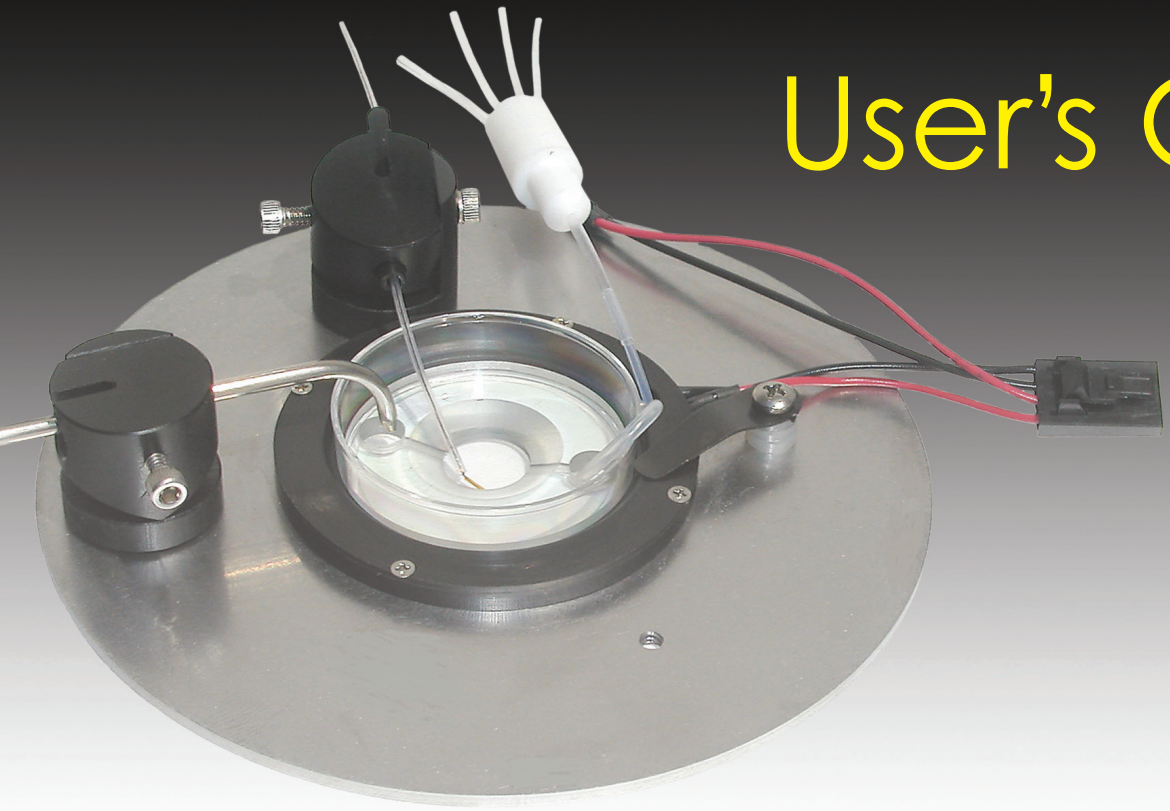
Temperature Control

User's Guide



Live sample Incubators, Heating/Cooling Stages & Objective Heaters

- **Precise Temperature Control throughout the experiment**
- **Conditions similar to** *in vivo*
- **Compatible with Imaging systems**
- **Heating stages for any microscope**
- **No drift with 0.01°C stability**

Bioscience Tools

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

Contents

Specifications

Range -80 to 150ºC
Accuracy 0.1ºC
Stability 0.01ºC, required for sensitive applications: nano & piezo positioning, AFM, TIRF and so on
No noise suitable for electrophysiology
No vibrations no external fans
Temperature sensors
built-in STAGE sensor
optional external BATH probes
Feedback
from STAGE or BATH sensors
Self-tuning and self-adjusting
Programmable
up to 4 steps/ramps (8 steps if only one channel is used)
Analog Input
analog voltage to SET temperature: 10V/230ºC
Analog Output
To monitor temperature (10V/230ºC)
Automatic cooling
RS232 port
to set and monitor temperatures
Size (Controller) : 12Wx6Hx8D in.
Output:
max 8A per channel (max 230W with 35VDC input)
Power Supply
100-240VAC, 230W

