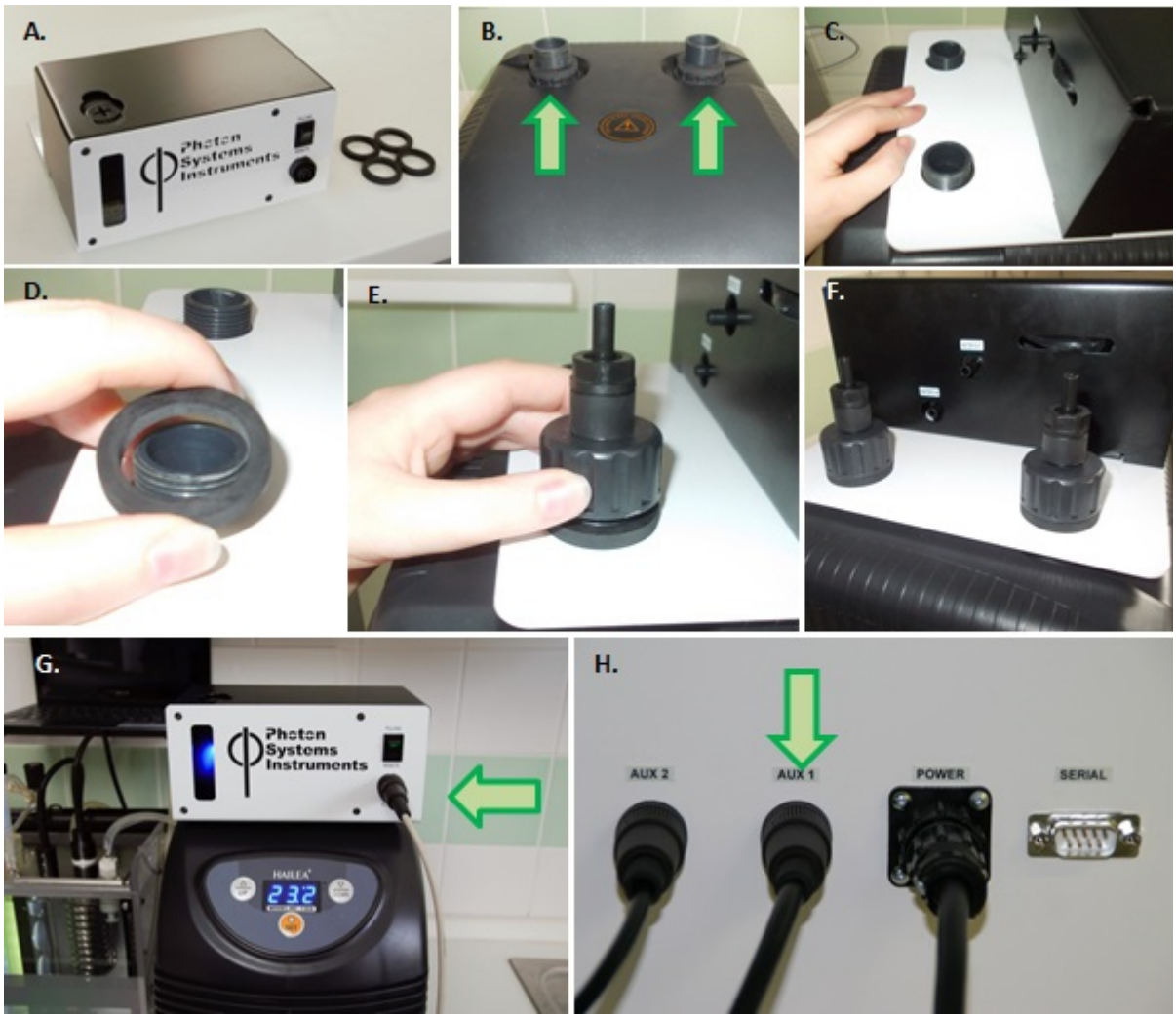


Fig. 8 A) Water pump AC-625, B) Water outlets on the top of the Hailea water chiller, C-F) Connection of the water pump to the water chiller, G-H) Connection of the cooling unit to the Multi-Cultivator through the AUX cable.

4. Connect the water circulation hose to the AC-625 water pump, water chiller and MC 1000 cooling spiral (Fig. 9A). First connect the short 20 cm silicon hose to the **WATER OUT** (Fig. 9A-1) port on the rear side of the

water pump. Connect the second end of the 20 cm tubing to the left top input of the water chiller (Fig. 9A-2).

5. Second connect the short 50 cm silicon hose to the **WATER IN** (Fig. 9A-3) port on the rear side of the water pump. Connect the second end of the 50 cm tubing to the right top input of the cooling spiral (Fig. 9A-4).

6. Use the long 1 m silicon hose to connect left output of the MC 1000 cooling spiral (Fig. 9A-5) with the HC-130A water chiller (Fig. 9A-6).

7. Put the Hailea HC-130A water chiller in 220 V AC plug.

   WARNING: ONLY 210-240 V AC might be used. In the case of 110 V AC power line use the 110/230 V AC converter.

8. Switch ON the HC-130A water chiller by the main switch on the right side of the instrument. Front display shows the actual temperature in the small water reservoir positioned inside of the HC-130A. Read the attached HC-130A manual for more information.

9. Unscrew the top cover of the AC-625 water pump. This way you access the filling tank of the water circuit (Fig. 9D).

10. Switch **ON** the MC 1000 device. Set AC-625 water pump switch in the position **FILLING** (Fig. 9B). Blue LED in the left side of the AC-625 water pump indicates that the circulating pump is operating.

11. Pour carefully approximately 1.5 liter of deionized water in the water pump reservoir (Fig. 9C). Let the water be pumped into the cooling system. Fill the water into the system the water returns from the **WATER INPUT** port.

12. Let the bubbles leave out by short switching **ON** and **OFF** switch of the pump (**ON** in **FILLING** position, **OFF** in the **REMOTE** position) and add the water into the filling tank. It must stay filled up to the **WATER INPUT** port.

13. Screw back the top cover of the AC-625 water pump (Fig. 9D).

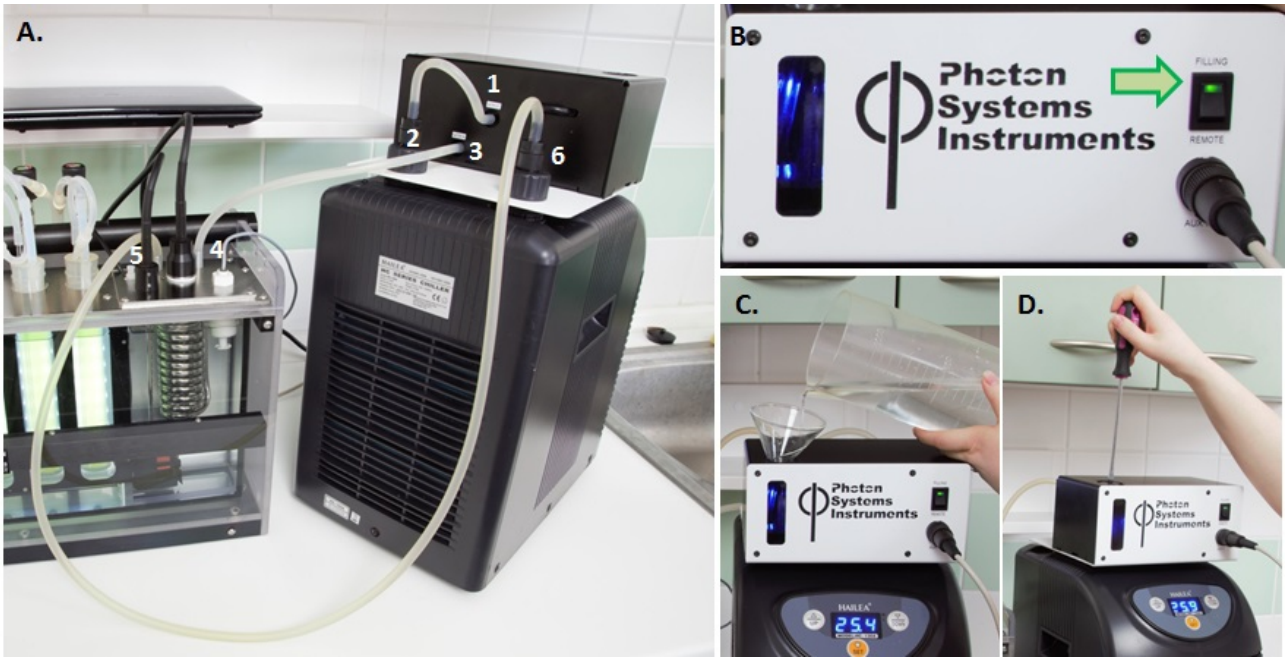


Fig. 9 A) Connection of the HC-130A water chiller with water pump and the MC 1000. B) Detail of the front side of water pump. C) Filling of the water pump with the deionized water. D) Unscrew/screw back the top cover of the AC-625 water pump.

14. Change the position of the AC-625 water pump switch to the **REMOTE** position.

15. Set the required temperature of the water in the water chiller always to 5 °C. It is easily done by long push of the **SET** button on the front panel. Afterwards (set value is blinking) change the temperature to 5 °C and confirm by the short **SET** push.

16. MC 1000 is now set to control automatically the temperature in the water bath by circulating the water from the water chiller. Regulation is provided by the MC 1000. AC-625 water pump switch **MUST** be in the **REMOTE** position.

17. Set the required temperature for cultivation in the control unit of the Multi-Cultivator and switch the temperature control ON. **Sensors>TControl>ON** (Fig. 10).

18. For the proper function of the AC-625 cooling device with the MC 1000-OD it is **IMPORTANT** to regularly check the water level in the cooling circuit. Water should be re-filled as described in Fig. 9C,D when the water level in water pump reservoir drops to 50 %. It is recommended not to let the water amount drop below this level as the cooling unit will not operate properly and the required temperature in MC 1000-OD may not be stable and increase.

19. **Note:** It is recommended not to leave the tank without the water. However the **pump operation without the water will not damage the AC-625 Unit.** The water pump is prevented of overheating as it is automatically switched off in the case when pump temperature rises up too high.

20. When Cooling Unit device is operating and the water bath is cooled down blue LED light indicator **COOL** in the Multi-Cultivator control panel is lit (Fig. 10).

Fig. 10 Display of the MC 1000 control unit when Cooling Unit AC-625 is operating.

5.2 PWM PUMP INSTALLATION

PWM Pump automatically refills water in the cultivation vessel when water level drops below the required level as detected by the water level sensor.

This device is recommended primarily when high cultivation temperature is required in the cultivation vessel and faster water evaporation from the water bath occurs.

5.2.1 PWM PUMP COMPONENTS

As shown in Fig. 11A:

- PWM Pump with remote control cable

- Silicon tubing with Luer Lock Fittings

Note: Check the contents of the package and compare it with the described package content (see above). Component specifications can be found in Table 1 on page 24.

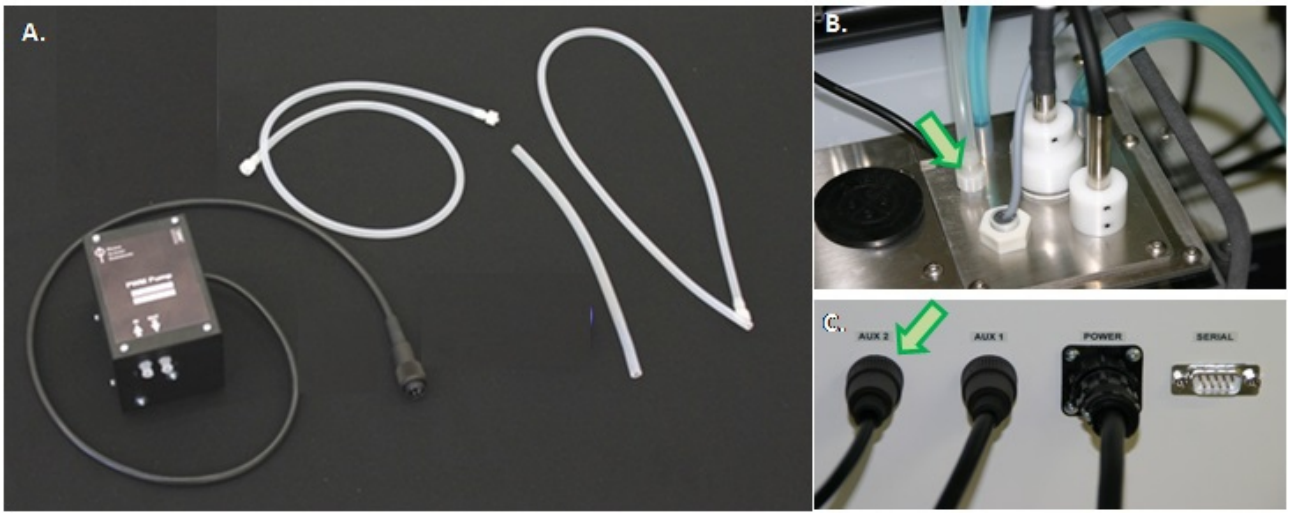


Fig. 11 PWM Pump set up. A) PWM pump components. B) Connection of the "OUT" outlet of the pump with the inlet placed in the lid of water level checking system. C) PWM pump cable is connected to AUX2 plug on the back panel of MC 1000.

5.2.2 INSTALLATION

Please follow these steps for the device installation:

1. Use any glass or plastic bottle and fill it up to 1 liter with distilled water (f.e. water re-filling (humidifier) bottle as shown on page 25 could be used; please note that additional water re-filling bottle needs to be ordered separately and is not part of PWM Pump set).

2. Two longer pieces of silicon tubing of 35-40 cm are provided. One of them is placed into bottle filled with water or connected to the port on the metal lid in case humidifier bottle is used as described on page 25. End of this tubing is connected with the MTLL Luer Lock Fitting. This silicon tubing coming from the water refilling bottle is connected via the MTLL Luer Lock with the "IN" outlet of the PWM Pump.

3. Second silicon tubing has MTLL Luer Lock Fitting on both ends. Connect one of the two MTLL Luer Lock Fittings to the "OUT" outlet of the PWM pump. The second end with the FTLL Luer Lock Fitting is attached to inlet placed in the lid of water level checking system as shown in Fig. 11B.

