Scientific Instruments

Heated Perfusion Cube

HPC-2A

Instruction Manual

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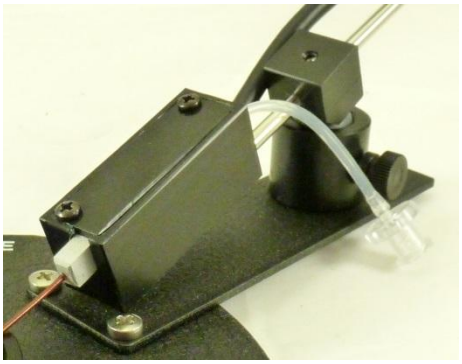
Cover photo includes MS Stage, extension and magnetic swivel holder—all sold separately.

Introduction

The Heated Perfusion Cube is another in ALA's line of systems for heating flowing liquids as they are introduced into a cell bath. The HPC has several important design features that make it unique. First, it's compact size and light weight, next its small internal volume and efficient power demand, and finally its tough and inert materials.



The HPCs' compact size and light weight make it ideal for use on a microscope stage. The specially shielded cable is thin and flexible and comes with a standard DIN connector. The HPC mounts easily to our **MMT-HPC** (optional) holder using its 1/8th inch (3.2mm) shaft. The MMT-HPC holder has a magnetic base and ball swivel for easy adjustment. The shaft can be held by a variety of manipulators and clamping devices as well and can come with a 7mm sleeve for Narishige manipulators..

Low internal volume is critical for many of today's demanding applications. Smaller internal wetted spaces mean less chance for contamination, less to flush, better conservation of materials and faster solution exchanges.

With a 10 Ohm power resistor, the HPC can output 14 watts at 12 volts. Heat is applied directly to the unique metallic heat exchanger for maximum performance. All internal wetted surface areas of the HPC are ceramic coated, the tubing is polyimide and the seals are silicone. The HPC has a tough outer shell as well. It can resist over-heating inside and out. More importantly, the internal wetted materials we chose are all hard and non-absorbent. In today's demanding lab applications more and more polymers are being found to retain biological agents causing false positives and data anomalies as they wash out at the wrong time.

Another key feature of the HPC is that the feedback temperature sensor is mounted in the block that heats the fluid and is situated so that the tip of the sensor is in the fluid path. This allows for tight control of the fluid temperature as well as the block. This prevents over-heating of the device as well as fluids.

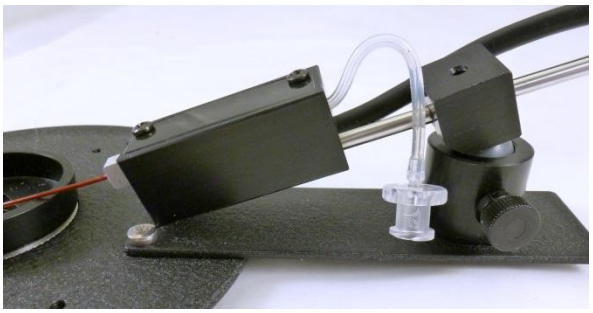
The unique design of the HPC also allows the user to adjust the flow rate through the unit. An internal adjustment is used to change the internal volume that affects the flow rate. The flow rate can be adjusted from 1.5ml/min at 1 meter gravity flow, up to 5ml/min at 1 meter gravity flow. (Lower flow rates such as .5ml/min can be achieved at lower head height of less than 1 meter.)

Unlike other inline heater system, the HPC's heat exchanger can be disassembled for direct cleaning if necessary.

Usage

The Heated Perfusion Cube is mounted to the stage assembly that holds the prep.

A steel shaft is provided to do that, and a magnetic stand (optional) is a convenient way to mount the unit, however, any type of clamping device can be used. The important thing is that the tip be able to reach the cell bath. Two things to keep in mind are that, the distance from the heated part to the cell bath will have a direct impact on the amount of heat loss of the fluid before it reaches the cell bath, and the flow rate will also have an effect. The lower flow rates of 0.5-2ml/min will have the most heat loss. You may shorten the output tube to help get the distance to the prep shorter.



For fluid connection, your HPC has a female Luer fitting attached to a short silicone tube. The silicone connects to a Polyimide barb inside the chassis. The silicone tube is about 1 inch long and has an ID of .030 inches (1.3mm). If you are connecting one of our Micromanifolds to the HPC, then you may want to remove the Luer fitting and connect your Micromanifold® directly to the tubing with a small intervening piece of tubing. This will keep dead volumes low since the Luer connection alone can be as much as 100uL. You can also adjust the internal volume of the HPC. When using a Micromanifold you will want to consider lowering the internal volume as described on page 4-5 in this manual.