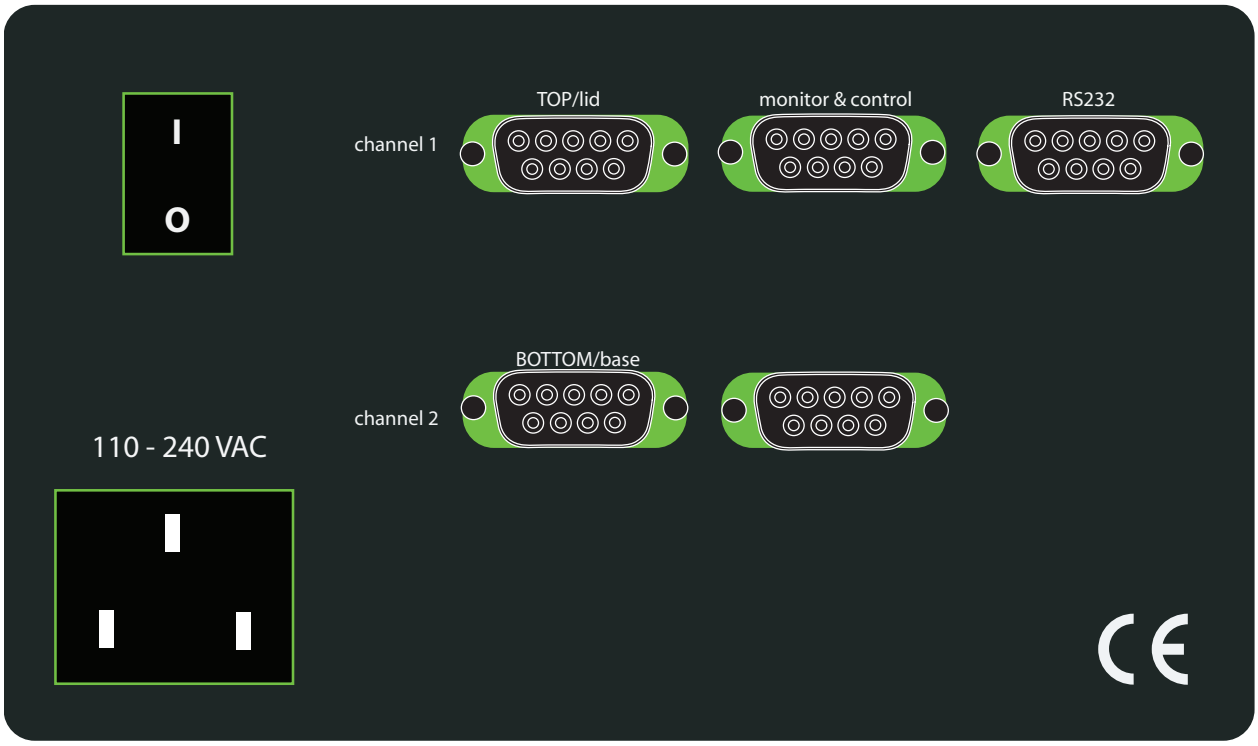
CE

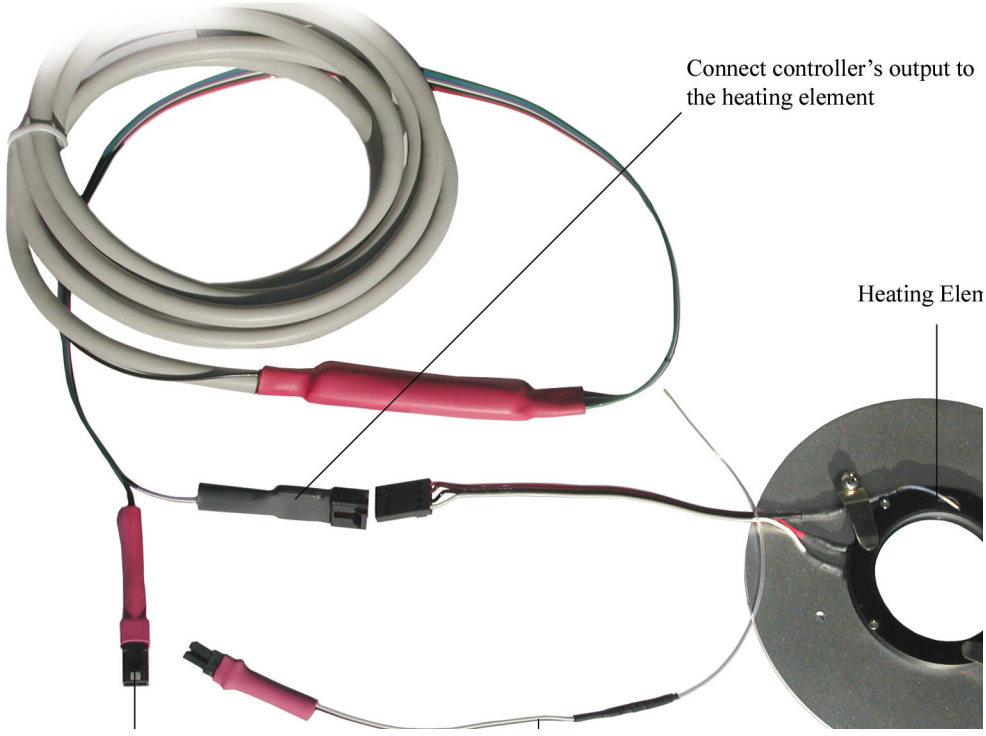
Introduction

The complete temperature control system comes with a controller, optional external temperature probes, and connecting cables to heating elements. All heating elements incorporate a temperature sensor built inside - STAGE sensor. This internal sensor is used for FEEDBACK. It is also used to prevent accidental overheating of the sample. Microscope adapters, MA or IMA type, are required to fit the heating elements to your microscope. Most heating elements can be used as inline pre-heaters, if connected to a perfusion systems. The following are an illustrated installation guide and example configurations of temperature controlled setups.

Installation Guide

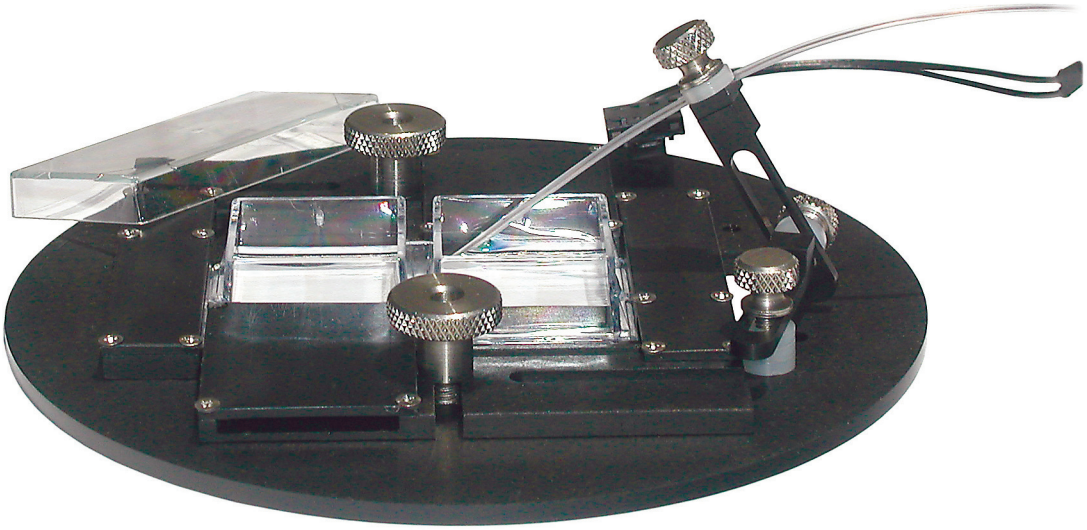
1 Connect power cable to the back of the controller. Plug the power cable into the wall outlet. Plug the heating stage cable into the output connector on the back of the controller. RED marker - channel I, YELLOW - channel II



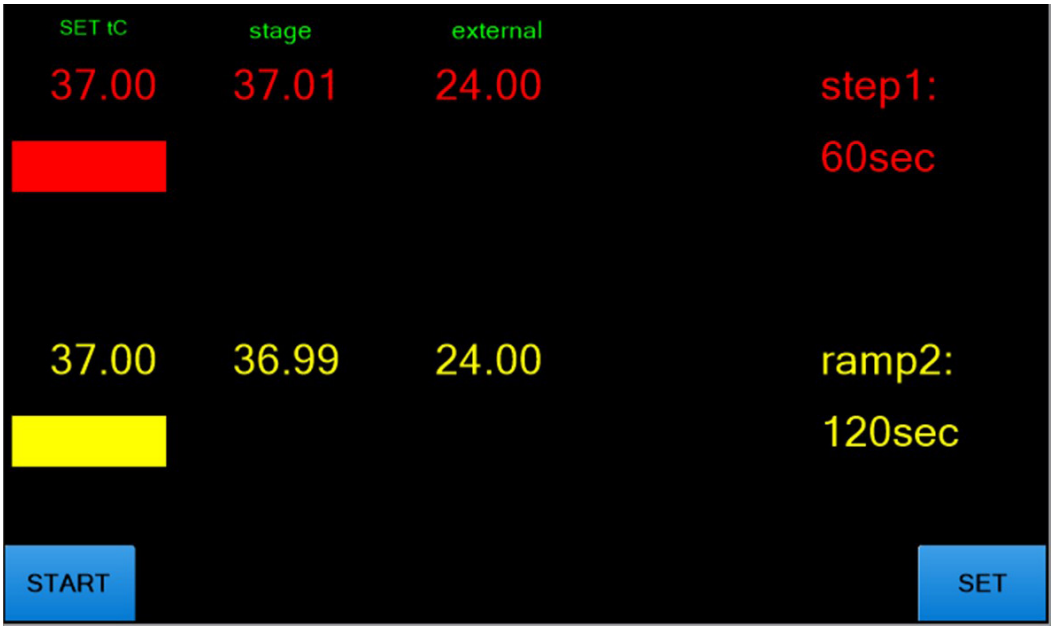


2 Connect the output cable to the heating element/stage and external temperature probes, if used.

3 Prepare the sample chamber, petri dish for example, by filling the chamber with water. Using optional adjustable holders, MTH or MH type, position the optional external temperature probe inside the chamber - 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.



4a



On the graphical display, you will see temperature readings from STAGE and BATH probes (if connected) for both channels. On the left are SET reference temperatures. On the bottom are two buttons: START and SET. Using any pointing tool, a stylus, hit the button START. The button turns into showing STOP. The power bars in the middle of the display will indicate power supplied to the heating elements. Initially, the controller will self adjust itself to the customer setup. After a few minutes, the temperature readings for STAGE sensors should stabilize around SET temperatures.

4b

If BATH sensor does not show the required temperature, several degrees off for example, the SET temperature can be offset accordingly (set several degrees higher) to achieve the required temperature around the sample. Hit button SET to switch the display. SET display allows to adjust SET reference temperatures using numerical keypad. You can also switch feedback to BATH probes, and program temperature steps and ramps.

Two radio buttons on the left (I and II), will switch between temperature settings for channel I and II.

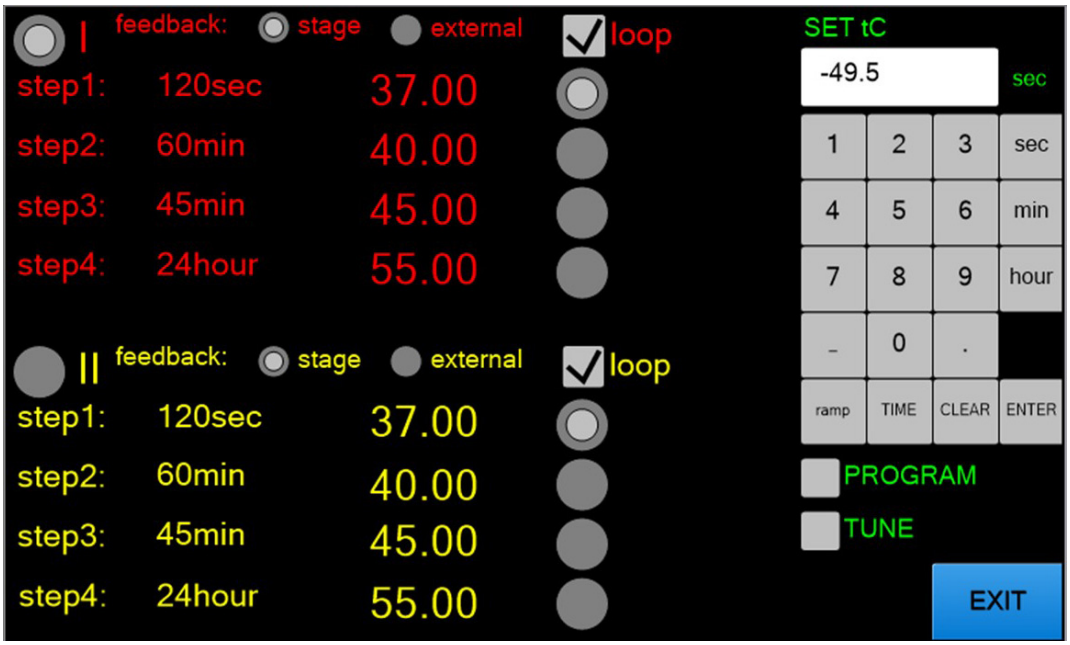
Feedback radio buttons will switch the controller between STAGE and BATH feedbacks.

