Temperature Control

User's Guide

Heated/Cooled 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

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Contents

CE

Specifications

Range -80 to 150ºC
Accuracy 0.1ºC
Stability 0.01ºC, required for sensitive applications: nano & piezo positioning, TIRF & AFM
Output 4A max (max 140W for 35VDC input)
No electrical noise suitable for electrophysiology
No vibrations no internal fan
Temperature sensors
built-in STAGE sensor
external BATH (0.87mm)
Selectable Feedback
from STAGE or BATH
adjustable DC and AC GAINs

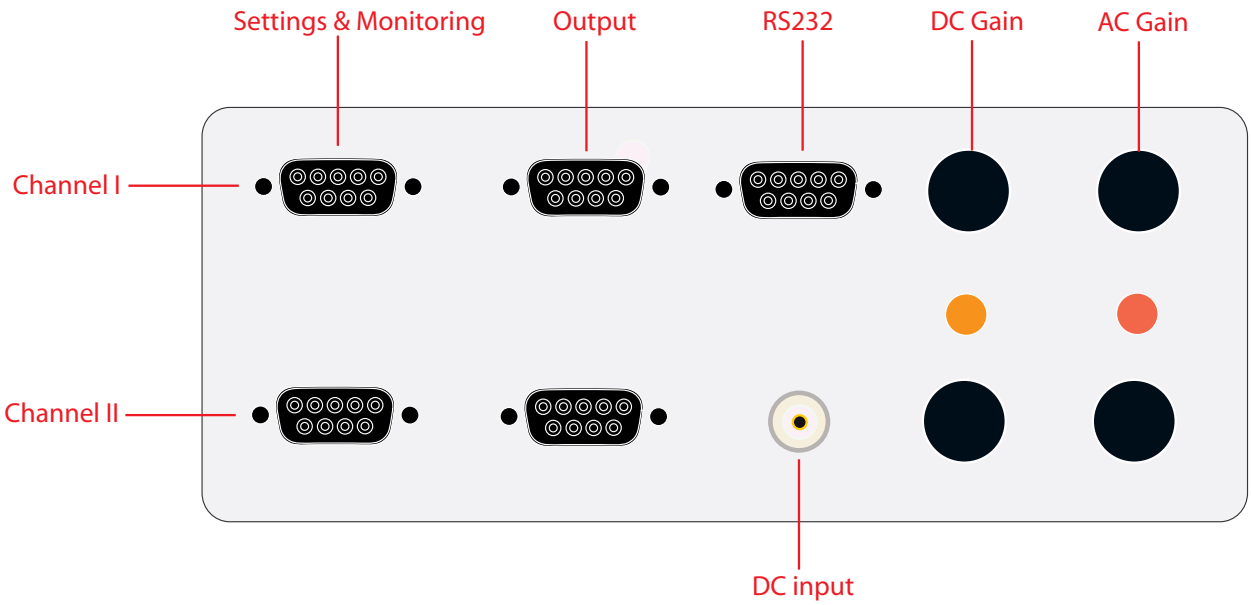
Analog Input
Input analog voltage to SET temperature;
Analog Output
To monitor temperature:
Automatic Cooling
Overheating protection
stops operating if STAGE is over 150ºC
RS232 port
to set and monitor temperatures
Size (Controller) : 6Wx2.5Hx9D in.
Power Supply
2.1mm jack, 12VDC min - 35VDC max

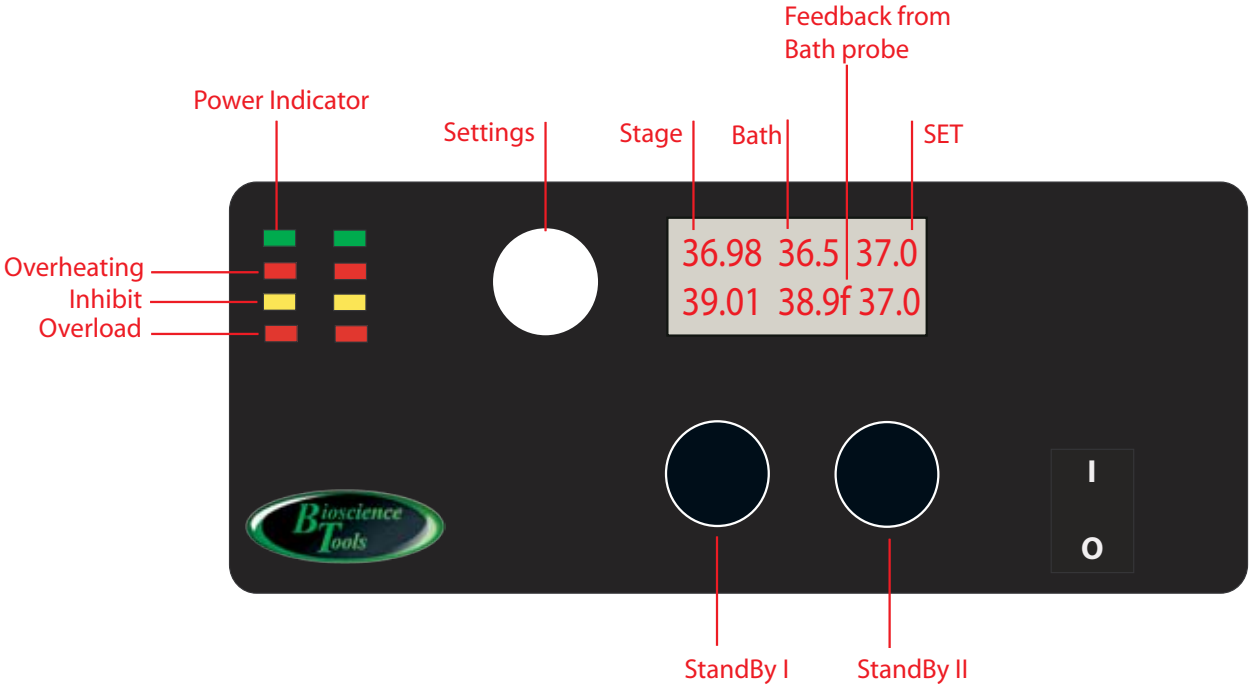
Introduction

The complete temperature control system includes a controller, an external power adapter, an external temperature probe, and a connecting cable to a heating element. All heating elements include a temperature sensor built inside the heating element - STAGE sensor. This internal sensor can be 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 are an illustrated installation guide and example configurations of temperature controlled setups.

