The IceCube

Temperature Controller
with cooling capacity

Operator's manual

Life Imaging Services
Efringerstrasse 79
CH-4057 Basel
Switzerland
www.lis.ch
e-mail info@lis.ch
fon +41 61 711 6461

Table of Contents

1 A NOTE ON INSTALLATION AND SAFETY

The IceCUBE Temperature Controller should be installed on an even surface. Tilted operation will damage the cooler. Due to its weight of about 35 kg it is recommended to place it on the floor. Avoid bad posture when moving it around. **Attention!** If the placement on a shelf seems more convenient the stability for such a weight should be tested beforehand!

Placement should occur as close as possible to the microscope table to avoid long hoses and heat loss. Places with temperatures above +30° C or direct sun light should be avoided. Operation is recommended only in a dry and clean place.

The IceCUBE generates heat from the air heater and the cooling compressor. Allow a minimal space of 25 cm on each side for proper ventilation. Do not obstruct the grills. The metal enclosure reaches the set temperature during operation.

In case of obstruction of the ventilation the heater may reach 70° C inside before it is turned off by the built-in protection circuit. Therefore, no heat-sensitive material should be placed close to or onto the unit. The enclosure does not constitute a burning hazard when touched with bare hands under normal operating conditions. The stainless steel enclosure of the cooler compressor becomes cold during operation and water condensation may form.

The IceCUBE operates with a precision air heater placed on top of an air cooler. The heater generates the air flow for proper temperature control. **Attention!** Never leave the cooler operating when the heater fan is not blowing! This could lead to severe ice formation and serious damage to the compressor. The air cooler is designed for continuous operation and requires no special maintenance as long as air circulation is provided.

The ventilation grill on the left side has to be inspected regularly for dust accumulation. Dust deposits might hinder ventilation and cause overheating. Dust can be removed with a brush, with pressurized air or, more conveniently, with a vacuum cleaner.

Cooling generates condensation of water which is guided into the internal evaporator and expelled through the grill on the right side of the steel casing. Under circumstances more water is being condensed than the evaporator can take. This water is trapped in a shallow water tray below the evaporator. This can be released by opening the tap screw on the right hand side of the casing. During normal operation this tap should be closed. For prolonged regular use an appropriate hose can be fitted to it

and guided to a container or a drain.

The IceCUBE should be operated only with the air circulation hoses attached. Operation without the air circulation hoses can cause aspiration and subsequent ejection of small objects. Shut off the power and unplug the AC power cord before removing the hoses.

Do not reach into the connection ports to avoid touching hot parts and high voltage. Obstruction of the hoses may lead to excessive heat-up of The IceCUBE. When the temperature inside the enclosure reaches 70°C the built-in protection circuit engages and shuts off the main power of the heater automatically. **Attention!** When this occurs the air cooler needs to be shut off manually!

After automatic shutdown operation becomes possible only after unplugging the AC power cord and a cooling period of about 10 minutes. Inspect the hoses for clear air circulation and remove obstructions before operating again.

If the IceCUBE, either the heater or the cooler, does not operate after an automatic shutdown call LIFE IMAGING SERVICES for inspection.

The IceCUBE is specified to work only as a temperature controller together with The BOX microscope enclosure. It is not designed for other uses like drying or ventilation of any other equipment manufactured by a company other than LIFE IMAGING SERVICES. Any other use voids the warranty. Any collateral damages caused to other equipment or persons as a consequence or accidental by the misuse of the IceCUBE are solely the responsibility of the purchaser.

Attention! To prevent fire or shock hazard use the IceCUBE only in dry environment. If liquid is accidentally spilled on it immediately shut off its power and unplug the AC power cord. Allow sufficient time for complete evaporation to occur before operating the IceCUBE again. If the liquid is anything else than water (e.g. physiological saline or organic solvents) the IceCUBE should be examined by a qualified technician before power is re-applied. Do not remove the cover or attempt to modify or repair the IceCUBE yourself. Refer all service to LIFE IMAGING SERVICES.

2 FIRST INSTALLATION

The first installation is normally performed by LIFE IMAGING SERVICES or by an authorized dealer designated by LIFE IMAGING SERVICES. If the operator performs the first installation or the system is dismantled and re-installed on another location the instructions below should be read and followed carefully.

