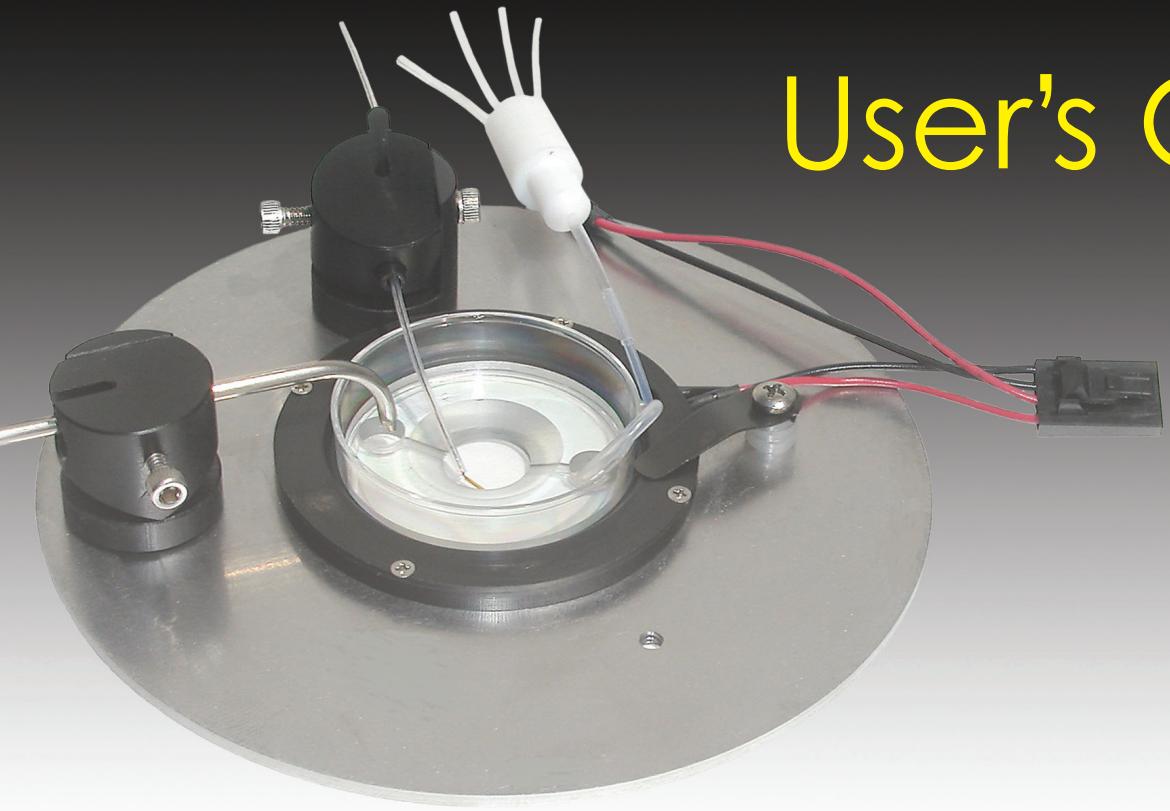
Temperature Control

User's Guide



Heated Microscope Stages & Miniature Incubators

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

Bioscience Tools

Ph: 877-853-9755,
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CE

Specifications

Range up to 150ºC
Accuracy 0.1ºC
Stability 0.01ºC, required for sensitive applications: nano & piezo positioning, TIRF & AFM
No electrical noise suitable for electrophysiology
No vibrations no internal fan
Temperature sensors
built-in STAGE sensor
optional external BATH (0.87mm)
Feedback
from BASE and LID
adjustable DC and AC GAINs, self-adjusting

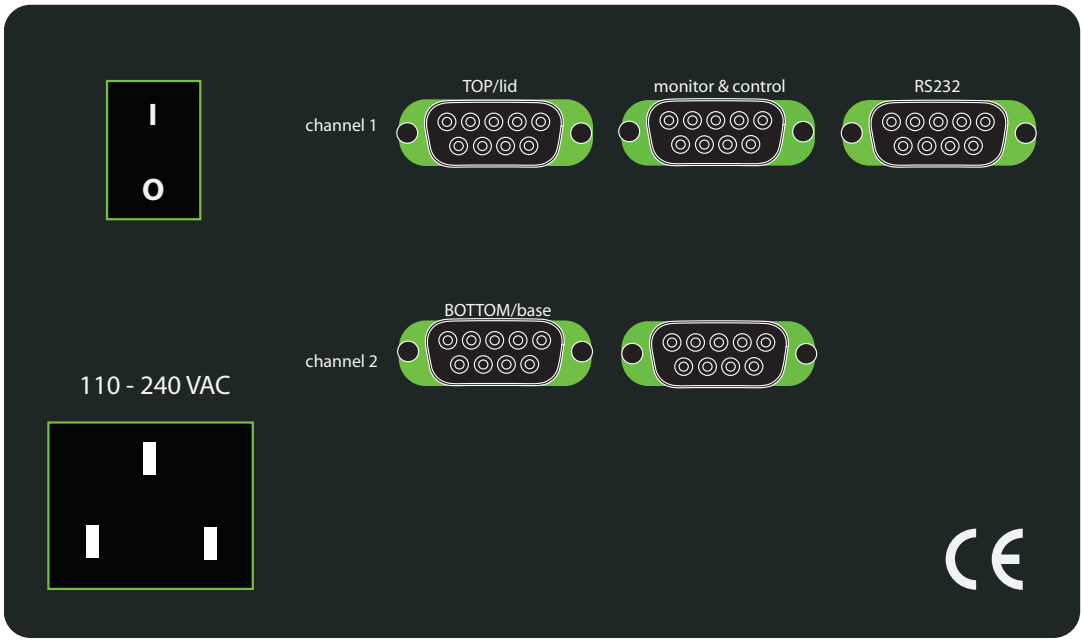
Analog Input
Input analog voltage to SET temperature;
Analog Output To monitor temperature:
Overheating protection
RS232 port to set and monitor temperatures
Size (Controller) : 8Wx4Hx9D in.
Power Supply
120-240VAC 150W
Output
4A max per channel

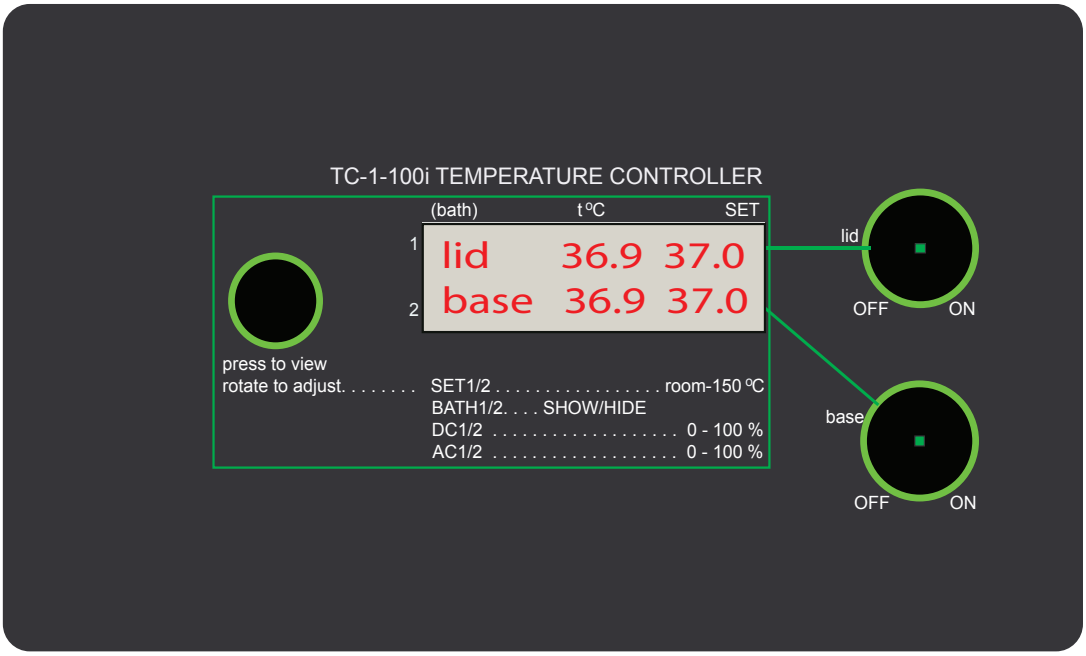
Introduction

The complete temperature control system includes a controller, 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 is used for FEEDBACK. It is also used to prevent accidental overheating of the sample. The following are an illustrated installation guide and example configurations of temperature controlled setups.