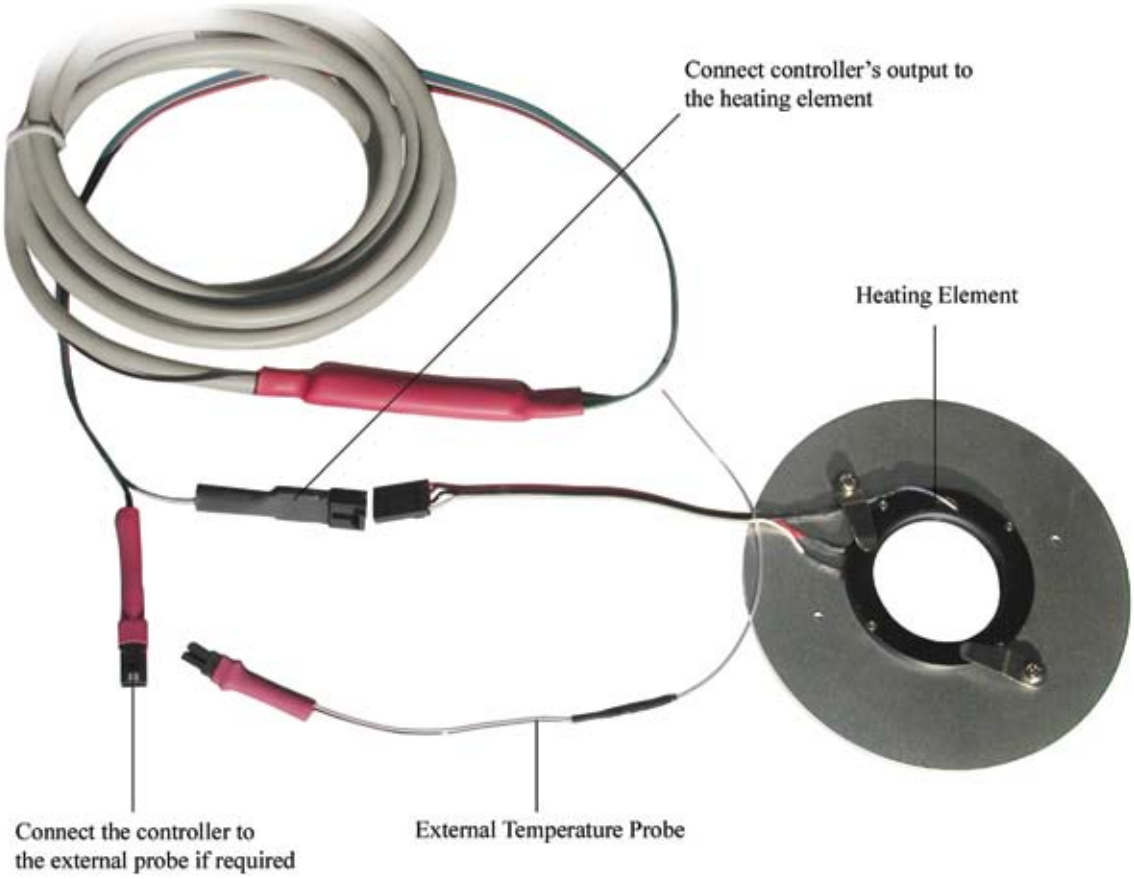
Installation Guide

1 Connect power cable to the external DC power adapter. Plug the power cable into wall outlet. Plug the adapter to the power jacks on the back of the controller - standard circular 2.1mm power jack. 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 provided adjustable holder, position the 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 - power switch on front.

4a Before using the system, you need to know how to adjust temperature settings. The controller has one LCD temperature monitor, and a switch, which allow you to adjust the reference temperature by rotating SET dial - SILVER knob on front. You can also choose which sensor to use to provide FEEDBACK to the controller. Two lnobs under the display will put the controller from STANDBY to ACTIVE operation for channel I (LEFT) and channel II (right). The controller ships set for feedback from STAGE sensors, with setting adjusted to provide stable operation at 37 C.

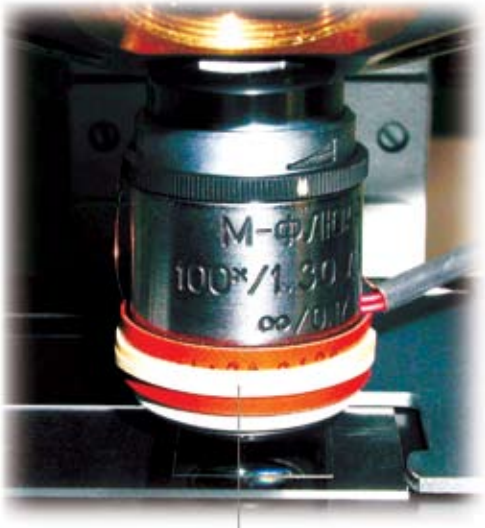
Now you can switch the controller from STANDBY state into ACTIVE state and observe on the temperature monitor how the controller regulates the temperature of the heating stage. The active state is achieved after increasing the output power by rotating the GAIN dial clockwise. At this point you can rotate GAIN dial all way. GAIN dials are located under the display - LEFT for channel I, and RIGHT - for channel II.

GREEN LED on the front panels will indicate that the controller is functional. The controller ships with settings adjusted. You can increase/decrease ORANGE DC level on the back (while AC PINK level is OFF - counter-clockwise all way) until temperature stabilizes near the SET level. Just by doing this, you might achieve the acceptable level of temperature control.

To make the controller follow the temperature fluctuations more precisely, however, you need to provide active FEEDBACK to the controller. After the system stabilizes at temperature around required SET level slightly below SET level), increase FEEDBACK gain by rotating PINK AC dial on the back of the controller clockwise. If the

temperature stabilizes at level higher/lower than SET level, decrease/increase DC ORANGE level. You can also change SET dial to achieve the required reading on LCD.

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.

Push down SETTINGS button once - the display will show the following screen:

SET1 37.0

Rotate the button to adjust SET level for channel I to the required level. Push the button again to switch the display to show SET level for channel II:

SET2 37.0; and adjust the level to the required reedings. If you push the button again, you will be able to select feedback between STAGE sensor and external BATH probe for channel I:

Feedb1 STAGE 37.0; and if you push again - for channel II:

Feedb2 BATH 37.0; If you select feedback from BATH probe, the display will show readings from BATH probe followed by letter “f” to indicate the BATH probe was selected to provide feedback to the controller.

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.

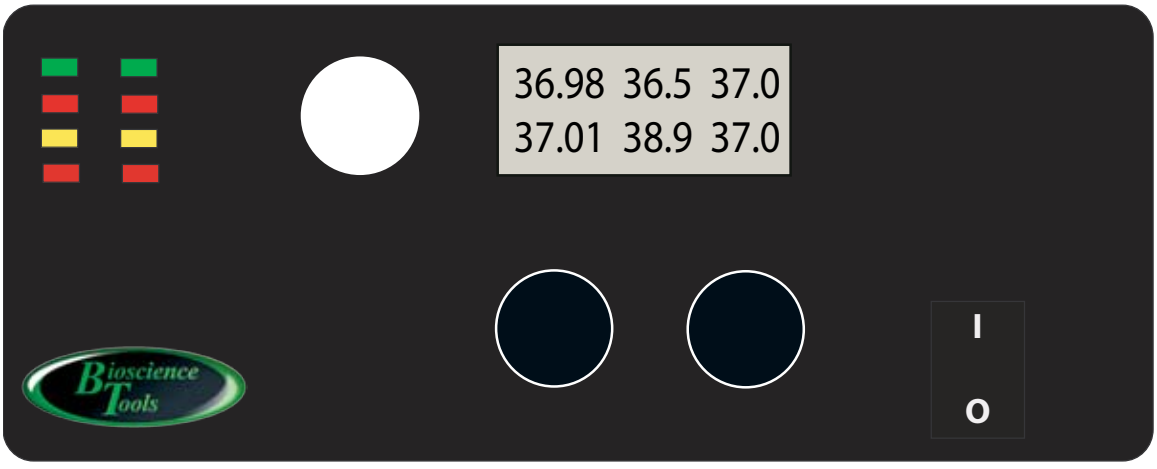
Using an objective heater with oil or water immersion objectives will eliminate this temperature gradient. The second channel of the controller is usually used to regulate the temperature of the objective heater, which has a built-in temperature sensor and does not require too much of fine tuning.