If TUNE box is checked, the controller will perform self-tuning procedure next time you push button START.

Checking box PROGRAM, will allow you to program steps and ramps.

EXIT button is used to return to the original display screen.

4c



To program each step, check the corresponding radio button on the left and use key-pad to SET reference temperature. To program time, touch button TIME. It is important to select time units by touching buttons: SEC, MIN, or HOUR. To make ramp, touch button RAMP. In order to enable programming, check box PROGRAM.

For continuos loops, check box LOOP. NOTE1: the sequence will go through steps with time length more than 0sec, and will stop/loops at the first step with length of 0sec (or go through all four steps). If nothing is connected to the second channel, the sequence for the first channel will continue through steps programmed for the second channel, making max number of steps for channel I - 8 steps/

4d

In order to perform tuning, check box TUNE. Self-tuning usually needs to be performed only once, and after successful tuning, box TUNE can be unchecked. Tuning is done to adjust the controller to new heating element or new SET reference temperatures. Before programming sequences, each temperature level needs to be tuned first. These different temeprature levels has to be tuned, if you are planning to switch manually to the different temeprature during operation. If you need more than four levels, tune the controller at four levels that cover the entire range of manual temperature changes.

After checking box TUNE, EXIT from settings screen and START the controller. Observe changes in temperature, and STOP the controller after temperatures do not change and stabilize around SET level. Go to SET screen again, and uncheck TUNE box. The controller should be tuned now. It will continue to self-adjust however during normal operation, if necessary.

NOTE: The controller has to be tuned in feedback from STAGE sensor first, before switching to feedback from

BATH probe. To do this you can offset/adjust SET temperature for STAGE sensor, until BATH temperature stabilizes around the required temperature level during tuning. After this, TUNE box can be unchecked, feedback switched to BATH, and SET level adjusted to the required temperature.

4e You can also select HOT temperature threshold level, by touching button HOT on the key-pad. After this, 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.

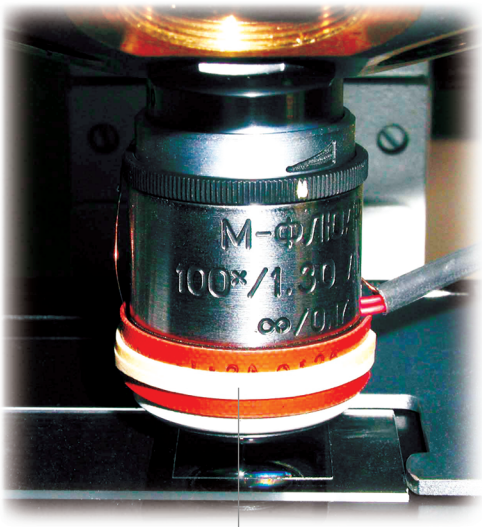
Manual Tune-up procedures

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”. The display will show that BATH temperature readings are usually several degrees lower than STAGE temperature, provided you connected an external temperature probe and placed it inside the sample chamber.

You can achieve the required temperature in the sample chamber by increasing SET reference level to compensate the temperature difference between the heating element and solution inside sample chambers.

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.

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



Objective Heater

Uniformly Heated Bottom

Another way to achieve the correct temperature around your sample is to switch the feedback of the controller to

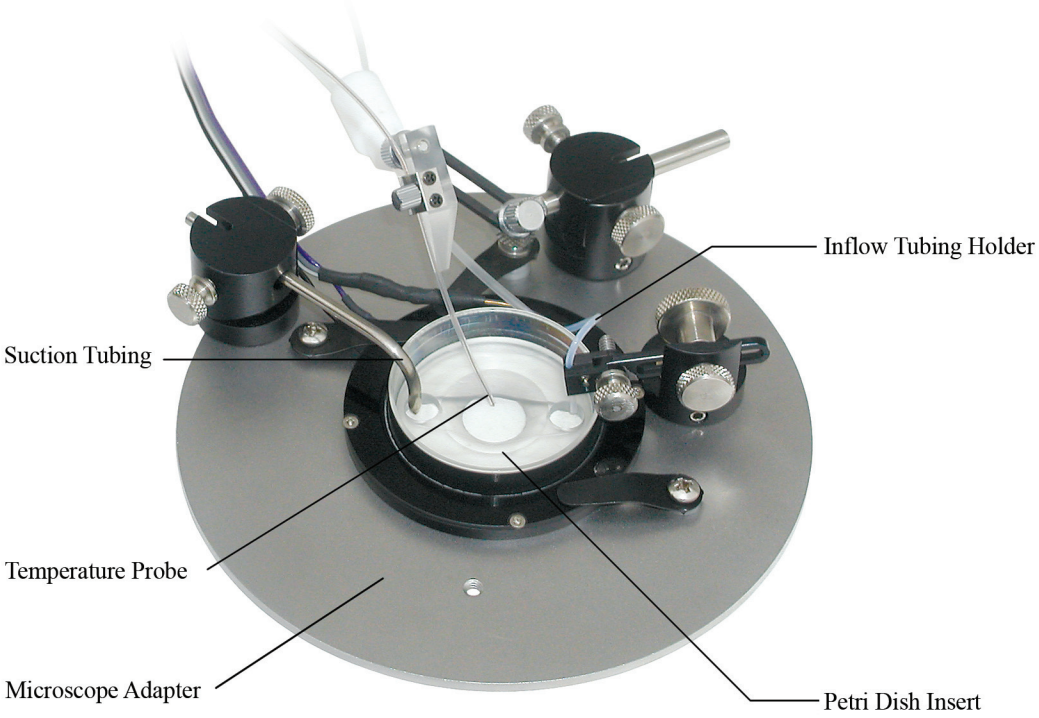
BATH temperature probe. This might result to temperature fluctuations, however. Before switching into feedback from the external probe, the setup needs to be adjusted and tuned in STAGE feedback first and SET level corrected to bring BATH temperature readings close to the required level.

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 use the controller in self-TUNE mode. Another is to change SET reference level.

NOTE 1: More stable operation is achieved by switching to STAGE feedback and increasing SET temperature to off-set the temperature gradient.

NOTE 2: If self-tuning takes too long to complete, stop the procedure by hitting button STOP. Go to SET mode, and un check TUNE box. Next time you hit button START, the controller will use the stored settings, and will not go through self-tuning procedure again.

NOTE 3: Using continuous perfusion of your sample helps to eliminate the undesirable temperature gradient in the system. If flow rate in the system does not change, better temperature stability might be achieved by switching the controller feedback to the 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 sensor for feedback might be used without perfusion as well. Using STAGE sensors for feedback usually provides more stable configuration with minimum temperature fluctuations around your sample.