2.1 PREPARATION

The IceCUBE is composed of two appliances: a re-circulating precision air heater (blue) placed on an air cooler. Both appliances run on 230 VAC and, therefore, need two power cables. The power consumption is 600 W for the heater and 300 W for the cooler. Internal circuits are protected by miniature fuses 5 x 20 mm:

For the heater: 2x F 230VAC / 3.15 A

For the cooler: 2x T 230VAC / 6.3 A

The fuses for the heater are located in a small drawer just within the power socket on the back. Slide the fuse drawer open using a small screwdriver. Do not apply force.

The fuses of the air cooler are located in the switch/power socket combination on the front panel.

The heater is connected to the cooler via a black cable with a 3-pole XLR plug. This wire leads a 230 VAC signal that starts the operation of the cooler when the measured temperature at the probe drops to +28° C or lower.

If the measured temperature is above +28° C the cooler does not start even if the power switch is in the ON position. To cool after a heating episode the BOX should be thoroughly ventilated to cool down the internal air before effective cooling can occur.

Around room temperature (e.g. 22° C) heating and cooling can be operated simultaneously to achieve a very stable temperature control.

2.2 CONNECTING THE AIR CIRCULATION HOSES

After secure placing of the IceCUBE the air hoses should be attached to the corresponding ports on the BOX.

The side ports of the heater (heated air outflow) connect to the top ports of the BOX into the air filter sheets.

The front ports of the air cooler connect to the bottom ports of the BOX where the air is aspirated.

For demanding cooling down to about 12° C the BOX should be equipped with a PVC foam insulation (white material, 13 mm thick) and the air hoses should be insulated along the whole length with neoprene sleeves.

2.3 INSTALLING AND POSITIONING OF THE TEMPERATURE SENSOR

Plug in the cable of the temperature sensor into the socket on the front panel of the heater. Lead the temperature sensor through a cable port inside the BOX. Attach the self-adhesive holder onto the lamp arm and position the tip of the temperature sensor as close to the microscope stage as possible. The tip of the sensor should not touch any surface and should be kept clean for accurate temperature measurement.

2.4 INSTALLING THE SERIAL INTERFACE (OPTIONAL)

Connect the 9-pole Sub-D socket on the rear panel of the heater to a serial interface (RS232C) of your computer using a link cable (null modem cable).

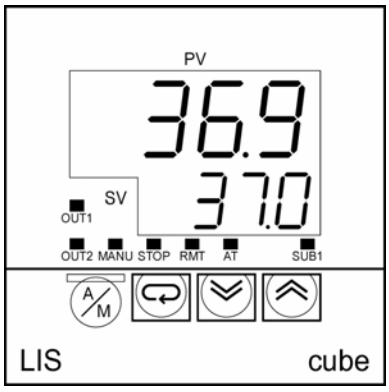
3 OPERATION

3.1 SWITCHING ON

Plug in both power cords into a 230 VAC/50Hz wall outlet or into a heavy duty extension cord. Switch on operating mode by pushing the switch located on the front panel of the heater. The red glowing of the switch confirms the presence of high voltage on the mains socket. By pressing the switch the temperature display lights up and the moving air from the rotating fan motor is audible.

If cooling is required push the power switch on the cooler to the ON position. Check the connection of the signal cable. The cooling starts as soon as the temperature drops below +28° C.

3.2 SETTING THE TEMPERATURE



The temperature is set by pressing the arrow keys below the LED display on the front panel of the heater. The up and down keys allow to scroll from 0°C to 45°C in steps of 0.1°. The current real temperature is shown in the red main display. As soon as the set temperature is reached the color changes first to yellow, then green. The smaller green digits below display the set temperature. The temperature control operates in real time and there is no need to confirm the set values by pressing an enter key.

The OUT1 indicator flashes with the control period of the controller. The relative duration of the flash indicates the duty cycle of the output. The other keys and indicators are not used in normal operation mode. Their function is described below.

When the cooler starts after an incoming signal from the heater below +28° C the red SUB1 indicator lights up permanently.

The best temperature setting for accurate feedback control is about 5° above ambient temperature. The maximal temperature setting allowed is 45° C. Around room temperature (22° C) best results are achieved when both heater and cooler are operating simultaneously. The cooling capacity of 300 W allows cooling to about 10° C below room temperature. However, effective cooling can only be achieved with an insulated BOX with insulated air hoses. The maximal reachable absolute temperature is then around +12° C.