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

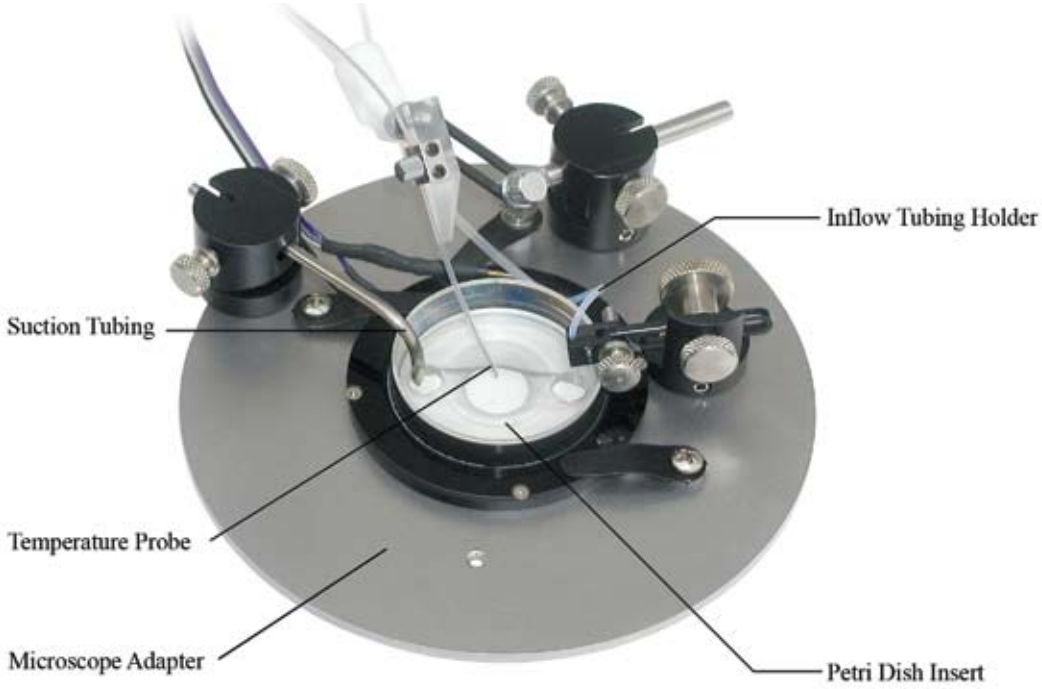
4b Another way to achieve the correct temperature around your sample is to switch the feedback of the controller to BATH temperature sensor. This might result to temperature fluctuations, however.

If fluctuations are too wide, decrease FEEDBACK GAIN - AC (PINK) on the back of the controller slightly. If the temperature stabilizes at a level different from SET reference level, increase/decrease SET dial or DC(ORANGE) level on the back panel slightly, until you read the required temperature. It is advised, however, to keep feedback from STAGE sensor instead BATH, and adjust SET level instead, to offset temperature reading from BATH probe, if required. 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.

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 FEEDBACK-GAIN on the back panel. 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.

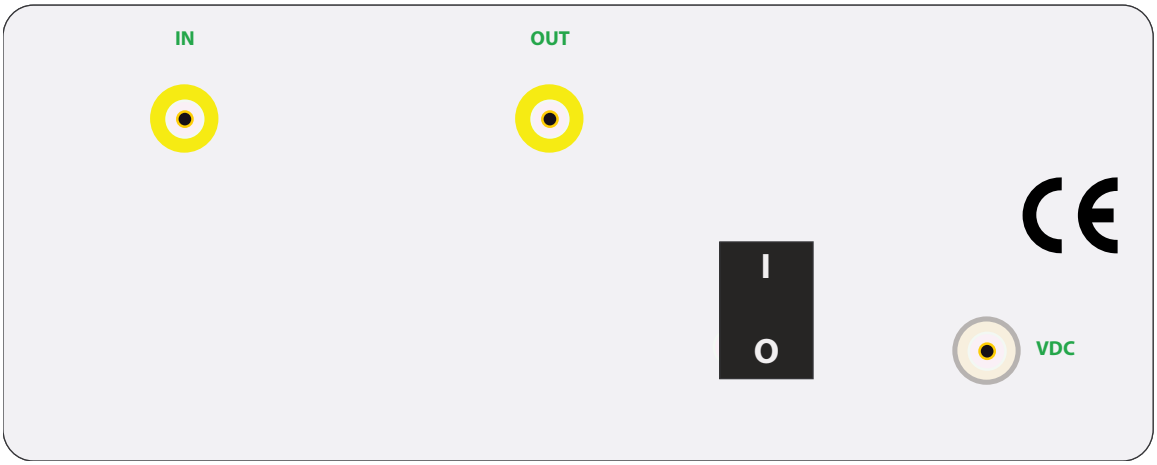


4c Using continuous perfusion of your sample helps to eliminate the undesirable temperature gradient in the system. Note: if flow rate in the system does not change, better temperature stability might be achieved by switching the controller feedback to heating element sensor STAGE, and adjusting SET 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.

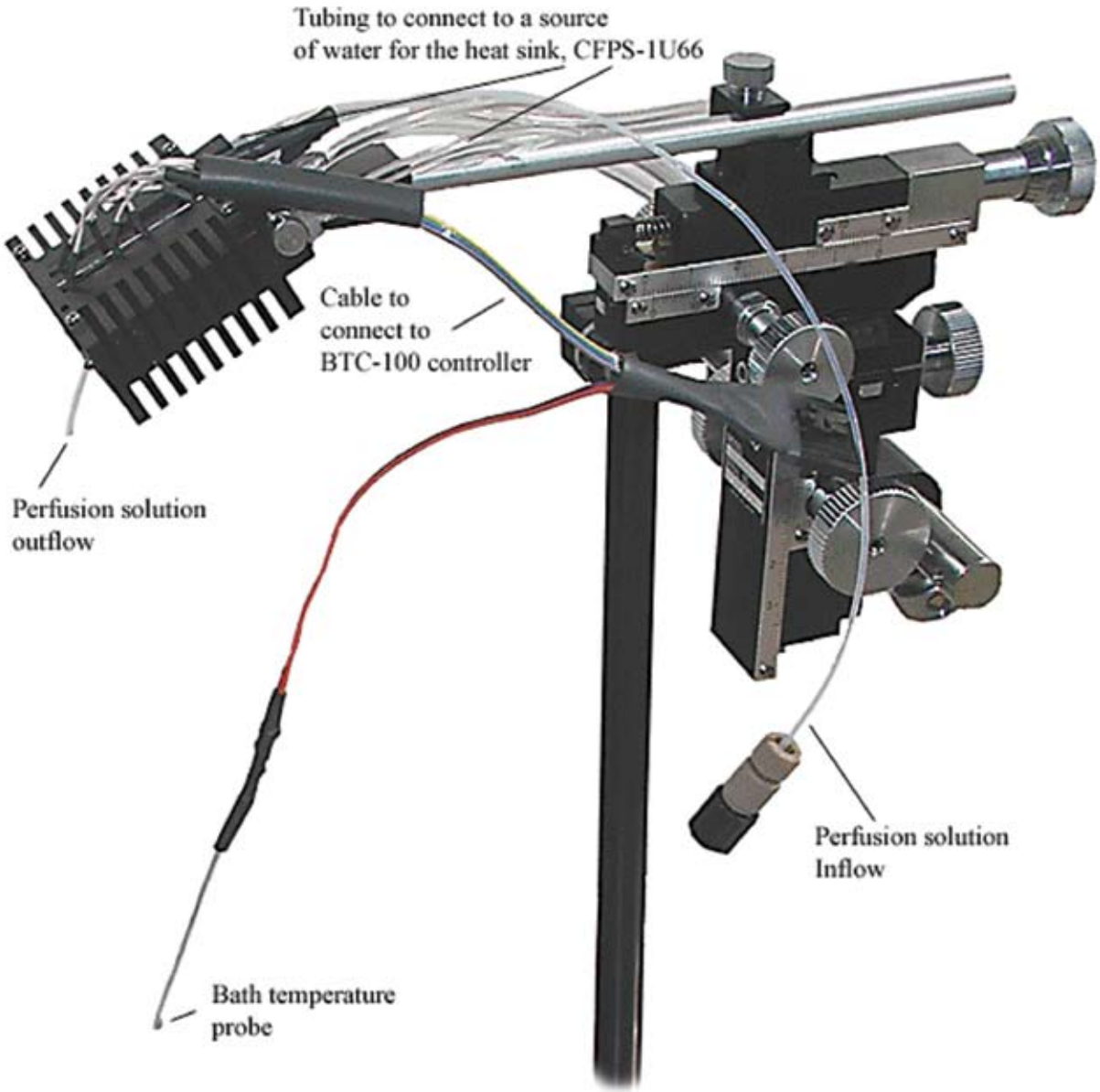


4d If a cooling stage is used for very low temperatures, you might need to provide cold water flow through the cooling unit heat sink using a CFPS-1U/66 unit. Two of positioned vertically ports need to be connected together, while the remaining two ports are used for inflow and outflow heat sink water