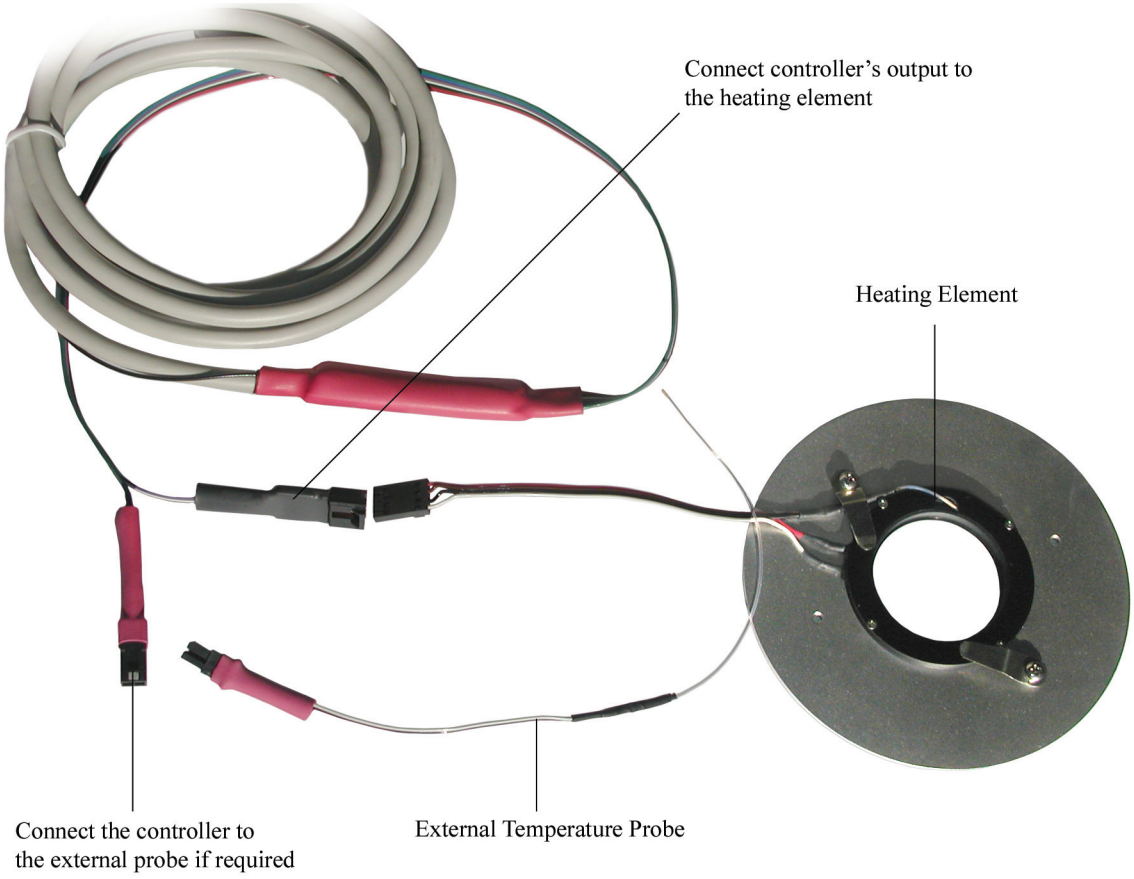
Installation Guide

1 Connect power. Plug the power cable into wall outlet. Plug the lid cable into the TOP output connector on the back of the controller - DB-9 female connectors, and BOTTOM to the incubator base.

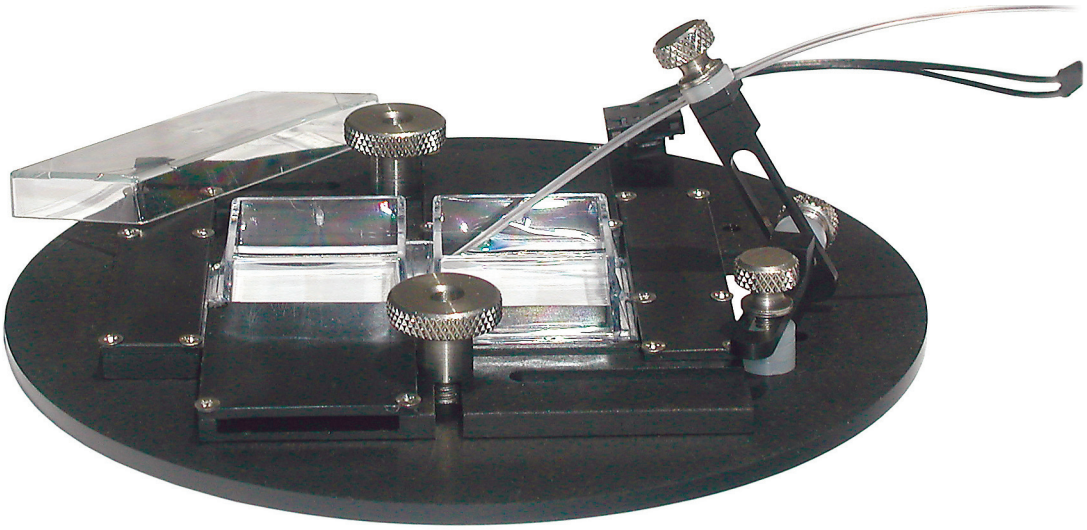




2 Connect the output cable to the lid/base of the incubator and external temperature probes, if used.



3 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 to the microscope after you are familiar with the system. Please note, that the incubator needs to be elevated above the desktop surface to prevent heat dissipation to the cold surface. Turn the controller ON - power switch on back.



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

Now you can switch the controller from STANDBY state into ACTIVE state and observe on the temperature monitor how the controller regulates the temperature of the heating stage.

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

Push to click SET button. The display will show:

SET1 37.0

click again, to show:

SET2 37.0

if you rotate SET dial while the display shows SET1 or SET2, you can adjust SET temperature for channel I and II respectively. Click the button again to display:

bath1 SHOW

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

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

Click again until the display shows:

DC1 % 15

at this point you can increase/decrease DC level to reach the required temperature level. Click again to adjust AC levels. NOTE: AC level is usually set to 100%, although less values might provide more stable operation.

AC% 100

You can also select HOT temperature threshold level below default 150 degrees, by pressing the dial again to display:

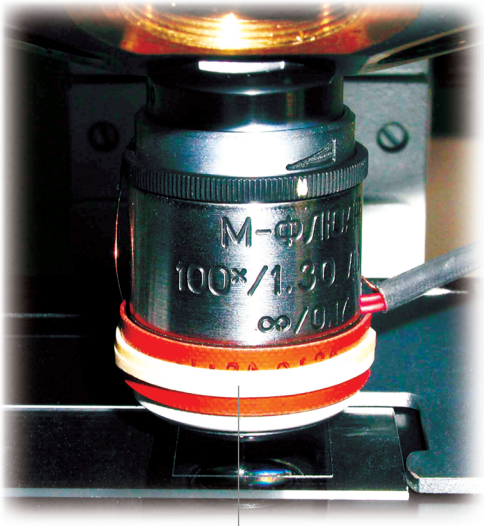
HOT tºC 45.0

After this, the controller will turn heating OFF, if STAGE overheats above the threshold.

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

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

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



Objective Heater

Uniformly Heated Bottom

Since samples in the petri dish are located at some distance from the heating element, the temperature of the sample will be different from the temperature inside the heating element - this is called “temperature gradient”. If you use an external probe to display BATH temperature, you will see this difference, provided the external temperature probe placed inside the sample chamber.

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

Using an objective heater with oil or water immersion objectives will eliminate this temperature gradient. A separate 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 incubators with uniformly heated glass bottom, TC-MIS-80x70HB for example, usually do not generate undesirable temperature gradient.

4b In order to use an external probe TC-TP, click SETTINGS dial until the display writes bath1, then rotate the dial to display SHOW . To offset temperature reading from BATH probe, change SET level 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. Please note that after connecting an external probe to the cable, the display will change to show both temperatures: STAGE and BATH for the corresponding controller channel.