4. Insert the PWM Pump cable into the plug labeled AUX2 on the back panel of the Multi-Cultivator as shown in Fig. 11C.

5. Switch the PWM pump ON via setting in the control unit of the MC 1000: **Settings>PWM Pump>ON**.

IMPORTANT NOTICE: Make sure that there is always water in the water refilling bottle and the end of the silicon tubing inside the bottle is always submerged in the water.

5.3 GAS MIXING SYSTEM

MC 1000 version with connectors for the Gas mixing system is a module establishing the connection between the Multi-Cultivator and the Gas Mixing System GMS 150 or an air pump. The system includes the valve and the connectors and can be used when controlled gas concentrations such as CO_2 are required for the inoculum cultivation in the MC 1000 (Fig. 12).

Before establishing connection between MC and the gas mixing unit, please read the Gas Mixing unit manual. To connect the Gas Mixing Unit with MC please follow next steps:

- Use parker tubing to connect gas mixing unit with the gas inlet connectors of the MC unit and gas outlet connectors with the humidifier bottle. As shown in Fig. 12 Gas Mixing Unit outlet tubing (in yellow) is connected with the MC gas inlet connector.
- Gas outlet tubing from the MC (in blue) is directly connected with the humidifier bottle. It is recommended to connect Parker tubing with silicon tubing (optionally via Luer Lock fittings) which is then connected to the humidifier bottle as shown in detail Fig. 20F.

Gas Mixing Unit is controlled locally from its front panel. The user can define the required gas mixture either by setting the flows of the individual gasses (e.g., 980 ml/min of N_2 and 20 ml/min of CO_2) or by setting the required relative composition of the gas mixture (2% CO_2) and the mixture gas flow (1000 ml/min). The side installation requirements for the proper operation of the GMS are pressurized air supply and CO_2 supply. Pressurized air used for the GMS must be dry and oil free. The inlet pressure should be in range of 3 - 5 Bars.

Note: MC 1000 version with connectors for the Gas Mixing System contains additional valve inside of the MC 1000 that is operating gas flow from the external gas mixing system. The control of the gas flow is done solely by the gas mixing device. No specific operation and set up is required to be done in the MC 1000 control unit.

It is recommended to keep the MC 1000-OD air pump in the running mode (**Settings>Air pump>ON**) even if the gas mixing system is connected to the MC 1000-OD. This allows stopping precisely the air flow during OD measurements.

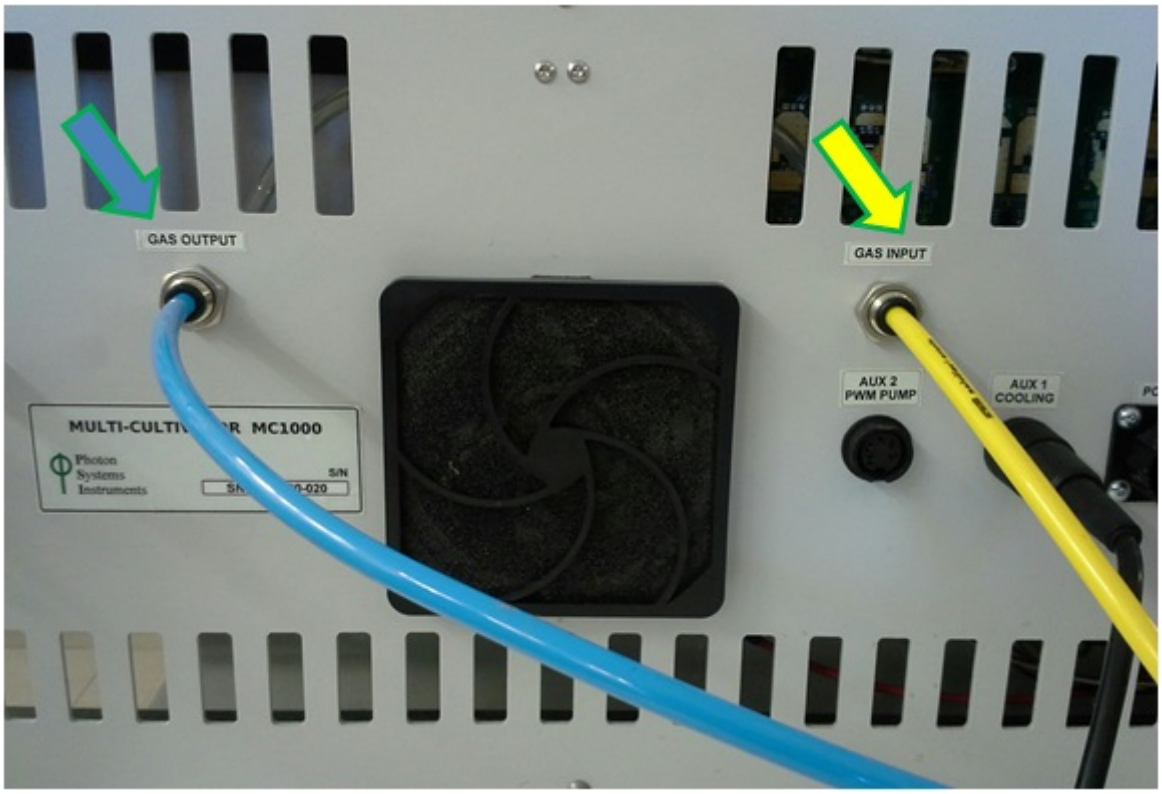


Fig. 12 Rear panel of MC 1000 version with gas/air mixing module. Note the gas inlet from Gas Mixing Unit in yellow and gas outlet connector bringing the desired air composition to the humidifier bottle.

5.4 THREE-WAYS SAMPLING VALVE

The valve serves for sterile culture sampling during cultivation (Fig. 13).

5.4.1 DESCRIPTION

- sterile,
- without influence on the flow rate,
- thread for quick and secure connection,
- resists pressure up to 4.5 bar,
- tightness connection with long-term application,
- transparent material.

Fig. 13 Three-ways sampling valve

5.4.2 INSTALLATION

Sampling valve is inserted between the two Luer Locks of the aeration tubing and is used for sterile culture sampling during the cultivation (Fig. 14).

- Connect the sampling valve between female luer lock (number 3 in Table 1) and male luer lock (4) as shown in Fig. 14A.
- Sterile syringe is used for sampling. Connect the syringe to the third connection of the sampling valve (Fig. 14B), turn the blue valve as shown in Fig. 14C and performed sampling.

  Note: Sterile syringe is not included of the spare part kit (Table 1).
- After the sampling is finished, close the valve to initial position and remove the syringe.

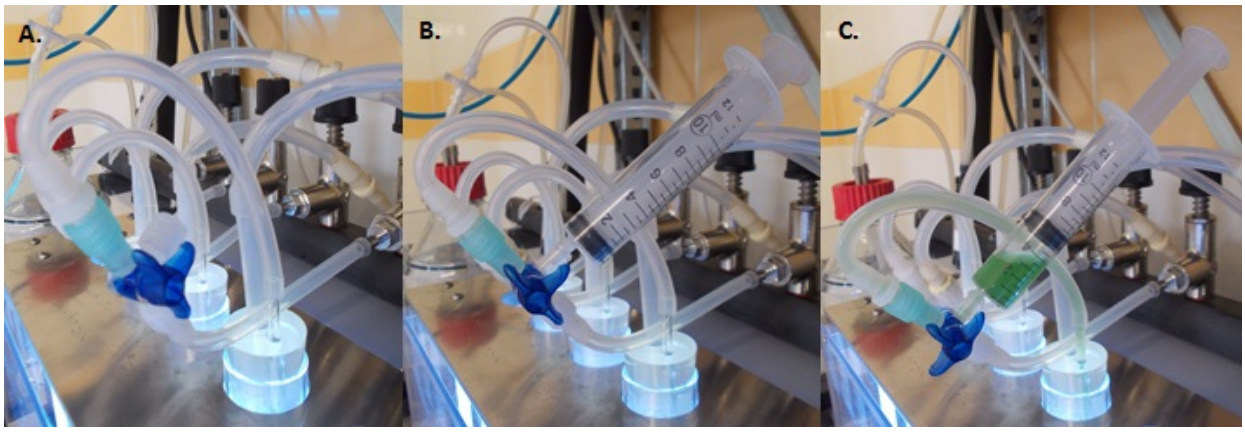


Fig. 14 A) Valve between Luer Locks. B) Valve with the attached syringe. C) Sampling of cyanobacteria.

6 USER'S GUIDE FOR CULTIVATION OF ALGAE AND CYANOBACTERIA

6.1 MC 1000-OD CULTIVATION KIT COMPONENTS

In the next section individual components are described that are delivered as part of the MC 1000-OD kit and are required for the initiation of 8-multi-well culture cultivation in the MC 1000-OD.

Table 1 lists standard Kit Components of MC 1000-OD and their specifications. The number corresponds with the numbering in the Fig. 15.

Component Number (Fig. 15)	Component Description	Specification, Lenght (number)
1	Outlet silicone tubing	Ø 8/5 mm cca 80 mm (8x)
2	Aeration silicone tubing	Ø 6/3 mm cca 100 mm (8x) cca 140 mm (8x) cca 200 mm (8x) cca 200 mm (2x)* cca 230 mm (1x)* cca 350 mm (1x)*
3	Fitting Luer Lock FTLL 240-1**	5/32” (4.0 mm)
4	Fitting Luer Lock MTTL 240-J1A**	5/32” (4.0 mm)
5	Reduction Tube Fitting 5060-1**	1/4" (6.4 mm) and 3/16 (4.8 mm)
6	Silicone Plug	Ø 29x23, 30 mm
7	Effluent teflon tubing	Ø 8/1 mm, 80 mm
8	Aeration glass tubing	Ø 4/0.8 mm, 230 mm
9	Cultivation vessels (2 sets)	ø 30/1.4 mm, 200 mm
10	USB Connector	
11	Humidifier	1 liter
12	Screw cap GL 45 with hole and sealing ring	
13	Metal lid with ports	
14	Air filter	20 µm
15	Lock ring plug LP 4-J1A**	
16	Teflon runner	
17	Specimen tube	
18	USB Flash Disk	
19	Hex Key	2.5 mm

Table 1 Standard Component Kit

* Silicone tubing for humidifier

** Provided by: www.valueplastics.com

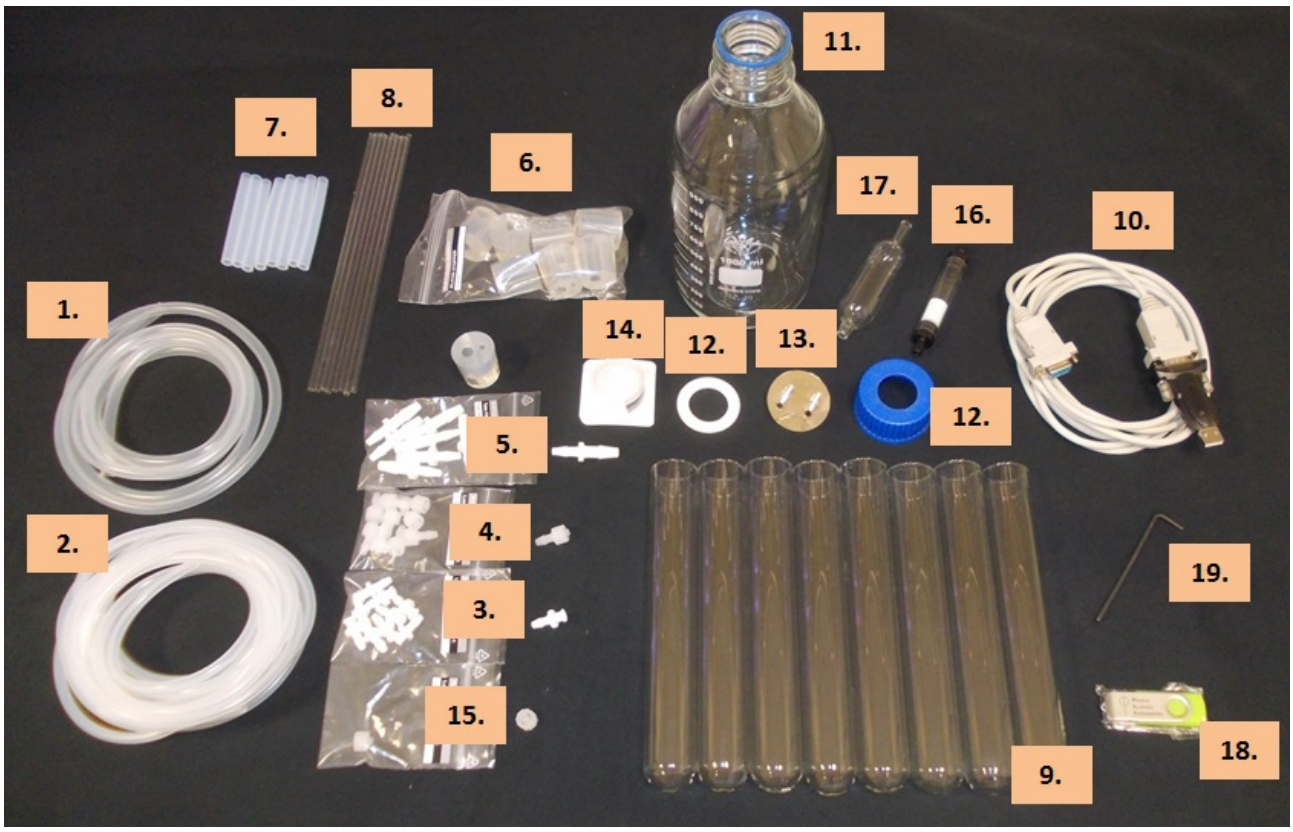


Fig. 15 MC 1000-OD kit components delivered with the standard package. The labeling corresponds to the number in Table 1.

6.2 PREPARATION AND SET UP OF THE COMPONENTS FOR MC 1000-OD

Below individual steps are described for set up of the cultivation kit components and the MC 1000-OD instrument prior to start of cultivation.

1. First prepare the glass cultivation vessels. All components required for setting up the glass cultivation vessels are shown in the Fig. 16A.