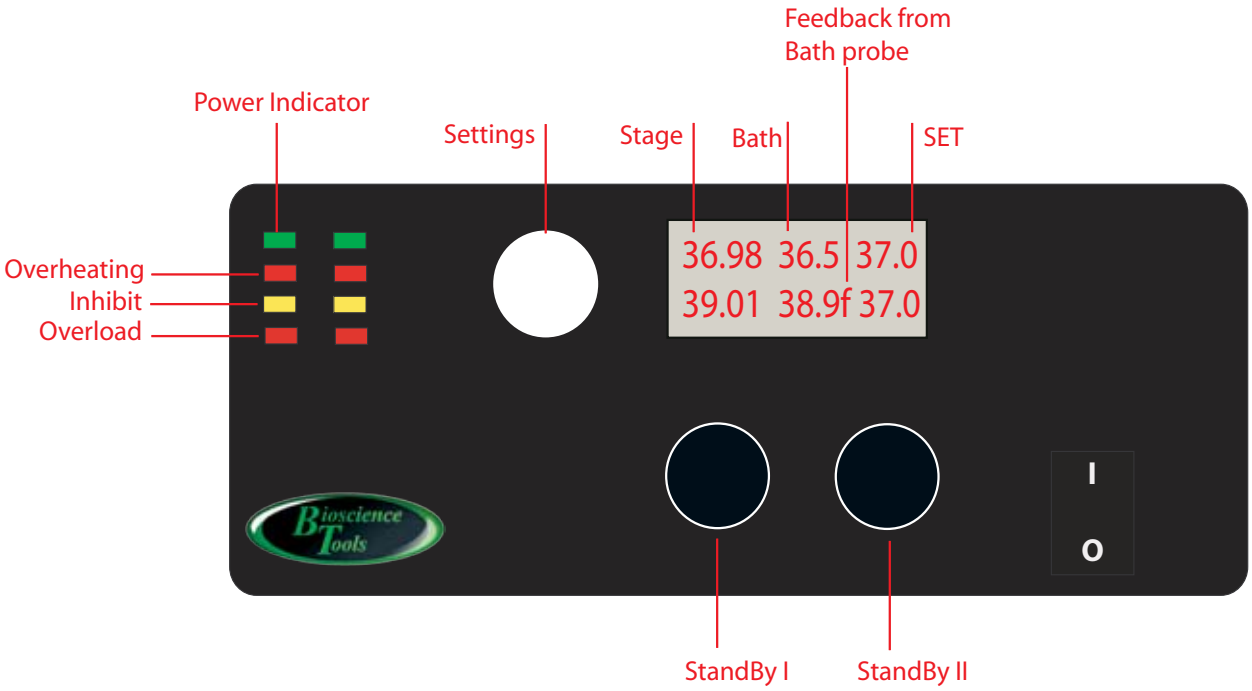
4e During cooling operation the tage heat sink can overheat, which will inhibit brining the temperature down too much. In order to help the stage to reach low temperatures, a BTC-W water cooling unit should be used. Simply connect INPUT to a water source and OUTPUT to the sink port on the stage. NOTE: the stages have separate sinks: on TOP and BOTTOM, so eather two BTC-W units should be used, or TOP should be connected to the BOTTOM in sequence. The water can be run using a CFPS-1U66 flow control unit.



This cooling unit can be also used with TC-RD miniature perfusion unit (on the right). TC-RD is used as a preheater or cooling unit during sample perfusion.

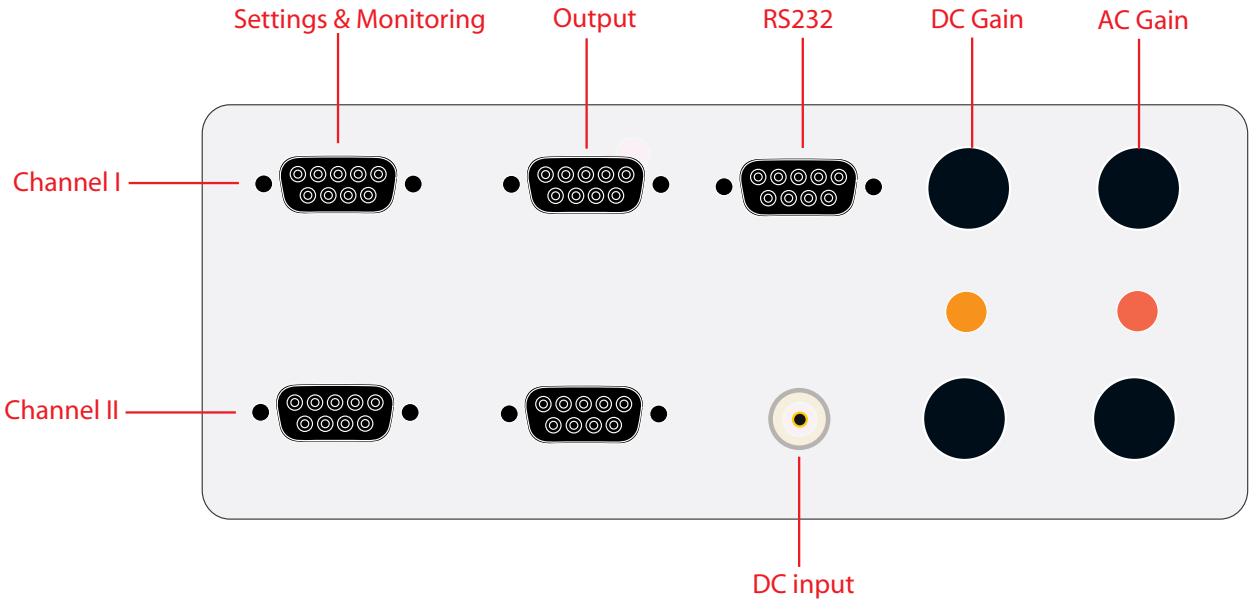

Tubing to connect to a source
of water for the heat sink, CFPS-1U66
Cable to
connect to
BTC-100 controller
Perfusion solution
outflow
Perfusion solution
Inflow
Bath temperature
probe

Front Panel Controls



Front Panel Controls	
POWER switch	Turns the controller ON.
LCD monitor	Display temperature readings from temperature probes, and shows SET temperature.
Display Switch	Switches the display to show settings by pushing the silver knob down: each click will switch to adjust different parameters in the following order: SET1, SET2, FEEDBACK1, FEEDBACK2
SET dial	After display shows SET1/2 - sets the reference temperatures, and, after displays shows Feedback1/2, selects FEEDBACK.from stage sensor or external BATH probe
STANDBY dials	Provide POWER to the heating stages. At the most counter-clockwise position, no power is provided to the heating stages (STANDBY mode).
GREEN LED	Indicate POWER provided to the heating elements.
YELLOW LED	Indicate INHIBIT mode induced by an external source through back panel DB9 connectors.
RED LEDs	Indicate heating element and internal overheating. The controller turns into STANDBY mode automatically until the overheating threat is eliminated. In case of internal overheating, the controller might need to be restarted by turning the power switch OFF and ON.

