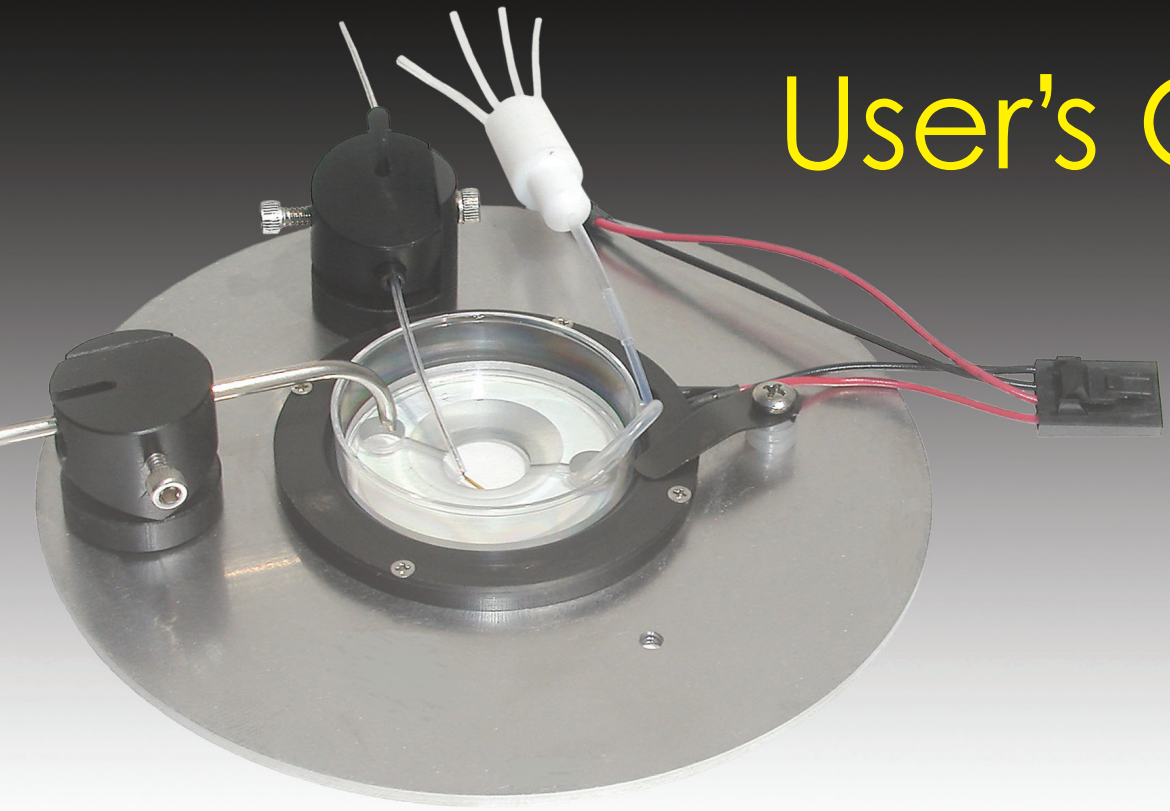
Temperature Control

User's Guide



Heated Microscope Stages & Objective Heaters

- **Precise Temperature Control throughout the experiment**
- **Conditions similar to** *in vivo*
- **Compatible with any perfusion system**
- **Heating stages for any microscope**
- **Compatible with Imaging systems**

Bioscience Tools

Ph: 877-853-9755
www.biosciencetools.com

Contents

CE

Specifications

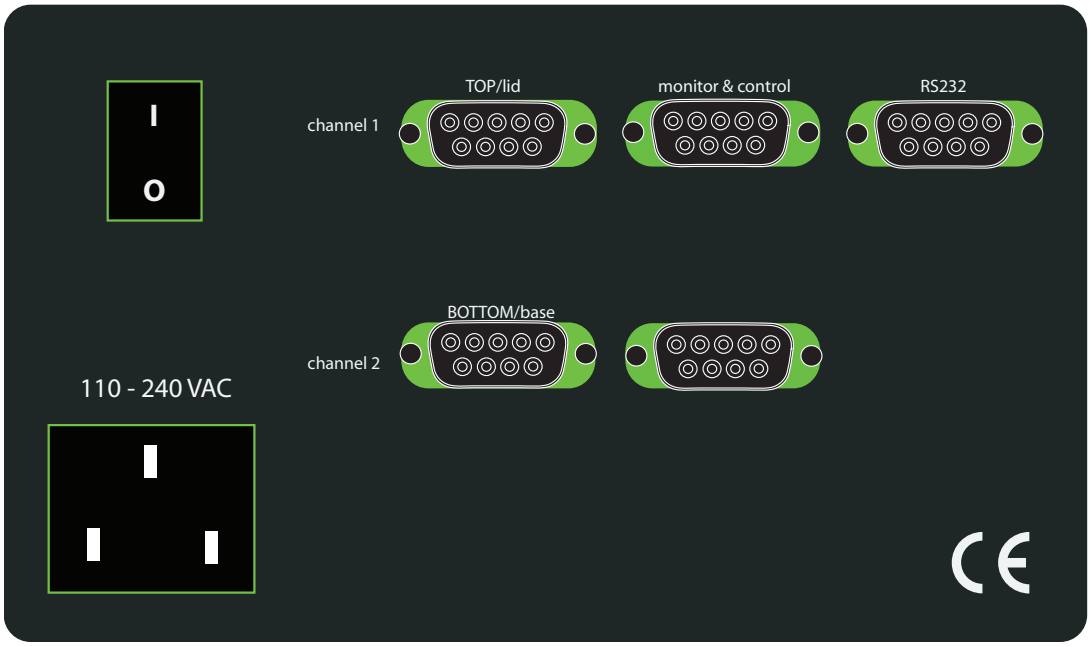
Range up to 150ºC
Accuracy 0.1ºC
Stability 0.01ºC, required for sensitive applications: nano & piezo positioning, TIRF & AFM
Output 12V 4A max per channel (24V optional)
Settings regulate output from 0 to 150W per channel, to prevent temperature overshoot and to provide dual overheating protection
No electrical noise suitable for electrophysiology
No vibrations no internal fan
Temperature sensors
built-in STAGE sensor
optional external BATH (0.87mm)
Selectable Feedback
from STAGE or BATH
adjustable DC and AC GAINs, self-adjusting
Analog Input
Input analog voltage to SET temperature;
Analog Output
To monitor temperature:
Overheating protection
RS232 port, optional software
to set and monitor temperatures
Size (Controller) : 8Wx4Hx9D in.
Power Supply
100-240VAC 150W

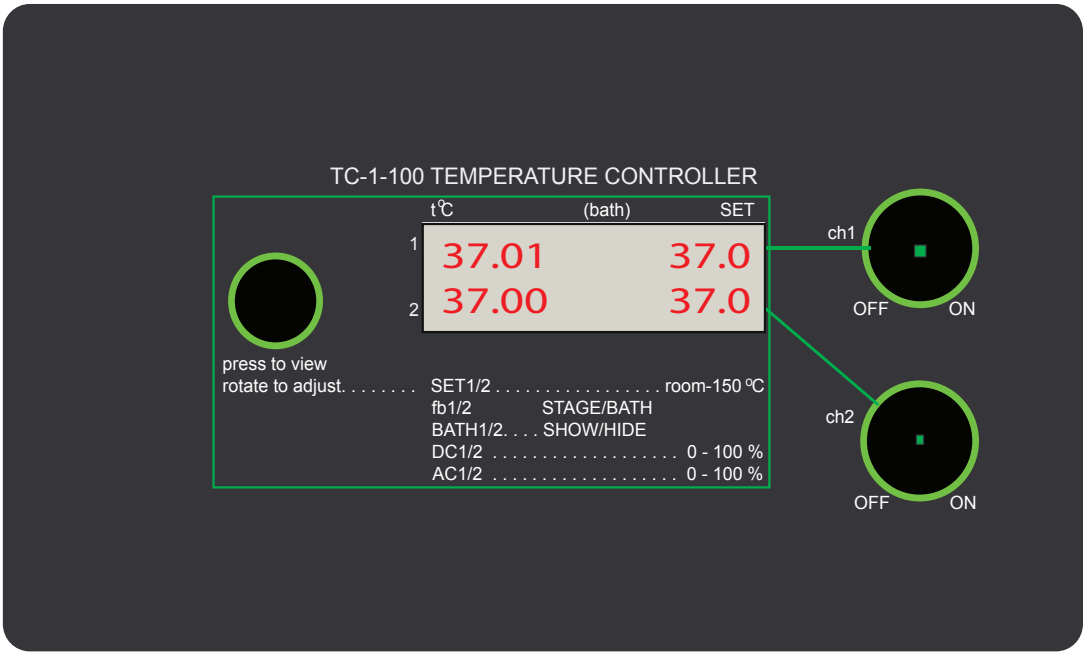
Introduction

The complete temperature control system includes a controller, an optional external temperature probe, and connecting cables to the heating elements. All heating elements include a temperature sensor built inside the element - STAGE sensor. This internal sensor is used for FEEDBACK. It is also used to prevent accidental overheating of the sample. Most heating elements can be used as inline pre-heaters, if connected to a perfusion systems. If used with a microscope stage, a microscope adapter might be required to fit the heating elements to your microscope stage. The following is an illustrated installation guide and example configurations of temperature controlled setups.