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.

4C

The controller can also minimize temperature fluctuations measured by the external BATH2 probe located/ placed remotely from the internal STAGE2 sensor (this procedure can be used with BATH2 probe connected to the second/bottom/base channel). The fluctuations are observed sometimes due to room temperature changes, during overnight experiments for example. The new tracking feature will report observed fluctuations and suggests recommended changes in compensation level (from 0 to 10 ºC/per ºC room).

Press the front knob to show TRACK OFF, and rotate to switch tracking ON: Make sure that the external BATH2 probe is positioned inside your sample.

TRACK ON

Press again, and make sure that dt/ ºC value is set to 0.0 vale:

dt/ ºC 0.0

After working for long time, the controller will detect any fluctuations in ROOM and BATH temperatures (ºC if any), which can be displayed by pressing the front knob several times:

MIN dBATH -0.1
MIN dROOM -0.2

After pressing the knob again, you can see MAX fluctuations during the experiment (ºC):

MAX dBATH 1.5
MAX dROOM 1.2

In order to compensate the changes in BATH temperature, that happened due to fluctuations in ROOM temperature: press the front knob several time until the display show

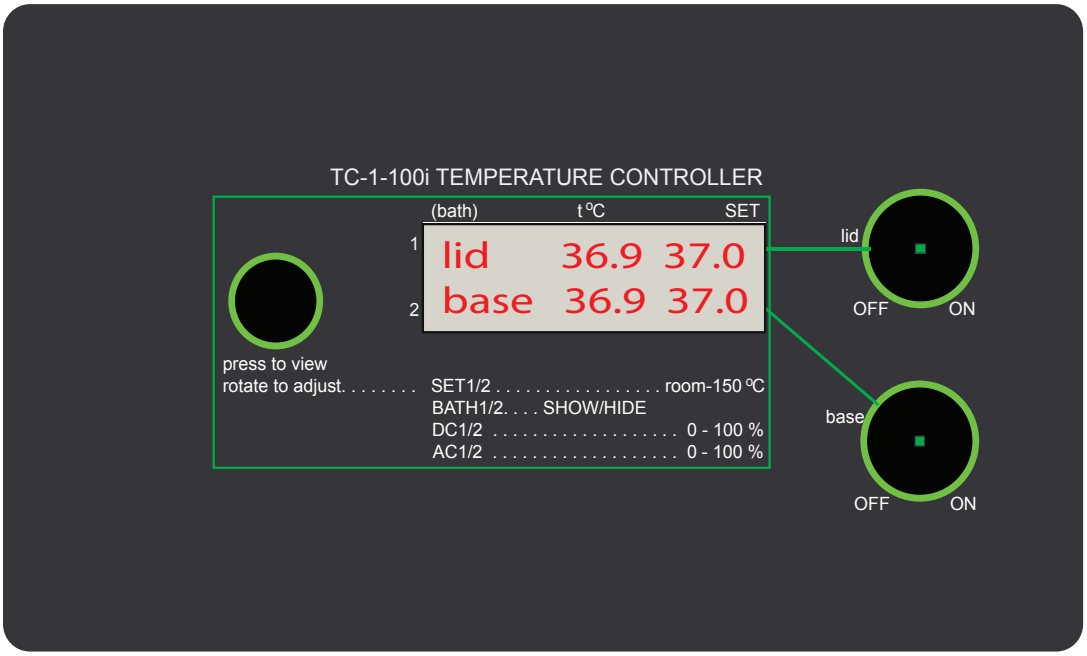
dt/ ºC 0.9
TRACK ON

And make a note of the suggested value of 0.9 for dt/ ºC parameter. Then, press the knob again and adjust the value for dt/ ºC:

dt/ ºC 0.9

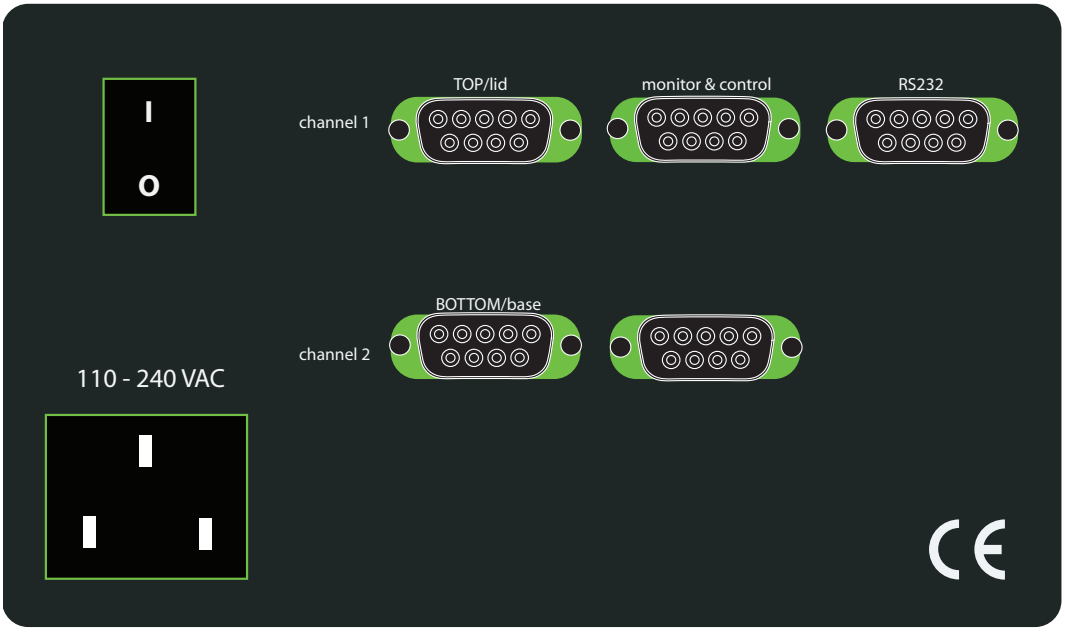
Note, that this is a suggested value, and might have to be adjusted after next experiment again. This new feature is similar to using feedback from BATH probe, but results in much more stable temperature control with minimal temperature fluctuations. This is also much safer in a sense, that it will nor result to overheating of your sample due to customer error - failure to position the external probe inside the sample for example.

TC-1-100-i Front Panel Controls



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

Outputs and Back Panel



Outputs	
Output	Connect to lid/base cables to provide power to the heating elements and to provide temperature readings to the controller. LID female DB-9 connector for channel I, BASE - channel II
MONITOR & Settings	DB-9 male connectors to monitor temperature readings 10V/0 to 150°C: pin 3 - STAGE, pin 8 - BATH, pin 7 - GROUND.
RS232	DB-9 male connector in the middle, connects using NULL MODEM cable.

Back Panel Controls	
RS232	Set reference temperatures.
DB-9 connector	pin 1, EXT1 temperature settings (10V/150°C, 0V = 25°C) pin 7 - GROUND pin 3 - STAGE readings, pin 8 - BATH (0 to 150°C = 0-10V)
POWER jack and switch	Connects to 100-240VAC power outlet.

Warranty

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

Software control and monitoring

Using a regular DB-9 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 <CR> code (decimal 13):

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

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

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

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

T5<CR> returns temperature readings from EXT1 input or SET1: T5- 037.0 C

T6<CR> returns temperature readings from EXT2 input or SET2: T6- 037.0 C

S1 03700<CR> sets reference temperature for channel I to 37.0
(NOTE: all five digits should be sent to the controller)

S2 03700<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

CTn<CR> will result to continuos temperature readings (n - channel number similar to the above)

CO2 - O2 Controller Specifications

Range 0 to 20% CO2; ships calibrated to provide 5% level of CO2 inside miniature incubators; 0 to 20% O2 (taken from the air) up to 750 SCCM output flow

Input

300PSI max

Power Supply

94 to 234 V AC, 50/60 Hz 35W

Input Port

4mm O.D. tubing (10-32 threaded) includes adapters for different size tubing

Output Port

1/8in O.D. tubing (10-32 threaded)

Size (Controller) : 12Wx6Hx8D in.