   First silicon tubings are cut in pieces of different length according to the parameters described in Table 1. Aeration glass tubing (8; number corresponds to the number in Table 1) and effluent teflon tubing (7) is carefully inserted into the silicone plug (6). The end of the wider effluent teflon tube should be aligned with the narrower bottom side of the silicone plug as shown in Fig. 16B. (Note: It is recommended to use protective gloves when inserting glass tubes into the silicone plug). Silicon tubing (2) is joined together using FTLL a MTLL Fitting Luer Locks (as shown in Fig. 16C) and are connected to the aeration glass tubing. Silicon tubing (1 and 2) is joined together with by Tube-to-Tube connector (5) and connected to the effluent teflon tubing according to the Fig. 16D. This way assembled silicone plug is inserted into the glass cultivation vessel (9). Prepare all remaining cultivation vessels following these instructions.

2. Assembled glass cultivation vessels and end parts of the silicon tubing are wrapped with aluminum foil (not included) and are now prepared for autoclaving.

3. Components required for the assembly of the humidifier bottle are shown in the Fig. 17A. First assemble the lid (12). Connect silicon tubing (2) to the metal portion of the lid with the ports (13) and insert into the screw cap. One end of the silicon tubing has FTLL Luer Lock and Lock Ring Plug, the second with MTLL Luer Lock (as

shown in Fig. 17B). Other silicon tubing of about 5-10 cm is connected to the other side of the metal sleeve on one side and to the specimen tube (17) on the other side place short silicon tubing of about 2 cm to the bottom end of the specimen tube as shown in Fig. 17B. **IMPORTANT:** Specimen tube is recommended to be used with MC 1000-OD as it assures proper stopping of aeration during the process of measuring OD. Fill the bottle up to 1 liter with distilled water, insert the sealing ring (12) into the screw cap and close the bottle with the assembled lid. End parts of the silicon tubings should be covered with aluminium foil. The assembled aeration bottle (as shown in Fig. 17C.) is now prepared for autoclaving.

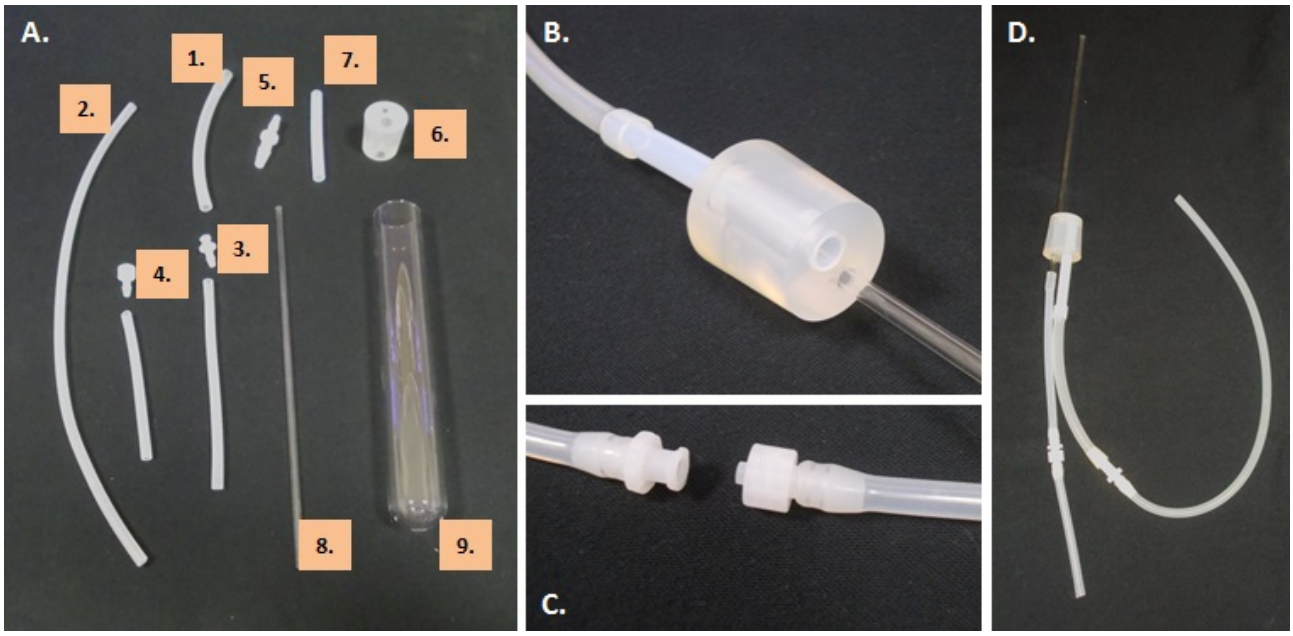


Fig. 16 A) Components required for assembly of one cultivation vessel. The labeling corresponds to the number in Table 1. B) Optimal positioning of the effluent teflon tubing in the plug. C) Schematic illustration of FTLL (left) and MTLL (right) Luer Lock assembly. D) Final set up of the cultivation vessel plug.

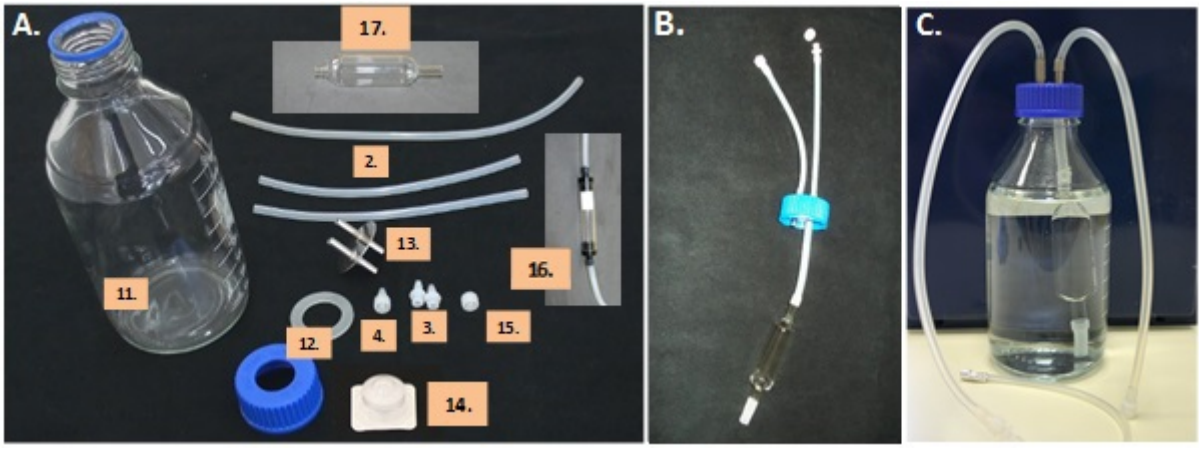


Fig. 17 A) Components required for assembling of the humidifier bottle. The labeling corresponds to the number in Table 1. B) Correct assembly of the silicon tubing to the lid is shown. C) Final set up of the humidifier bottle.

4. Prepare suitable medium for the cultivation and autoclave (**Note**: For standard experimental set up with 8 cultivation vessels of 80 ml volume per vessel (up to 85 ml of media can per cultivation vessel can be used), total of 650 ml of media are required. But twice as much should be prepared as half of it will be required for OD calibration (should be done with the cultivation vessels filled with medium and no inoculum). The other

half will be used for cultivation. **Note:** The volume of 80 ml is recommended as optimal volume for the setting up of inoculation.

5. All the cultivation kit components as listed below are now prepared for the sterilization by autoclaving:
   - 8 assembled cultivation vessels,
   - assembled humidifier bottle

   Other equipment required for the initiation of the cultivation that should be sterilized by autoclaving:
   - 2 x 100ml measuring cylinder,
   - 2 x 250ml beaker,
   - 2l Erlenmeyer flask or other glass flask for the pre-cultivation of the inoculums,
   - cultivation media.
6. Sterilize medium and all the instruments as described in step 5 by autoclaving at 121 °C for 30 min.
7. Dry the glass in a drier and let it cool down to room temperature.

6.3 PREPARATION OF INOCULUM

In this section individual steps are described for preparation of the inoculum for establishment of homogenous and reproducible culture in the MC 1000-OD.

Note: Please note that not all 8 cultivation vessels have to be used. In such case scale down accordingly the volume of inoculums and required media and close the unused cultivation vessel slots by a lid to avoid water evaporation (Fig. 18).

All described steps should be done in sterile conditions in a flow-hood.

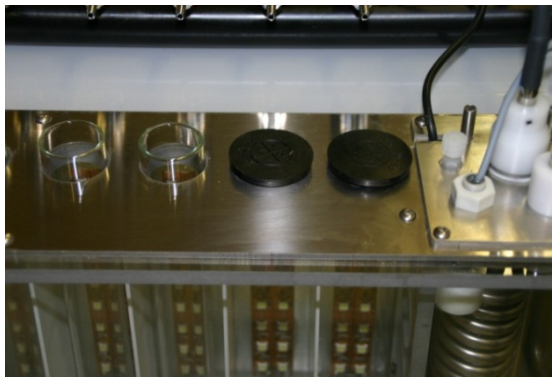


Fig. 18 Closed slots of the cultivation vessel.

8. In case of organisms such as *Chlorella vulgaris*, *Cyanothece* or *Synechocystis* the optimal growth rate was obtained when initial inoculum with concentration of 3 million cells per ml was used to establish culture for growth measurements in the MC 1000-OD cultivation vessels.
9. Concentration of *Chlorella vulgaris* culture in a stationary phase when grown and kept under 60 µE illumination, standard aeration and 24 °C is about 55 - 60 million of cells. This corresponds to OD680 of about 1.0. The measurement of OD can be quickly and easily obtained with an AquaPen (not included; http://www.psi.cz/products/pocket-sized-instruments/aquapen-c-ap-c-100).

10. To obtain the recommended concentration of the initial culture dilute the inoculum down to OD of 0.1 - 0.15 (3 million cells/ml). Prepare appropriate volume of the inoculum according to the number of the cultivation vessels used in the experiment. Optimal volume of the inoculum needed for setting up 8 test vessels of 80 ml is 650 ml of initial culture.

11. It is recommended to pre-cultivate the diluted inoculum for few hours prior to the initiation of the cultivation in MC 1000-OD. This ensures synchronization of the culture before start of an experiment. For diluted culture of *Chlorella vulgaris* (OD680 of 0.1) pre-cultivation of 12 hours under 60 µE illumination, standard aeration and 24 °C is used to prepare optimized culture (OD680 of 0.15) that is sufficient used for the initiation of growth in MC 1000-OD.

6.4 SETTING UP AND PREPARATION OF MC 1000-OD DEVICE

The following steps describe further set up and control of the MC 1000-OD device for the initiation of cultivation.

12. In the flow hood sterilize the main gas dispenser tube with 70% ethanol by squirting ethanol into the tube and rinsing it. Allow the tube to dry and place it back in its position.

13. Fill the MC 1000-OD water bath with distilled water up to 2/3 of the volume.

14. Switch ON the MC main power switch. Warning “water level low” will be displayed as shown in Fig. 19A.

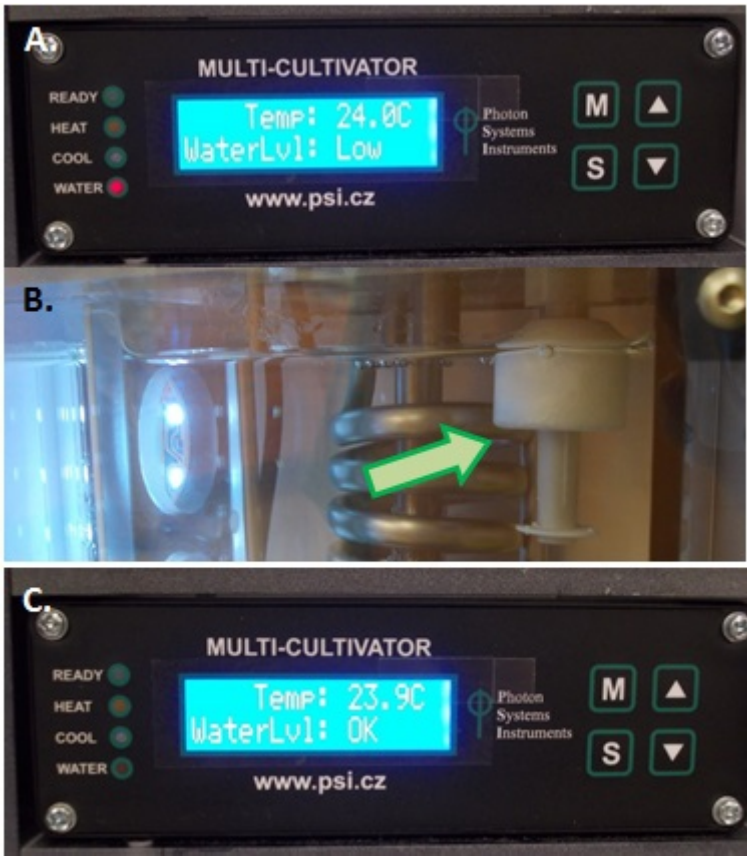


Fig. 19 A) Display of the control unit when the water level in water bath is low. B) Position of the water level controller with optimal amount of water in water bath. C) Display of the control unit when the water level in water bath is optimal.

15. Place the sterilized humidifier bottle in MC 1000-OD above the control unit and connect the tubing as described in the following steps. Remove the Lock ring plug (15; number corresponds to the number in Table 1) from the silicon tubing and connect the MTLL Luer Lock (4) with FTLL Luer Lock (3) placed in the main gas dispenser tube (Fig. 20A). Prepare silicon tubing of approximately 30-35 cm length and connect it with the air pump as shown in Fig. 20B. The second end of the tubing should be pulled through the hole in the plastic lid where the humidifier bottle is inserted (Fig. 20C) and connected with teflon runner (Fig. 20D) (**IMPORTANT NOTE:** The side of the teflon runner with the small hole in the transparent plastic tube should be connected with the silicon tubing from the humidifier bottle. The side without the hole is connected with the silicon tubing from the air pump). **IMPORTANT:** Teflon runner is recommended to be used with MC 1000-OD as it assures proper stopping of aeration during the process of measuring OD. Connect supplied 20 µm air filter with the MTLL Luer Lock end (3) of the silicon tubing from the humidifier bottle and via other FTLL Luer Lock connect with the silicon tubing coming from the teflon runner (Fig. 20E). Final set up of the humidifier bottle is shown in Fig. 20F.