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 3.3V/230°C: pin5 - STAGE, pin 6 - BATH.
RS232	DB-9 male connector in the middle.
Back Panel Controls	
RS232	Set reference temperatures.
DB-9 connector	Used for setting the reference temperature through external sources, data acquisition systems for example. (pin 1 -10V/230°C), pin 2 - Inhibit.
INHIBIT	Used to turn the controller to STANDBY mode by external TTL signals (+5V, pin 2).
DC POTs ORANGE	Set the level of power provided to the heating elements independent on temperature readings from FEEDBACK sensors..
AC POTs PINK	Set the level of sensitivity to the difference between SET temperature and the actual temperature reading from FEEDBACK temperature sensors.
POWER jack	Connects to the provided external DC power adapter.

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, 4527 52nd Street San Diego, CA 92115, ph: 1-877-853-9755.

Software control and monitoring

Using a serial 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 <CR> code:

T1<CR> returns temperature readings from STAGE1 sensor: T1 37.10 C

T2<CR> returns temperature readings from BATH1 sensor: T2 36.90 C

T4<CR> returns temperature readings from STAGE2 sensor: T1 37.10 C

T5<CR> returns temperature readings from BATH2 sensor: T1 36.90 C

T6<CR> returns temperature readings from EXT2 sensor: T1 37.0 C

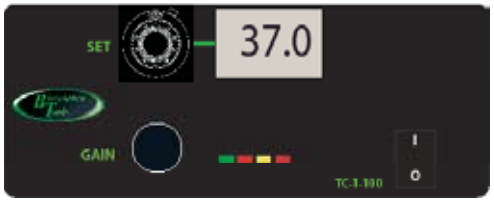
S1 0370<CR> sets reference temperature for channel I to 37.0
(NOTE: all four digits should be sent to the controller)

S2 0370<CR> sets reference temperature for channel II

OFF<CR> turns operation - heating/cooling - OFF

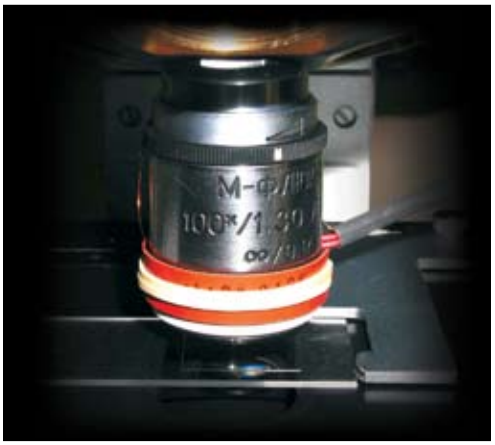
ON<CR> starts operation again: works only after operation stopped by OFF command

Complete Temperature Controlled System

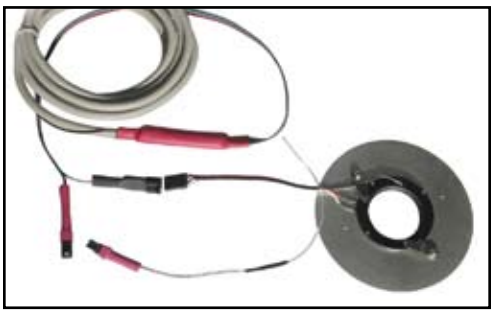


The complete functional temperature controlled setup includes the following components:

1 The main component of the system is a controller, which regulates the temperature of your sample by providing appropriate amount of energy to the heating/cooling elements. The controller uses sensors to get the temperature feedback from the sample and compares these readings with required settings. There are two types of feedback: one is determined by the volume or thermal mass of solution around your sample, and the second is determined by difference between required temperature and the actual temperature of the sample. The first type is responsible for providing steady amount of power to the system to compensate thermal energy dissipation due to temperature gradient between your sample and environment. It is regulated by DC GAIN. The second type is regulated by AC GAIN, and traditionally called FEEDBACK GAIN.



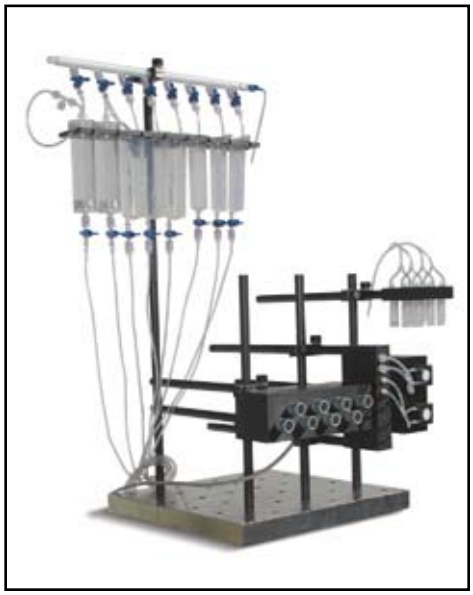
If heated bottom chambers TC-HB are used in the system, the sample is heated uniformly. The traditional chambers like petri dishes, however, are usually heated from sides, along the outer walls of the dish. This inevitably creates temperature gradient inside the dish with temperature being higher along the walls of the dish than temperature in the middle, where your sample is usually located. Using oil or water immersion objectives with regulated objective heaters effectively eliminates this undesirable gradient. Another way to eliminate the temperature gradient in the system is to use continuous perfusion, or flow of solution, which is preheated by passing through the heating element. Most of our heating elements can be used as solution pre heaters.



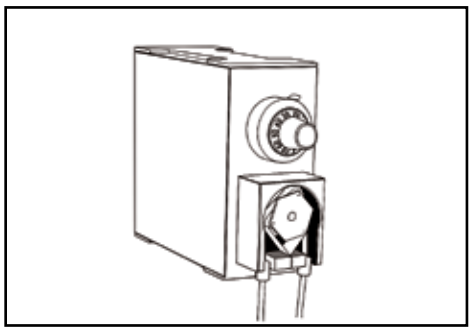
2 Each system includes a set of connecting cables and temperature probes. The heating elements might require microscope adapters, The heating element incorporate a built-in temperature sensors.

3 Closed controlled environment systems not only define gas composition and preserve moisture inside the system, but also help to prevent heat dissipation. In combination with heated top and heated immersion objectives, they provide effective way to control environment around your sample during long term experiments, time lapsed imaging for example. The closed systems also include a set of accessories to configure solution exchange, test substance application, or continuous perfusion of the sample. Petri dishes, chambers for coverslips, and chambered cover glasses can be used with these systems.

4 A set of perfusion accessories, from heated zero-dead volume manifolds to automatic solution switches, allow you to manipulate media around your sample and keep stable temperature control at the same time. Automatic flow controllers and simple gravity driven systems can be combined to switch and mix up to 320 different solutions. Computerized packages with software to program any solution exchange protocols will create flexible experimental environment to perform not only test substance applications during imaging, but staining your sample while still under the microscope.



To complete the heated perfusion system you need to configure solution outflow, which is required for most systems - petri dish heaters, for example. The controlled flow unit CFPS-1U66 can handle up to 22ml/min. Outflow starts automatically, every time perfusion is ON, to prevent accidental solution overflow in the system. Multiple flow control units can be used to control inflow rate as well.