The IceCUBE features a fast and precise PID controller. The PID parameters are continuously optimized by a fuzzy-logic algorithm. However, when starting the system from room temperature a heating phase (3 hours at least recommended) should be allowed to achieve a homogeneous equilibration of all parts inside the BOX to the desired temperature. Both the heater and the air cooler are designed for continuous operation. To avoid long idle times and thermal stress of the microscope's optical components it is recommended to leave the IceCUBE on unless it is not used for several days.

3.3 SETTING THE FAN SPEED

The heater is equipped with a fan speed control. The control knob is located above the main switch on the front panel. With the knob turned fully counter-clockwise (min) the fan runs at about 2,000 rpm and at about 6,000 rpm in the fully clockwise position (max).

The typical setting for most imaging experiments is in the center (5). For heating up a microscope from room temperature the first time the fan can be set to maximal speed. This creates a rapid air circulation and allows reaching an even distribution of warm air in shorter time. After reaching a steady state (allow at least 3 hours for warming the whole microscope) the speed should be set to 5 again. The temperature controller will adapt its parameters to this air flow.

In some rare occasions, depending on the sensitivity of the whole microscope setup and image magnification, some sub-micrometer vibration artifacts might be observed in the images when the fan speed is set too high. In these cases the fan speed can be set to lower values thus shifting possible resonance frequencies that are being picked up by the stage components. Allow enough time for the temperature controller to adapt its parameters to the reduced air flow.

3.4 ADDITIONAL KEYS AND INDICATORS

The RMT (remote) indicator lights up when the IceCUBE is controlled externally through the serial port. The A/M key, the menu key (recycling symbol), and the OUT2, MANU, STOP and AT indicators are not used in normal operation mode. The SUB1 indicator lights up when the cooler is operating.

3.5 SECURITY SETTINGS

By pressing the A/M key and the menu key for 3s, you enter the protect mode. (display SECr). The basic setting is security level 5 which enables access to the set temperature only. To block users from changing the set temperature, increase the setting to security level 6

Security levels lower than 5 must not be set unless so instructed by LIFE IMAGING SERVICES. Security levels 0 to 4 enable access to control parameters which may prevent the IceCUBE from operating safely if set inappropriately.

(Pressing the menu key enables access to the A/M key protection(display AEYP). Leave the protection on).

Press the A/M key and the menu key again for 3s to exit the protect mode.

3.6 READ-OUT OF THE ACTUAL TEMPERATURE WITH THE COMPUTER

If required, the actual temperature can be monitored using the serial interface. For technical details please contact your dealer.

4 MAINTENANCE & CLEANING

Both heater and cooler are designed for continuous operation with no special maintenance required. After prolonged use dust deposits may form on the grill on the left side of the air cooler which can be removed by wiping the enclosure with a brush, by blowing with compressed air or by aspiration with a vacuum cleaner.

The cooler should be inspected periodically (once a month recommended) for ice formation which can damage the compressor. This usually occurs only when air circulation is poor or the air is very humid (e.g. after rain storms). To this end the heater can be lifted by hand without the use of tools. Through the 100 mm opening and with a flash light the cooling cavity can be inspected. If visible ice formation has occurred switch off the compressor and allow enough time for complete thawing of the ice.

Excess condensation water can be trapped in the tray underneath the evaporator. Occasionally the outlet on the lower right side should be opened to release the water if no hose to a drain is connected.