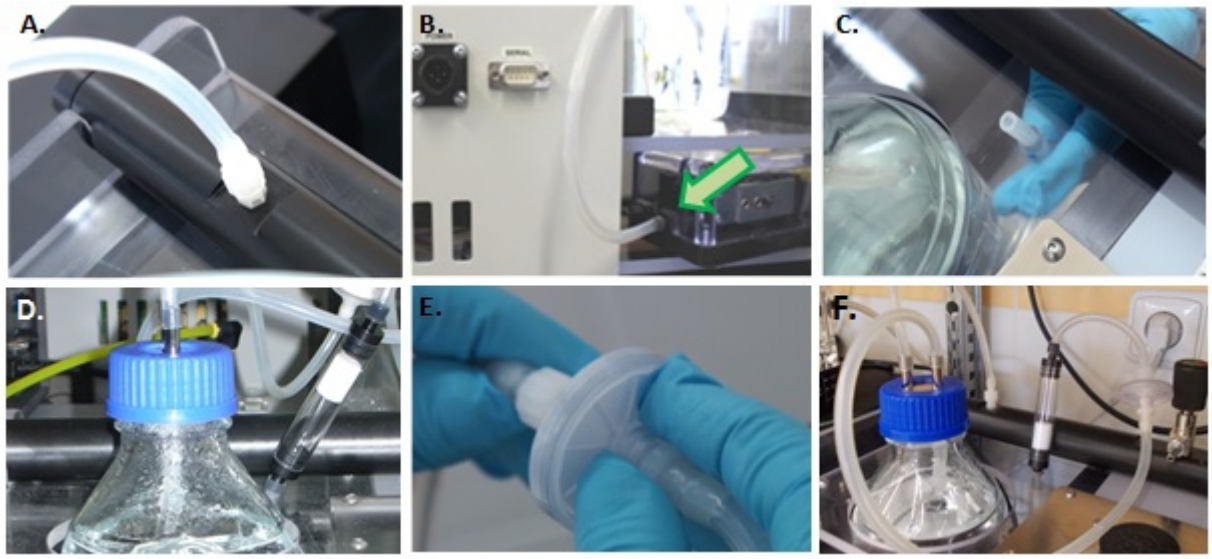


Fig. 20 Steps for set up of the humidifier bottle. A) Connection of the silicon tubing from the bottle to the main gas dispenser tube. B) Connection of silicon tubing with the air pump. C) Set up for the connection of the air pump with the humidifier bottle. D) Silicon tubing from the air pump is connected with the teflon runner. E) Connection of the humidifier bottle with teflon runner via 20 µm filter. F) Final set up of the humidifier bottle.

16. To switch the aeration pump ON go to **Settings>Air pump>ON**.

17. Prepare the MC 1000-OD for the OD calibration step.

    Place all 8 glass cultivation vessels, cylinder and glass beakers in the flow-hood and fill the vessels with required volume of cultivation medium. The volume corresponds to the volume of inoculum to be cultivated in individual vessels.

    Note: When performing this step under sterile conditions, medium used for the OD calibration can be further re-used. As a result the same set of cultivation vessels can be used for OD calibration for culture cultivation. Alternatively, a second set of culture vessels can be used for calibration that are provided as part of the standard set up.

    Note: In case of using less than 8 cultivation vessels at a time, empty slots should be closed with the lid to prevent water evaporation from the cultivation vessel.

Important: Prior placing cultivation vessels for OD calibration into MC 1000-OD, clean the outer side of the vessels with 70% ethanol to remove any dust or finger prints on the surface.

18. Switch the lights ON: **Lights>All lights>ON**. For *Chlorella vulgaris* light intensity of 60 µE is used.

    Note: MC 1000-OD control unit allows set static and dynamic light regimes (pre-designed sinus, daylight and pulse form regimes. For dynamic light regimes please refer to Menu Tree Control description on page 39.

19. In case the warning "water level low" is still displayed fill the water bath with distilled water up to the level shown in Fig. 19B until the message "water level ok" is displayed on the control (Fig. 19C).

20. ***Optional step***: for the users of MC 1000-OD instruments, which are supplied with PWM Pump follow the installation instructions as described on page 20.

21. Set the temperature control ON: **Sensors>TControl>ON**. For *Chlorella vulgaris* temperature of 25 °C is used. It is important to calibrate the OD sensors at the temperature used in the experiment.

    Important: MC 1000-OD device itself does not have temperature regulator built-in that would allow regulate the temperature in water-bath below the ambient temperature. If high light intensities are used, please be aware that the water bath temperature will increase even above the ambient room temperature. MC 1000-OD built-in temperature regulator allows only to warm up the temperature inside the water bath.

22. ***Optional step***: for the users of MC 1000-OD instruments, which are supplied with Cooling Unit AC-625 follow the installation instructions as described on page 17.

23. The MC 1000-OD device is now prepared for the OD calibration step. Prior to start of each experiment OD calibration protocol should be performed with the medium used in that experiment. Blank cultivation medium should be used for calibration in all 8 cultivation vessels. Run the OD calibration protocol: **Settings>OD Calibration>Run**.

    Now the MC device is ready for initiation of the culture growth.

6.5 ESTABLISHMENT AND GROWTH OF SELECTED CULTURE IN THE MC 1000-OD

These steps describe procedure for the culture growth initiation and establishment in the MC 1000.

24. Place autoclaved glass cultivation vessels, cylinder, beakers and pre-cultivated inoculum into the flow-hood. Under sterile conditions measure 80 ml of the inoculum and pour it into the cultivation vessel. Sterilize the end of the test vessels in the flame and close the vessel with the assembled silicone plug. Follow the procedure for all the cultivation vessels.

25. Place the cultivation vessels with the pre-cultured inoculums in the MC 1000-OD slots. **Important**: Prior placing the cultivation vessels into MC 1000-OD, clean the surface with 70% ethanol to remove any dust or finger prints on the surface. Repeat this step for each cultivation vessel. (**Note**: If same set of cultivation vessels is used as in the OD calibration remove carefully the medium under sterile conditions and replace with 80 ml of pre-cultivated inoculum).

    Warning: If number of cultivation vessels is removed from the cultivation vessel at the same time, water level will drop and warning "water level low" on the control unit display will appear and the alarm will sound. Press the **S** button on the MC 1000-OD control unit to stop the alarm system.

26. Remove the aluminum foil at the end of the aeration silicon tubing and connect to the valve of the main dispenser tube (Fig. 21). Repeat the step for all the cultivation vessels.

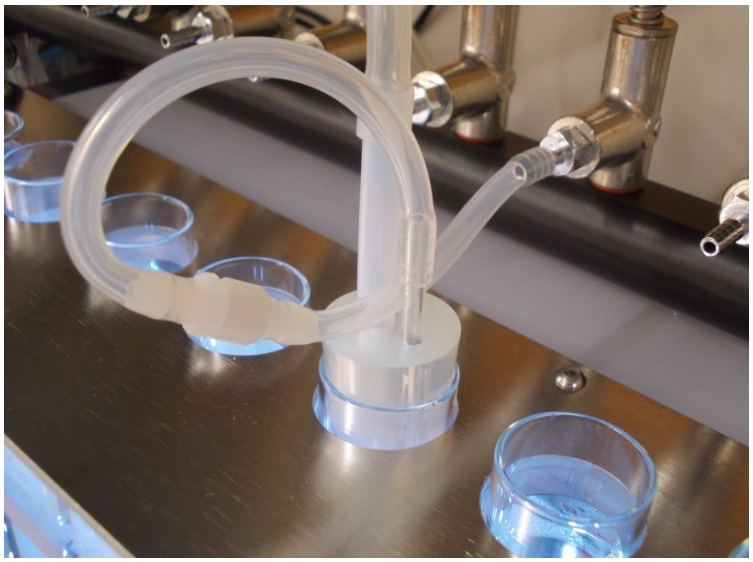


Fig. 21 Connection of the cultivation vessel to the main gas dispenser tube .

27. **Warning**: The OD sensor is aligned with the center of each cultivation tube so to avoid interference of aeration glass tubing with OD measurements it is important to place the aeration glass tubing to either side of the vessel as shown in Fig. 22A.

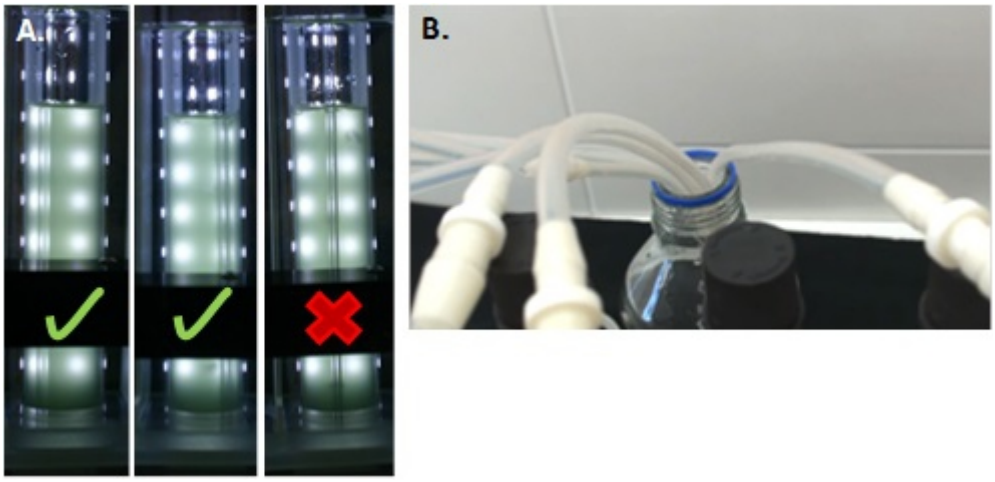


Fig. 22 A) Left and middle image show correct placement of the glass aeration tubing in the cultivation vessel. B) End portion of the effluent tubings from the cultivation vessels are placed into the waste bottle.

28. Effluent tubing from the cultivation vessel should be placed into a beaker or glass bottle in case any waste water comes out of the tubing (Fig. 22B). Place the bottle behind the MC 1000-OD device.

29. Adjust the air flow rate for each cultivation vessel by using the individual valves on the main gas dispenser tube.

    Important note: It is important to check that all cultivation vessels, silicone plugs and aeration glass tubing are at the same position. All aeration glass tubing should be the same distance from the bottom of the

cultivation vessel. Note that the position of the aeration tubing end affects the size of the bubbles. Optimal position of the end should be in about 0.5 mm from the bottom of the vessel. Ensure that there are no kinks in the silicon tubing that may impede the flow of gas.

30. Completion of all the steps outlined above will ensure optimal inoculation and homogenous and reproducible growth rate of the culture.

31. OD measurements are not continuous. They are done at specific time interval. To set up OD measuring protocol go to: **Sensors>OD Protocol>ON**. Set the time interval for the OD measurement between 5 minutes up to 1 hour.

32. Measured OD values can be read during the growth of the culture and without stopping of the experiment by going through the menu system as follows: **Sensors>OD measure>Light1 - Light 8**

    To visualize all of the stored OD values these have to be downloaded onto a PC using the ODView software supplied with the MC 1000-OD and the serial cable with the USB connector. Follow the instructions described in the next chapter on page 35.

Important: Note that the MC 1000-OD control unit can collect limited number of data points before it runs out of memory. Maximum number of data points for each OD sensor is 3533. This number corresponds to 147 days of measurement if 1 h measuring interval is used. To check the memory status of the MC 1000-OD wait few seconds without manipulating with the control unit display. An idle screen will appear with actual measured temperature of the water bath displayed. On the bottom section of the display shows % memory occupied. By pushing the button **S** memory space in hours will be displayed. Optionally the memory status can be found in: **Sensors>OD Protocol.** Remaining memory space is displayed as shown in Fig. 23.

Fig. 23 Control unit display with remaining memory space in % and in hours is shown.

7 TERMINATION OF CULTIVATION AND MC 1000-OD MAINTENANCE AND STORAGE

Below recommendations are given that help the user to successfully terminate the growth of selected culture in MC, evaluate the measured data and maintain the MC device itself.

7.1 DATA TRANSFER AND VISUALISATION

1. **Important**: Prior initiation of new experiment and starting new OD protocol it is **essential** to download the measured OD values. Data saved to the MC 1000-OD memory will be stored **ONLY** until new OD protocol is started, since initiation of new OD protocol will automatically reset the memory space and measured OD values will overwrite stored data set. To proceed with data transfer connect the USB adaptor and the serial cable between the PC and the serial plug in the back of the MC 1000-OD.

2. To visualize all of the measured and stored OD values for each cultivation vessel the data has to be first downloaded from the MC 1000-OD control unit to the PC. This is done using the ODView software that is included with the MC 1000-OD device.

3. Copy the ODView software from the Flash Disc onto the PC computer first. Run the software. The initial screen will appear as shown in Fig. 24.