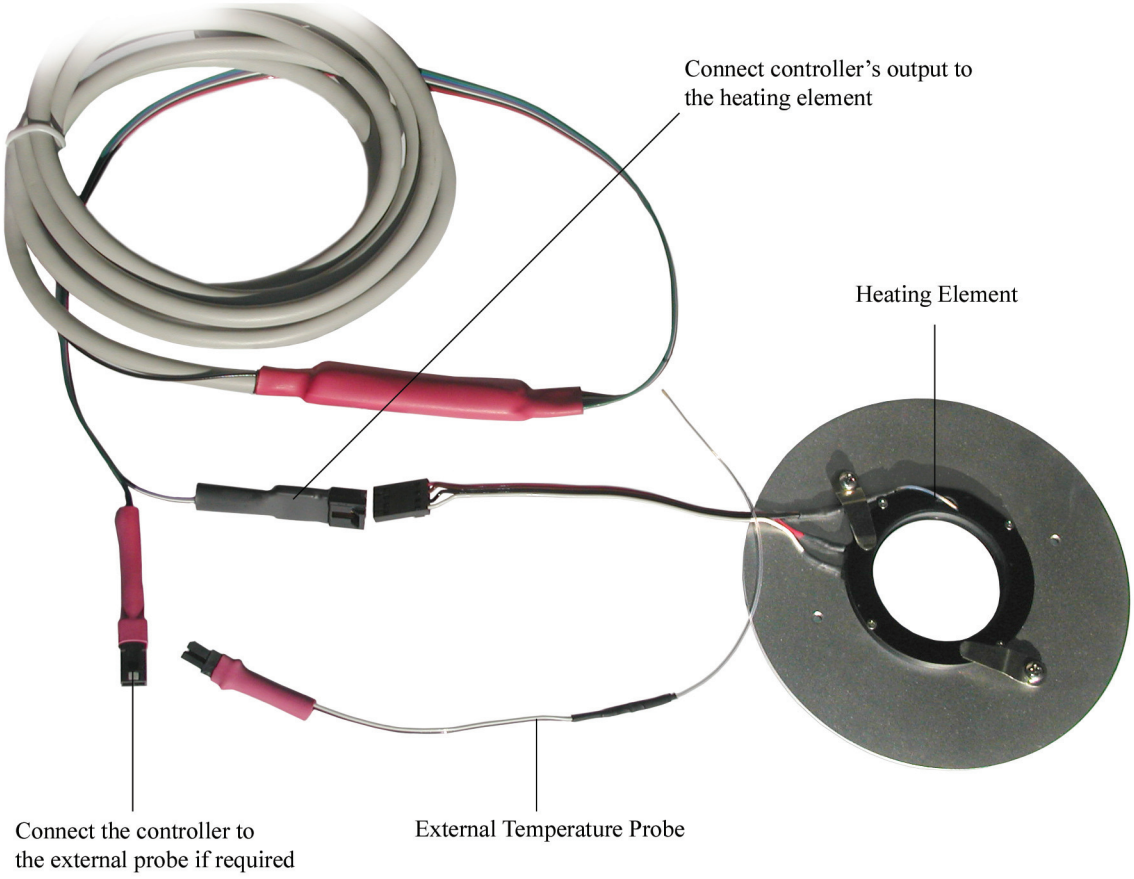
Installation Guide

1 Connect power cable. Plug the power cable into wall outlet. Plug the heating stage cable into the output connector on the back of the controller - DB-9 female connectors - TOP for channel I, and BOTTOM for channel II.

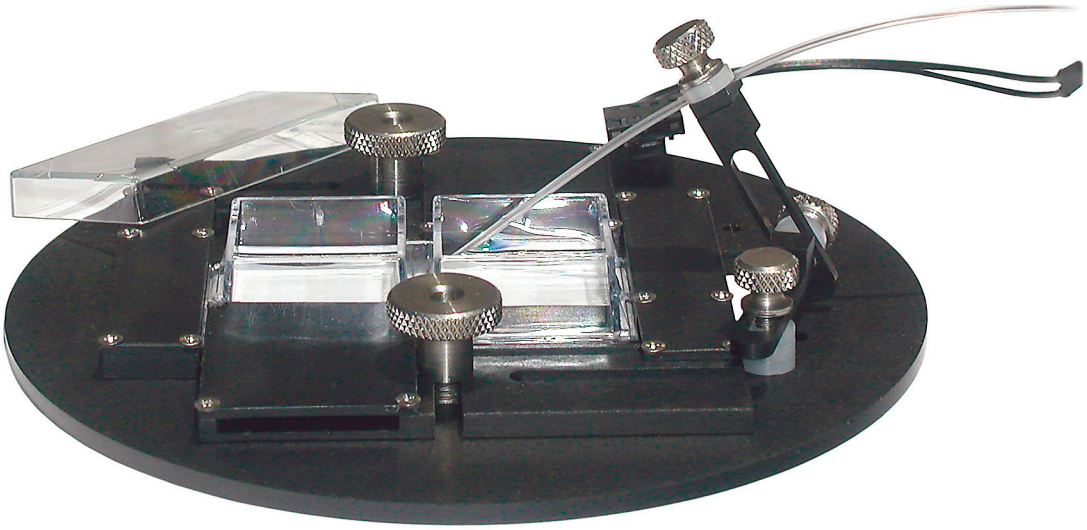




2 Connect the output cable to the heating element/stage and external temperature probes, if used.



3 Prepare the sample chamber, petri dish for example, by filling the chamber with water. Using optional adjustable holder, position the external temperature probe inside the chamber - optional BATH probe. You do not have to do this initial setup procedure while the heating stage is on the microscope. Use a desktop instead. You can transfer the heating stage on the microscope after you are familiar with the system. Turn the controller ON - power switch on back.



4a The controller has one LCD temperature monitor, and SET dial, which allows you to adjust the reference temperature by rotating SET dial - BLACK knob on front. You can also choose which sensor to use to provide FEEDBACK to the controller. Two knobs next to the display will put the controller from STANDBY to ACTIVE operation for channel I and channel II . The controller ships set for feedback from STAGE sensors, with setting adjusted to provide stable operation at 37ºC.

Now you can switch the controller from STANDBY state into ACTIVE state (ON/OFF switch) and observe on the display how the controller regulates the temperature of the heating stage.

GREEN LED inside the knobs will indicate that the controller is functional. The controller ships with settings adjusted. If the controller does not stabilize at the required temperature, you can increase/decrease DC level until temperature stabilizes near the SET level.

Push to click SET button. The display will show:

SET1 37.0

click again, to show:
SET2 37.0

if you rotate SET dial while the display shows SET1 or SET2, you can adjust SET temperature for channel I and II respectively. If you push the button again, you will be able to select feedback between STAGE sensor and external BATH probe for channel I:

fb1 STAGE; and if you push again - for channel II:

fb2 STAGE; If you select feedback from BATH probe, letter "f" will show on the display to indicate the BATH probe was selected to provide the feedback to the controller.

Click the button again to display:

bath1 SHOW

if you rotate SET dial now, you can make the display to show/hide reading from the external probe if used. If the display indicates:

bath1 HIDE, no BATH readings from the external probe will be shown, even if connected.

Click again until the display shows:

DC1 % 15

at this point you can increase/decrease DC level to reach the required temperature level. If the temperature stabilizes at level higher/lower than SET level, decrease/increase DC level.
Click again to adjust AC levels. NOTE: AC level is usually set to 4%, although less values might provide more stable operation.

AC% 4

NOTE: AC levels below 1% (0.9% for example) are used to prevent temperature overshoot for small sensitive heating elements like objective heaters. Levels down to 0.1% might be used for very sensitive custom heating elements or for very high SET temperatures. Eliminating temperature overshoot provides some extra overheating protection for your sample. You can also select HOT temperature threshold level below default 150 degrees, by pressing the dial again to display:

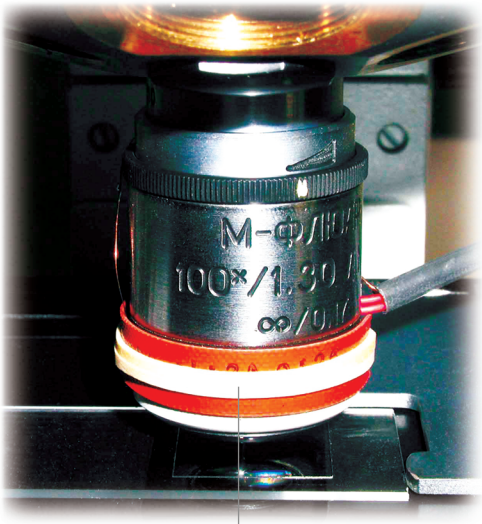
HOT tºC 45.0

After reaching this threshold, the controller will turn heating OFF (if STAGE overheats above the threshold). The overheating threshold is also used with feedback from BATH probes, to prevent the sample overheating due to customer error - due to failure to keep the external probe inside the sample for example.

Although the heaters tested and the controller is adjusted before shipment, the controller might need to be adjusted again after installation (attaching the heater to the objective for example):

First, turn heating ON with factory adjusted settings. Heating is turned ON by pressing the knobs on the front panel. The controller starts self-adjusting (tuning) to stabilize around SET temperature level. If tuning takes too long, press the front knob to display DC% level. DC% level can be adjusted manually, if temperature does not reach SET level fast enough, or stabilizes below/above SET level: increase/decrease gradually DC level in steps not more than 0.5% until temperature stabilizes at SET level

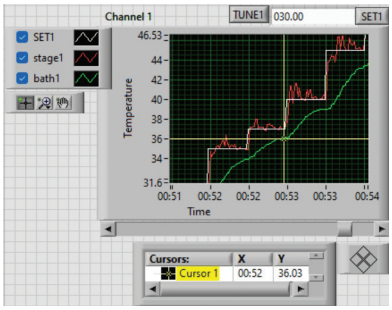
This simple setting procedure will make systems with built-in temperature sensors functional within a few minutes. Setups with heating elements surrounding your sample, heaters for petri dish or chambers for coverslips for example, might require additional steps to achieve the correct temperature around your sample.



Objective Heater

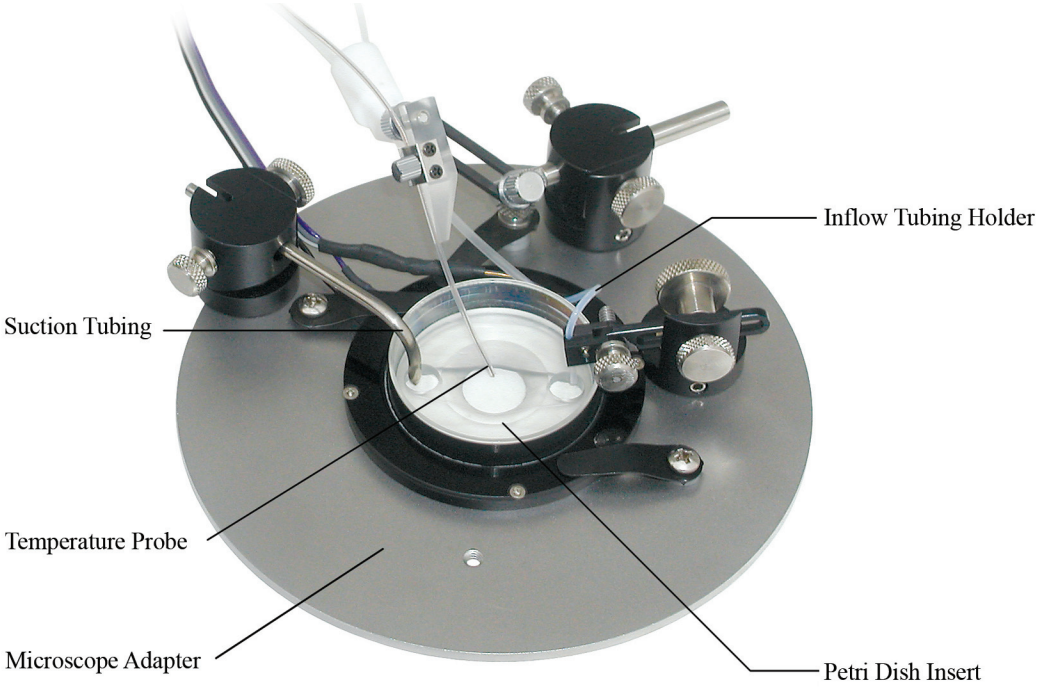
Uniformly Heated Bottom

Since samples in the petri dish are located at some distance from the heating element, the temperature of the sample will be different from the temperature inside the heating element - this is called “temperature gradient”. If you use an external probe to display BATH temperature, you will see this difference, provided the external temperature probe placed inside the sample chamber. You can achieve the required temperature in the sample chamber by increasing SET reference level to compensate the offset temperature difference between heating elements and solution inside sample chambers. Below is an example of temperature recordings from STAGE sensor (red) and BATH probe (green) placed inside the sample. The bath temperature is around one degree below the stage temperature. However, by adjusting SET reference higher to offset this gradient, the bath temperature can be elevated to the required level:



Using an objective heater with oil or water immersion objectives will eliminate this temperature gradient. The second channel of the controller is usually used to regulate the temperature of the objective heater, which has a built-in temperature sensor and does not require too much of fine tuning.