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

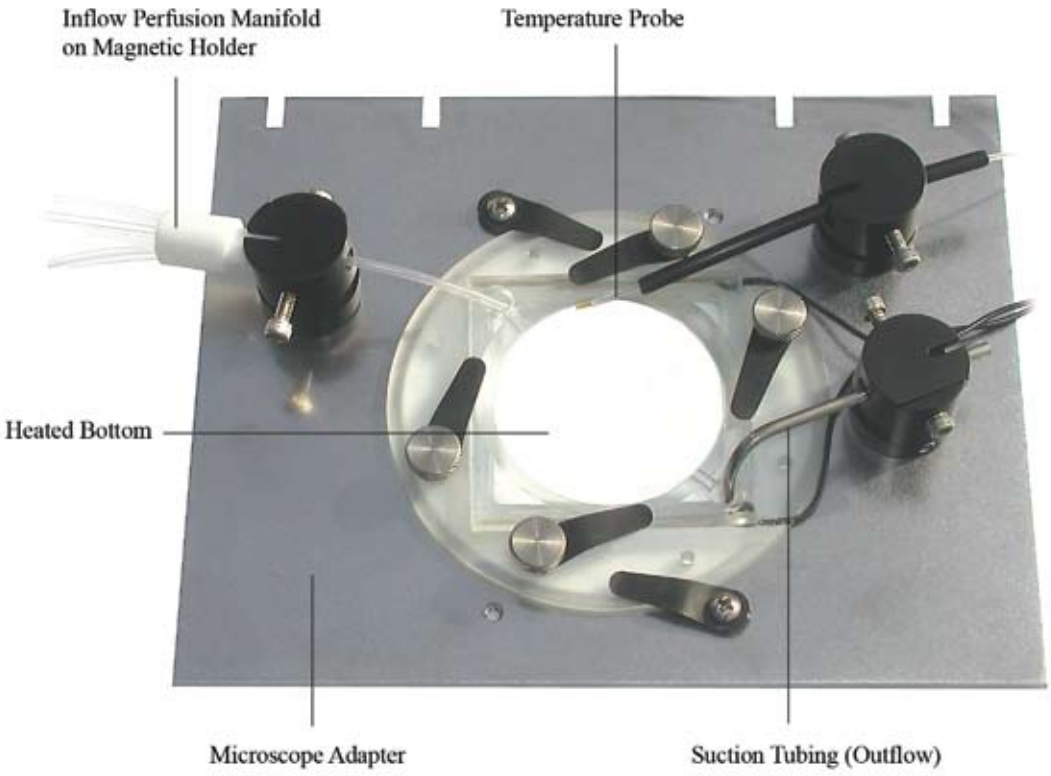
The transparent indium tin oxide (ITO) coated heated chambers can be used with inverted or upright microscopes. The electrically conductive coating is on one surface only, with opposite clean surface contacting your sample media.

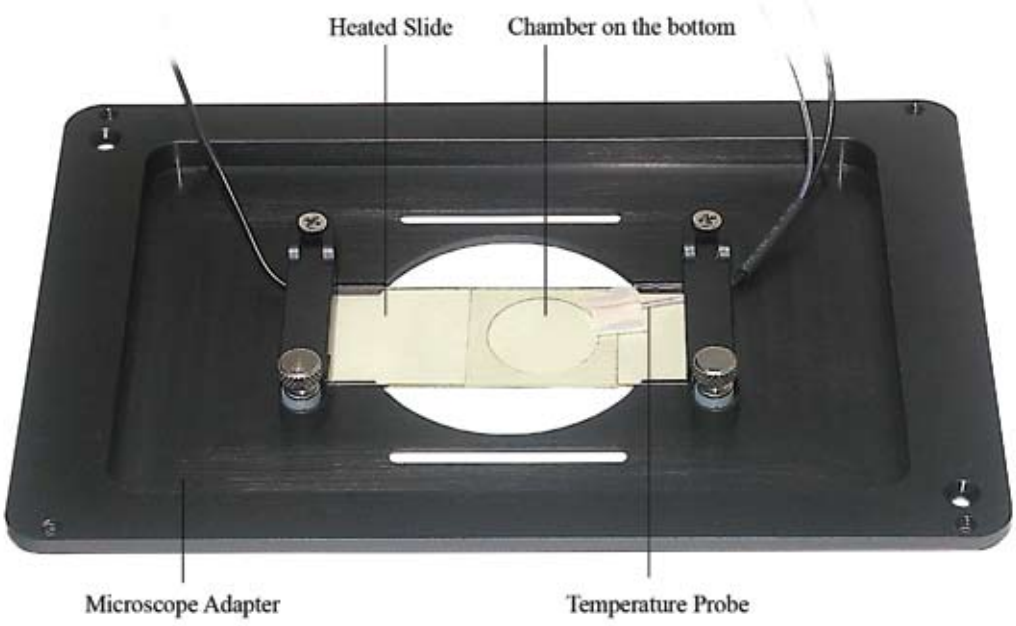
TC-WI Chamber This is a larger volume open chamber that provide optical clearance to accommodate water immersion objectives of upright microscopes. TC-WI chamber (top) for upright water immersion optics, and TC-GSH uniformly heated slides to form sealed chambers for inverted microscopes (bottom).

TC-PH Heated Plates These are transparent glass heaters with large working surface to accommodate large objects like standard glass slides, petri dishes, or our ultra-thin imaging chambers. The heater will provide uniform temperature distribution throughout the whole surface. A set of flat clamps will keep the samples in place. The imaging chambers can be formed directly on the glass surface of the heater using our ultra-thin silicone gaskets.

TC-GSH Uniformly Heated Glass Slides These are standard size 3x1 in. glass slides coated with ITO transparent layer on one side only. A sealed imaging chambers can be formed on a coverslip using our adhesive silicone gaskets. The heated glass slide attaches from the top and provides uniform temperature distribution. Recommended for inverted microscopes. Use MTC-PH and MTC-GS for upright microscopes.

TC-DIS Miniature Water 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. Switch the controller to display STAGE/BLOCK temperature and to read temperature feedback from STAGE/BLOCK sensor.

Attaching Heater to Lens

If possible remove the lens from the microscope. Use included Velcro tape to fix the heater securely around the objective.

DIMENSIONS: Specify the size of the heater required. The default/standard size is 1x4 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. The minimum height is 0.25 in.

Flexible silicone 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.

Miniature Incubators

Incubator for motorized stages TC-MI with chambered cover glass inside.

The closed controlled environment setup can provide conditions around your sample similar to those obtained inside incubators. At the same time it allows you to position the sample on microscope stages to perform imaging while keeping the samples in controlled environment. The incubators can be used with coverslip holders the same way as with petri dishes and cover glasses.

Catalog #	Features:
TC-MIS	Incubator for petri dishes and cover glasses.
TC-MI	Incubator for motorized stages.
TC-CIC	Light-weight incubator for 35mm petri dishes and coverslip holders

1. Place the dish inside the heating element. Use petri dish adapters to fit different brand dishes. 50mm reducing adapter can be used with TC-MI and TC-MIS.

If water evaporation and condensation is an issue, a heated cover can be used. If you are doing short-term imaging experiments, you do not need to fill the incubator with water. If you are concerned about evaporation of media, however, you might fill the reservoir (groove on the side of the incubator) with distilled water to keep certain level of moisture in the incubator and to prevent evaporation of your media. The water can be refilled through one of the ports on the side of the incubator.

2. The setup also allows you to exchange media inside the dish or chamber. To make a perfusion setup, you need to

configure your system to provide solution flow/exchange using PS15 perfusion systems or controlled flow systems CFPS-1U, CFPS-2. The solution outflow can be provided by using additional CFPS-1U, or one of the channels in CFPS-2. Using provided tubing holders, adjust inflow tubing so that it goes inside one of the compartments in your dish or chamber. A luer-lock connectors can be used to attach the inflow solution to the incubator. After opening the port, feed thin Teflon tubing through the port inside the incubator. Another luer-lock tubing fitting should be attached to the outflow port. Similarly, using another holder, adjust the suction tubing so that the outflow/suction tubing goes inside another compartment in your dish or chamber. Before closing the incubator, make sure the inflow and outflow tubing are positioned inside the dish or chamber.