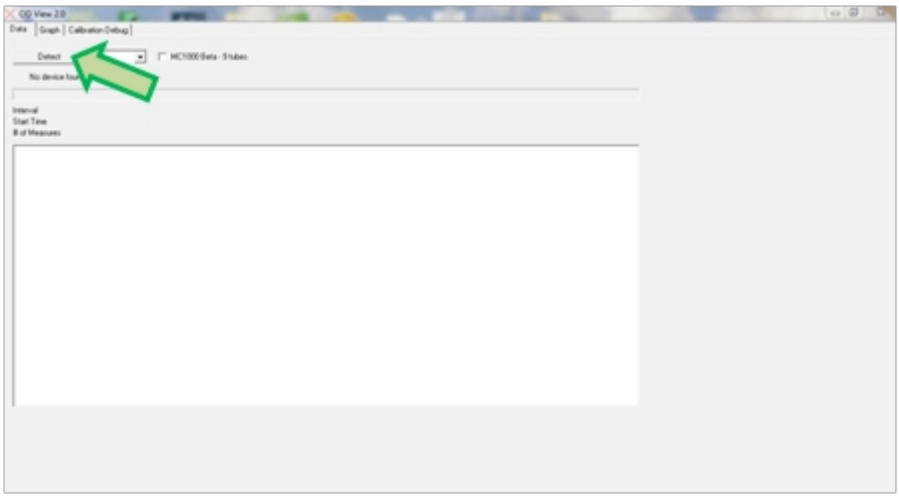
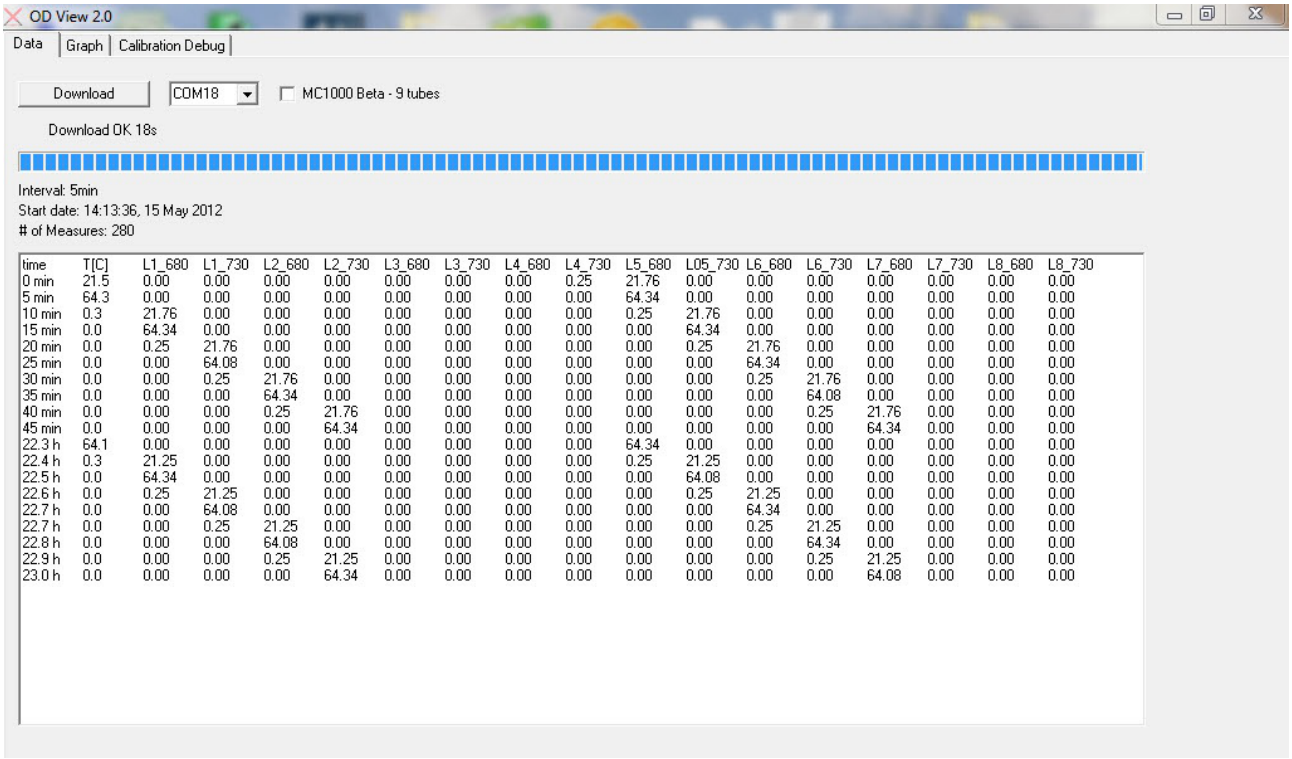


Fig. 24 The initial window of the ODView program .

4. Click “detect” button for the software to connect with the Multi-Cultivator control unit. Once the connection has been established click download button that appears. The stored data from the MC 1000-OD control unit will be downloaded and the following screen will appear as shown in Fig. 25.

   Note: In the table format (data) only the first 10 and the last 10 values will be shown. To visualize all of the data collected for each culture vessel click on “graph” and select the culture vessels with appropriate OD wavelength as shown in Fig. 26. In this window description of the experiment and notes associated with the experiment can be made.



time	T[C]	L1_680	L1_730	L2_680	L2_730	L3_680	L3_730	L4_680	L4_730	L5_680	L05_730	L6_680	L6_730	L7_680	L7_730	L8_680	L8_730
0 min	21.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	21.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 min	64.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10 min	0.3	21.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	21.76	0.00	0.00	0.00	0.00	0.00	0.00
15 min	0.0	64.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.34	0.00	0.00	0.00	0.00	0.00	0.00
20 min	0.0	0.25	21.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	21.76	0.00	0.00	0.00	0.00	0.00
25 min	0.0	0.00	64.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.34	0.00	0.00	0.00	0.00	0.00
30 min	0.0	0.00	0.25	21.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	21.76	0.00	0.00	0.00	0.00
35 min	0.0	0.00	0.00	64.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.08	0.00	0.00	0.00	0.00
40 min	0.0	0.00	0.00	0.25	21.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	21.76	0.00	0.00	0.00
45 min	0.0	0.00	0.00	0.00	64.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.34	0.00	0.00	0.00
22.3 h	64.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22.4 h	0.3	21.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	21.25	0.00	0.00	0.00	0.00	0.00	0.00
22.5 h	0.0	64.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.08	0.00	0.00	0.00	0.00	0.00	0.00
22.6 h	0.0	0.25	21.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	21.25	0.00	0.00	0.00	0.00	0.00
22.7 h	0.0	0.00	64.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.34	0.00	0.00	0.00	0.00	0.00
22.7 h	0.0	0.00	0.25	21.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	21.25	0.00	0.00	0.00	0.00
22.8 h	0.0	0.00	0.00	64.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.34	0.00	0.00	0.00	0.00
22.9 h	0.0	0.00	0.00	0.25	21.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	21.25	0.00	0.00	0.00
23.0 h	0.0	0.00	0.00	0.00	64.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.08	0.00	0.00	0.00

Fig. 25 OD and Temperature downloaded data window.

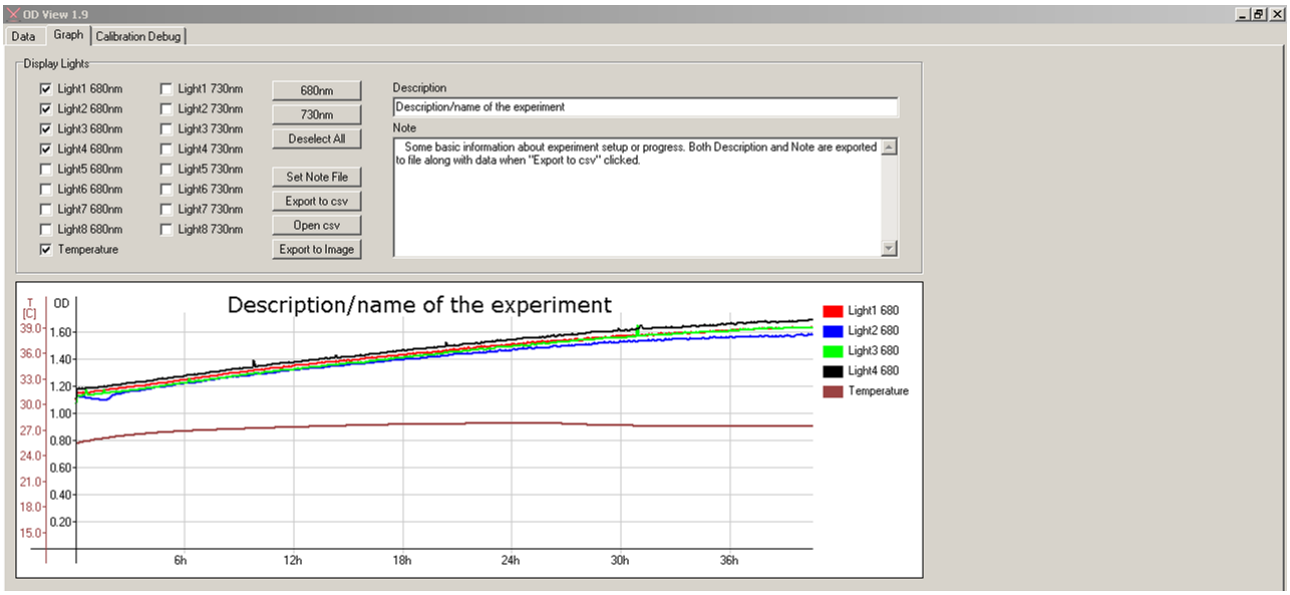


Fig. 26 The graph window of the data. OD 680 was measured for *Chlorella vulgaris* culture in 5 min intervals for 40 hours. Temperature values can be displayed together with OD values.

5. The logged data can then be exported to .csv file using the buttons shown in Fig. 27 and further analyzed as required using a spreadsheet program such as Excel.

Note: The ODView software can only be used to download and visualize the data stored in the MC 1000-OD control unit while the computer and the unit are connected with the serial cable. This software will not save downloaded data and allow its visualization later while the MC 1000-OD is disconnected. Downloaded data has to be exported as a .csv

file so it can be saved and manipulated later.

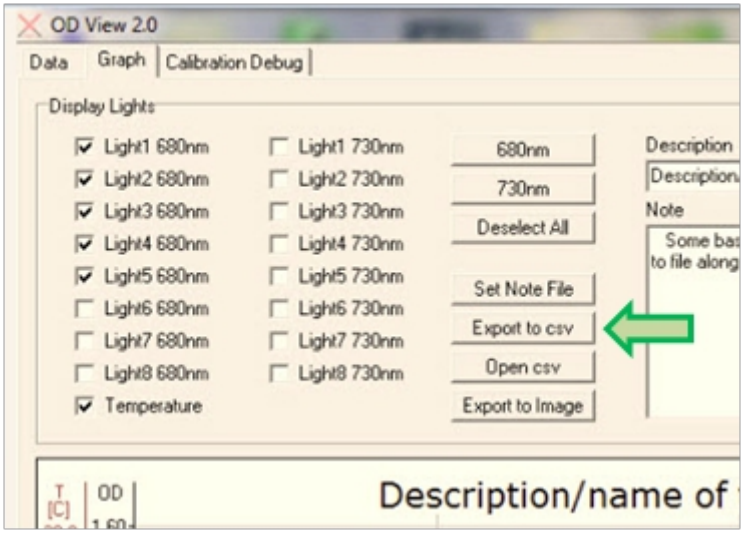


Fig. 27 Data export and data selection functions window.

7.2 TERMINATION OF CULTIVATION EXPERIMENT

6. After downloading the logged data proceed with the termination of the cultivation experiment.
7. First stop the OD protocol: **Sensors>OD Protocol>OFF**
8. Switch off the lights: **Lights>All lights> OFF**
9. Stop the temperature controller: **Sensors>TControl>OFF**
10. Stop the aeration: **Settings>Air Pump>OFF**
11. Unscrew the FTLL and MTLL Luer Lock fittings on the aeration tubing and remove the cultivation vessels.
12. Remove and empty the humidifier bottle.

7.3 CULTIVATION VESSEL MAINTENANCE

13. Use only distilled water in the cultivation vessel to avoid boiler incrustation.
14. Use a tube to pump water out of the cultivation vessel. Do not place the vessel on an angle to empty it out as damage may occur.
15. To clean the vessel, unscrew the 4 screws on the top of the small square metal cover with inlets for heater, cooler, water level sensor and remove it (Fig. 28A). Then unscrew 8 screws in the lid of the cultivation water bath with slots for cultivation vessels and remove it (Fig. 28B). Pull out the stand for cultivation vessels and water pump.

    Wash inside of the cultivation vessel and its content with a mild detergent or diluted vinegar (provide 50% dilution).

16. To remove rough pollution on the walls of the cultivation vessel, use a soft brush or plastic scouring pad.

17. When assembling the cultivation vessel, please, do not overtighten the screws to avoid stripping the threads.

18. Plastic tubing, plastic connectors and glass components of the Multi-Cultivator can be autoclaved at temperatures not exceeding 121 °C.

WARNING: Avoid spilling water on any parts of the Multi-Cultivator except inside of the cultivation vessel.

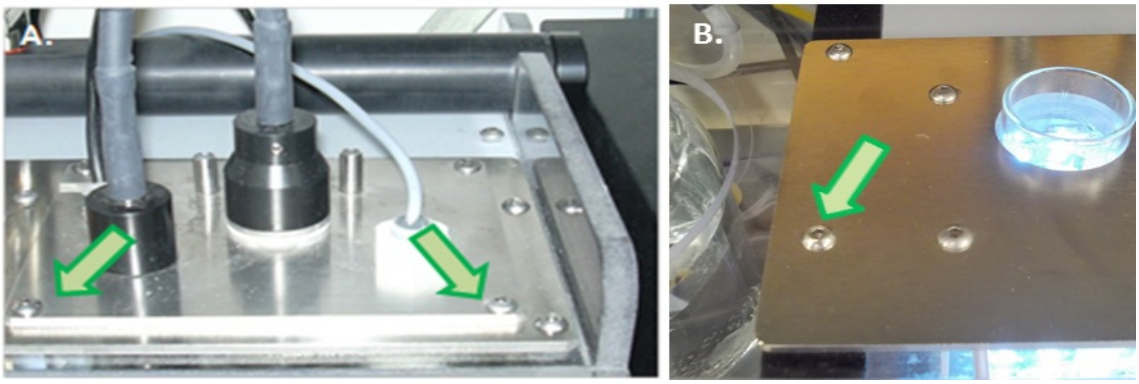


Fig. 28 Note 2 out of 4 screws in the metal cover of the cooling and heating unit. B) Note one out of 8 screws in the lid of the cultivation water bath.

8 MULTI-CULTIVATOR 1000-OD CONTROL

Parameters such as light intensity and light regime, temperature, bubbling and online optical density measurement can be controlled via the Control Unit of MC 1000-OD. Use four keys located at the right side of the front panel to control the settings of the instrument (Fig. 3, label 3):

[M] key: Used to move back in the menu tree or to exit the menu.

[S] key: Used to move forward in the menu tree or to save your selection.