The chambers with uniformly heated bottom, TC-HB for example, usually do not generate undesirable temperature gradient.

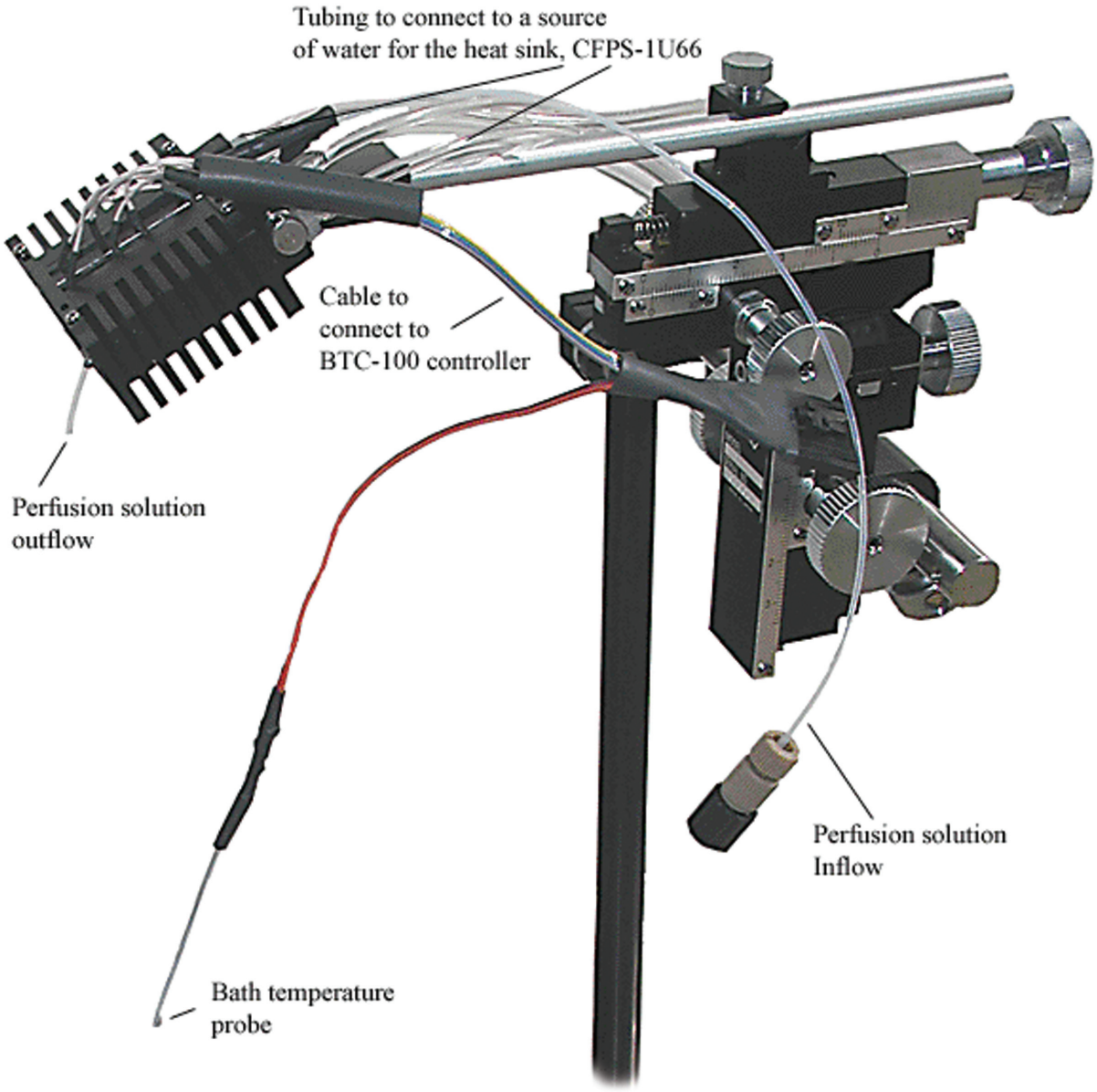


4b Another way to achieve the correct temperature around your sample is to switch the feedback of the controller to BATH temperature sensor. This might result to temperature fluctuations, however. NOTE: it is recommended to use feedback from STAGE first, so the controller can be tuned to required temperatures inside the heating element (read about compensating OFFSET/gradient temperature and overheating threshold above and below).

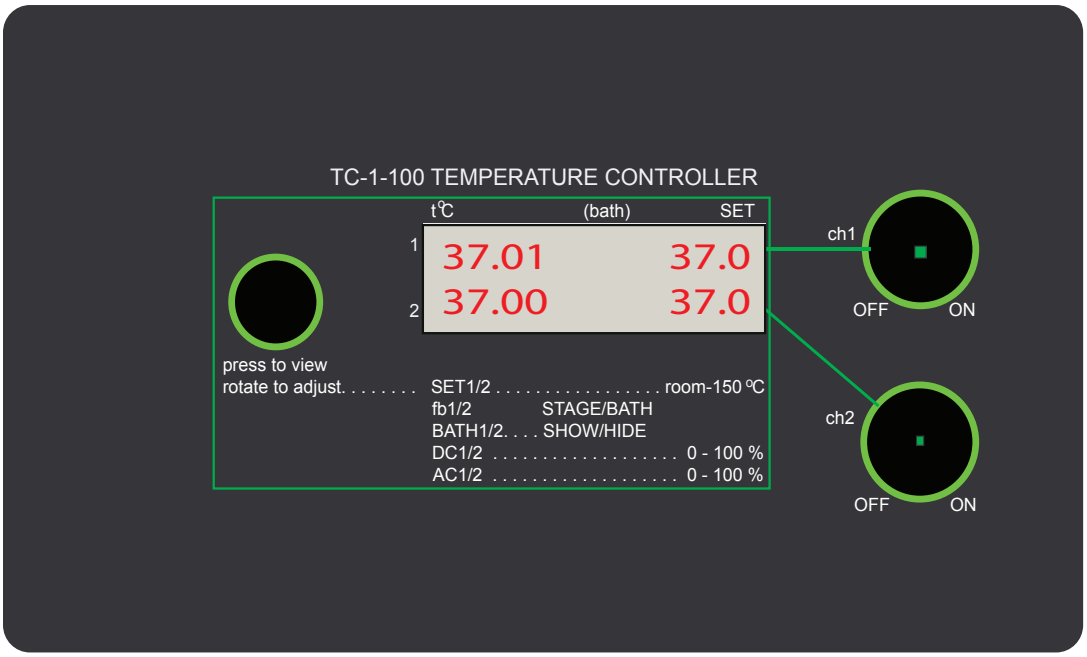
1. Switch feedback to STAGE. If the bath temperature stabilizes at a level different from required temperature level, increase/decrease SET temperature or DC level slightly, until you read the required BATH temperature. For example: if BATH readings are 36.2 C while SET level is 37.0, try increasing SET level to 37.8 and observe if BATH readings are near 37.0 after the system stabilizes. Repeat if necessary. 2. Switch the controller to read feedback from BATH probe.

The setup procedure needs to be done only once before using the system. Changing the sample configuration, like volume of solution, might require settings adjustments. One way to readjust the system is to change DC/AC FEEDBACK GAIN. Another is to change SET reference level. Note: more stable operation is achieved by switching to STAGE feedback and increasing SET temperature to off-set the temperature gradient.

4c Using continuous perfusion of your sample helps to eliminate the undesirable temperature gradient in the system. Note: if flow rate in the system does not change, better temperature stability might be achieved by switching the controller feedback to heating element sensor STAGE, and adjusting SET temperature to a higher level, so that the BATH temperature is still at the correct point. This trick of using STAGE probe for feedback might be used without perfusion as well. Using STAGE sensors for feedback usually provides more stable configuration with minimum temperature fluctuations. The miniature perfusion unit TC-RD (below) is used as a preheater or cooling unit during sample perfusion. It connects to the second channel, or a separate controller

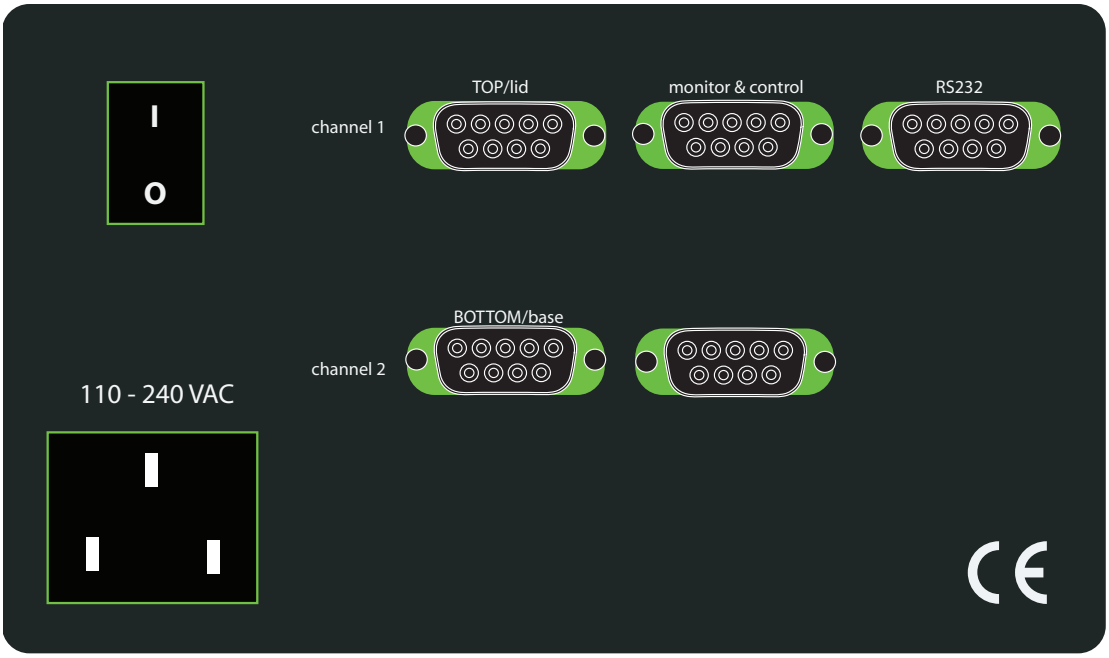


TC-1-100 Front Panel Controls



Front Panel Controls	
LCD display	Display temperature readings from temperature probes, and shows SET temperature.
Display Switch (knob)	Switches the display to show settings by pressing the knob down: each click will switch to adjust different parameters.
SET dial (knob)	After the display shows the parameter, rotating the knob will adjust the parameter.
STANDBY switches (ON/OFF)	Provide POWER to the heating stages, ON/OFF.
GREEN LEDs	Indicate POWER provided to the heating elements.