Software control and monitoring

Using a standard NULL MODEM cable connect the controller (middle DB-9 connector) to a serial port of your computer. Set the serial port at 115,200 speed, 8 bits, 1 stop bit, NONE parity, and Hardware control. The following is the list of text commands supported. NOTE: Each command should follow by \n "Enter" code (<CR>):

T1<CR> returns temperature readings from STAGE1 sensor: 37.1 C

T2<CR> returns temperature readings from BATH1 sensor: 36.9 C

T5<CR> returns SET 1 temperature: 37.0 C

T3<CR> returns temperature readings from STAGE2 sensor: 37.1 C

T4<CR> returns temperature readings from BATH2 sensor: 36.9 C

T6<CR> returns SET 2 temperature: 37.0 C

CTn<CR> continuous readings from n (n=1 - STAGE1, 2 - BATH1, 3 - STAGE2, 4 - BATH2) sensor: 37.1 C

ON<CR> turns temperature control ON

OFF<CR> turns temperature control OFF

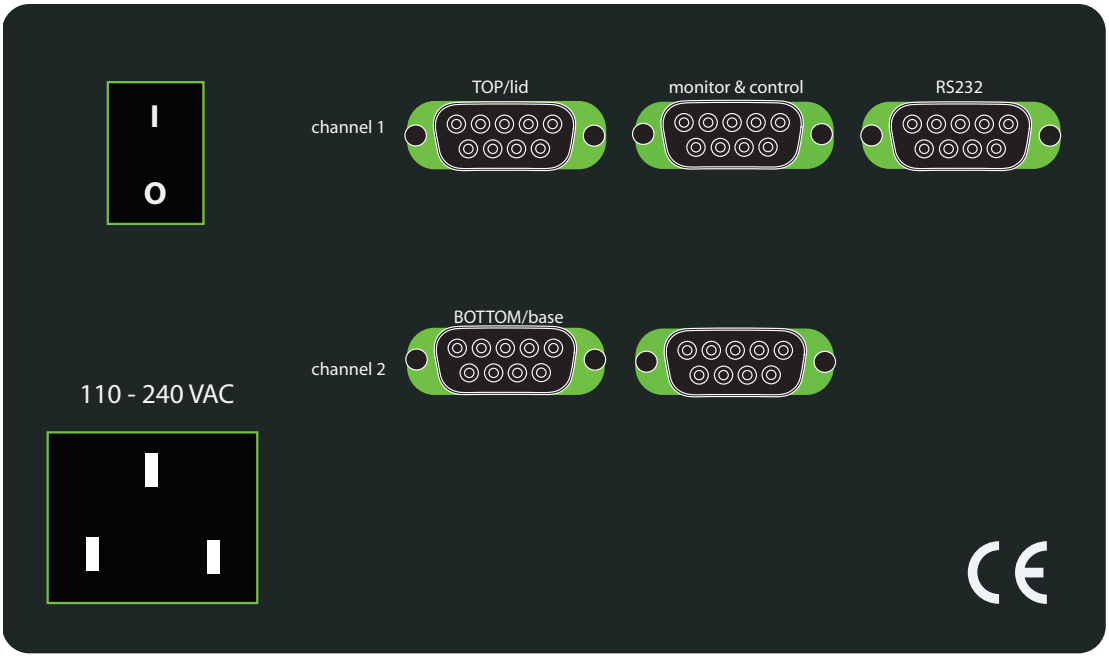
S1 03700<CR> sets reference temperature for channel I (NOTE: all five digits should be sent to the controller)

S2 03700<CR> sets reference temperature for channel II

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.

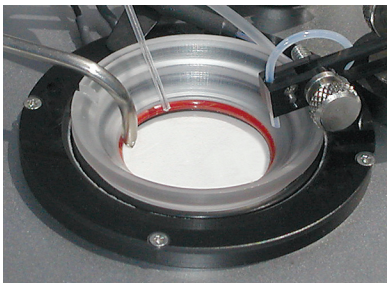
Outputs and Back Panel

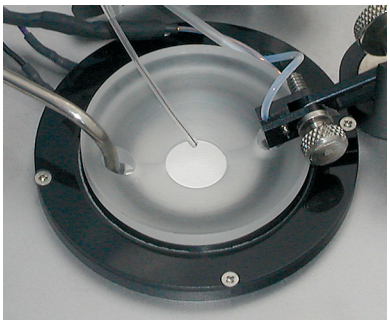


Outputs	
Output	Connect to STAGE cables to provide power to the heating elements and to provide temperature readings to the controller. TOP female DB-9 connector for channel I, BOTTOM - channel II
MONITOR & Settings	DB-9 male connectors to monitor temperature readings 0V=-80 3.3V/150°C: pin 3 - STAGE, pin 8 - BATH.
RS232	DB-9 male connector in the middle, use regular cable with all pins wired straight through.

Back Panel Controls	
RS232	Set reference temperatures and reads sensor temperatures.
DB-9 connector	pin 1, EXT temperature settings (10V/150°C, 0V = -80°C) pin 6, INHIBIT signals +3-5V shut the channel OFF) pin 7 - GROUND pin 3 - STAGE readings, pin 8 - BATH (-80 to 150°c = 0-3.3V)
INHIBIT	Used to turn the controller to STANDBY mode by external TTL signals (+5V, pin 6).
POWER jack and switch	Connects to 100-240VAC

Heating Elements



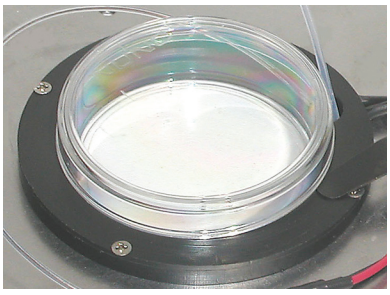


Heating element with 35mm clearance for Coverslip Chambers and Petri dishes TC-E35 Ready to use heated system for samples cultured/placed on coverslips. Used with bath chambers for replaceable coverslips CSC and UTIC. Replaceable coverslips allow to culture cells before performing experiments. The heater 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

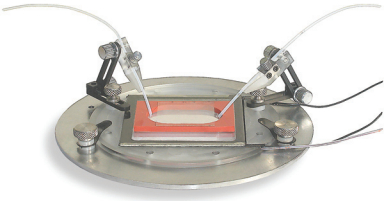


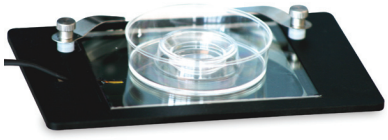
Heating Element for 50mm dishes with 40mm aperture TC-E50x40 Fits 50mm dishes and chambers. The bottom has 40mm optical clearance, which makes it ideal for 50x40 glass bottom dishes. Wide 40mm optical clearance allows you to access your sample with immersion optics from the bottom. Built-in temperature 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

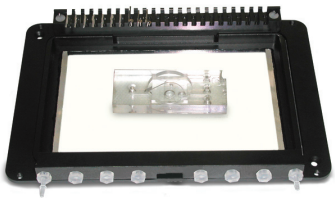
Heating Element for 50mm dishes with 30mm aperture TC-E50x30 Fits 50mm dishes. The whole bottom is heated to eliminate temperature gradient, which makes it ideal for 50x30 glass bottom dishes. Wide 30mm optical clearance to access your sample with immersion optics from the bottom. Built-in temperature 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



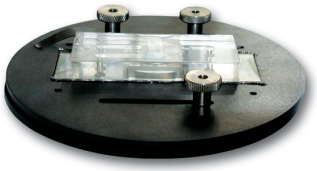




Uniformly heated glass plate for stages Prior, Ludl, Marhauzer, Zeiss, ASI TC-HP108x72

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**

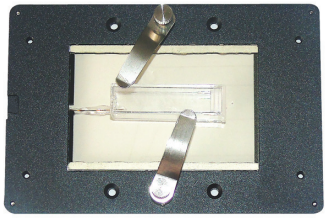


- **Optical window:** 75x20mm
- **Glass thickness:** 1mm
- **Temperature stability:** 0.01°C, built-in sensor
- **Microscope adapter:** specify microscope model

Uniformly heated quartz plate, TC-HPQ75x50

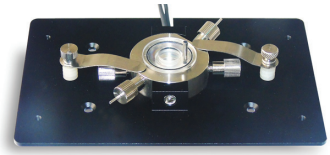
Fused quartz (1.1 mm thickness) for working in the UV or near infrared range of illumination, where regular glass cannot be used (because it is not transparent in these wavelength ranges of illumination). Quartz can also withstand high temperature applications without cracking. Allows you to heat your 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