The tubing holders are adjustable and allow you to position the tubing at any angle (tilt), and can be rotated to bring the tubing closer to the center of the dish/chamber. First, rotate the holder so that tubing/probe is positioned above the right compartment inside the dish/chamber (you might use provided glass bottom dish insert with different inflow and outflow compartments to facilitate perfusion of the dish). Then, adjust tilt & length so that the tubing goes to the right depth. Note: after the experiment, the sequence is opposite. First, pull out the tubing from the dish/chamber, and then, rotate the holder to clear the dish/chamber.

Note: if perfusion is used, the media can be saturated with gases (CO2/O2, for example) before it enters the dish; in this case, using the cover and connecting the setup to a source of the gas mixture might be unnecessary, unless perfusion can be stopped during the experiment.

3. You can use an External Temperature Probe inside the dish similar to perfusion setups below. Since solution perfusion will effectively eliminate temperature gradient inside the dish, you can also attach the temperature probe to the heated base. This will make the system more stable, but you might need to offset the reference temperature, if the actual temperature in the dish is different from the required temperature. Or simply use FEEDBACK from a sensor inside the base - STAGE/BLOCK. To use incorporated inside the base temperature sensor, switch the controller to display STAGE temperature, and read STAGE/BLOCK temperature feedback. Refer to setting reference temperature procedure in the manual.

The source of CO2 mixture connects to one of the ports in the cover or in the base and should provide a very slow continuous stream – enough to replace the residual gases inside the incubator (the incubator is not sealed).

4. The incubators can be used with coverslip holders the same way as with petri dishes and cover glasses.

5. The heated cover of TC-MI and TC-MIS incubators can be connected in parallel with heating base. Use the cable-adapter to connect both the cover and the base to the same channel of a temperature controller. Usually, the thinner outlet connects to the cover, and the wider - with four wires - connects to the base to provide feedback from the sensor inside the base.

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.

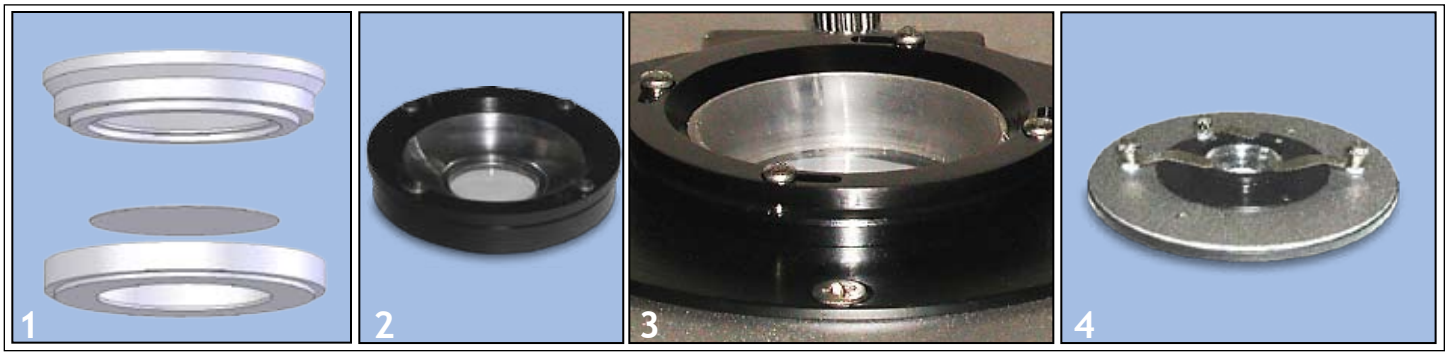
2. Fix the plastic insert with a metal ring from the top.

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

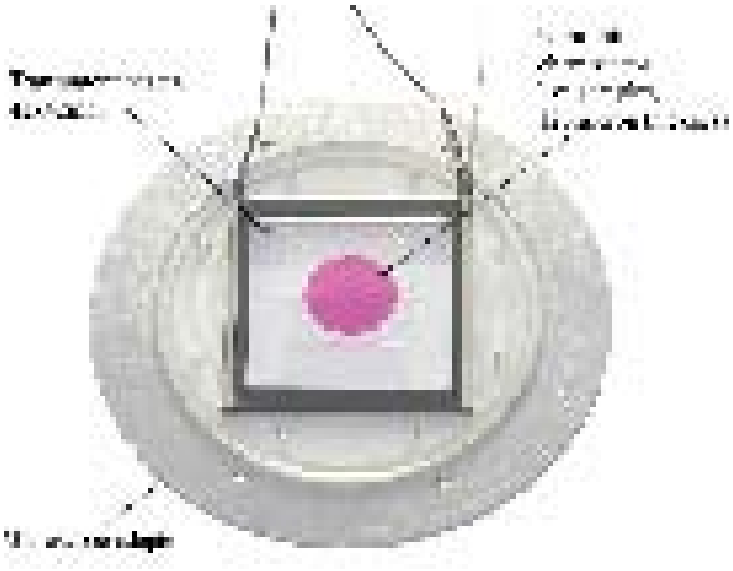
Catalog #	Features:
CSC	Chamber for replaceable round coverslips. Simply put a coverslip inside and seal by a snap-in action.
	Choose the right diameter to fit your coverslips.



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-HP50x50. Heated slides TC-GS can be also used.

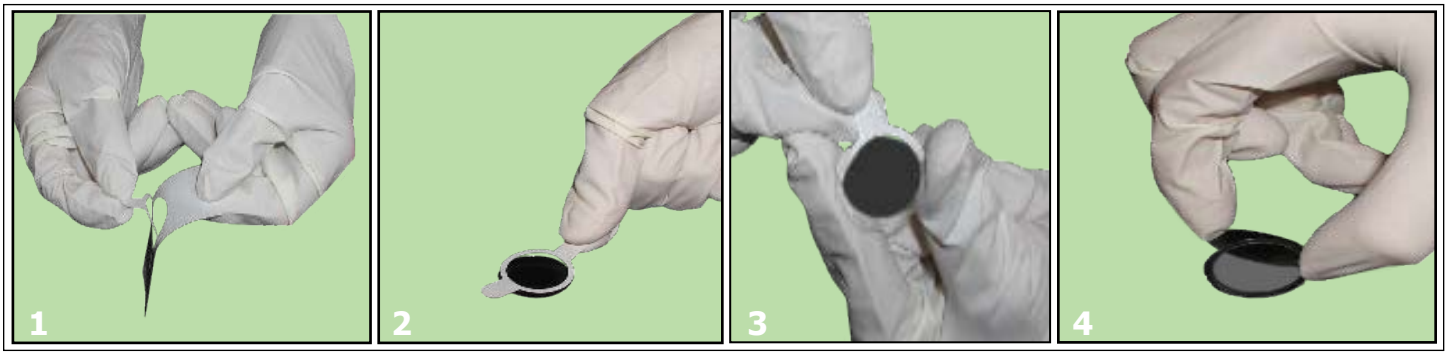
1. Remove protective liner from the bottom surface to expose the adhesive.

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.



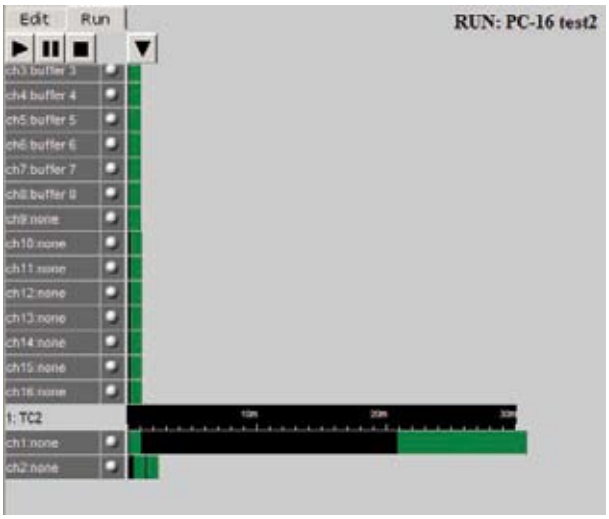
5. Place the sealed chamber into metal holder UTIC-25, which fits microscope adapters MA and heating stages, TC-E35. An open chamber can be also formed using a plastic holder, PCCS1 for example.