Introduction

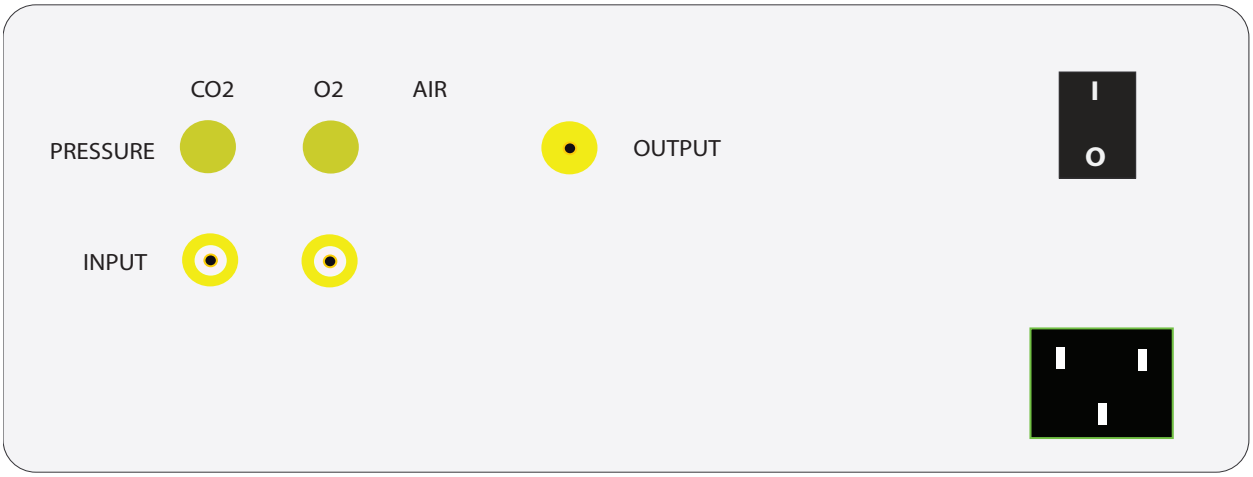
The controller ships with tubing to connect to miniature incubators, and fitting to connect to a source of CO2/N2 (a cylinder, for example, or a wall outlet). A source of CO2/N2 is required to operate the system. The CO2 and N2 sources need to be regulated, since the maximum input pressure should not exceed 300 PSI. The controller ships adjusted for input pressure 40 PSI. During operation, the controller is continuously monitoring CO2 and O2 content of the output gas mixture.

Installation Guide

1 Using provided fitting and clamps, connect CO2 (and N2, if planning to reduce O2 concentration) source (cylinder or wall outlet) to the controller. Some tubing and additional fitting might be required to connect to your source as designs vary. Usually some luer-lock fitting or other easy-connect adapters are used to splice different diameter tubing connecting your source to 4mm O.D. translucent tubing, which fits inside INPUT ports on the back of the controller. After splicing provided 4mm tubing to CO2/N2 source, simply push the tubing inside INPUT ports all way, and slightly pull back to clamp. In order to disconnect the source, push YELLOW rim inside the connector, and pull the tubing out. Make sure the regulator on CO2/N2 source does not show more than 300 PSI of output pressure. Pressures around 40 PSI should be sufficient to operate the system. The controller ships tuned to work with 40 PSI input pressure

Similarly, insert a piece of 1/8in. O.D. BLACK tubing inside OUTPUT port on the back of the controller, and connect the other end of tubing to the incubator, or heated humidifier CO2-500ML. If a humidifier is used, connect the output of humidifier to the incubator.

Connect power cable. Plug the power cable into wall outlet. Connect grey cable to DB-9 connector on one end, and to the incubator lid on another end.


CO2
O2
AIR
PRESSURE
OUTPUT
INPUT
I
O

2 Turn the controller ON. The controller will self-calibrate itself for 5min. After 5min, the display will show concentrations of CO2 and O2 in the output mixture and start making the mixture according to factory settings of 5% CO2 and 20% O2.

CO2 % 0.0
O2 % 20.5

To adjust settings press the front knob to go to CO2/O2/FLOW rate menu and rotate the knob to adjust:

SET CO2 % 5.0

SET O2 % 20.0

SET FLOW 200

IMPORTANT: If you are not planning to reduce O2 concentration in the output mixture - you should leave O2% setting at 20.0%

3 ERROR MESSAGES:

AIR CLOSED - the air source is closed - press AIR button on the front to open - GREEN LED will be ON.

CO2 LOW - CO2 source might not be connected. If connected, rotate CO2 pressure regulator on the back clock-wise slowly until the message disappears.

CO2 HIGH - the input CO2 pressure is too high. Rotate CO2 pressure regulator on the back anti-clock-wise until the message disappears.

CO2 CLOSED - CO2 input is closed - press CO2 button on the front - GREEN LED will be ON.

N2 LOW - N2 source might not be connected. If connected, rotate N2 pressure regulator on the back clock-wise slowly until the message disappears.

N2 HIGH - the input N2 pressure is too high. Rotate N2 pressure regulator on the back anti-clock-wise until the message disappears.

N2 CLOSED - N2 input is closed - press N2 button on the front - GREEN LED will be ON.

REPLACE THE PUMP - the air pump needs to be replaced.

4

The controller also allows you to see other measured parameters:

1. Actual output flow rate in SCCM. Press the front knob until the display shows:

SET FLOW	300
FLOW	299

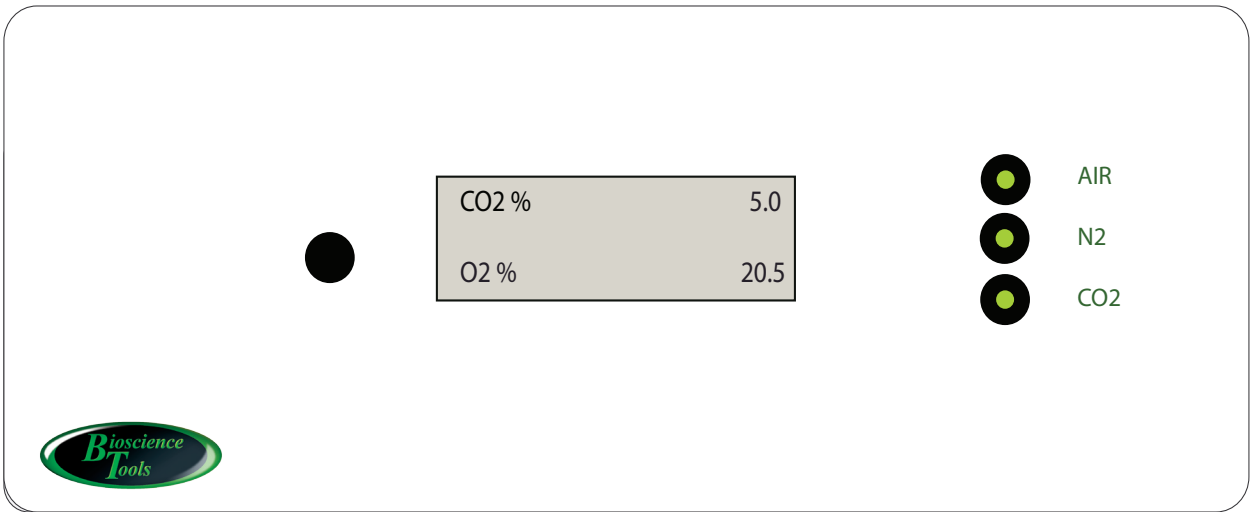
2. CO2 flow rate. Press the front button until the display shows:

CO2 %	5.0
FLOW CO2	32

3. N2 flow rate. Press the front knob until the display shows:

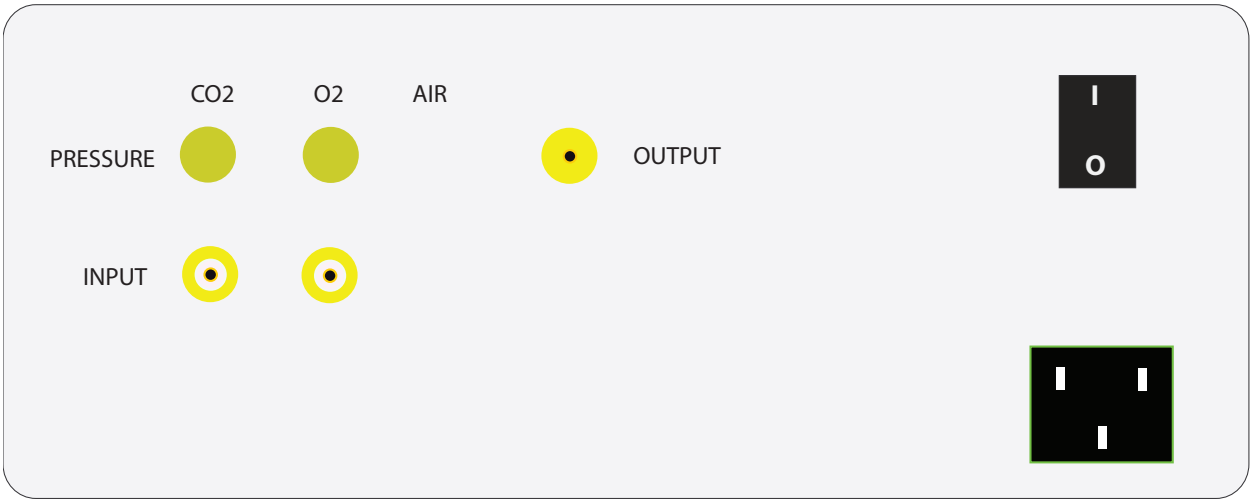
FLOW N2	000
02 %	19.3

Front Panel Controls



Front Panel Controls	
Knob	Sets CO2 level, O2 level and FLOW rate

Inputs, Outputs and Back Panel controls



Inputs & Outputs	
INPUT ports	Connects to a source of CO2/N2. Maximum input pressure is 300 PSI.
OUTPUT port	Connects to the incubator to supply CO2/O2/N2 mixture.
PRESSURE regulators	Adjust input pressure inside the controller.

Back Panel Controls	
Input Pressure regulators	Turn CLOCK-wise to increase inside pressure and turn ANTI-clockwise to reduce available pressure..

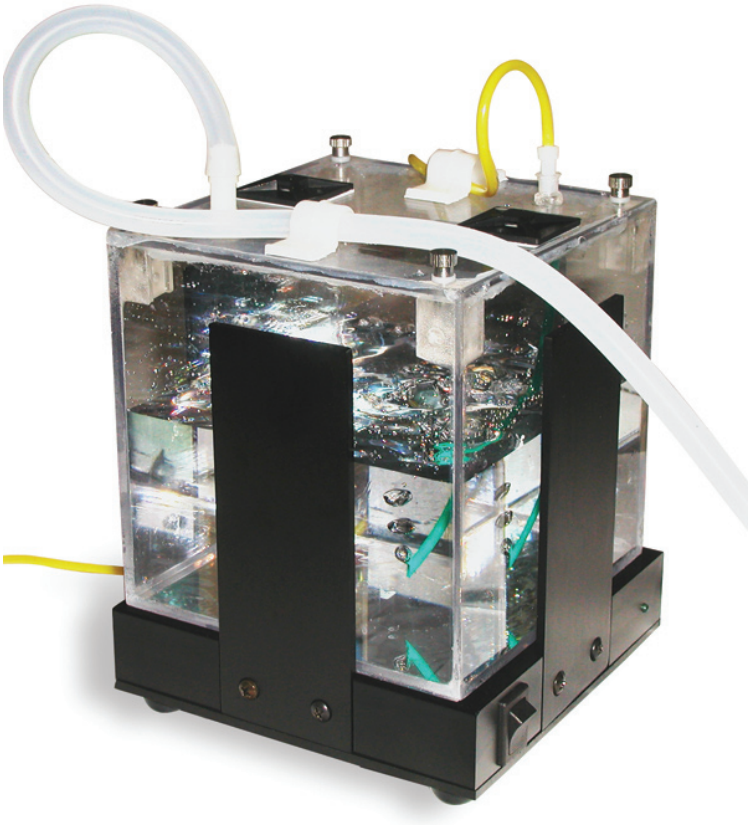
Using Heated Humidifier CO2-500ML

A heated humidifier can be used to pre-heat and saturate with water gas mixtures, before the mixture enters the incubator. The humidifier consists of a heated base and a reservoir, which needs to be filled with distilled water. Fill the reservoir just enough to observe bubbles of gas coming out of input tubing, which has a female luer connector. The input tubing should be connected to BLACK output tubing coming out from a CO2 controller. After connecting tubing, place the reservoir on the base.

Plug provided DC power adapter into the base and a wall power outlet. Turn the humidifier ON - a GREEN LED indicator will be ON. Let the base to warm up to facilitate water evaporation. After gas mixture enters the reservoir, it will be heated and mixed with water vapors.

NOTE: You can use the reservoir as an indicator of gas mixture flow rate. Usually, enough gas flow is provided to the incubator, as long as you can observe slow but continuous stream of bubbles coming up from the inflow input tubing.

Using provided soft tubing, or any other tubing, connect the outflow MALE luer port to the incubator. Turn the CO2 controller ON to provide gas flow inside the incubator.

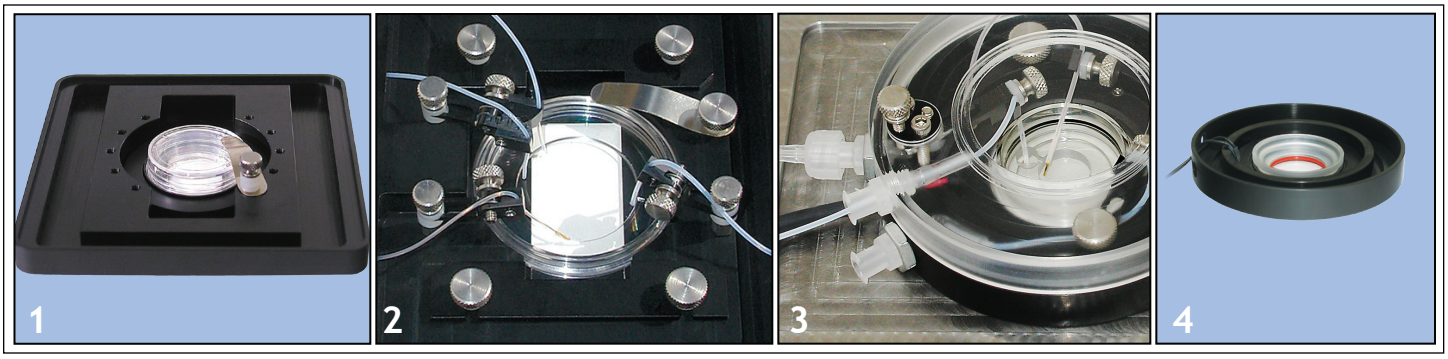


Miniature Incubators

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.
RS232/USB	RS232, parallel and USB port control



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.

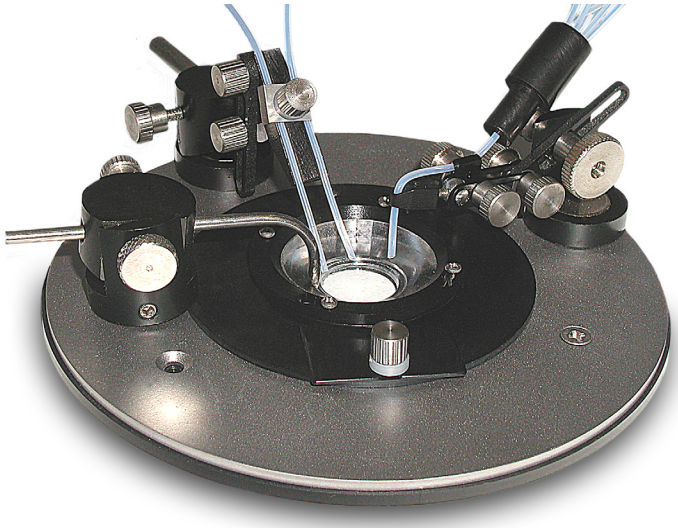
The tubing holders are adjustable and allow you to position the tubing at any angle (tilt), and can be rotated to bring the tubing closer to the center of the dish/chamber. First, rotate the holder so that tubing/probe is positioned above the right compartment inside the dish/chamber (you might use provided 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. 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.

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.