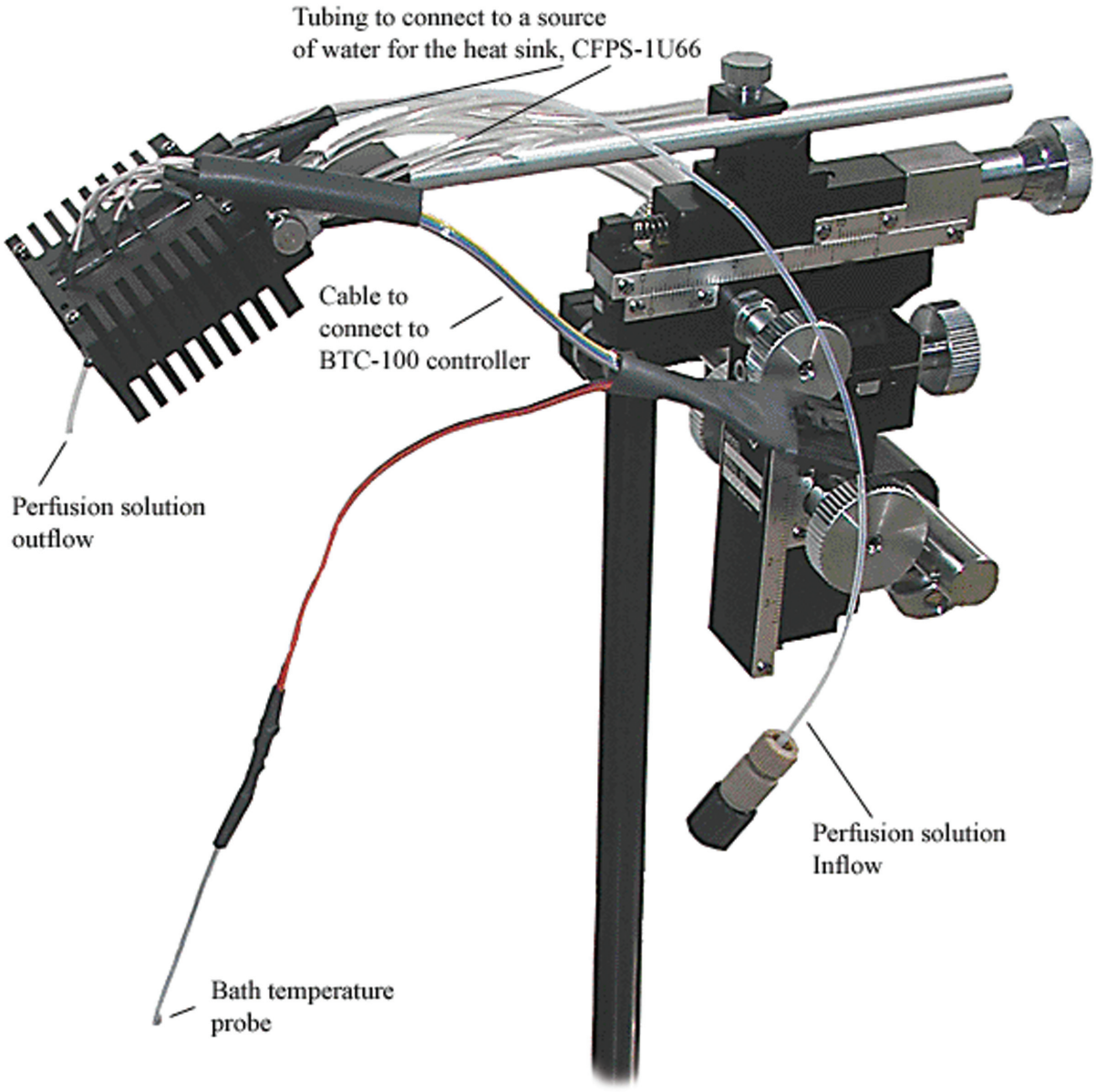
A heating element designed for 35mm culture myograph chambers. The mounting frame is 128x86mm, the size of standard multi-well plates to fit motorized stages and type-K mechanical stages. Two set screws and two clamps to fix the chamber from two sides and the top. Recessed area for connecting tubing. 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**



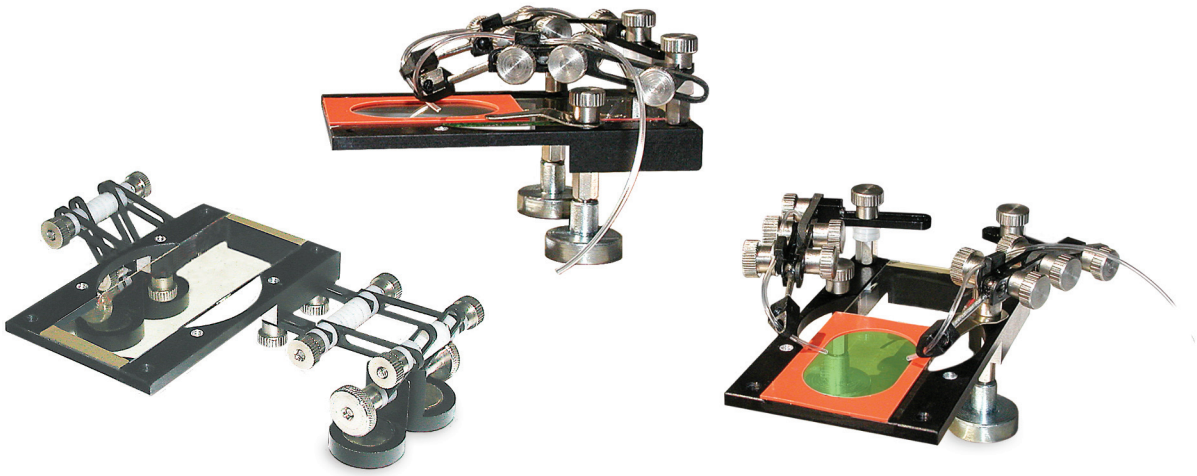
Syringe heater with temperature controller

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

This miniature perfusion unit TC-RD is used as a preheater or cooling unit during sample perfusion. It connects to the second channel, or another controller



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

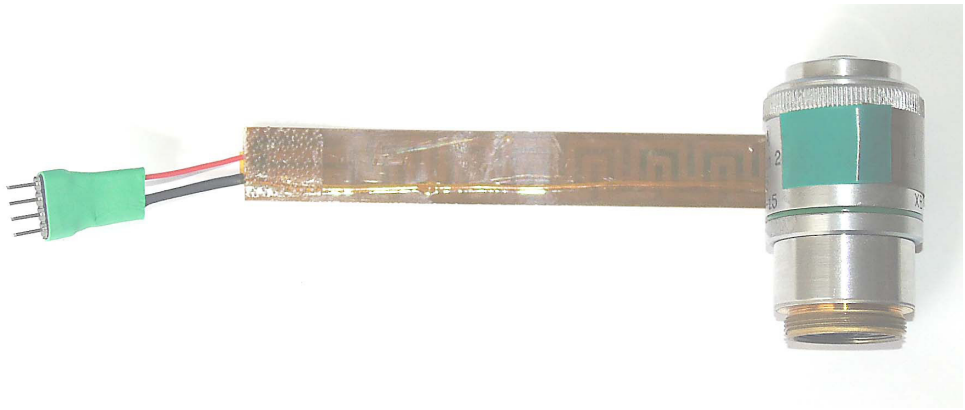
The Objective Heater is wrapped around a microscope objective. An incorporated temperature sensor is used to regulate and monitor the objective temperature. Flexible objective heaters can be used with any objective and are easy to install. Using objective heaters provide an effective way to stabilize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

Attaching Heater to Lens

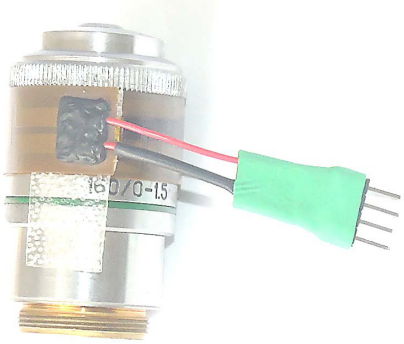
If possible remove the lens from the microscope. Use included Velcro tape to fix the heater securely around the objective, placing the sensor between the objective surface and the heating element.

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.

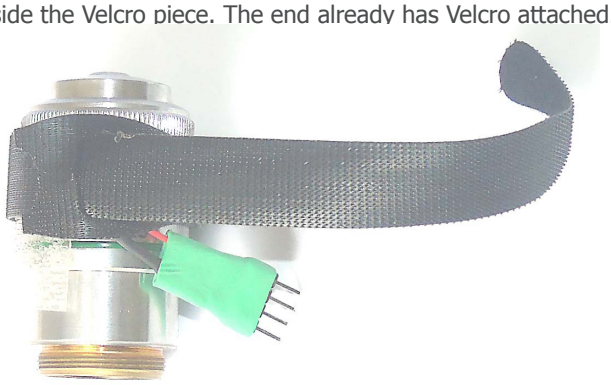
Recommended procedure to mount the objective heaters:



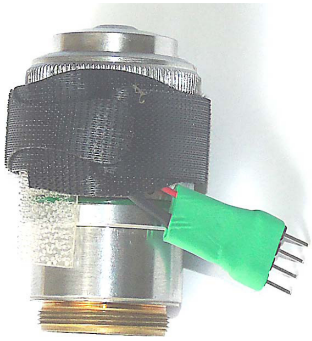
1. Position the heater on the objective closer to the sample plane, the sensor down touching the objective surface, and fix in place using a small piece of electrical tape.