Outputs and Back Panel



Outputs	
Output TOP/BOTTOM	Connect to STAGE cables to provide power to the heating elements and to provide temperature readings to the controller. TOP female DB-9 connector for channel I, BOTTOM - channel II
MONITOR & Settings	DB-9 male connectors to monitor temperature readings 0V=0ºC; 10V/150ºC: pin 3 - STAGE, pin 8 - BATH, pin 7 - GROUND.
RS232	DB-9 male connector, use NULL MODEM cable.

Back Panel Controls	
RS232 DB9	Set reference temperatures and reads sensor temperatures.
settings DB-9	pin 1, EXT temperature settings (10V/150ºC, 0V = 25ºC) pin 7 - GROUND pin 3 - STAGE readings, pin 8 - BATH (0 to 150ºc = 0-10V)
POWER jack and switch	Connects to 100-240VAC

Warranty

This product is warranted to be free from defects in material and workmanship for the duration of one year. Normal wear, or damage resulting from abuse, accident, alteration, misuse, service by an unauthorized party or shipping damage, are excluded from this warranty and are not covered. Bioscience Tools will repair or replace the defective product covered by this warranty free of charge if it is returned, postage prepaid, to Bioscience Tools, ph: 1-877-853-9755.

Software control and monitoring

Using a DB-9 null modem cable connect the controller (DB-9 connector marked RS232) to a serial port of your computer (USB adapter can be also used). Set the serial port at 115,200 speed, 8 bits, 1 stop bit, NONE parity. The following is the list of text commands supported. NOTE: Each command should follow by \n, <CR>, or “Enter” code (decimal 13):

T1<CR> returns temperature readings from STAGE1 sensor: T1- 037.10ºC

T2<CR> returns temperature readings from BATH1 sensor: T2 - 036.90ºC

T3<CR> returns temperature readings from STAGE2 sensor: T3 - 037.10ºC

T4<CR> returns temperature readings from BATH2 sensor: T4 - 036.90ºC

T5<CR> returns SET1: T5 - 037.00ºC

T6<CR> returns SET2: T6 - 037.00ºC

S10 37.0<CR> sets reference temperature for channel I to 37.0

S20 37.0<CR> sets reference temperature for channel II

OFF1/0<CR> pauses programmed protocol execution - OFF1, and continues - OFF0

ON1/0<CR> starts/stops programmed temperature sequence. Optional software package is required to program sequences

CT<CR> will return SET1, stage1, bath1, power output 1 (%), SET2, stage2, bath2, power output 2 (%) in sequence after each CT\n command. To get all eight readings, the command has to be sent eight times.

Automation Software, TC-SOFT

This Windows based software package allows to program TC-1-100 and TC-1-100i 2-channel controllers to automatically tune within wide temperature range, to run temperature sequences (up to eight steps), including ramps, and to save and read temperature log files in Excel format. The graphical presentation of the temperature recordings allows to visualize and measure data using ZOOM features and moveable cursors.

Programming features allow to built the sequence protocol for each channel independently, with sec, min or hour resolution, up to 999 hours long for each step. The sequence can be visualized before execution. It is automatically stored in the controller memory, and retrieved by the program. The protocol can also run as a loop continuously. The protocol execution can be PAUSED in the middle of the protocol.

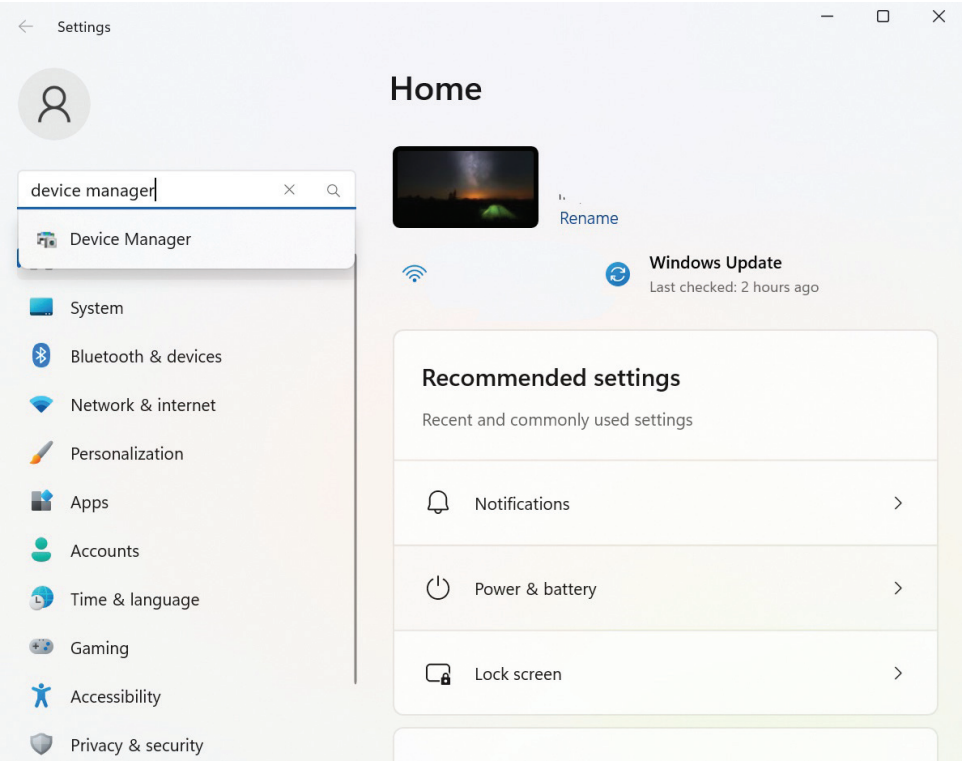
The package comprises two major parts: hardware control (including recording log files) and reading the log files. The first part also allows to edit and execute the temperature protocols, and to tune the controller to work in wider temperature range.

After purchasing, a link to download the installation package will be sent by email. Ships separately: USB adapter and RS232 NULL MODEM cable to connect to the controllers.

Quick Tour

Configure USB port

Insert the provided USB adapter into available USB port on your computer. Go to Windows **SETTINGS** and type "device manager" inside SEARCH window, and select **Device Manager**:



In **Device Manager** window, find **Ports (COM & LPT)** listed, and extend this list to show:

USB Serial Port
Double-click on this port to open another window to adjust the port settings. The port should be configured to the following settings:

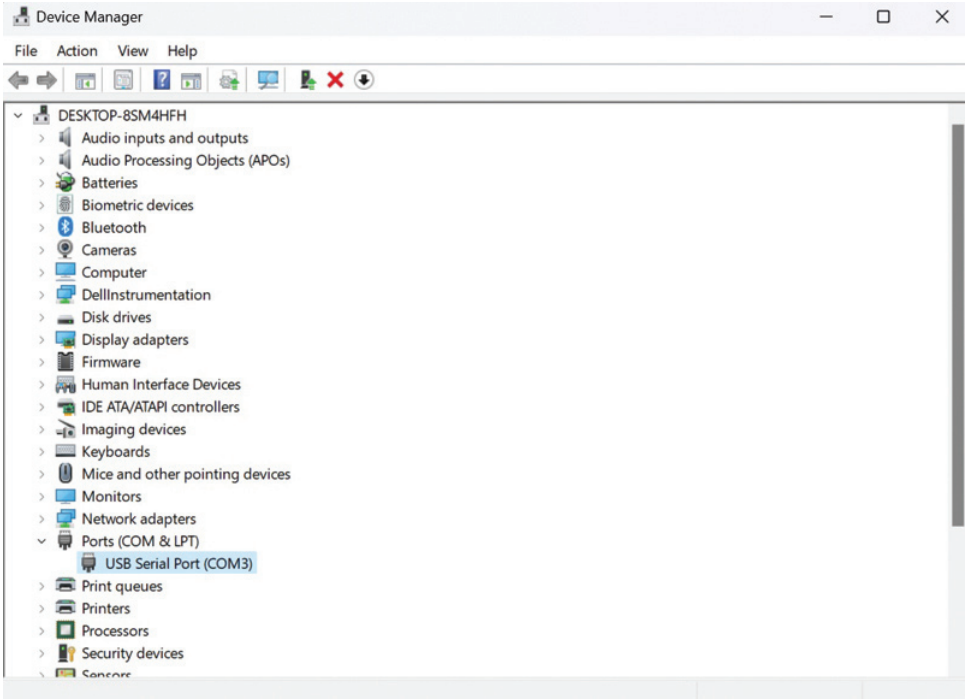
Bits per second: 115,200

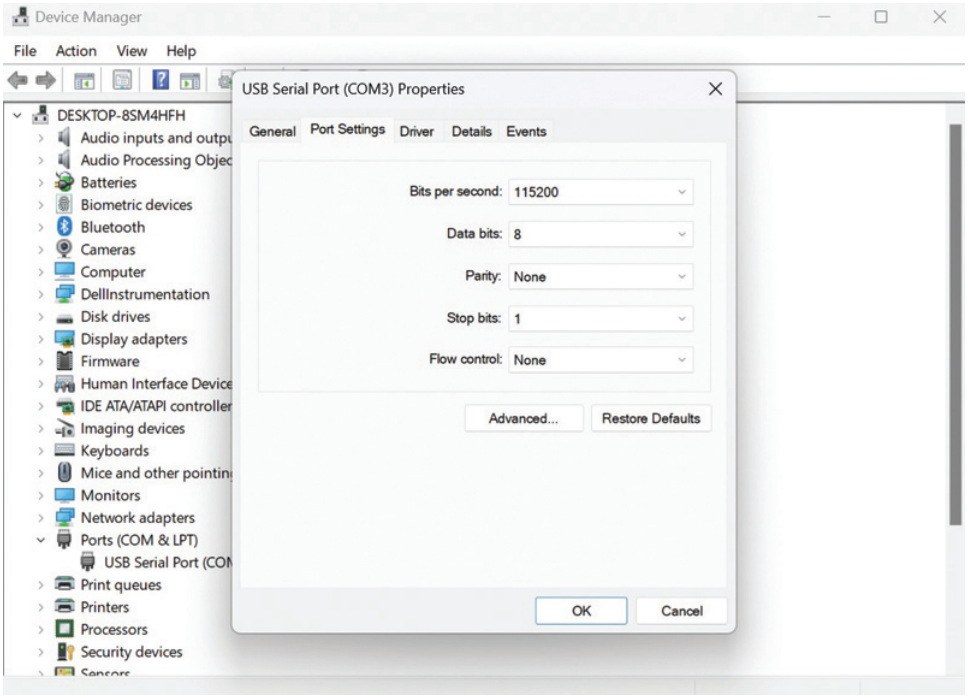
Data bits: 8

Parity: None

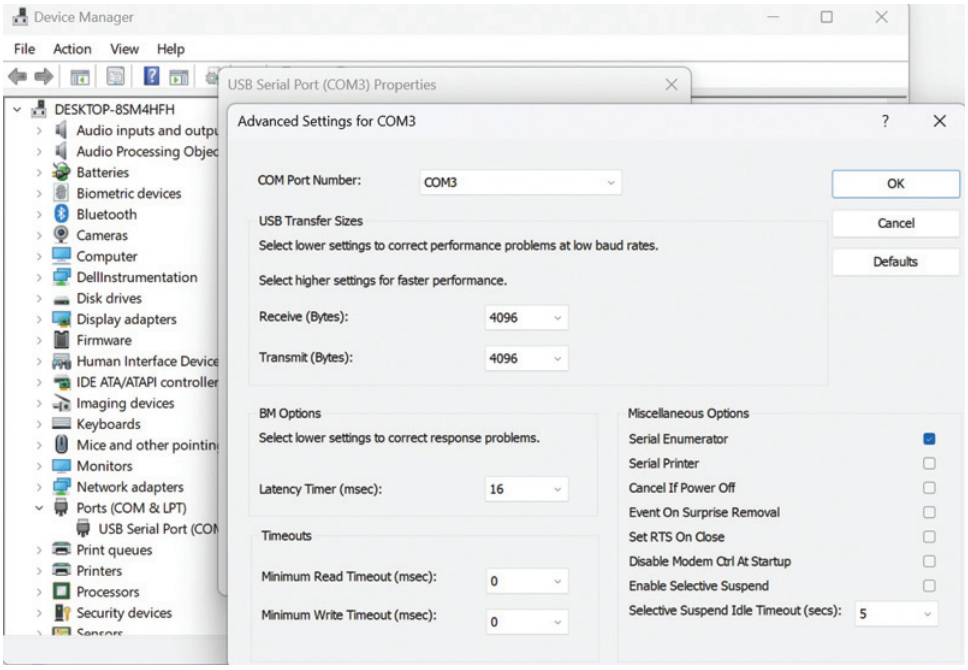
Stop bits: 1

Flow control: None





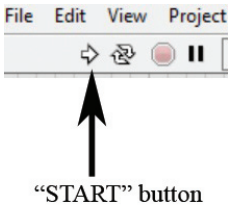
Click button “Advanced”, select the number for the port “COM3”. If for some reasons COM3 is not available, you need to contact us to readjust the software to use another port name/number. Click button “OK” to save the changes and close the window. Click button “OK” again on the next window and close **Device Manager** window and Windows **Settings** window. Connect the provided NULL-MODEM cable to the USB adapter and to the controller.



Before using the software package, the controller has to be powered ON. Otherwise, it will not be recognized by the software.

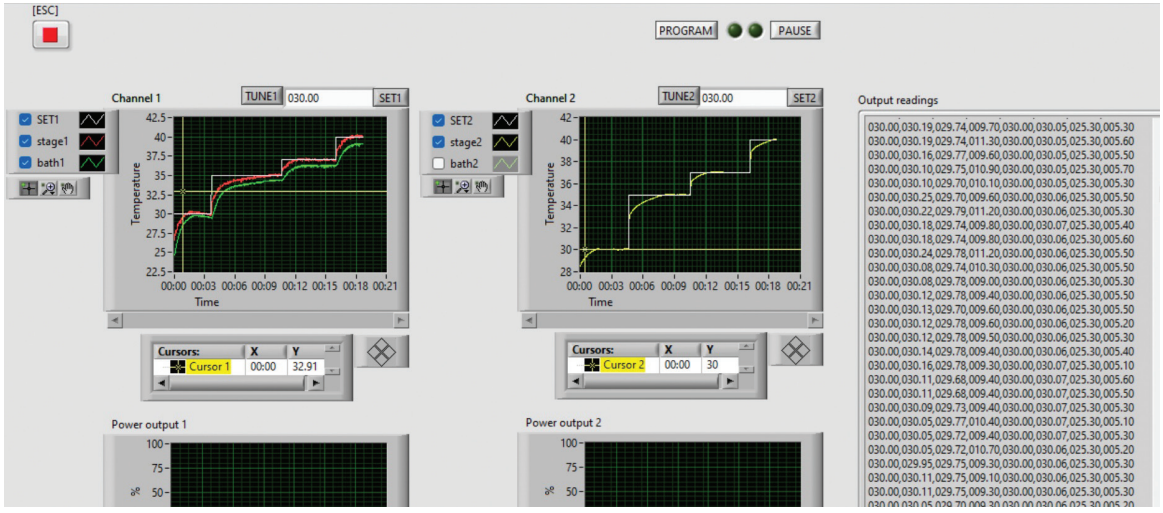
Start recording

After double-clicking the executable file, TC_WRITE.exe, a general window will open. There are two graphs to show temperature readings from both channels of the 2-channel controller, and a separate area to show readings in real time as a text file. To start recordings, click “START” button on the top of the widow:



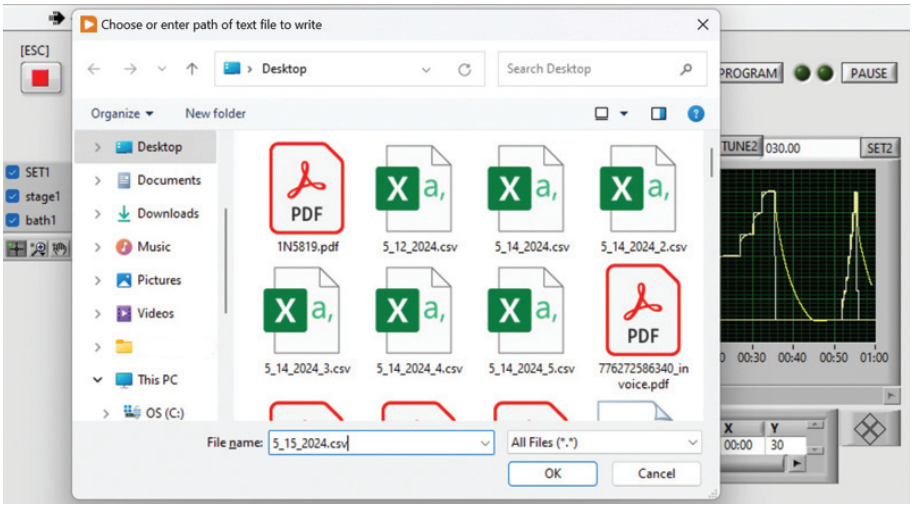
The graphs will start showing changes in stage and bath temperatures, as well as in reference SET temperature. In case the heating element (stage) or the temperature probe (bath) are not connected, the room temperature will be recorded. A recording can be hidden by un-checking the corresponding box on the left side of the graph.

SET reference temperature can be changed by typing new values in the field above of the graph, and clicking button SET1/SET2. The controller should adjust itself to the new SET values automatically. However, if the temperature cannot reach the higher SET level, click button TUNE1/TUNE2 to switch the controller into TUNE mode. This should result in gradual increase in temperature of the heating element, provided the controller has powerful enough power supply.
The graph, that is below the temperature recordings, is the power output, showing percentage of total power used by the controller. If the controller cannot reach higher SET reference levels, it means the controller has reached 100% output available and needs a higher voltage power supply (contact us to upgrade the controller).



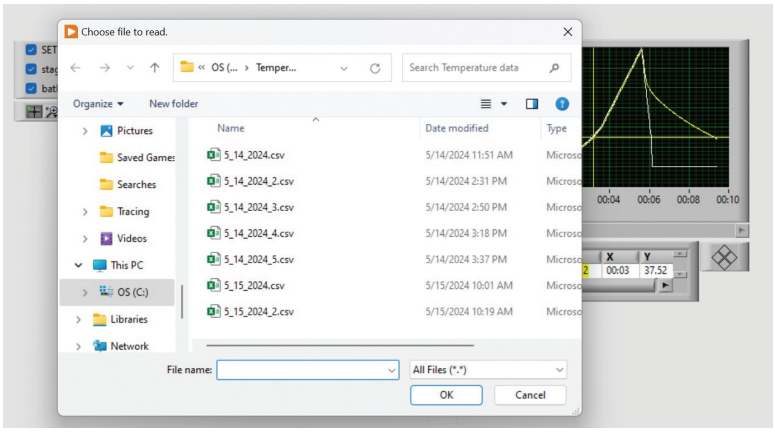
Stop Recording

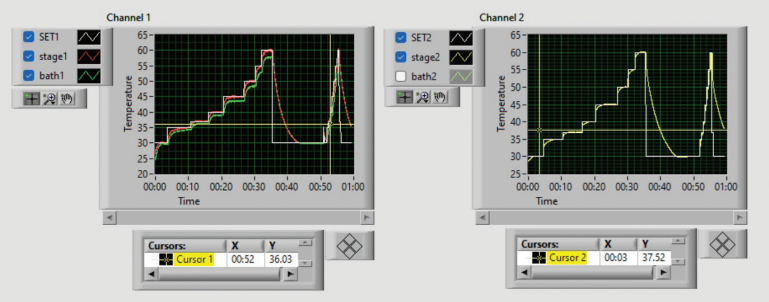
To stop recordings, press “Esc” (escape) button on the computer keyboard, or click “ESC” button on the screen. This will result in opening of another window, that will ask to type a file name for the temperature log file. Type a corresponding name, usually the current date or the type of the experiment. The time and the date will always be associated with the new file inside the computer memory. We recommend typing “.csv” extension at the end of the name, so EXCEL can open and read the file. If the log file is not needed, simply click CANCEL button.



Reading the log files

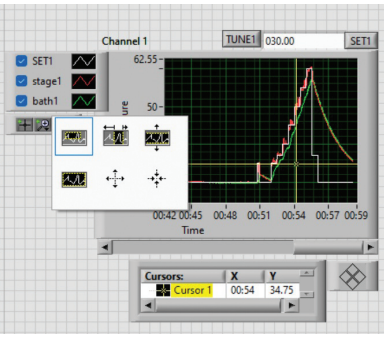
After the recording was stopped, the recording data on the graph can be studied and measured using ZOOM and cursor features, located on the left and on the bottom of the graph. The past recordings can be also retrieved by opening TC_READ.exe executable file. After TC_READ windows opens, click “START” button on the top to choose the file to read. After analyzing the log file, another can be opened by clicking “START” button again.