[↑] key: Used to move up in the menu or to add value.

[↓] key: Used to move down in the menu or to subtract value.

The following pages show the graphical re-presentation of the operation scheme for the Multi-Cultivator. This scheme is structured in five levels:

Main menu (blue)

First-level nested sub-menu (yellow)

Second-level nested sub-menu (green)

Third-level nested sub-menu (orange)

Fourth-level nested sub-menu (grey)

See pages 39-48 of this Manual for the graphical representation of individual menus and for explanations of their functions.

Explanation of symbols and color differentiation* used in the graphical presentation:

Full-line arrows are used for the [S] key.

Dashed-line arrows are used for the [M] key.

Dotted-line arrows are used for the [UP/DOWN] keys.

* The Multi-Cultivator screen does not reflect this color differentiation.

Note:

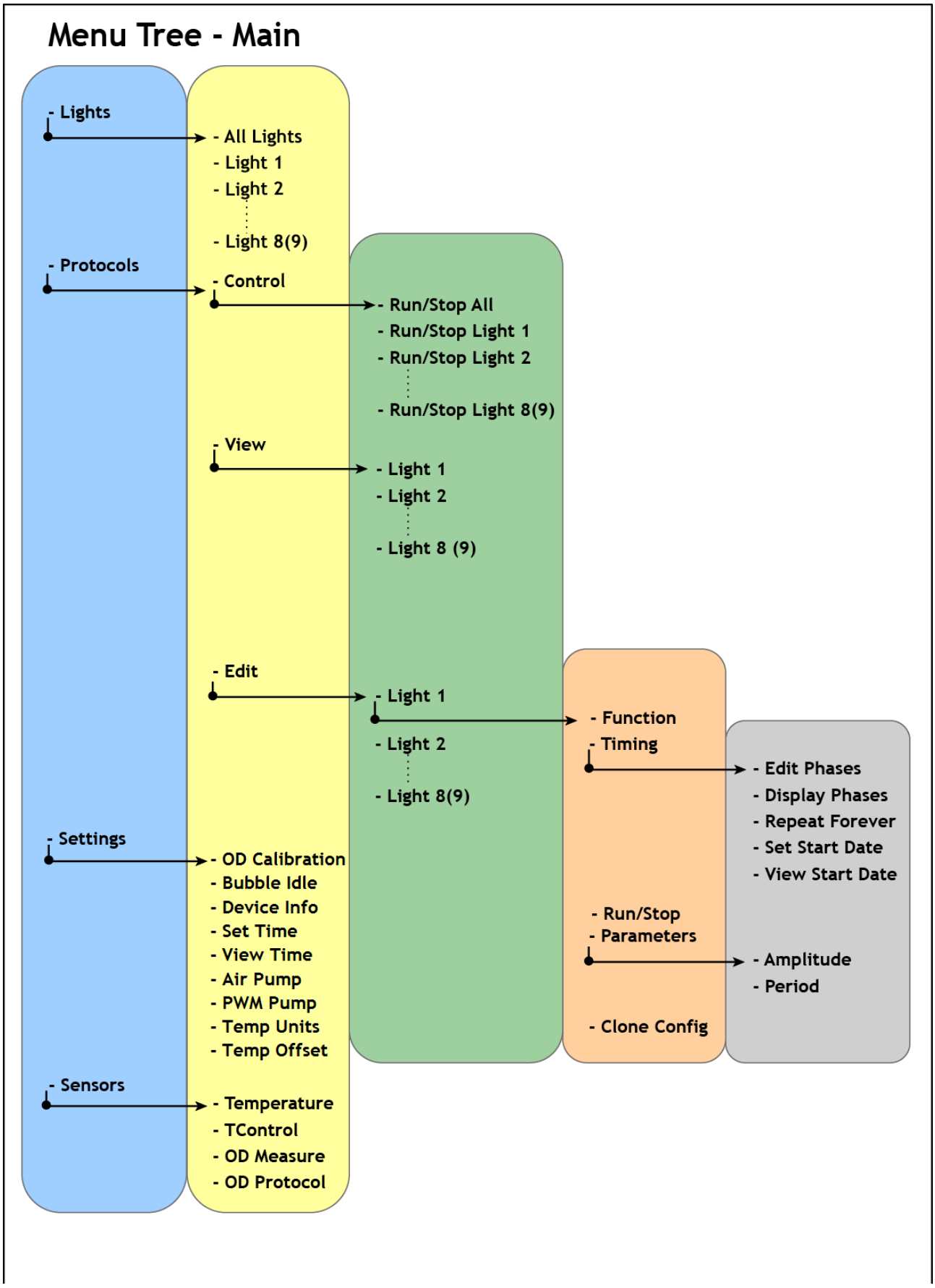
After 10 seconds of no action, an idle screen appears on the control unit which displays the actual measured temperature inside the Multi-Cultivator water bath (Fig. 19C).

Warning:

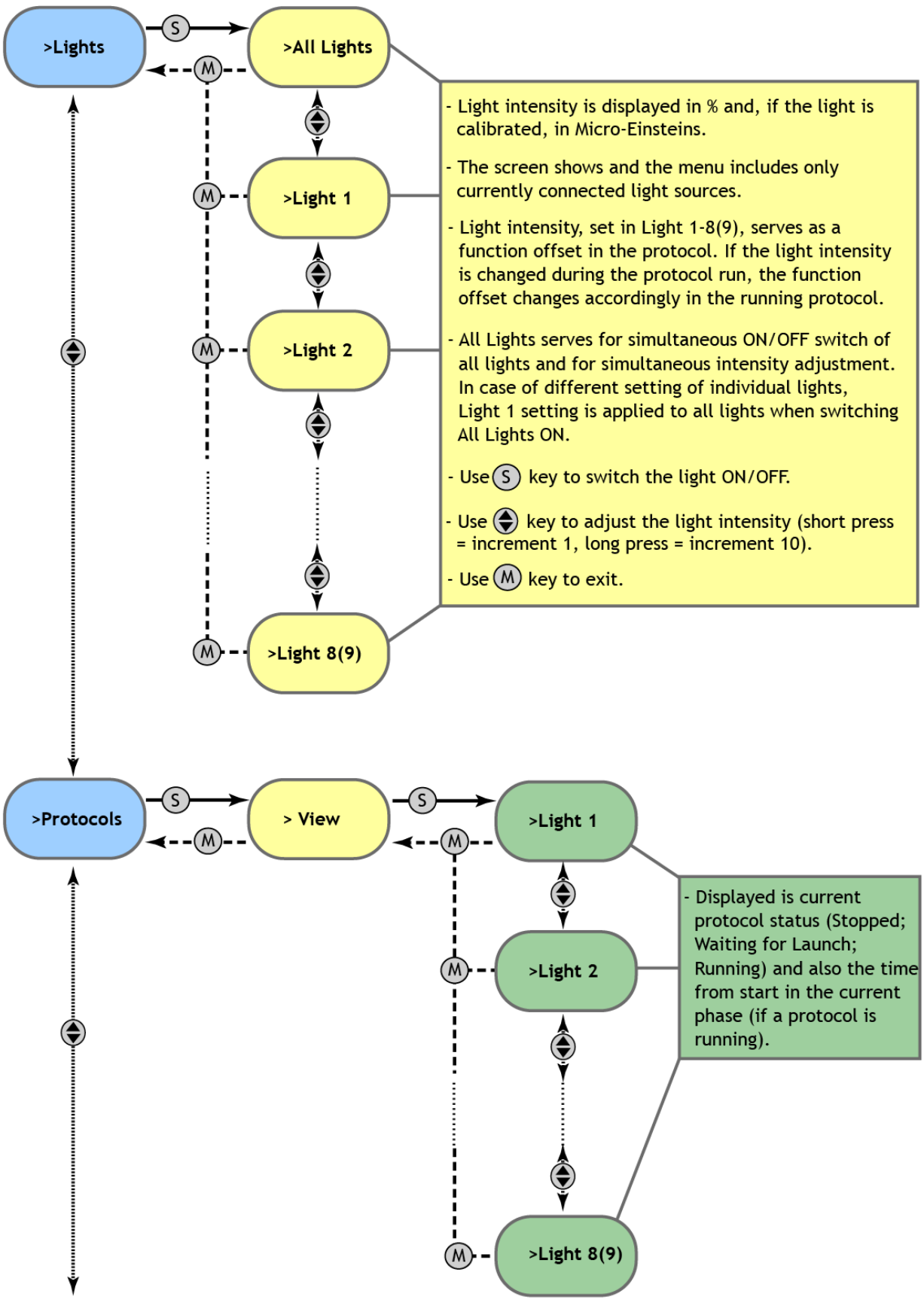
When error message “BOInfo: ODProt. Resumed!” is shown on the display (Fig. 29), MC 1000-OD was turned off while the protocol was running (for example in case of electric power outage). In this case OD Protocol and OD measurement was automatically re-started after the MC 1000-OD was again switched ON.

Fig. 29 Control unit display after OD protocol was resumed following MC 1000-OD power outage.

8.1 CONTROL MENU TREE



Menu Lights. Menu Protocols→View



Menu Protocols→Control. Menu Protocols→Edit→LightN

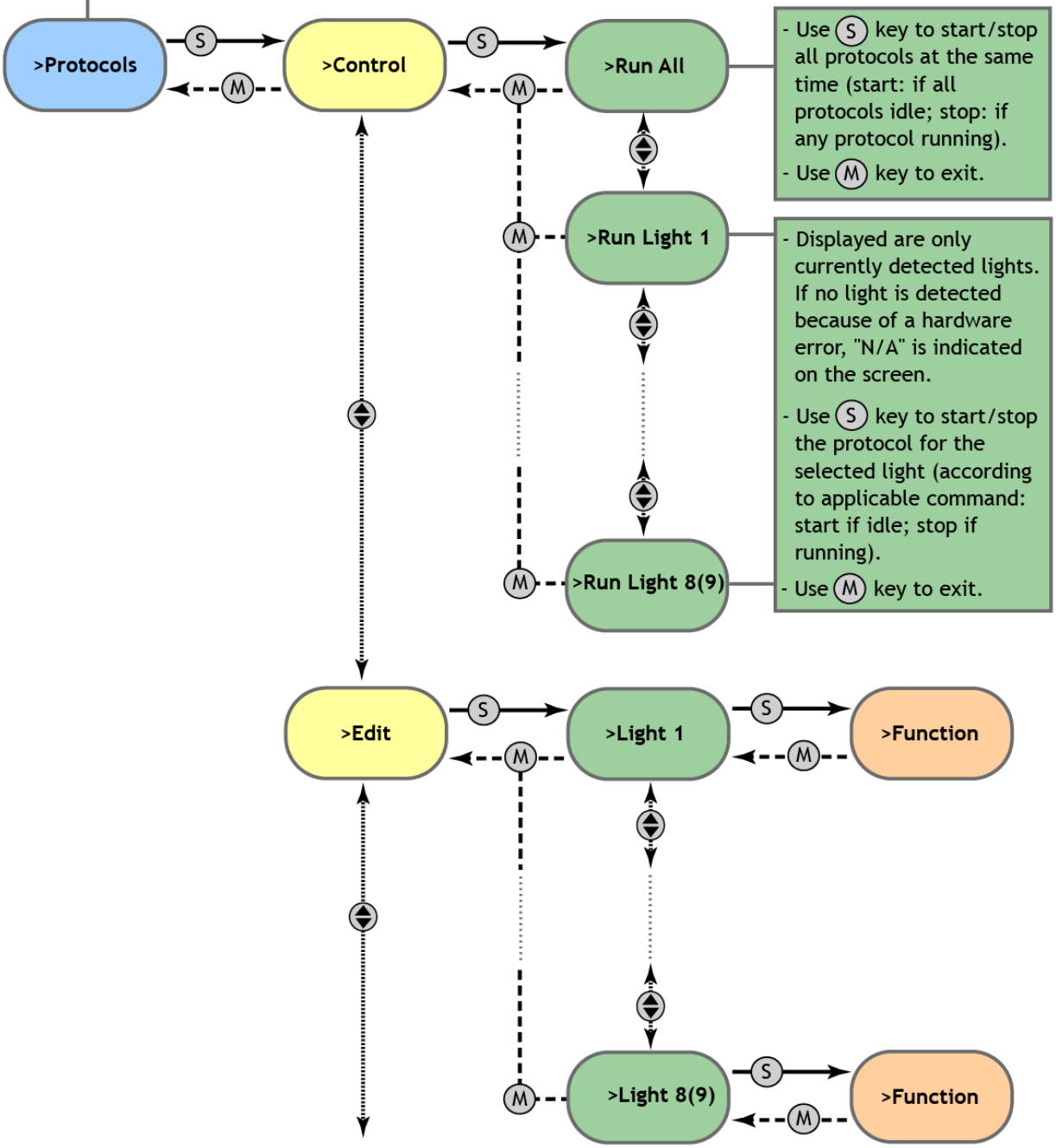
EACH PROTOCOL CONSISTS OF THREE INDEPENDENTLY CONFIGURABLE PHASES:

1) Light Period (LP) = Time period during which the defined function is performed.
2) Dark Period (DP) = Time period during which the light is off.
3) Repeats = Number of repeats for the phase.

OTHER EDITABLE PROTOCOL FUNCTIONS:

Repeat forever = The whole protocol runs in infinite loop.

Zero phase = LP + DP = 0; or Repeats = 0. Editing of phases is finished when the Zero phase is confirmed.