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.



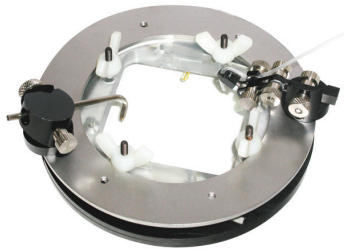
3. Make a loop using black Velcro tape, and tighten it around the heater so the connector is sticking outside from the tape.



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

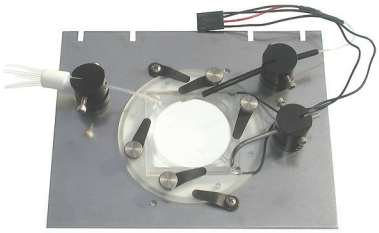
Large Volume/Bath/Dissecting Chamber for in vivo imaging TC-DIS

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

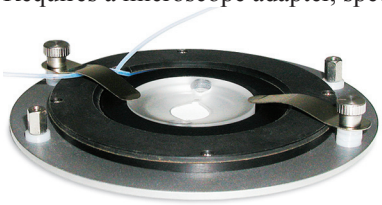
This chamber has uniformly heated glass bottom with large clearance of 42mm diameter. Separate compartments for inflow and outflow prevent bubbles from entering the chamber and provide smooth perfusion. Built-in temperature probe. Includes 2-channel temperature controller, microscope adapter, two magnetic 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

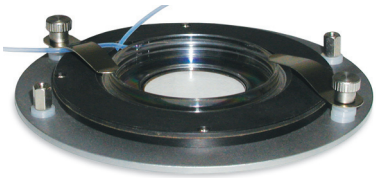


Low Profile Heated Stage, TC-E50x30

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

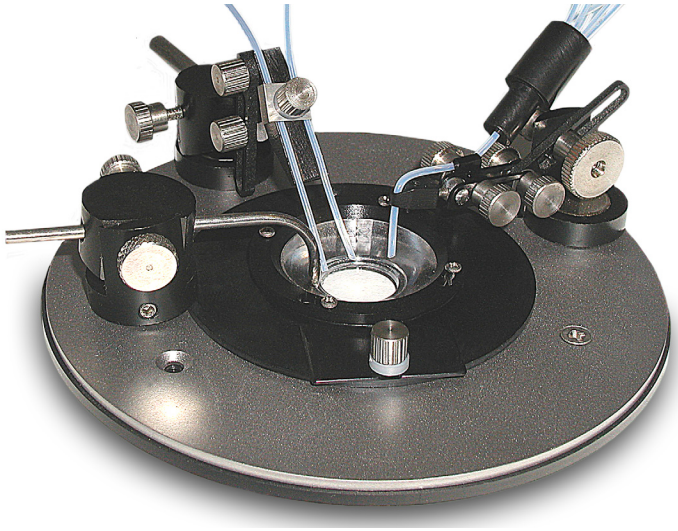
The incubator can be used with round replaceable coverslips for long-term time-lapse high resolution imaging. Comes with thin high optical quality glass cover to prevent evaporation (can be removed). Easy to use: simply drop the sample coverslip into the holder, seal with silicon chamber, and secure 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 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

Chambers for replaceable coverslips - CSC



Example of using CSC chamber in a perfusion setup. Magnetic holders are arranged on a microscope adapter MA to provide solution inflow and outflow.

1. Position the bottom part of the 2-parts chamber on a flat surface. Put a cover slip inside the groove in the bottom part. Put the top part inside the bottom part.

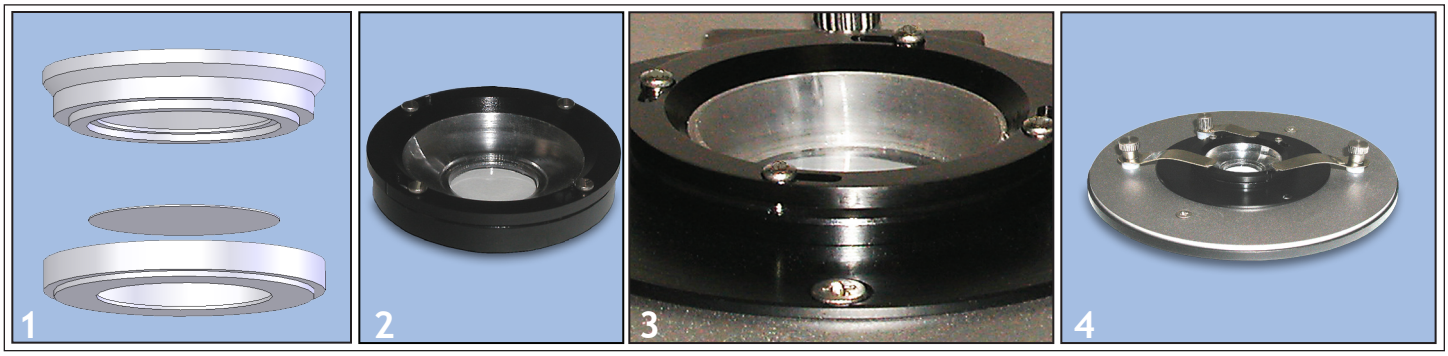
2. Fix the plastic insert with a metal ring from the top.

3. Put the assembled chamber inside microscope adapter or the temperature controlled stage.

4. Use provided clamps to fix the chamber in place, this is especially useful if oil immersion objective is used with an inverted microscope.

Arrange magnetic holders with inflow manifold and

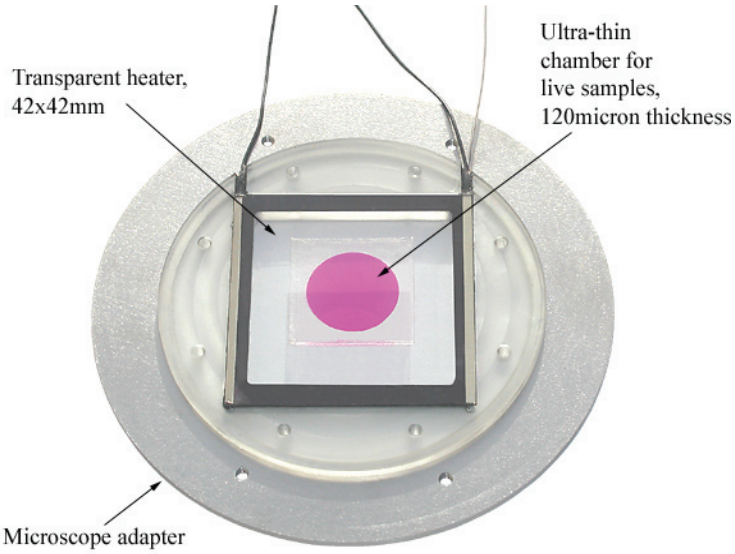
Catalog #	Features:
CSC	Chamber for replaceable round coverslips. Simply put a coverslip inside and seal by a snap-in action.
	Choose the right diameter to fit your coverslips.



suction tubing around the chamber. While using the cover slips with cultured cells, excess of solution on the cover slip might result in bad seal and cause leakage. Try to leave only a minimum amount of liquid on the cover slip before assembling the chamber.

Note: Although the plastic CSC-10P chamber is tight enough, you can further improve the seal against solution leak by putting a thin layer of silicone grease or mineral oil (or Vaseline) inside the bottom part of the chamber, especially along the edges of the groove for the cover slip. Using provided clamps helps to seal the chamber as well.

Ultra-thin imaging chambers - UTIC



Ultra-thin chamber formed on top of a heated glass plate tc-hp65x75. Heated slides TC-GSH can be also used.