5 APPENDIX

5.1 CALIBRATION OF THE CONTROLLER AND THE TEMPERATURE SENSOR

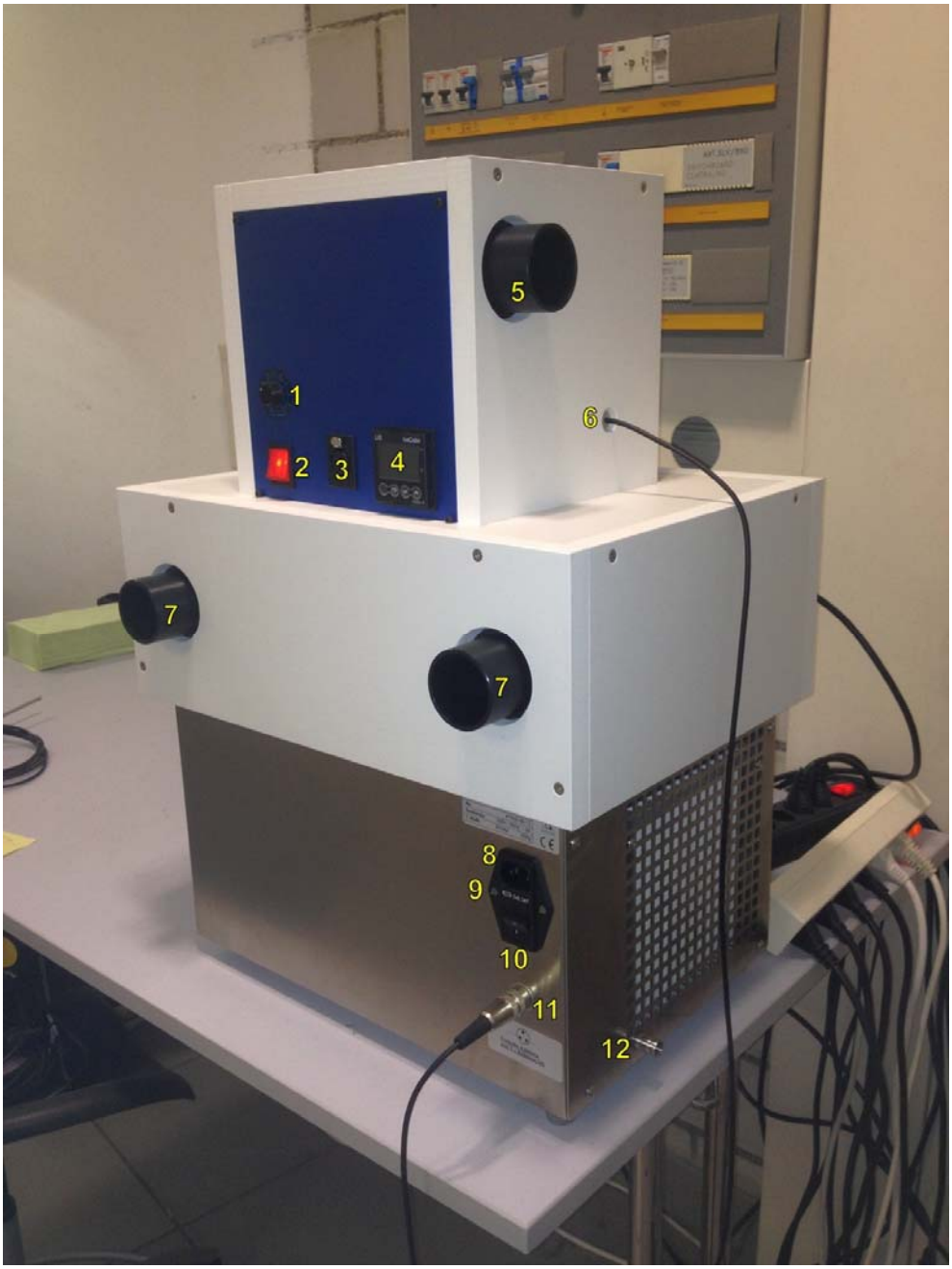
Use the Pt100 platinum resistance sensor that came with the IceCube. The basic accuracy is ±0.3°C at 0°C (EN 60751 class B). Repeatability and drift per year are typically <0.1°C. The controller and the sensor are calibrated by LIFE IMAGING SERVICES to ±0.1°C at 37°C. Contact LIFE IMAGING SERVICES if recalibration is required.

5.2 PROGRAMMING THE CONTROLLER

More than 50 parameters are available to adapt the controller to different situations. Programming can be performed directly (after enabling access in protect mode) or via the serial interface

 Inappropriate parameters settings may prevent the IceCube from operating safely!
Therefore, parameters may only be changed upon instruction by LIFE IMAGING SERVICES.

5.3 FIGURE



1	Fan speed setting	2	Mains switch heater
3	Socket for temperature probe	4	Temperature display and setting
5	Air out, for air hose to Box	6	Signal cable for cooler
7	Air in, for air hose from the Box	8	Mains socket cooler
9	Fuses	10	Mains switch cooler
11	Socket for signal cable	12	Water outlet