Menu Protocols→Edit→LightN→Function

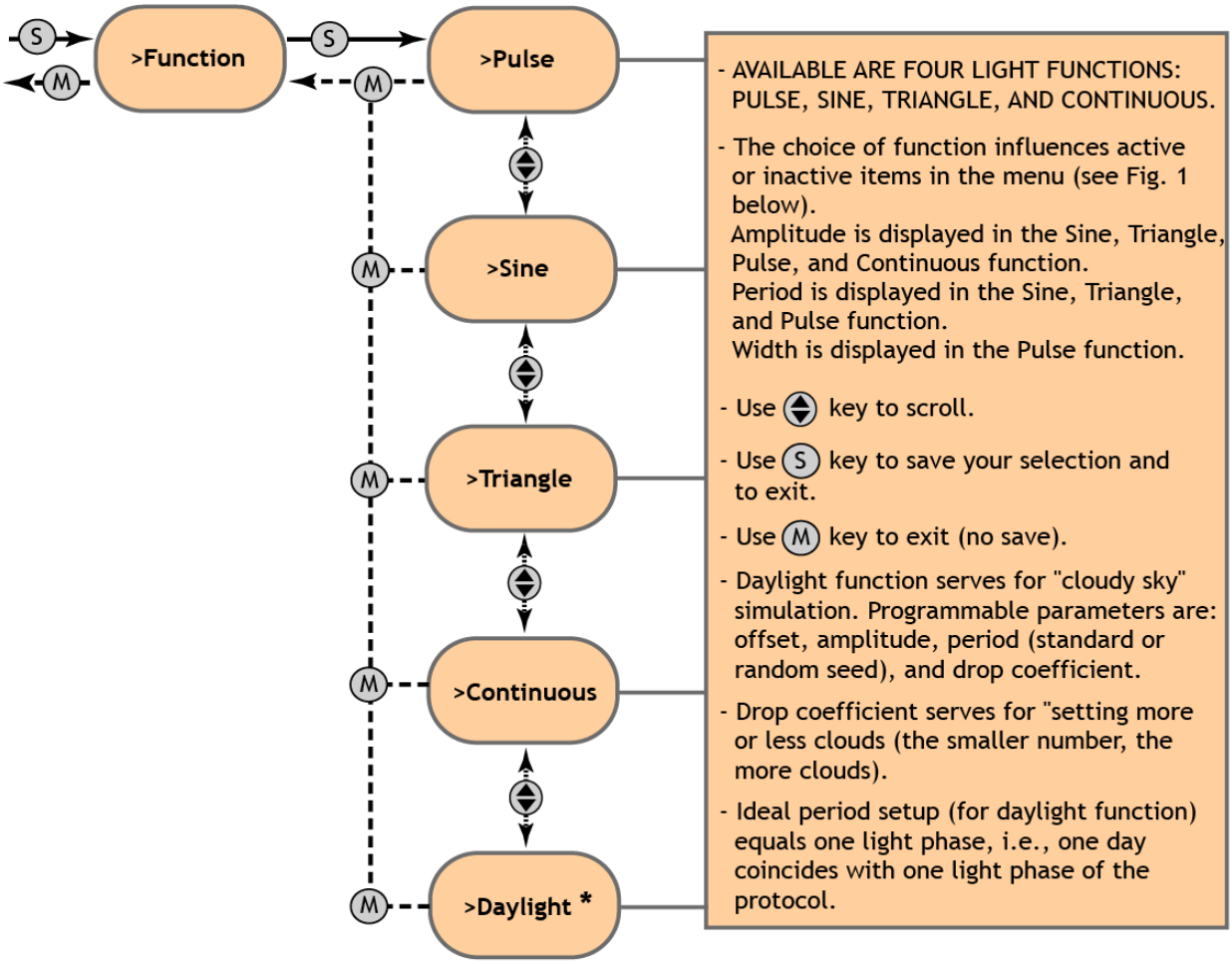
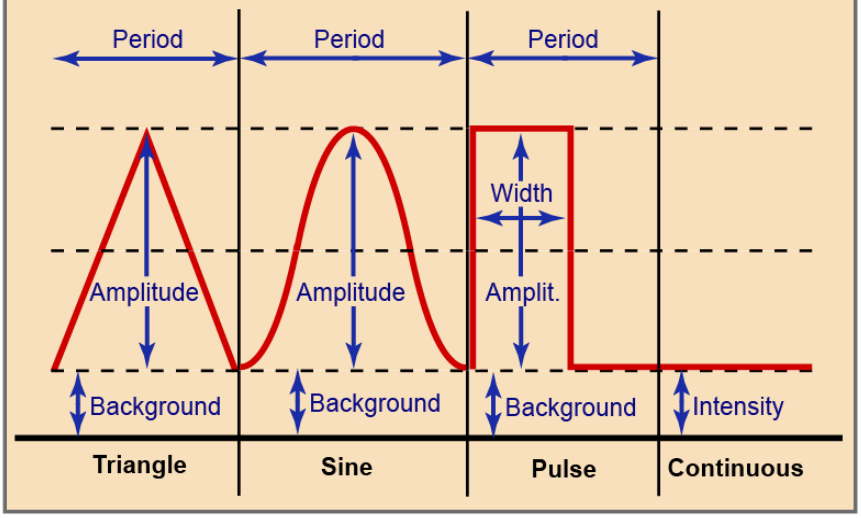


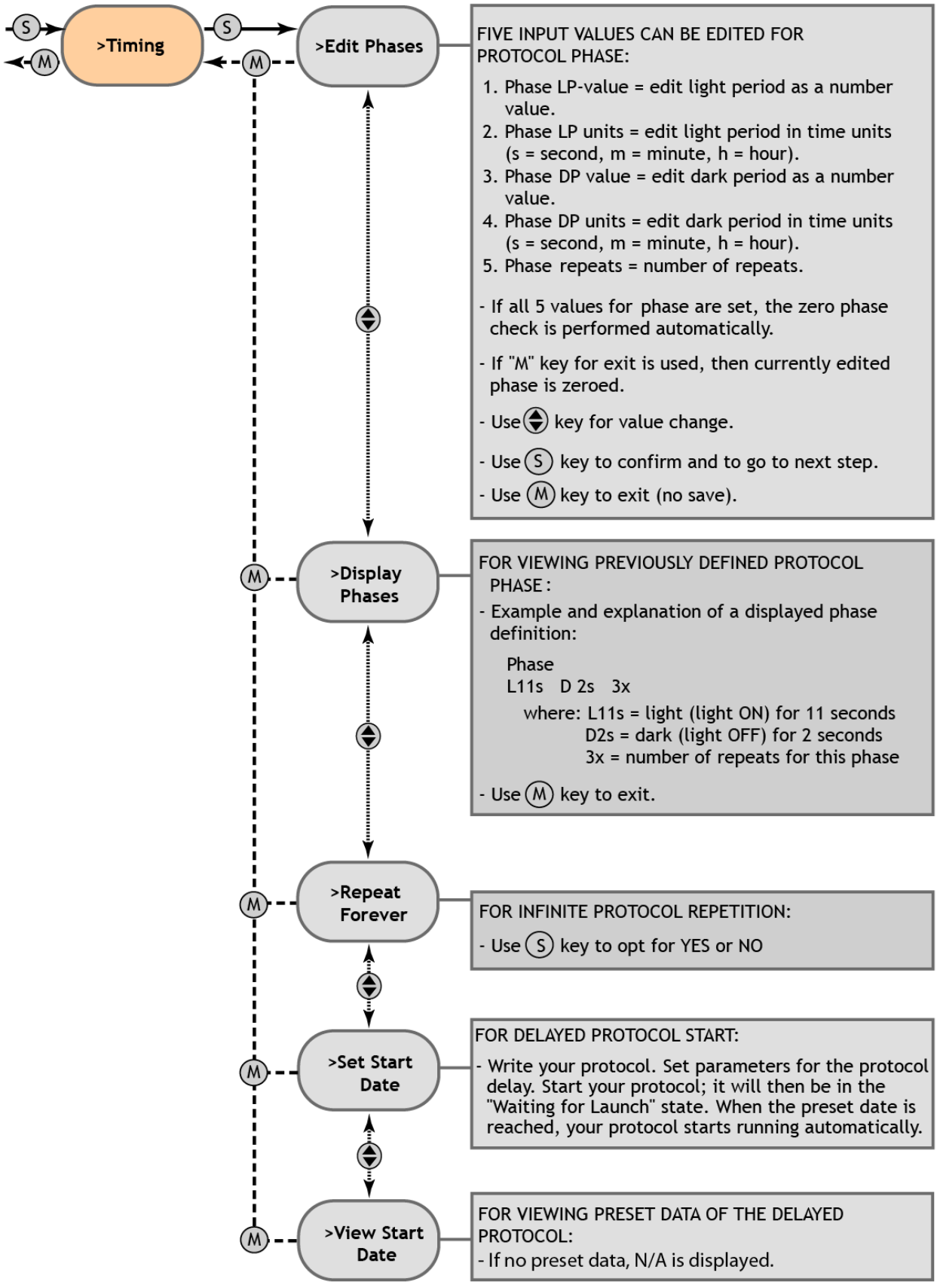
Fig. 1

Light Function Visualization

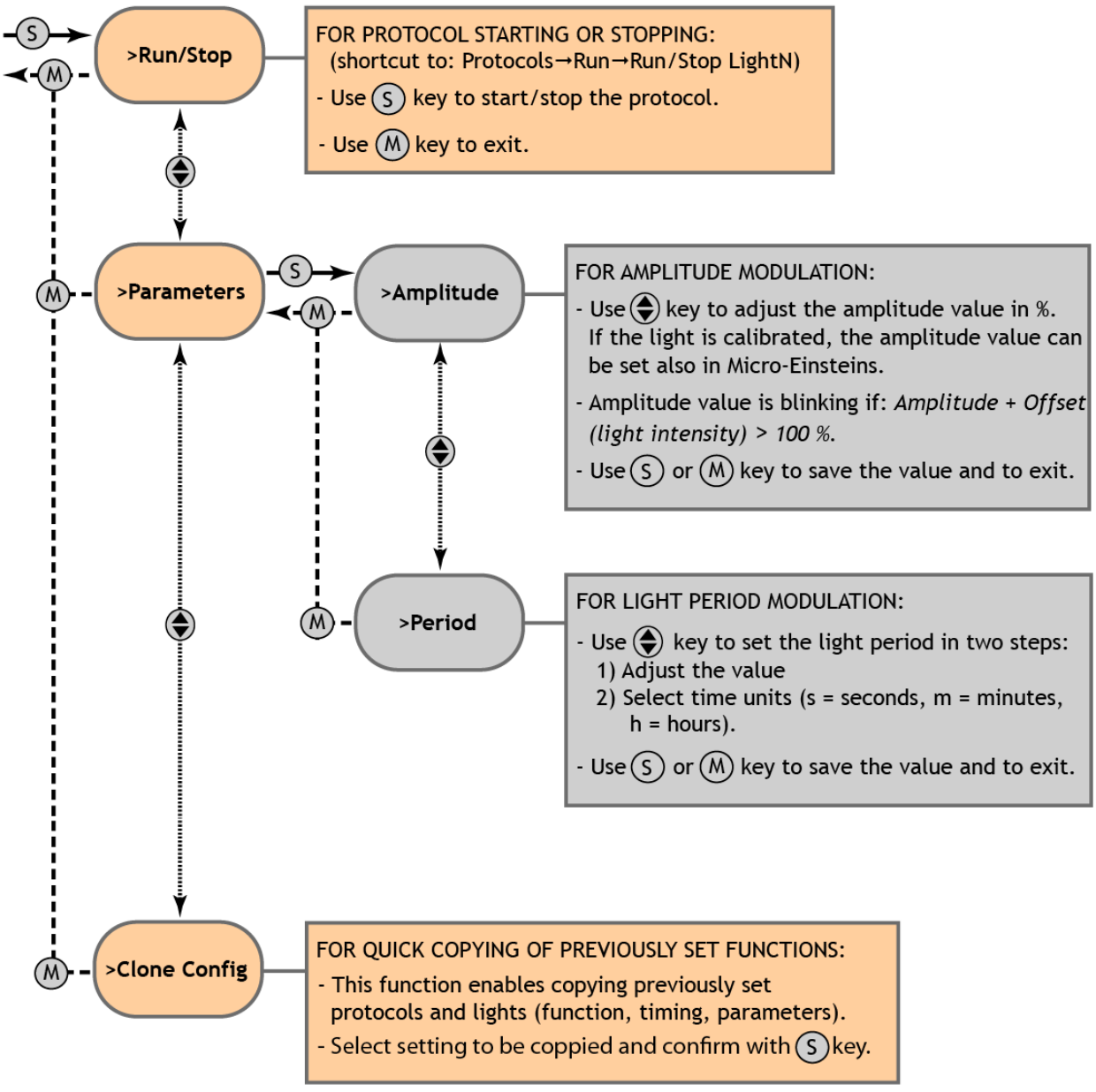


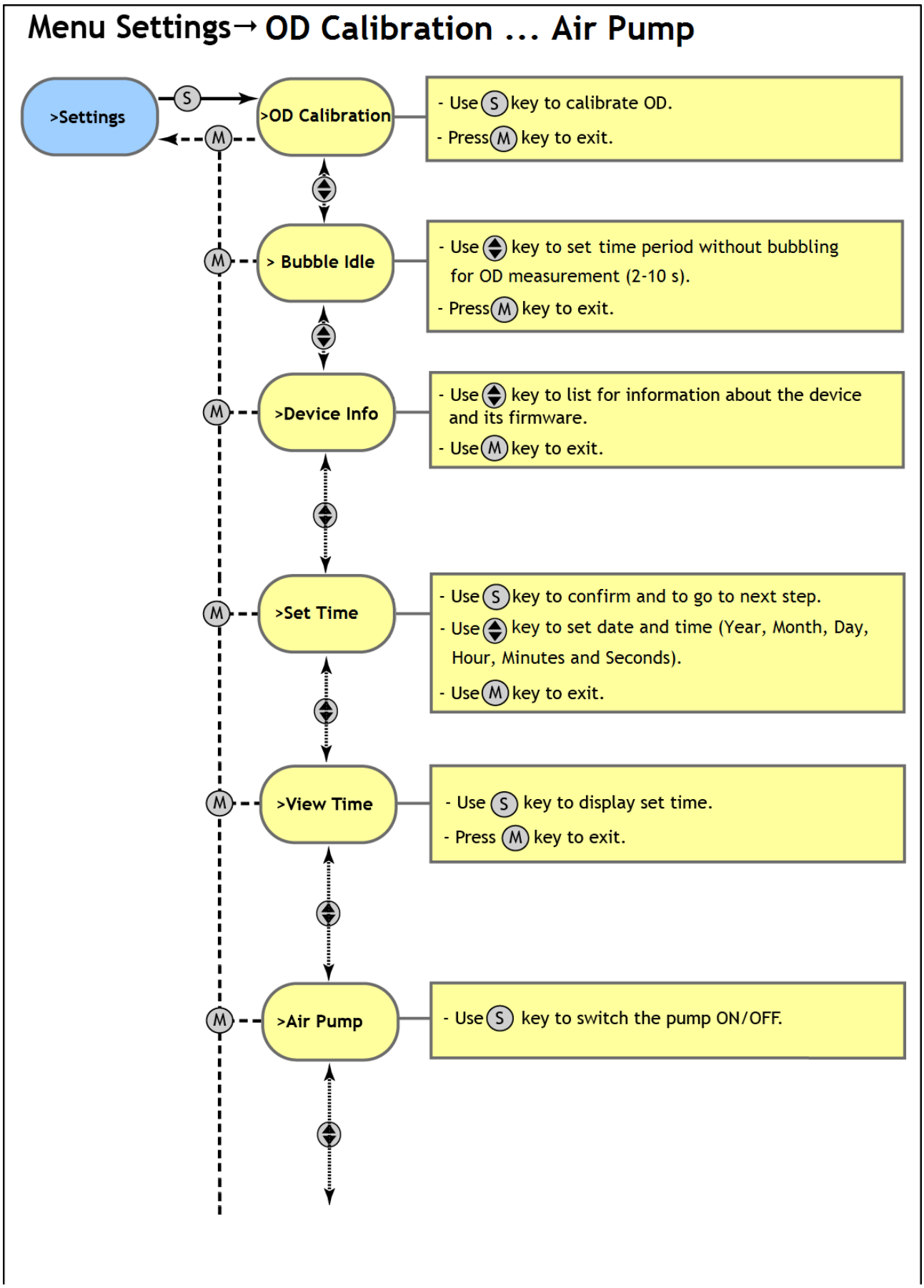
* There is a PC application for daylight protocol light curve visualization available as an upgrade to the standard Multi-Cultivator package. Seed parameter in the Daylight protocol is used to synchronize this application and the FytoScope, so with the same protocol settings, it produces identical light curve.