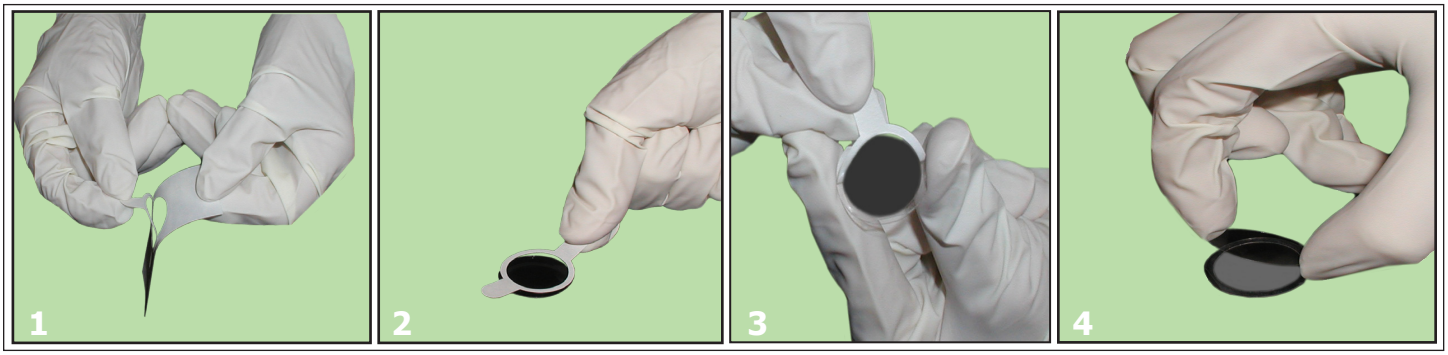
1. Remove protective liner from the bottom surface to expose the adhesive.

2. Apply the adhesive side down onto the surface of a coverslip, glass slide, or on the bottom of a chamber. Press gently to seal.

3. Remove the remaining protective liner. Aliquot a small amount of media into the chamber, or place your sample inside and fill the chamber with additional medium.

4. Place another coverslip on the top. Press gently but firmly to seal the chamber.

Catalog #	Features:
UTIC-21 UTIC-11D UTIC-20-24x24 UTIC-13-24x24	Ultra-thin self adhesive chambers for high resolution imaging. Can be used with coverslips, and on any glass or plastic surface.
quantity	Pack of 100 layers.



5. Place the sealed chamber into metal holder UTIC-25, which fits microscope adapters MA and heating stages, TC-E35. An open chamber can be also formed using a plastic holder, PCCS1 for example.

6. The holder and glass surface can be cleaned after use by removing residual adhesive with a scalpel. Adhesive Removal solutions are also helpful.

Cooling stages BTC-S/I, BTC-SL/I, BTC-S50, TC-RD

The controller will automatically detects if SET temperature is below ambient level and starts cooling your sample, provided a cooling/heating stage is connected. If SET temperature is very low an additional sink cooling might be required. Each cooling stage incorporates four ports to connect to a source of water. Two ports on top are for the sink on the top, and other two ports are for the sink on the bottom. Two positioned vertically ports need to be connected together to form a closed loop. You can use CFPS-1U66 miniature flow unit, which can provide up to 22ml/min water flow to cool the sink.

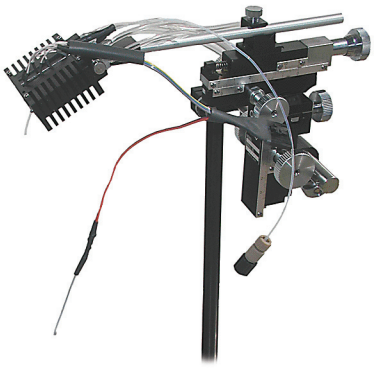
If the controller detects the cooling stage, it will actively control the temperature by heating and cooling the stage alternatively. This feature can be used to generate linear temperature changes ("ramp") by providing an EXT temperature level, or sending software commands through RS232 computer port.

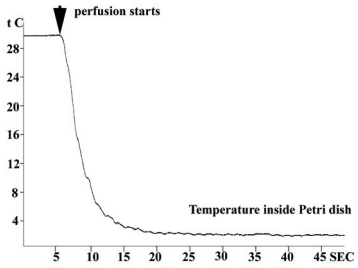
Sink cooling using BTC-W

During cooling operation the stage heat sink can overheat, which will inhibit bringing the temperature down too much. In order to help the stage to reach low temperatures, a BTC-W water cooling unit should be used. Simply connect INPUT to a water source and OUTPUT to the sink port on the stage. NOTE: some stages have separate sinks: so either two BTC-W units should be used, or one sink should be connected to the other in sequence.

This water cooling unit can be also used with TC-RD miniature perfusion unit. TC-RD is used as a preheater or cooling unit during sample perfusion.

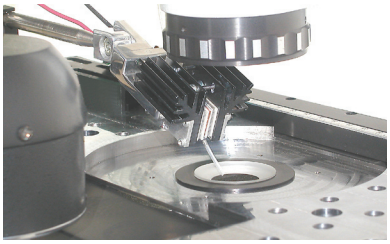
Cooling/Heating Elements





Miniature Perfusion Cooler/Heater Unit TC-RD

Controls temperature of perfusion solutions in the range from 0 to 100°C. A small heating/cooling element is designed to mount on a manipulator next to your sample to provide fast temperature changes by streaming the solution directly onto the sample. Monitoring and control temperature by data acquisition systems through BNC connectors on the back panel. Set temperature either manually or using your data acquisition interface, to generate ramps, for example. Optimized for patch clamp applications: no electrical noise. Can be powered by 12V rechargeable batteries (charger and batteries are included).



On the right is an example of fast temperature change inside a petri dish. Experimental conditions: TC-RD system was set at 0°C; the petri dish was set at 30°C using another TC-1 controller and TC-PCP heating stage; two flow control CFPS-1U66 units were used - one for solution suction from the dish, through PDI insert inside the dish; and another CFPS-1U66 to cool heat sink of TC-RD unit; the third CFPS-1U unit was used to perfuse the dish; a slow temperature sensor was used to simulate temperature change in the whole dish; the actual temperature change in the point of solution application is much faster. Item#: TC-RD

- **Dimensions:** 1 x 2 x 2in
- **Temperature stability:** better than 0.1°C, built-in sensor
- **Sink:** water cooling for very low temperatures
- **Feedback:** Selectable Stage, or External sensor (Bath)

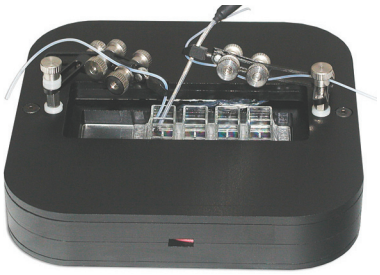
Cooling & Heating Microscope Stage for coverslips BTC-S-35

- **Dimensions:** 120x120x23mm
- **Optical aperture:** 22mm
- **Temperature stability:** 0.1°C, built-in sensor
- **Sink:** liquid cooling for very low temperatures, optional water cooler unit BTC-W
- **Solution Pre-heater/cooler:** Replaceable/Removable Teflon tubing, easy to wash
- **Microscope adapter:** Fits to 74mm cutout of standard microscope adapters

Can be used with: Standard 35mm disposable Petri dishes; CSC chambers for replaceable coverslip chambers. Requires BTC-100 controller. Requires a microscope adapter (specify microscope model). Item#: BTC-S

Cooling & Heating microscope stage for slides, BTC-SL

- **Dimensions:** 120x120x23mm
- **Temperature stability:** 0.1°C, built-in sensor
- **Sink:** liquid cooling for very low temperatures, optional water cooler unit BTC-W
- **Optical aperture: 40x**22mm
- **Microscope adapter:** Fits to 74mm cutout of standard microscope adapters



Can be used with: Standard 1 in. (25mm) wide disposable slides and chambered coverglasses. Built-in temperature sensor for stable operation. Can be used with perfusion systems. Top surface can be used to attach miniature holders for custom accessories: from solution delivery lines to electrodes and sensors. Click on image to enlarge. Requires a microscope adapter (specify microscope model when ordering), and BTC-100 temperature controller. Item#: BTC-SL

Cooling & Heating microscope stage for 50mm dishes, BTC-S50

- **Dimensions:** 145x145x23mm
- **Temperature stability:** better than 0.1°C, built-in sensor
- **Sink:** water cooling for very low temperatures, optional water cooler unit BTC-W
- **Optical aperture:** 33mm
- **Microscope adapter:** Fits to 74mm cutout of standard microscope adapters

Can be used with wider up to 59mm disposable dishes, including Willco 50mm glass bottom dishes. Comes with reducing adapter for 50mm dishes. Built in lines to cool heat sink for deep cooling. 30mm clearance. Click on image to enlarge. Consider a different cooling stage for rectangular slides. Requires a microscope adapter (specify microscope model when ordering), and a temperature controller. Item#: BTC-S50