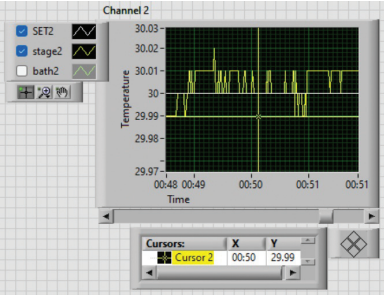


ZOOM and cursors

The recordings can be analyzed using ZOOM and cursor features. After clicking ZOOM button on the left of the graph, a new window will allow to select different zoom modes:

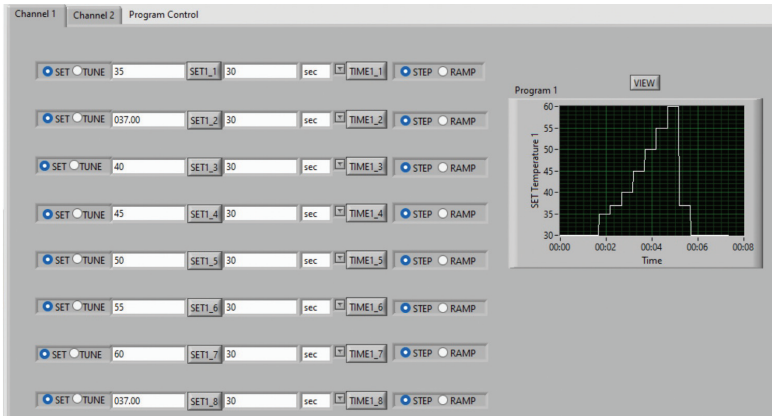


Different parts of the graph can be accessed at the same zoom scale by selecting “HAND” tool on the left of the graph, which allows to move the graph inside the frame. By selecting “CURSOR” tool on the left of the graph, measurements can be performed by moving the cursor along the graph, and reading the values on the bottom of the graph. If the cursor is not visible inside the frame, type coordinates values to corresponding fields to move the cursor inside the frame.



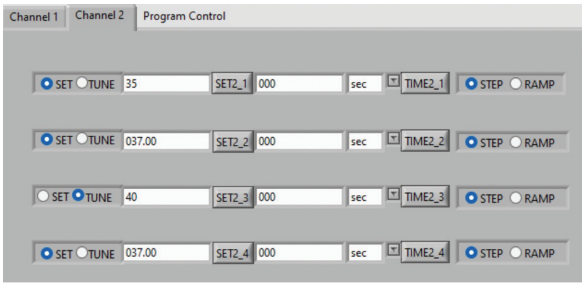
Programming the controller

Programming of the controller can be done through user interface located on the bottom half of TC_WRITE window. Up to eight different SET reference points can be programmed into the controller memory:



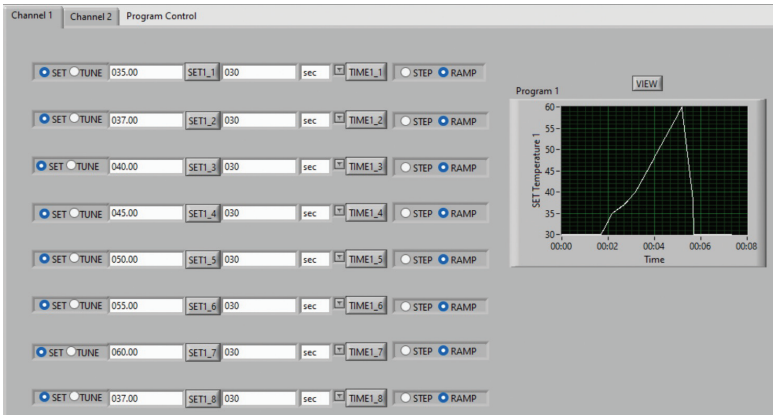
Since different heating elements and different temperatures need different controller parameters, which might require significant time for the controller to self-adjust, it is recommended to tune the controller to work at different SET temperature references within a wide range. This should be done regardless of the mode of operation: manually entered SET references or automatically generated temperature sequences. The programming interface allows to tune the controller at preset levels. Then, the controller can calculate the required parameters, even if the SET level is between the preset points.

Below is an illustration of tuning procedure for 40ºC: simply select TUNE circle, enter SET reference point, and click SETxx button. Note: entry into time length field is not required for this procedure. After this, the controller starts tuning at this level. The new parameters will be stored in the controller memory. The results of the procedure can be observed on the temperature recordings graph. After the temperature readings are at the required level, repeat for other levels needed. Tuning can be stopped by returning the controller to original SET level by clicking SET1/ SET2 buttons on the top of the window.



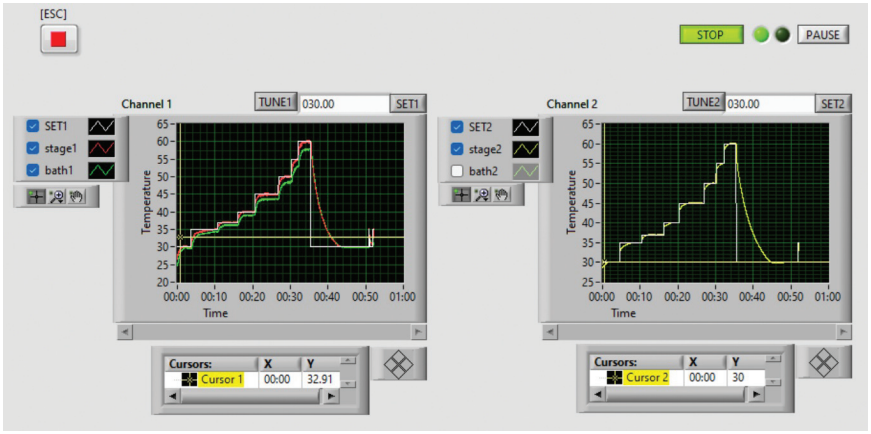
Temperature sequences and ramps

To program temperature sequences and ramps, enter the time length of each step and ramp in the controller memory by typing the time values and clicking the corresponding TIME button. The time scale can be selected as sec, min or hour. The 0 length step will be ignored by the program. To convert the step into ramp, select RAMP circle on the right, before entering the value into the controller memory. The sequence can be visualized by clicking button VIEW. To run the sequence as a continuos loop, the last (number 8) SET level should be the same as the original SET level, which can be entered on the top of the temperature graph. In the case of 0 length of the last step (number 8), the reference temperature will jump/ramp to the first SET level in sequence (after ignoring all 0 length steps). The period of the loop will be determined by the length of all steps. Each channel can be programmed independently by selecting appropriate tab, Channel 1/Channel 2.



Running the program

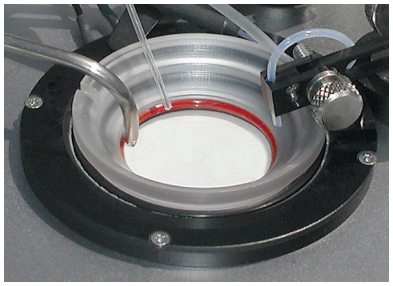
To start the programmed protocol, click PROGRAM button on the top of the window. The button will turn GREEN saying STOP. By clicking the STOP button, the protocol can be terminated. The program can be also stopped in the middle of the sequence by entering SET level and clicking SET1/SET2 button on the top of the recordings graph.

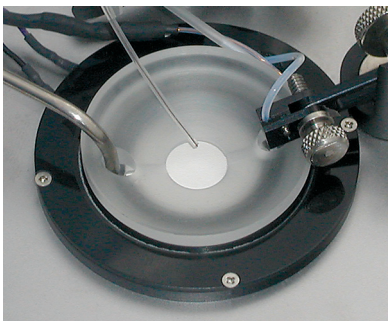


The program can be also paused by clicking PAUSE button, and continued again by clicking red PLAY button.

Below is an illustration of “ramp” protocol recordings to show that the controller will “follow” the ramp well, provided the rate of the ramp is slow enough. The last ramp down was too fast for the controller to “follow”.

Heating Elements



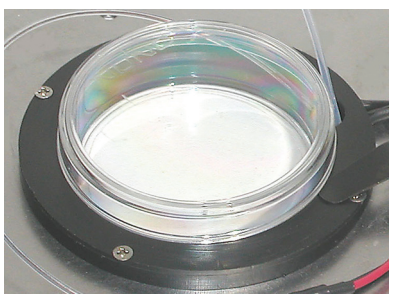


Heating element with 35mm clearance for Coverslip Chambers and Petri dishes TC-E35 Ready to use heated system for samples cultured/placed on coverslips. Used with bath chambers for replaceable coverslips CSC and UTIC. Replaceable coverslips allow to culture cells before performing experiments. The heater preheats perfusion solution before it enters the chamber. This keeps temperature stable even if used with perfusion systems. Inline heated Teflon tubing fits manifolds included with perfusion systems. Can be used for imaging and recording. Can be used with 35 mm petri dishes. Since some brands of petri dishes have different diameter, reducing adapters TC-PA might be required. Requires a microscope adapter (specify microscope model when ordering, ships installed inside the microscope adapter). Requires a temperature controller. Item# TC-E35

- **Dimensions:** 52mm diameter
- **Temperature stability:** 0.01°C, built-in sensor
- **Optical clearance:** 35mm
- **Use with:** Coverslips and Petri dishes, including 35mm glass bottom dishes
- **Solution Pre-heater:** Replaceable/Removable Teflon tubing, easy to wash
- **Microscope adapter:** Fits to 50mm cutout of standard microscope adapters MA and IMA

Heating Element with 15mm aperture TC-E35x15 Fits 35mm dishes. The whole bottom is heated to eliminate temperature gradient, which makes it ideal for petri dishes, including glass bottom dishes. Wide 15mm optical clearance to access your sample with immersion optics from the bottom. Built-in temperature sensor. Since some brands of petri dishes have different diameter, reducing adapters TC-PA might be required. Incorporates Teflon perfusion tubing, which makes the element to work as inline preheater. Requires a microscope adapters with 50mm mounting opening. Requires a temperature controller. This element is a part of TC-PCP-15 heating stages. If wider clearance is required, use TC-E35 with 35mm clearance. Item#: TC-E35x15

Heating Element with 11m aperture TC-E35x11 Fits 35mm dishes. The whole bottom is heated to eliminate temperature gradient, which makes it ideal for petri dishes, including glass bottom dishes with small optical clearance. Wide 11mm optical clearance to access your sample with immersion optics from the bottom. Built-in temperature sensor. Since some brands of petri dishes have different diameter, reducing adapters TC-PA might be required. Incorporates Teflon perfusion tubing, which makes the element to work as inline preheater. Requires a microscope adapters with 50mm mounting opening. Requires a temperature controller. This element is a part of TC-PCP-11 heating stages. If wider clearance is required, use TC-E35 with 35mm clearance. Item#: TC-E35x11

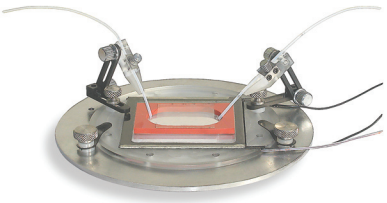


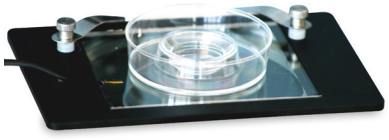
Heating Element for 50mm dishes with 40mm aperture TC-E50x40 Fits 50mm dishes and chambers. The bottom has 40mm optical clearance, which makes it ideal for 50x40 glass bottom dishes. Wide 40mm optical clearance allows you to access your sample with immersion optics from the bottom. Built-in temperature sensor. Incorporates Teflon perfusion tubing, which makes the element to work as inline preheater. Requires a microscope adapters with 74mm mounting opening IMA-74. Requires a temperature controller. This element is a part of TC-PD-50x40 heating stages. Item#: TC-E50x40