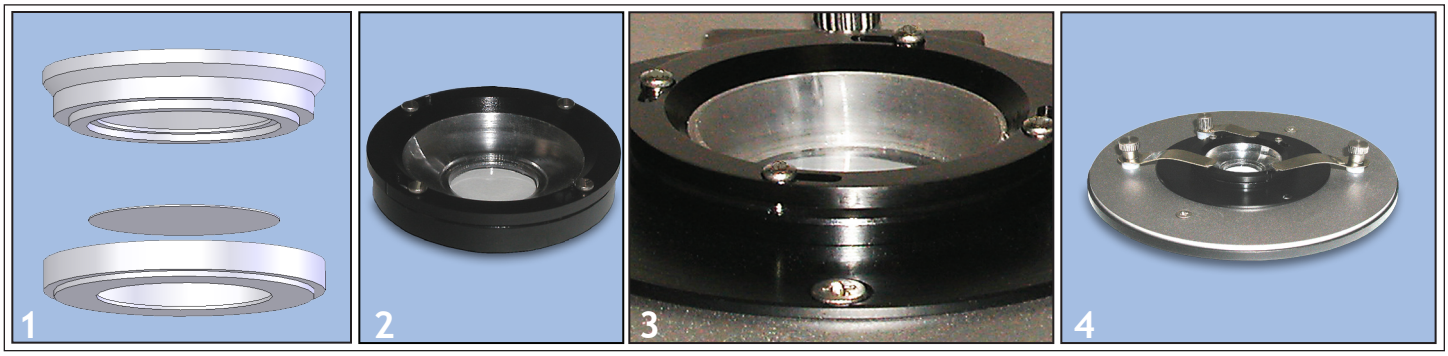
2. Fix the plastic insert with a metal ring from the top.

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

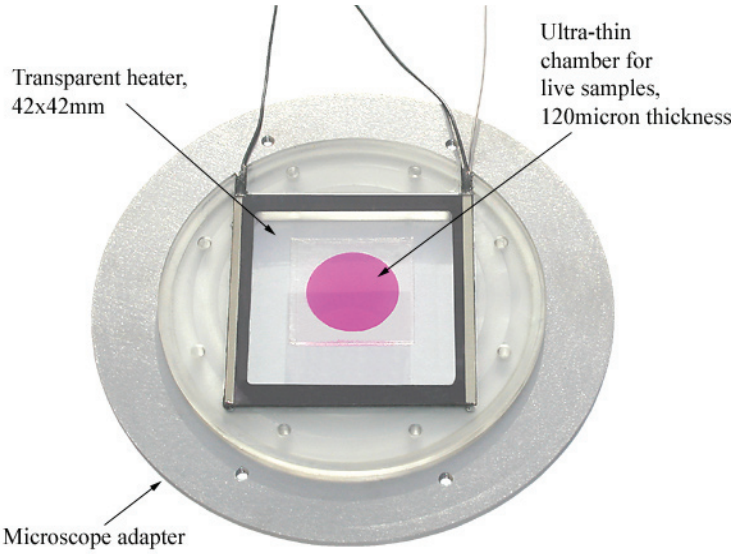
Catalog #	Features:
CSC	Chamber for replaceable round coverslips. Simply put a coverslip inside and seal by a snap-in action.
	Choose the right diameter to fit your coverslips.



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.

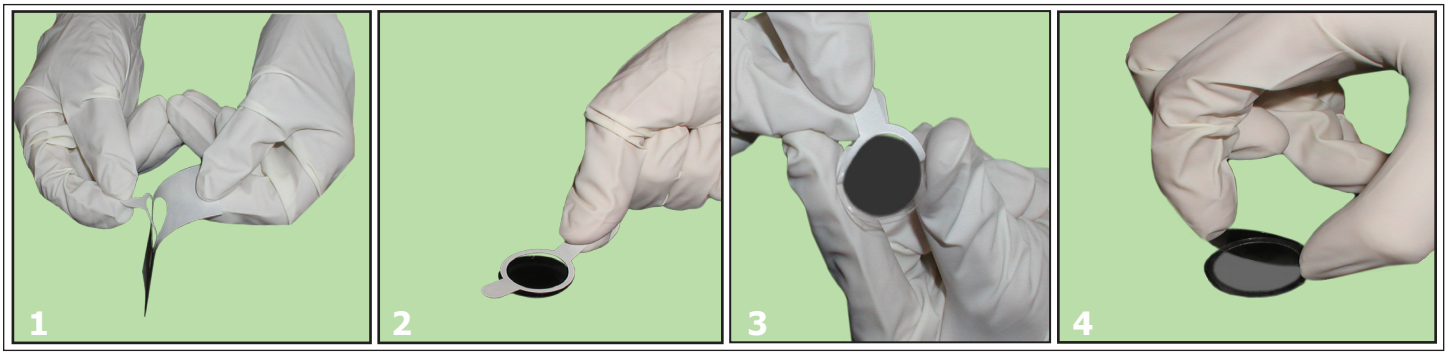
1. Remove protective liner from the bottom surface to expose the adhesive.

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.

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

Objective Heaters, MTC-HLS-025

The Objective Heater is wrapped around a microscope objective. An incorporated temperature sensor is used to regulate and monitor the objective temperature. MTC-HLS-025 item includes the temperature controller and all connecting cables

Attaching Heater to Lens

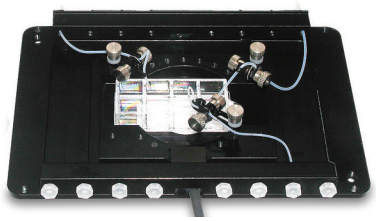
If possible remove the lens from the microscope. Use included Velcro tape to fix the heater securely around the objective.

DIMENSIONS: 0.5x5 in. The heater should be long enough to cover the hole perimeter of the objective. Usually the heater is attached to the end of the objective close to your sample.

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.

Closed Controlled Environments - 160x110mm incubators for Time-Lapse Microscopy to use with motorized stages ASI, Ludl, Marhauser, Prior, type K Zeiss, ThorLabs, and Nikon stages

Miniature Incubator TC-MI The miniature incubators can be used with chambered coverglasses, coverslip holders CSC and UTIC, petri dishes and glass bottom dishes, both 35 and 50mm. Incorporates luer-port for gas mixture (to control CO2 or hypoxia), inside reservoir for water to control humidity, and heated cover to prevent condensation (the heated lid is purchased separately). Built-in multiple sealed ports for tubing and accessories, probes and sensors. Can be upgraded with an objective heater for immersion optics. Can be used for long-term imaging. An optional set of adjustable tubing holders MH-MIS allows you to position perfusion tubing for continuous media exchange. Requires a temperature controller. Fits all brands of motorized stages and Zeiss type K stages with 160x110mm insert (radius on the corners). Optional adapters are available to fit ThorLabs (170x130mm cutout) and Nikon (236x 155mm cutout) stages Item#: TC-MI



Incubator with 22x46mm bottom window, TC-MI-20x46. Can be used with 50mm dishes and chambers, slides/coverglasses, and, in combination with 50mm reducing insert TC-PA50 (-C, -N, -F, -W), with 35 dishes and coverslip holders CSC/UTIC.

Incubator with 35mm bottom window for use with petri dishes and coverslip holder CSC and UTIC, TC-MIS-35. Has the whole bottom open for easy access with immersion optics.

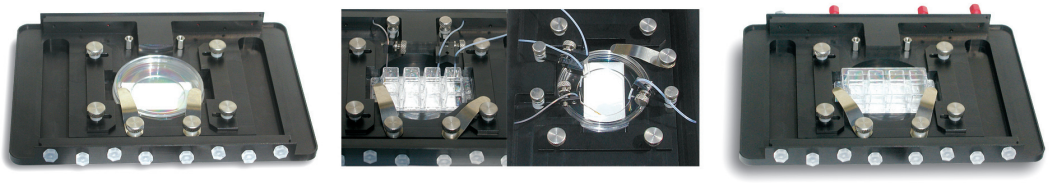
Incubator with 15mm bottom window for use with petri dishes, TC-MI-15. Provides heat from the bottom. Might require reducing insert TC-PA-C/F/N/W for different brands of petri dishes.

Incubator with 11mm bottom window for use with petri dishes, TC-MI-11. Provides heat from the bottom. Might require reducing insert TC-PA-C/F/N/W for different brands of petri dishes.

Incubator with 45mm bottom window for use with 50mm petri dishes and chambers, TC-MI-45. If used with 50mm reducing insert TC-PA50, can be also used with 35mm dishes and coverslip holders CSC and UTIC.