Cooling & Heating microscope incubator for petri dishes, BTC-S

- **Dimensions:** 120x120x23mm
- **Optical window:** 22mm aperture
- **Temperature stability:** 0.1°C, built-in sensor
- **Sink: optional** water cooling for very low temperatures, requires BTC-W unit
- **Microscope adapter:** Fits to 74mm cutout of standard micro-

Can be used with: Standard 35mm disposable Petri dishes (petri dish adapters TC-PA might be required), or glass bottom dishes (TC-PA-W or TC-PA-F adapter is required); and replaceable coverslip chambers CSC. Built-in temperature sensor for stable operation. Can be used with high optical quality glass cover with ports for gas input, to control CO2 or hypoxia. Built-in lines to cool sink during deep cooling. Consider a different cooling stage for rectangular slides below. Requires a temperature controller TC2-80-150-C. Requires a microscope adapter (specify microscope model). Item#: BTC-S

Cover-incubator for Cooling & Heating microscope stage for petri dishes and coverslip chambers, BTC-SI

- **Dimensions:** 63mm diameter
- **Optical window:** 44mm double glass window
- **Thickness:** 3mm
- **Ports: x2 barbed gas ports**

If placed on top of BTC-100 stage, will form a closed system to control gas composition inside. Incorporates two high optical quality glass covers and ports for gas input, to control CO2 or hypoxia. Item#: BTC-SI

Cover-incubator for Cooling & Heating microscope stages for slides, BTC-SLI

- **Dimensions:** 38x88mm
- **Optical window:** 22x57mm double glass window
- **Thickness:** 3mm
- **Ports: x2 barbed gas ports**

Can be used with BTC-SL stages for standard 1 in. (25mm) wide disposable slides and chambered coverglasses. Incorporates two high optical quality glass covers and ports for gas input, to control CO2 or hypoxia.. Item#: BTC-SLI

Slides and Chambered Coverglasses Cooling & Heating stage, BTC-SLM

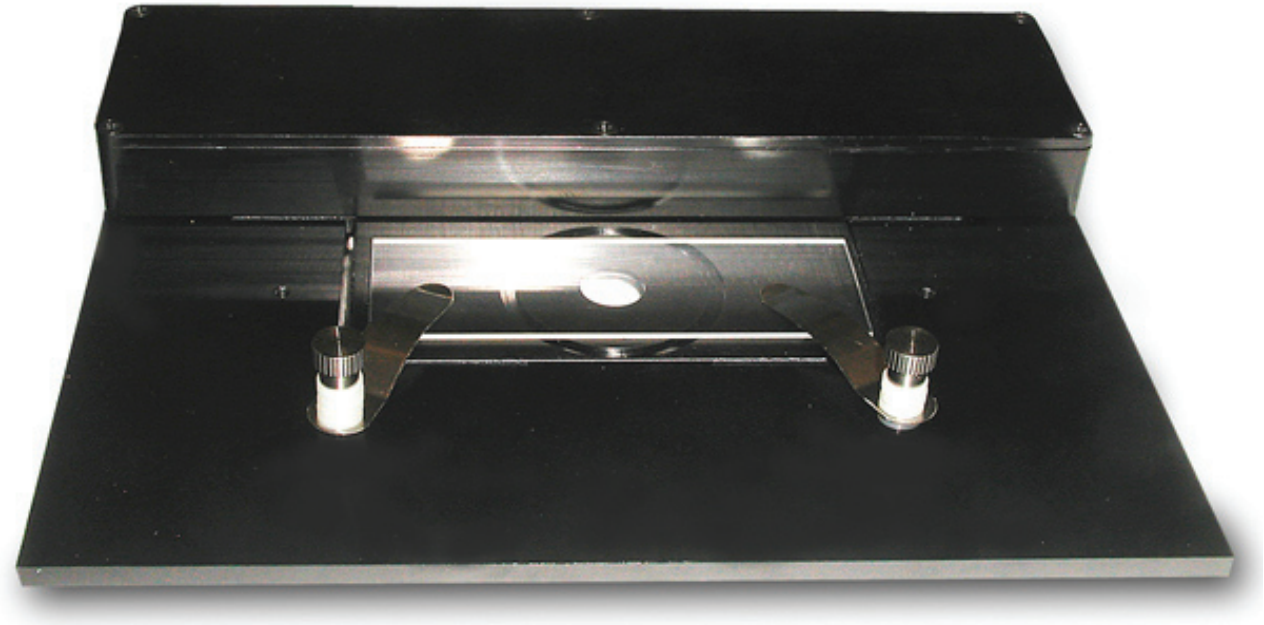
Can be used with: custom devices, disposable slides and coverglasses. Can cool the sample down to -5°C (or heat up to 150°C). Fits 160x110mm cutout of motorized stages, and type K Zeiss stages. The cooling area is an inside cutout 26x79mm (to fit standard slides), with 20x40mm aperture in the middle. The inside cutout is 17mm deep, with 1mm lip to hold the sample. Requires sink cooling and a temperature controller. **Item#: BTC-SLM**

- **Dimensions: 110x160x18mm, 26x79mm cooling/heating area**
- **Optical aperture:** 20x46mm
- **Objective working distance, minimum:** 0mm (for inverted microscopes)
- **Temperature stability:** 0.1°C, built-in sensor
- **Sink: optional** water cooling for very low temperatures, requires BTC-W unit
- **Microscope adapter:** Fits to 74mm cutout of standard microscope adapters IMA-74

Low-Profile Cooling & Heating plate, BTC-L

Can be used with: standard 35mm disposable Petri dishes, glass bottom dishes, and disposable slides and coverglasses. Can cool the sample down to -2°C (or heat up to 150°C). The cooling area is 40x80mm with 10mm aperture in the middle. The low profile of the stage allows easy access to your samples. Provided clamps will fix the sample in place. Can be placed on upright microscopes. Can be mounted on a microscope stage (specify dimensions of microscope stage cutout, 108mm diameter for Nikon for example). Requires sink cooling and a temperature controller. **Item#: BTC-L**

- **Dimensions:** 120x160mm, 80x40mm cooling/heating area
- **Optical aperture:** 10mm diameter
- **Objective working distance, minimum:** 0mm (for upright microscopes)/ 3mm (for inverted microscopes)
- **Temperature stability:** 0.1°C, built-in sensor
- Heat **Sink: optional** water cooling for low temperatures, requires BTC-W unit
- **Microscope adapter:** Fits to 74mm cutout of standard microscope adapters IMA-74



Low Profile Cooling & Heating stage for Slides and Chambered Coverglasses, BTC-SL-128x86

This low profile heating/cooling stage designed to fit inside 128x86mm holders for standard multi-well plates. Can be used with: custom devices, disposable slides and coverglasses. Positioned on both sides threaded #4-40 holes can be used to mount optional IMA-MH tubing and probes holders. Can cool the sample down to 0°C (in combination with BTC-W heat exchange unit) or heat up to 150°C. The cooling area is an inside cutout 29x79x1mm (to fit standard slides), with 20x40mm aperture in the middle. Requires a temperature controller. **Item#: BTC-SL-128x86**

- **Dimensions: 128x86mm, 29x79mm cooling/heating area**
- **Optical aperture:** 20x46mm
- **Objective working distance, minimum:** 0mm (for inverted and upright microscopes)
- **Temperature stability:** 0.1°C, built-in sensor
- **Sink: optional** water cooling for very low temperatures, requires BTC-W unit
- **Microscope adapter:** Fits to 128x86mm holders for standard multi-well plates

Cooling & Heating Microscope Objective, BTC-O

Can be used with any microscope objective (or any cylindrical object). Can cool the objective down to -6°C (or heat up to 150°C). The cooling area should be specified when ordering, for example 22.5mm diameter and 10mm wide for x40 Zeiss objective (technical drawings are required). Built-in clamp will fix the objective in place. Can be placed on upright and inverted microscopes. Requires sink cooling and a temperature controller Item#: **BTC-O**

- **Dimensions:** custom cooling/heating area (22.5x10mm for example)
- **Optical aperture:** custom
- **Objective working distance, minimum:** 0mm (for upright microscopes)/ 0mm (for inverted microscopes)
- **Stability: 0.1°C, built-in sensor**
- **Heat Sink: optional water cooling for low temperatures**

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.