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

Using Protocol Automation Software

The Protocol Automation software package ships installed on a laptop computer. Connect the computer to the PC-16 controller using provided a regular DB-9 cable (no RS232 cable is needed). Turn the computer ON. Find and double-click BIOSCIENCE TOOLS icon, which is located in the middle of the Desktop. What you will see on the monitor is a sample protocol to activate all channels of the controller. Click the botton PLAY (black triangle) to start the protocol. The controller's channels will be activated in sequence. The indicators on the controller's front panel and manual buttons on the computer's monitor will be ON for the duration of the protocol. After the last channel is OFF, pop-up window will notify you that the protocol is completed.

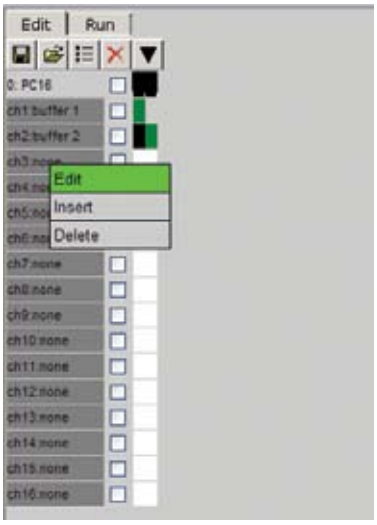
Manual channel control can be achieved by clicking small round button located next to the name of the channel. This can be used during initial setup of your experiment.

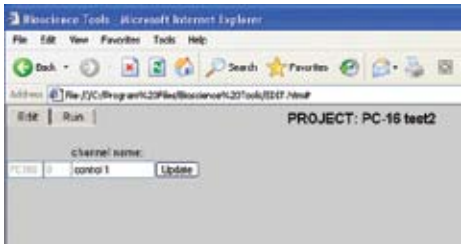


In order to edit or create a new protocol, click the tab EDIT. On the following screen click the button SAVE AS. The following screen will let you create another protocol under different name. After typing a new protocol name, click button SAVE.

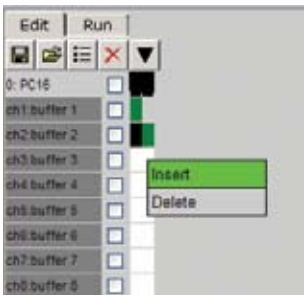
To delete the project, click icon SAVE AS, and clik button DELETE on the following screen. To open another project click icon OPEN and select a project from pull-down list. To insert devices into the project, click icon INSERT and select a device from pull-down list.

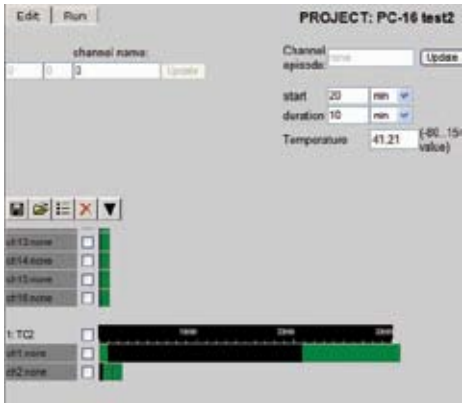
Each channel can be renamed to reflect different settings used during the protocol. In order to rename the channel, click on the channel name, and on the pop-up window select EDIT. In the top-left corner of the screen, type in a new name, and click button UPDATE.





Each channel can have an unlimited number of time episodes, during which it is changing SET temperature. If the channel does not have active episodes, it will be represented by an white square. In order to created an episode, click on the white square and select INSERT on the pop-up widow. In the top-right corner of the screen, type in start time and duration, SET temperature. and click button INSERT. Start time is calculated from the beginning of the protocol. The episode will be represented by a GREEN area. The duration of the episode is not important, as the temperature will not change until the start of another episode for the same channel.

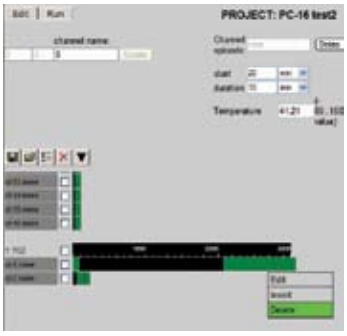




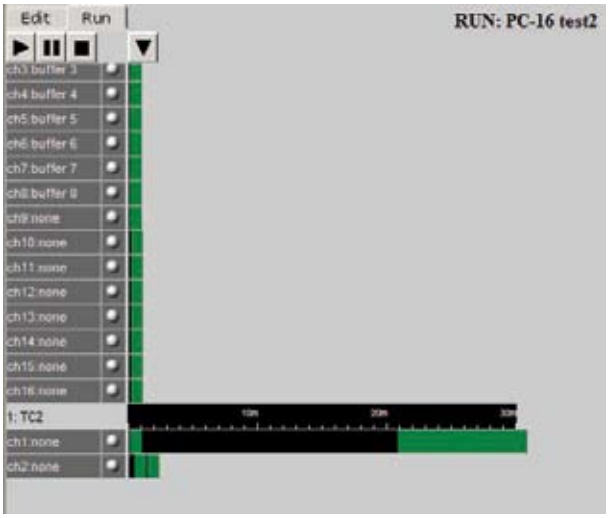
In order to change time settings or temprature for an episode, click on the episode and select EDIT on the pop-up. In the top-right corner of the window, type in new parameters and click button UPDATE.

An additional OPEN episode can be added after an existing episode for the same channel. Click on GREEN episode and select INSERT on the pop-up window. In the top-right corner, type in time parameters required and click button INSERT.

In order to DELETE an OPEN episode, click on the episode and select DELETE. Click button DELETE in the top-right corner to confirm. The episode and corresponding GREEN area will be removed from the screen.



In order to execute the protocol, click tab RUN. On the following screen, click button PLAY to start he protocol.



Syringe Heaters, SYR-T8

The Syringe Heaters were designed to heat 60cc (or smaller) syringe barrels of perfusion systems for degassing solutions or maintaining solutions at temperatures above ambient. They can be used, however, with any syringes or containers, or any other object.

Flexible heaters can be wrapped around any size syringes (or any other containers) to keep solutions at temperatures above ambient. The heaters are easy to install and remove. If possible, the heaters should be positioned on the syringes so that the level of solutions remains visible when near the bottom. Multiple heaters can be attached to the same syringe

Instructions

1. Before connecting to cables, the heater should be wrapped around the syringe barrel and Velcro Tape applied to hold it against the barrel. Two (or more) heaters can be attached to the same syringe.
2. One of the heaters incorporates a temperature sensor to use with any temperature controller: TC-1, TC-1-100, BTC-100 or even TC2-80-150.
3. This Heater has a 4-pin connector and should be attached to a cable included with temperature controllers.
4. This heater also provides splitter connector to attach another heater (with 2-pin connectors), and a (color coded) splitter to attach the remaining six heaters.
5. The heaters should be always used in pairs as no power will provided to a single heater.

Caution

1. At least one extra heater should be attached to the splitter cable coming from the temperature sensing heater.
2. If the temperature sensing heater is not positioned on a syringe, the temperature of the solution can not be controlled properly.
3. Use color coded splitters and matching connectors to attach multiple heaters: 2-pin black connectors are used to attach heaters, and color coded connectors are used to attach splitter cables.