Incubator with 30mm bottom window for use with 50mm petri dishes and chambers, TC-MI-30. Provides heat from the bottom. If used with 50mm reducing insert TC-PA50, can be also used with 35mm dishes and coverslip holders CSC and UTIC.

- **Outside dimensions**: fits 160x110mm cutout of motorized stages from Ludl, Prior, Marhauser, Zeiss and ASI. Brings the sample 7mm below the mounting surface (10mm from the top of 3mm mounting lip to the bottom of the incubator), can be elevated using included 3mm spacers
- **Clearance:** 40mm clearance from bottom to top surface; 20mm for low-profile lid TC-MIL
- **Use with:** 50mm and 35mm dishes, chambers, chambered coverglasses and slides
- **Condensation free cover:** Uses a built-in temperature sensor to connect independently to the second channel of temperature controllers, 65x75mm low optical window
- **CO2 port:** Luer-lock connector to a source of gas mixture.
- **Water reservoir:** Controls humidity. Can be replenished through outside ports.
- **Media exchange and perfusion:** Multiple sealed inflow/outflow ports, a set of optional adjustable tubing holders to position inflow and outflow tubing inside sample chambers.



Low-Profile Lid for Miniature Incubator TC-MIL Cover for Miniature Incubator for motorized stages, low profile. The decreased height allows to use condensers for DIC and phase contrast optics: 20mm from top cover to the sample plane. Note: not recommended for use with perfusion and media exchange tubing holders inside the incubator. Can be elevated 9.5mm using TC-I-E spacers. Multiple spacers can be attached to the lid, or to the base of the incubator. Item#: TC-MIL

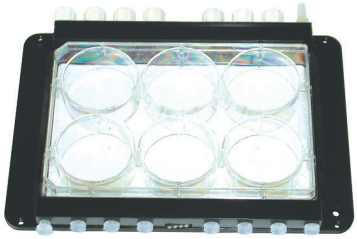
Lid for Miniature Incubator TC-MILL Cover for Miniature Incubator for motorized stages. The increased height allows to use perfusion tubing holder s MH-MIS: 40mm from top cover to the sample plane. Item#: TC-MILL

Adapter for ThorLabs stages TC-MI-THOR If attached to the bottom of incubators for motorized stages, allows you to fit the incubator inside 170x130mm cutout of ThorLabs stages. Includes two pieces for both sides. Item#:

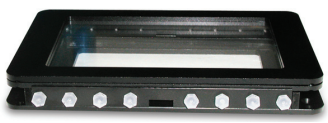
TC-MI-THOR

Adapter for Nikon motorized stages TC-MI-NIK If attached to the bottom of incubators for motorized stages, allows you to fit the incubator inside 236x155mm cutout of Nikon motorized stages. Includes two pieces for both sides. Item#: TC-MI-NIK

Incubators for multi-well plates, dishes and slides TC-MWP For use with standard multi-well plates. Optional inserts allow you to use: TC-I-3 - slides and chambered coverglasses (x3), and TC-I-4 - petri dishes (x4). The insert for petri dishes can be used with four coverslip holders CSC. Incorporates luer-lock port for gas mixture (to control CO2 or hypoxia), and heated cover purchased separately), to prevent condensation. Built-in multiple ports for tubing and accessories (probes and sensors). Fits all brands of motorized stages, some optional adapters might be required). TC-I-4 inserts can be used with a set of adjustable tubing holders MH-MIS to position perfusion tubing for continuous media exchange. Requires a temperature controller. Can be upgraded with an objective heater for immersion optics. The whole bottom is open for access with objective (for closed heated bottom incubator - consider another model TC-MWPHB). Can be used for long-term imaging. Item#: TC-MWP



- **Outside dimensions**: Fits 160x110mm cutout of motorized stages from Ludl, Prior, Marhauser, Zeiss and ASI; the bottom is recessed 10mm below the top surface (7mm below the mounting surface inside cutouts) of motorized stages, and can be elevated by included 3mm spacers
- **Optical window and clearance**: 112x72mm window on the bottom; 34mm from bottom to top surface; 24mm for low-profile lid; optional spacers allow to elevate the top surface 9.5mm - to provide more space inside the incubator
- **Use with:** Standard multi-well plates, 35mm dishes, and 1x3in. glass coverglasses/slides (requires replaceable inserts)
- **Condensation free cover:** Uses a built-in temperature sensor to connect independently to the second channel of temperature controllers, 81x121mm optical window
- **CO2 port:** Luer-lock connector to a source of gas mixture: CO2-O2-MI or PC-MI controller
- **Media exchange and perfusion:** Multiple sealed inflow/outflow ports, an optional set of adjustable tubing holders to position inflow and outflow tubing inside sample chambers.



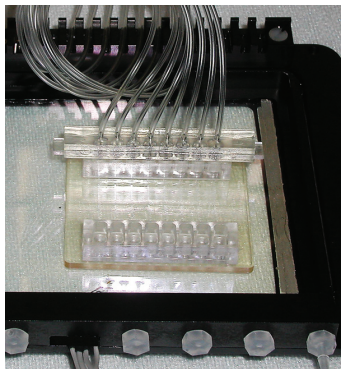
Lid for MWP incubators, low-profile TC-MWPL Low-profile lid to use with TC-MWP incubators. Total height

is 24mm. Not recommended to use with perfusion tubing holders. Can be elevated 9.5mm using optional TC-I-E spacers. Item#: TC-MWPL

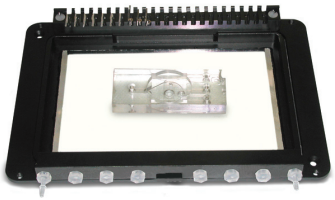
Lid for MWP incubators, elevated-profile TC-MWPLL Low-profile lid to use with TC-MWP incubators. Total height is 34mm. Item#: TC-MWPLL

Petri dish insert for MWP incubators, TC-I-4 Allows to place four petri dishes inside MWP incubators. Might require reducing adapters for different brand dishes, TC-PA-C for example for Corning dishes. Can be used with MH-MIS holders to position perfusion tubing. The insert for petri dishes can be used with four coverslip holders CSC. Item#: TC-I-4

Slides insert for MWP incubators, TC-I-3 Allows to place three chambered coverglasses inside incubators. Item#: TC-I-3



Miniature Incubator for custom micro-fluidics devices and chambers TC-MIW For use with any chamber or plate. Incorporates heated bottom, luer-lock port for gas mixture (to control CO2 or hypoxia), and heated cover (purchased separately), to prevent condensation. Built-in multiple ports for tubing and accessories (probes and sensors). The chambers and devices can be formed directly on the glass bottom. One removable side provides multiple openings for tubing. Fits all brands of motorized stage and Zeiss type K stages. Can be used with a set of adjustable tubing holders to position perfusion tubing for continuous media exchange, provided optional inserts TC-I-100 or TC-I-4/3 are placed inside, and miniature holders MH-MIS are attached. The bottom is closed (for open bottom incubator, to access with immersion objective - consider another model TC-MWP). Can be used for long-term imaging. Item#: TC-MIW

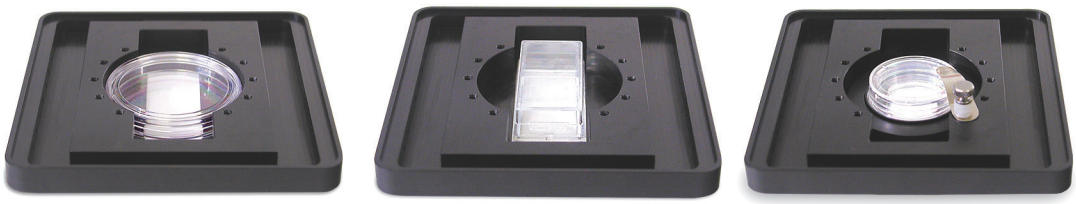


- **Outside dimensions**: Fits 160x110mm cutout of motorized stages, adapters for other stages are available
- **Use with:** custom devices and chambers
- **Condensation free cover:** Uses a built-in temperature sensor to connect independently to the second channel of temperature controllers, 81x121mm optical window
- **CO2 port:** Luer-lock connector to a source of gas mixture: CO2-O2-MI or PC-MI controller
- **Media exchange and perfusion:** multiple sealed inflow ports, a set of adjustable tubing holders to position inflow and outflow tubing inside sample chambers
- **Heated bottom:** 1mm glass
- **Stability:** 0.01°C