Menu Protocols→Edit→LightN→Timing

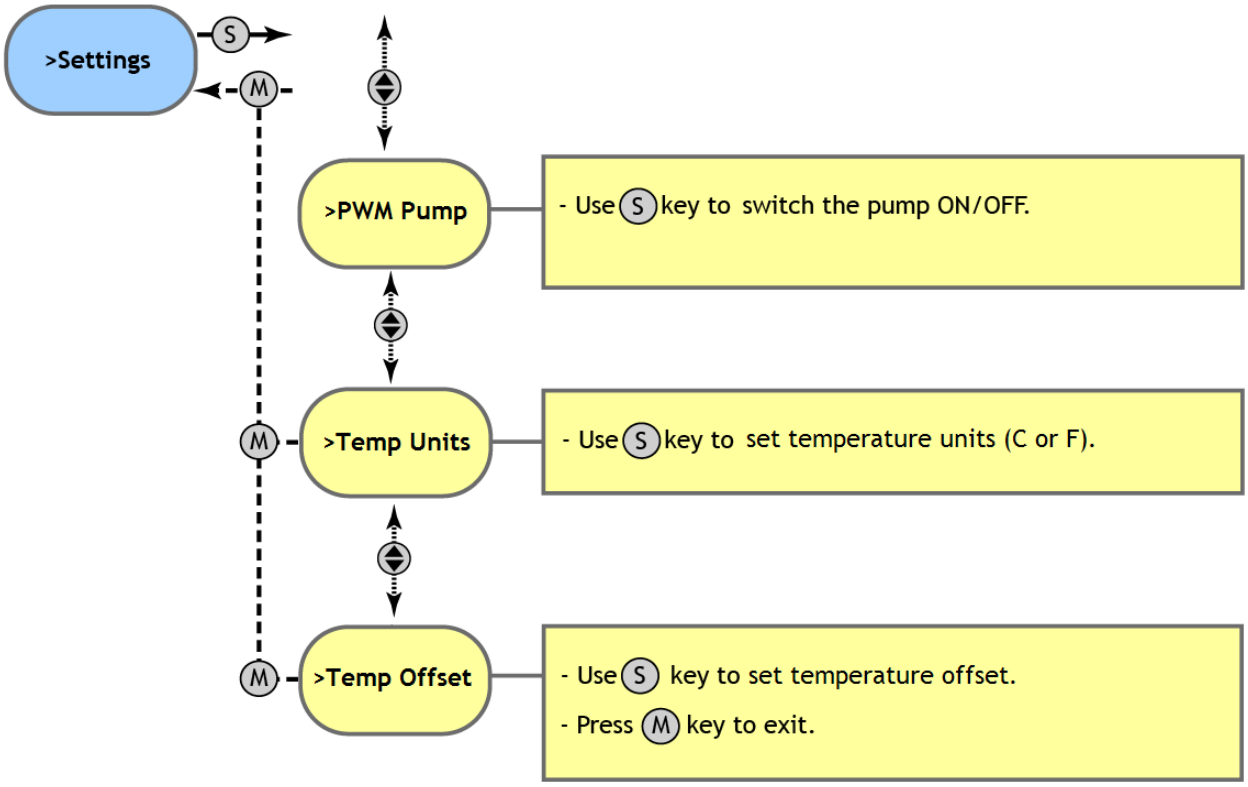


Menu Protocols→Edit→LightN→Run/Stop... Clone Config

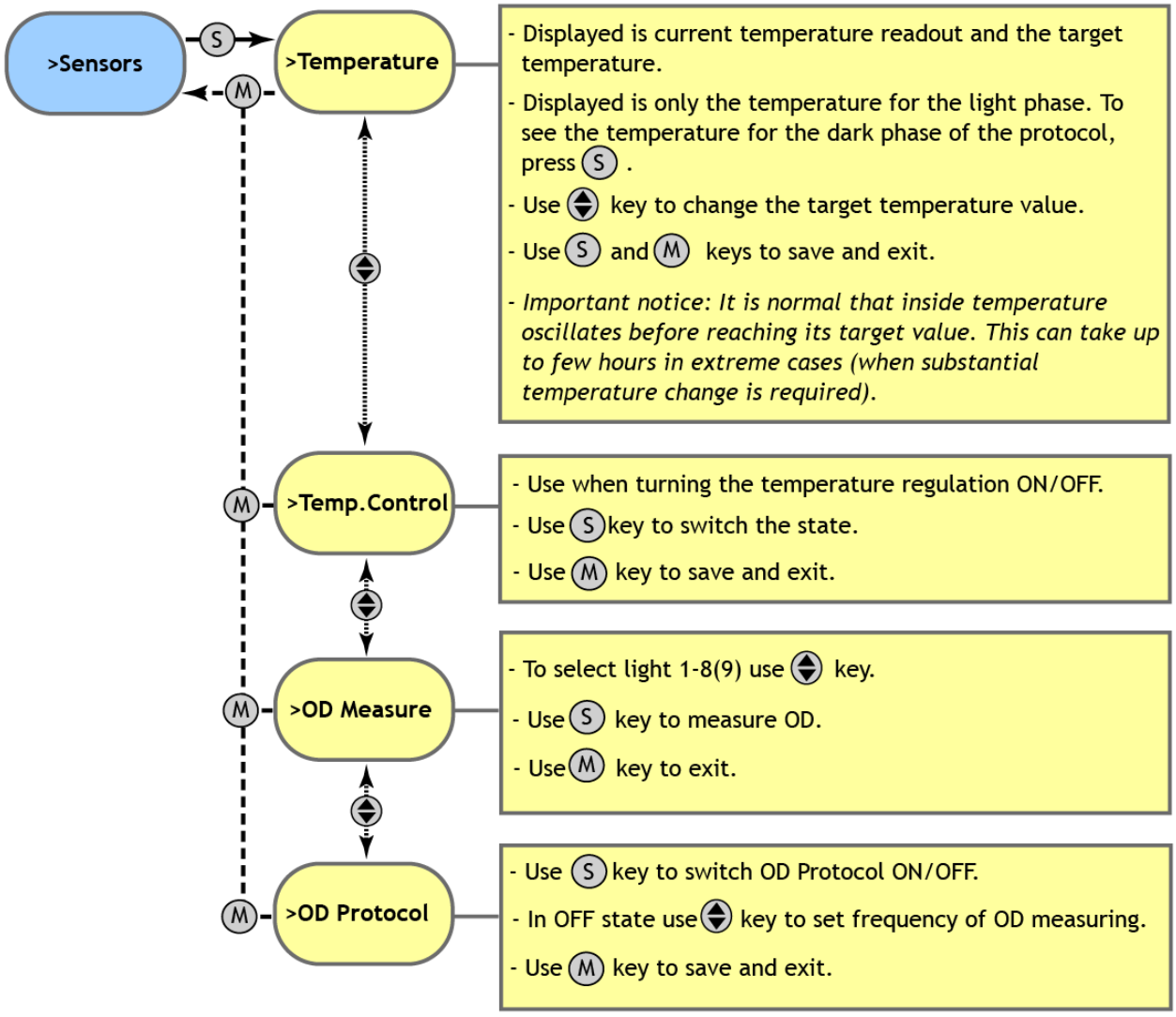




Menu Settings→PWM Pump ... Temp Offset



Menu Sensors



8.2 CONTROL MENU TREE – UPDATE VERSIONS

Please note that updated firmware versions are available for the MC 1000 and MC 1000-OD. Firmware versions might differ depending on the production date of the device. The Menu Tree Protocols might differ slightly for different versions of firmware from the Control Menu Tree described on page 39-48.

Please find below the description of the modifications for given firmware version based on production date. To find the production date go to Settings>Device Info.

Menu Tree – Protocols Versions for:

Firmware version from 9. 5. 2013 and higher

To start the protocol *FUNCTION*, *TIMING* and *START* must be defined. Follow the next steps to set the protocol.

- *FUNCTION* refers to one period.
- *TIMING* refers to Light Period (LP) during which the defined *FUNCTION* is performed, Dark Period (DP) refers to dark phase without any light illumination. This is repeated according to predefined number of repetitions or can be repeated forever with *REPEATFOREVER* function.
- *START DATE* – it is possible to set the start date to start/terminate the protocol. If the date is set to future, the protocol is waiting until desired start time is reached and the protocol is automatically initiated. If the desired start date is in past, the protocol is switched on and set to the phase where the predefined protocol is in the current moment. For example: If 16 h light/8 h dark daylight protocol is defined with start time from 7:00 am and the user starts the protocol at 11:00 am, in the *MENU PROTOCOLS-VIEW* the time displayed will be 4 hours, such that the protocol is already 4 h running.
- To *START* the protocol go to *RUN LIGHT x* in *PROTOCOLS-CONTROL*.

Firmware version from 22. 4. 2015 and higher

- *BUBBLE IDLE* allows to set a time period without gas sparging for the OD measurement mode. As the bubbles disturb the OD measurement the gas sparging is automatically stopped for this purpose for a while. As a default setting 4 seconds are used but the user can adjust this period in range from 2 up to 10 seconds.

9 TECHNICAL SPECIFICATION

Number of Cultivation Vessel Slots:
8

Volume of each Cultivation Vessel:
R100 ml (maximum recommended cultivation volume of each cultivation vessel is 85 ml)

Precision Controlled Temperature:
20 °C - 60 °C (20 °C are maintained when ambient temperature is 20 °C and light intensity is not above 30 µE)
15 °C – 60 °C (optional with AC-625 cooling unit)

Heating System:
One 150 W cartridge heater

LED Lighting:
Cool white LED lightning (optional with warm white LED´s or red LED´s)

Light intensity adjustable from 0 to 100 %

Maximum light intensity up to 950 µmol(photon)/m^2/s

Light Regime:
Static or dynamic (sinus, daylight, pulse form)

Display:
System control + actual readings

Controlled Flow of Bubbled Air:
Manual via manifold valves

Controlled Composition of Bubbled air:
Optional with purchase of GMS 150

Volume of Water Bath:
5 liters

Measured Parameters:
Optical density (OD) – optional (MC 1000-OD only)

Optical Density Measurement:
Real time measurement of OD by two IR LEDs (720 nm, 680 nm) per culture vessel. Measurement made at specified time intervals.

Detector Wavelength Range:
PIN photodiode with 665 nm - 750 nm bandpass filters

Bios:
Upgradeable firmware

Communication Port:
Serial - RS232

Material:
Glass, stainless steel, silicon gasket, polycarbonate

Dimension:
71 x 20,5 x 33 cm

Weight:
13.0 kg

Electrical:
110-240 V

10 WARRANTY TERMS AND CONDITIONS

- This Limited Warranty applies only to the Multi-Cultivator MC 1000 and MC 1000-OD. It is valid for one year from the date of shipment.
- If at any time within this warranty period the instrument does not function as warranted, return it and the manufacturer will repair or replace it at no charge. The customer is responsible for shipping and insurance charges (for the full product value) to PSI. The manufacturer is responsible for shipping and insurance on return of the instrument to the customer.
- No warranty will apply to any instrument that has been (i) modified, altered, or repaired by persons unauthorized by the manufacturer; (ii) subjected to misuse, negligence, or accident; (iii) connected, installed, adjusted, or used otherwise than in accordance with the instructions supplied by the manufacturer.
- The warranty is return-to-base only, and does not include on-site repair charges such as labor, travel, or other expenses associated with the repair or installation of replacement parts at the customer's site.
- The manufacturer repairs or replaces faulty instruments as quickly as possible; the maximum time is one month.
- The manufacturer will keep spare parts or their adequate substitutes for a period of at least five years.
- Returned instruments must be packaged sufficiently so as not to assume any transit damage. If damage is caused due to insufficient packaging, the instrument will be treated as an out-of-warranty repair and charged as such.
- PSI also offers out-of-warranty repairs. These are usually returned to the customer on a cash-on-delivery basis.
- *Wear & Tear Items* (such as sealing, tubing, padding, etc.) are excluded from this warranty. The term *Wear & Tear* denotes the damage that naturally and inevitably occurs as a result of normal use or aging even when an item is used competently and with care and proper maintenance.

11 TROUBLESHOOTING AND CUSTOMER SUPPORT

In case of troubles and for customer support, please, write to **support@psi.cz** or contact your local distributor.

ALPHABETICAL INDEX