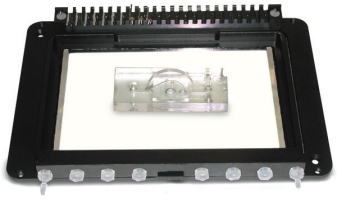
Heating Element for 50mm dishes with 30mm aperture TC-E50x30 Fits 50mm dishes. The whole bottom is heated to eliminate temperature gradient, which makes it ideal for 50x30 glass bottom dishes. Wide 30mm optical clearance to access your sample with immersion optics from the bottom. Built-in temperature sensor. Incorporates Teflon perfusion tubing, which makes the element to work as inline preheater. Requires a microscope adapters with 74mm mounting opening. Requires a temperature controller. This element is a part of TC-PD-50x30 heating stages. Item#: TC-E50x30

Uniformly heated glass plate for stereo microscopes, upright microscopes, and long-distance objectives of inverted microscopes, TC-HP75x65 Large 75x65mm optical clearance allows you to heat your samples on 80x70mm glass surface. The heated glass plate provides thin profile and uniformly heated surface. Built-in temperature sensor. Flat glass top surface is flashed with the microscope adapter. Can be used to heat plates, flasks, slides and petri dishes. Open or sealed chambers can be formed directly on class surface, using self-adhesive gaskets for example. Requires a microscope adapter (specify microscope model when ordering). Can be upgraded with an objective heater and chamber-attachments (TC-DIS, TC-DIS-8, TC-WI). Item#: TC-HP75x65

- **Optical window:** 75x65 mm
- **Glass thickness:** 1mm
- **Height (adapter):** 3mm
- **Use with:** Petri dishes, including glass bottom dishes
- **Temperature stability:** 0.01°C, built-in sensor
- **Microscope adapter:** specify microscope model



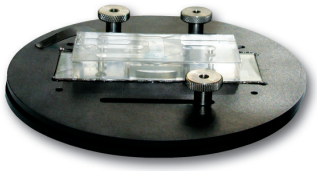




Uniformly heated glass plate for stages Prior, Ludl, Marhauzer, Zeiss, ASI TC-HP108x72

Uniformly heated glass plate provides thin profile and uniformly heated surface. Built-in temperature sensor. Large 108x72mm optical clearance allows you to heat slides and dishes samples on 118x74mm glass surface and to form open or sealed sample chambers. Electrodes and tubing can be fixed around your sample chamber using adjustable holders MH-MIS attached to optional inserts for slides, petri dishes and cover-slip chambers. The holders can be used to position perfusion tubing for continuous media exchange, provided that optional inserts TC-I-100 or TC-I-4/3 are placed inside (see table below). Can be upgraded with an objective heater. Item#: TC-HP108x72

Uniformly Heated Glass Slides TC-GSH This is a standard size 3x1 in. glass slide used as a heater from the bottom of any sample. Ideal for use with upright microscopes. Long-distance objectives of inverted microscopes can be also used. A sealed imaging chamber can be formed on top of the slide using adhesive gaskets. Any chambers and bio-chips can be placed directly on the slide and clamped by provided flat springs. Threaded surface of microscope adapter allows you to attach custom accessories. Built-in temperature sensor. Can be used with an objective heater. Requires a microscope adapter (specify a microscope model when ordering; ships installed on the adapter) . Requires a temperature controller. Might require an objective heater if used with an immersion optics. **Item#: TC-GSH**

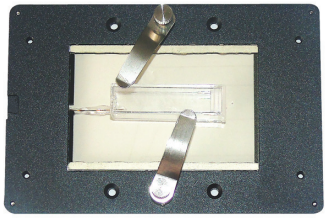


- **Optical window:** 75x20mm
- **Glass thickness:** 1mm
- **Temperature stability:** 0.01°C, built-in sensor
- **Microscope adapter:** specify microscope model

Uniformly heated quartz plate, TC-HPQ75x50

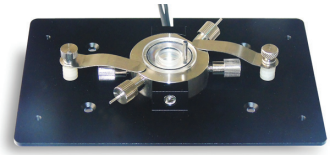
Fused quartz (1.1 mm thickness) for working in the UV or near infrared range of illumination, where regular glass cannot be used (because it is not transparent in these wavelength ranges of illumination). Quartz can also withstand high temperature applications without cracking. Allows you to heat your samples on 75x50mm surface. Large 70x45mm optical window. The heated quartz plate provides thin profile and uniformly heated surface. Built-in temperature sensor. Flat glass top surface is flashed with the 128x86mm mounting frame (5mm thick). The frame is the size of standard multi-well plates and fits most microscope stages. Open or sealed chambers can be formed directly on class surface, using self-adhesive gaskets for example. Might require a microscope adapter (specify microscope model when ordering). Can be upgraded with an objective heater. Requires a temperature controller (TC-1-100s-24V model for high temperature applications). **Item#: TC-HPQ75x50**

- **Optical window:** 70x45 mm
- **Glass thickness:** 1.1mm
- **Height (frame/adapter): 5mm**/3mm
- **Temperature stability:** 0.01°C, built-in sensor
- **Microscope adapter:** specify microscope model, ships mounted inside 128x86x5mm metal frame;



Heater for chambers from Culture Myograph Systems

A heating element designed for 35mm culture myograph chambers. The mounting frame is 128x86mm, the size of standard multi-well plates to fit motorized stages and type-K mechanical stages. Two set screws and two clamps to fix the chamber from two sides and the top. Recessed area for connecting tubing. Bottom aperture is 25mm, with 1mm thick lip to hold the chamber. Requires a temperature controller. The controller stores two settings in its memory for different temperatures for easy temperature jumps. **Item#: TC-MYO**

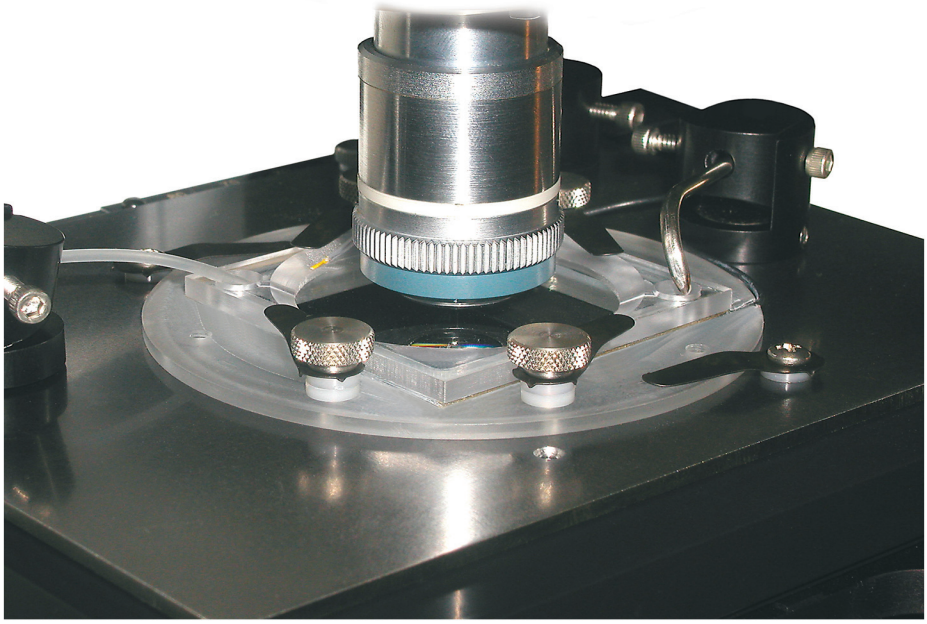


Syringe heater with temperature controller

The syringe heaters are used to heat different sizes syringe barrels (or any other cylindrical surfaces) for degassing solutions or maintaining solutions at temperatures above ambient (up to 150°C). Includes a temperature controller. Can be used with perfusion systems or syringe pumps. Easy to install and remove. The replaceable flexible 0.25x10in. heaters are wrapped around syringes and fixed with included Velcro straps Item#: TC-SYR10x025

Uniformly Heated Bottom Chambers

Uniformly heated chambers incorporate glass heaters on the bottom to provide uniform temperature distribution without gradient. Below are small and large volume chambers.



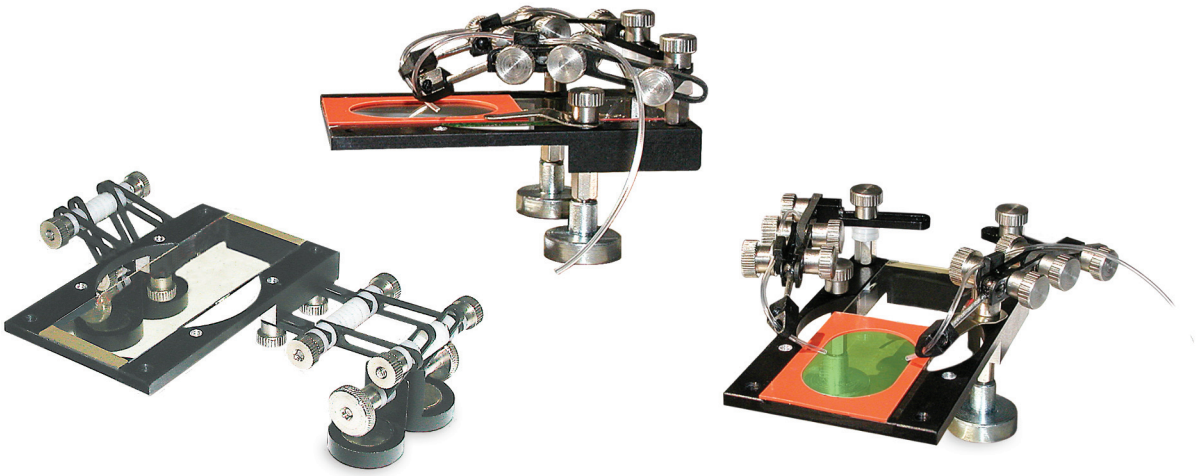
Introduction

The transparent indium tin oxide (ITO) coated heated chambers can be used with inverted or upright microscopes. The electrically conductive coating is on one surface only, with opposite clean surface contacting your sample media.

TC-WI Chamber This is a larger volume open chamber that provide optical clearance to accommodate water immersion objectives of upright microscopes. TC-WI chamber (top) for upright water immersion optics

TC-DIS Bath/Dissecting Chamber is a large (54x54x8mm) volume chamber for different applications, including dissecting of tissue. Can be used as a miniature water bath. The chamber has glass bottom, which is used as a heater to provide uniform temperature distribution throughout the whole surface. Optical clearance is 42x42mm.

Heater for *in vivo* experiments



A temperature controlled heater to keep exposed organs at animal body temperature. This heater can be adjusted to position next to or above a small animal. Live attached organs can be placed into a silicone chamber attached to the glass surface of the heater. Easy to clean after use. Custom chambers of any shape are available. Adjustable miniature tubing holders can be used for solution exchange or to apply test compounds (the holders can be also used to fix electrodes and sensors). Magnetic stands provide solid support on the microscope table. The stands are adjustable for easy elevation change during experiments.