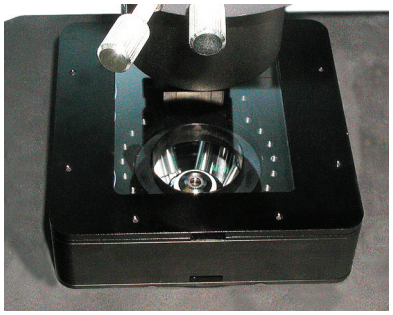
Universal Miniature Incubators for standard microscope stages

Miniature Incubators for Slides, coverslips and Petri Dishes TC-MIS Can be used with petri dishes, chambered coverglasses, coverslip holders and glass bottom dishes, both 35 and 50mm. Incorporates luer-lock port for gas mixture (to control CO2 or hypoxia), inside reservoir for water to control humidity, and heated cover to prevent condensation (purchased separately). Built-in multiple ports for tubing and accessories (probes and sensors). Requires a temperature controller. Fits any microscope (specify microscope model when ordering, ships installed on the microscope adapter). Can be upgraded with an objective heater for immersion optics. For use with long-distance objectives, select TC-MIS-65x75-HB incubator with closed 1mm heated glass bottom, which allows you to use custom devices, and both slides and petri dishes. Can be used for long-term imaging. Can be used with multi-channel solution switch and perfusion systems. An optional set of adjustable tubing holders MH-MIS allows you to position inflow and outflow tubing for continuous media exchange.

Incubator with 22x46mm bottom window, TC-MIS-20x46. Can be used with 50mm dishes and chambers, slides/coverglasses, and, in combination with 50mm reducing insert TC-PA50 (-C, -N, -F, -W), with 35 dishes and coverslip holders CSC/UTIC.



Incubator with 35mm bottom window for use with petri dishes and coverslip holder CSC and UTIC, TC-MIS-35. Has the whole bottom open for easy access with immersion optics.



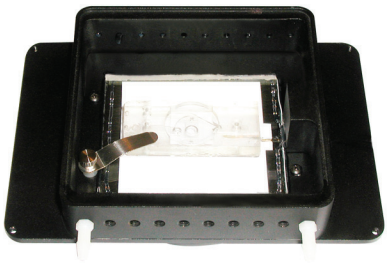
Incubator with 15mm bottom window for use with petri dishes, TC-MIS-15. Provides heat from the bottom. Might require reducing insert TC-PA-C/F/N/W for different brands of petri dishes.

Incubator with 11mm bottom window for use with petri dishes, TC-MIS-11. Provides heat from the bottom. Might require reducing insert TC-PA-C/F/N/W for different brands of petri dishes.

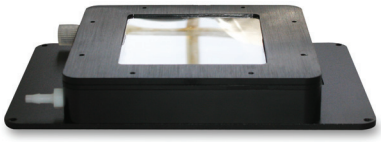
Incubator with 45mm bottom window for use with 50mm petri dishes and chambers, TC-MIS-45. If used with 50mm reducing insert TC-PA50, can be also used with 35mm dishes and coverslip holders CSC and UTIC.

Incubator with 30mm bottom window for use with 50mm petri dishes and chambers, TC-MIS-30. Provides heat from the bottom. If used with 50mm reducing insert TC-PA50, can be also used with 35mm dishes and coverslip holders CSC and UTIC.

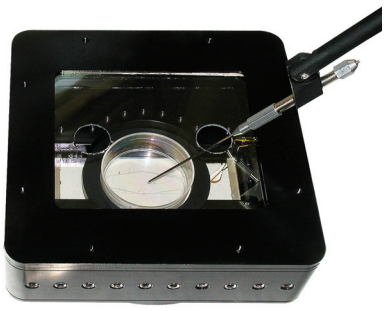
Incubator with 65x75mm bottom window and 1mm heated closed bottom for use with slides, and petri dishes, TC-MIS-80x70-HB. For use with long-distance objectives only. Has the whole bottom closed with 1mm glass to provide 80x70mm surface with uniform heating.



- **Outside dimensions**: 110x110 mm, 34mm from sample plane to the top cover (25mm clearance for low-profile configuration)
- **Optical window (on the bottom):** TC-MIS-20x46: 20 x 46 mm,
  TC-MIS-65x75-HB: 65 x 75 mm,
  TC-MIS-45: 45mm,
  TC-MIS-35: 35mm,
  TC-MIS-30: 30mm,
  TC-MIS-15: 15mm,
  TC-MIS-11: 11mm
- **Use with:** 50mm (TC-MIS-40 and TC-MIS-30) , 35mm petri dishes and glass bottom dishes, 1x3in. coverglasses/slides, and chambers for replaceable coverslips CSC/UTIC
- **Condensation free cover:** Uses a built-in temperature sensor to connect independently to the second channel of temperature controllers, 70x70 mm optical window
- **CO2 port:** Luer connector to a source of gas mixture: CO2-O2-MI or PC-MI controller; CO2-MI controller requires CO2-UP modification;
- **Water reservoir:** Controls humidity. Can be replenished through outside ports.
- **Media exchange and perfusion:** multiple sealed inflow ports, a set of adjustable tubing holders to position inflow and outflow tubing inside sample chambers
- **Heated bottom (TC-MIS-65x75-HB) :** 1mm glass



Low-Profile configurations (/L) are only 25mm high and can be used with microscope condensors that require low vertical clearance to obtain bright-field images with Phase-contrast and DIC optics. Incorporates four ports for CO2 input and to replenish water to control humidity inside. Although this configuration provides two ports that can be used for tubing, it is not recommended for perfusion applications due to limited space inside.



Miniature Incubators Lid for micro-injection and cell manipulation Can be used with petri dishes, chambered coverglasses, coverslip holders and glass bottom dishes, both 35 and 50mm. Allows you to insert micro-injection tools through openings in the glass window, which remains heated by a temperature controller during cell manipulation. Requires a temperature controller. Fits any microscope. Can be used for long-term imaging. Can be used with multi-channel solution switch and perfusion systems. The openings can be closed after manipulation. item# TC-MIS-INJECT

Heated Covers for microscope stages Heated Incubator-Cover for microscope stages, low profile, 81x121mm optical window TC-CWL This heated enclosure can provide controlled environment on top of any surface. Simply place the cover on top of your sample, and connect to a temperature controller. If connected to CO2 controllers can regulate gas composition as well (5% CO2, and hypoxia). Multiple ports can be also used to connect to perfusion lines. Designed to provide enough space for accessories: electrodes and tubing. Height inside cover is 9.5mm, (15mm total height, can be elevated 9.5mm using optional spacers TC-I-E). Incorporates luer-lock port for CO2 gas mixture. Requires a temperature controller TC-1-100-i. One channel of the controller is used to heat the top surface, and the second - inside the cover. Can be upgraded with an objective heater for immersion optics. Can be used for long-term imaging. Item#: TC-CWL

- **Outside dimensions**: 157x108mm
- **Optical window (top):** 86x65mm (TC-CL); 81x121mm (TC-CWL)
- **Height (inside vertical clearance):** 15 (9.5) mm (TC-CL, TC-CWL); can be elevated 9.5mm with optional spacer TC-I-E
- **Stability:** 0.01°C
- **Condensation free:** Uses a built-in temperature sensor to connect to temperature controllers
- **CO2 port:** Luer-lock connector to a source of gas mixture
- **Media exchange and perfusion:** Multiple sealed ports to connect inflow and outflow tubing inside sample chambers supply

Incubator cover for microscope stages, low profile, 75x65mm optical window TC-CL For smaller samples: cover slip holders, petri dishes and slides. The hole glass surface is uniformly heated. The decreased height of this incubator allows using condensers for DIC and phase contrast optics: 21mm from top cover to the sample plane.

Note: not recommended for use with perfusion and media exchange tubing holders inside the incubator. Incorporates luer-lock port for CO2 gas mixture. Requires a temperature controller TC-1-100-i. One channel of the controller is used to heat the top surface, and the second - inside the cover. Can be upgraded with an objective heater for immersion optics. Can be used for long-term imaging. Item#: TC-CL

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.