Specifications:
Dimensions: 1x 3 in. transparent glass heater
Temperature stability: better than 0.01°C, built-in sensor
Adjustable elevation: Flexible, up to 2in. Can be custom modified

Objective Heaters, TC-HLS

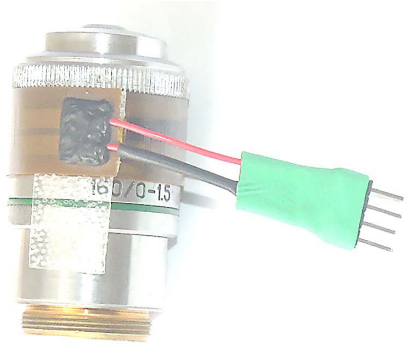
The Objective Heater is wrapped around a microscope objective. An incorporated temperature sensor is used to regulate and monitor the objective temperature. Flexible objective heaters can be used with any objective and are easy to install. Using objective heaters provide an effective way to stabilize the temperature around your sample.

Attaching Heater to Lens
If possible remove the lens from the microscope. Use included Velcro tape to fix the heater securely around the objective, placing the sensor between the objective surface and the heating element.

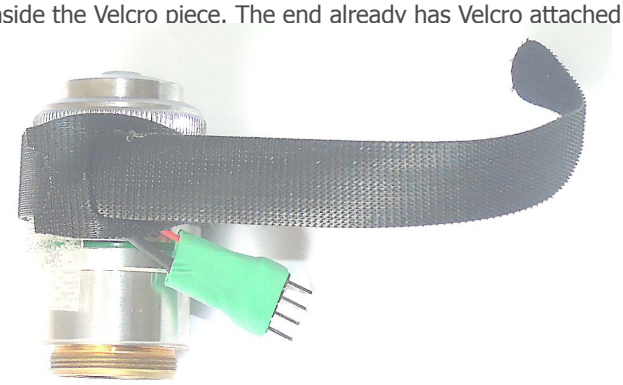
DIMENSIONS: 0.5x5 in. The heater should be long enough to cover the hole perimeter of the objective. The height of the objective can be limited by the space available on your objective. Usually the heater is attached to the end of the objective close to your sample.

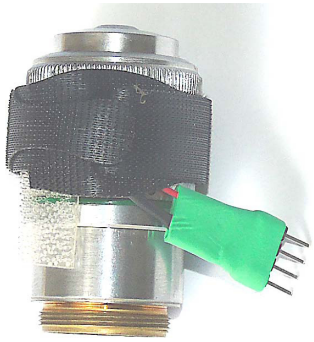
Recommended procedure to mount the objective heaters:

1. Position the heater on the objective closer to the sample plane, the sensor down touching the objective surface, and fix in place using a small piece of electrical tape.



2. Wrap the heater around the objective, and mark the point where the end of the heater with Velcro already attached will be placed. Adhere a piece of Velcro over the mark. It is recommended to put an excess of Velcro so it overlaps some surface of the objective for extra stability (some Velcro can be cut). Secure the end of the heater inside the Velcro piece. The end already has Velcro attached.



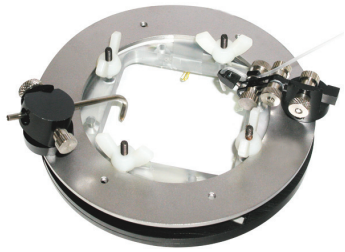


3. Make a loop using black Velcro tape, and tighten it around the heater so the connector is sticking outside from the tape.

4. Wrap black Velcro tape around the heater for extra stability and better heat conductance (to prevent heat dissipation to the air).

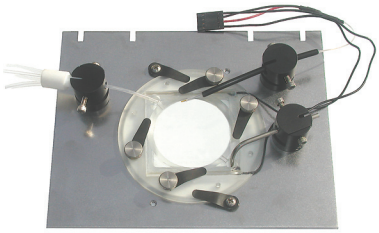
Large Volume/Bath/Dissecting Chamber for in vivo imaging TC-DIS

This is a large (54x54x8mm) volume chamber for different applications, including dissecting of tissue. Can be extended up by placing additional 8mm high chambers. The chamber has a glass bottom with transparent coating, which is used as a heater to provide uniform temperature distribution throughout the entire surface. Optical clearance and heated area is 54x54mm. Requires a microscope adapter. Built-in temperature sensor. An optional magnetic plate can be placed on top upon request. This will allow mounting optional magnetic holders for tubing, electrodes and suction: MTH-S, MTH, and MH-2. Can be upgraded with an objective heater TC-HLS-05/025. Item#: TC-DIS/-8



Open Heated Perfusion Chamber for Water Immersion Objective

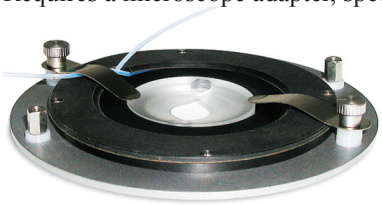
This chamber has uniformly heated glass bottom with large clearance of 42mm diameter. Separate compartments for inflow and outflow prevent bubbles from entering the chamber and provide smooth perfusion. Built-in temperature probe. Includes 2-channel temperature controller, microscope adapter, two magnetic holders for suction tubing (included), and perfusion manifold (optional). Can be used with controlled flow perfusion systems. Might need an objective heater (above) if water immersion optics is used. Specify microscope model when ordering. Item#: TC-WI

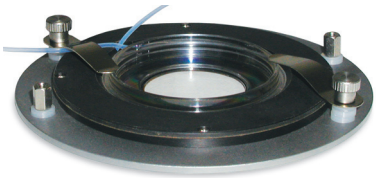


Low Profile Heated Stage, TC-E50x30

Larger diameter of this heating element allows you to form low-profile recording and perfusion setups, suitable for use even under upright microscopes. The heating element accepts dishes up to 52mm diameter. Can be used with smaller chambers and 35mm dishes, if combined with reducing adapter-rings. Heating happens from the bottom to eliminate temperature gradient. Optical clearance is 28.5mm. Can be used with PCCS1 and PCCS2 low-profile coverslip chambers, which are only 4mm high. Can be used with sealed thin chambers for high resolution imaging. Can be upgraded with an objective heater for immersion optics. Can be used with CSC coverslip chambers as well.

Requires a microscope adapter, specify microscope model when ordering. Item#: TC-PD-50x30





- **Dimensions:** 76mm diameter
- **Temperature stability:** 0.01°C, built-in sensor
- **Optical aperture:** 30mm
- **Use with:** Coverslip chambers, 50mm dishes, Petri dishes, including 35mm glass bottom dishes
- **Solution Pre-heater:** Replaceable/Removable Teflon tubing, easy to wash
- **Microscope adapter:** Fits to 74mm cutout of standard microscope adapters

Heated chamber-incubator for replaceable coverslips, TC-CSC

Can be used for imaging and recording. Consists of a heated bottom base, and a silicone O-ring to seal the coverslip. The metal base facilitates heat transfer. There is no contact between solution and the chamber base to prevent ions leakage. The included top glass coverslip can be used to seal your sample from top as well - to from a micro-incubator. The top can be secured using the included metal ring, or using flat springs of microscope adapters. The bottom part has a recessed profile to fit round or square coverslips. The included O-rings allows you to use different thickness coverslips. Simply put the coverslip inside and seal it with silicone ring by a snap-in action, then secure with a top metal ring (the silicone ring can be also secured by flat springs of microscope adapters). For low-profile chambers, consider TC-CSC -L design, where no top clamps are required. Can be used as a perfusion chamber, if combined with miniature tubing holders. The heating element incorporates replaceable Teflon perfusion tubing inside, which makes the element to work as inline pre-heater. Requires a microscope adapter and a temperature controller. Item# TC-CSC

- **Dimensions:** 50mm diameter
- **Temperature stability:** better than 0.01°C, built-in sensor
- **Solution Pre-heater:** Replaceable/Removable Teflon tubing, easy to wash
- **Microscope adapter:** Fits to 50mm cutout of standard microscope adapters MA and IMA

- **Working volume:**

25mm coverslip - 21mm, approx. 350 microl
22x22mm coverslip - 19mm, approx. 280 microl
20mm coverslip - 16mm, approx. 200 microl
18mm coverslip - 14mm, approx. 150 microl
13mm coverslip - 9mm, approx. 50 microl
12mm coverslip - 8mm, approx. 50 microl
10mm coverslip - 6mm, approx. 30 microl

Heated Micro incubator with CO2 and hypoxia control for coverslips, TC-CSC-I

The incubator can be used with round replaceable coverslips for long-term time-lapse high resolution imaging. Comes with thin high optical quality glass cover to prevent evaporation (can be removed). Easy to use: simply drop the sample coverslip into the holder, seal with silicon chamber, and secure with the top ring. There is no contact between solution and the chamber base to prevent ions leakage. The bottom part has a recessed profile to fit round coverslips. The air-tight seal will prevent media evaporation for hours. Incorporates a temperature sensor and a heating element for temperature control. Requires a CO2 controller. Requires a microscope adapter. Specify microscope model when ordering. Can be upgraded with an objective heater for immersion optics. Item# TC-CSC-I

- **Dimensions:** 50mm diameter
- **Height:** 30mm
- **Top Optical window:** 28mm
- **Temperature stability:** 0.01°C, built-in sensor
- **CO2 control:** x2 barbed ports
- **Microscope adapter:** Fits to 50mm cutout of standard micro-

- **Working volume:**

25mm coverslip - 21mm, approx. 350 microl

22x22mm coverslip - 19mm, approx. 280 microl

20mm coverslip - 16mm, approx. 200 microl

18mm coverslip - 14mm, approx. 150 microl

13mm coverslip - 9mm, approx. 50 microl

Noise and Grounding

Noise

50/60-Hertz power line noise may be encountered because of:

1. Improper grounding of probes, micro electrodes, bath or instrument chassis.
2. Radiation from transformers of adjacent equipment.
3. Power noise from attached equipment, i.e., stimulators, etc.
4. Antenna effects of cable or wire.
5. Potential difference between various components of electronic set-up (due to the distance electronics are from one another, or different earth grounds).

50/60 Hz noise is not the only electrical signal likely to cause interference problems, some others are:

1. Remote switches, such as in refrigerators or heaters.
2. Voltage pulses emanating from adjacent micro electrodes.
3. Broadcast interference from TV/Radio.

Instrument Grounding and System Ground

The chassis ground and the output cable shielding are internally connected to the system (circuit) ground. You can access the shielding ground by attaching a shorting wire connecting your system ground either to the screws of one of the OUTPUT DB-9 connectors, or to a small wire showing from the inside the cable closer to STAGE connector. If ground loops are experienced (objectionable 50/60 Hz), try placing the shorting wire to a different point (one of these two). If TTL or analog signals are used, the controller might be already connected to the system ground through the shielding of the cables.