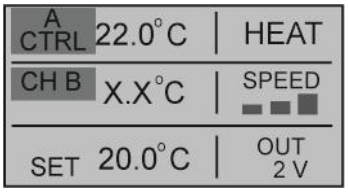
Fluid input to the HPC is best by gravity flow. Gravity flow is typically smooth and even. A pump can be used, and the HPC will work well with that, but keep in mind that the pulsatile nature of peristaltic pumps can give slightly poorer temperature control performance. Generally a fluid height of 1m is best for flow. Pressurized fluid flow works very well also, and will provide a good range of flow, like a pump, but without the pulsation.

Controlling the HPC

HPC-2A with ALA Scientific Instruments Temperature Controllers

The HPC-2A is designed to work directly with ALA temperature controllers. The user should refer to the manual for the ALA HCT-10 or HCT-30 (Tri Temp) for specifics on how to operate the temperature controller with this device.

The plug from the HPC will be plugged into the input on the front panel. The Sensor A in the case of the HCT-10 or A or B in the case of the HCT-30. The internal sensor and the power are contained in the plug so no other connection is necessary. Once the HPC is connected, then the temperature controller can be switched on.



When the HCT-10 is switched on, the menu will come up and the user can set the temperature and the power in volts. The power should be set between 5 and 12 volts, but higher voltage, over 9V, should be reserved for high flow rates. The feedback sensor of the HPC is internal so it will quickly register the temperature and give tight control. With the speed set at the third bar (as in the illustration at left) the HPC will respond in a few seconds. Further information about settings and operation can be found in the HCT-10 manual.

HPC-2A with npi electronic controllers

The HPC-2 and -2A is designed to work directly with npi electronics temperature controllers. We recommend the TC-10 or TC-20, or desk-top MTC controller. The HPC-2A will plug into a DIN connector on the front panel of these instruments (see photo left).

Each instrument allows a mode of operation to be selected. In control mode, the controller monitors the internal temperature of the HPC and displays it. A set-point is selected and the unit works to control to that set-point. All npi electronic controllers have the three controls shown at the right. We recommend these settings for the HPC. The integrator sets the time phase of the PID control loop. The gain adjusts the sensitivity to temperature change and the limiter limits the amount of power that the controller can output. Full power is 12V, so if the LIMITER is set for 100% there is 12V output, if it is set for 50%, then 6V. Power output can be measured with a meter across the blue and red banana terminals show above. More information about the npi controllers can be found in their manuals.

Another way to operate the HPC is in Direct Mode. Direct mode turns the npi temperature controller into a voltage supply. The pin-wheel dial becomes a selector to set the percentage of full power that can be applied to the HPC. (The Limiter will have no effect in this mode) So if you had the unit set at 37°C, and then you switch to Direct Mode, you will output 37% of 12V (about 4.4V) to the HPC. Also, there is no feedback control in this mode, so power must be applied carefully to avoid over-heating the HPC.

In a typical experiment a fluid source is connected to the back of the HPC. Flow should be tested before the unit is turned on, but under normal use, the HPC can be turned on first, while dry, brought to set-point and then the flow can be started. Alternatively, flow can be started and then the unit turned on. Either way, the first fluid to come out may not be at the desired temperature. It usually takes about a minute for the controller to settle in. Note the more stable the flow rate, the more accurate the set-point will be held. Since the internal temperature of the HPC is being monitored, as long as there is feedback control, it will not over-heat. All npi controllers have an over-heat alarm that shuts off power above 45°C.

One advantage of the HPC is the close proximity of the sensor, the heat exchanger, and the fluid. With flow rates of 1ml/min. or above, there is very little fall off in temperature from the internal sensor to the cell bath (see charts below) So much so that we think it is unnecessary to add an additional bath sensor as a control point when using the HPC.

For more information on temperature control, please see the npi manuals for the temperature controllers.

HPC-2 for other Controllers

The HPC-2 can be operated with other temperature controller as long as the following is met:

- Device can deliver 12V and 1.5A.
- Device is calibrated for a 2252 Ohm thermistor as the feedback sensor.
- The connector is a standard 8 pin circular din. Other connectors are available.

Flow control and volume adjustment

The flow of liquid through the HPC can be varied somewhat by an internal adjustment that is explained below in **Maintenance**. This adjustment also affects the internal volume of the device. Limiting the internal volume will reduce the flow rate and vise versa.

SAMPLE DATA CHARTS

Control Mode data (Feedback from sensor is active)

- **Limiter : 100%**
- **Integrator 5th division**
- **Gain- 9th scale mark**

Set Point Temperature for Temperature Controller (°C)	Initial Temperature of the Solution (°C)	Output Solution Temperature (°C)	Temperature of Solution Inside the Temperature Controller(°C) (Also Block Temp.)	Flow rate (mL/Min)	Voltage (V)
36	24.4	34	36.2	5	7
36	24.4	34.7	36.2	4	6.15
36	24.4	35.4	36.2	3	5.1
36	24.4	35.7	36.1	2	4.35
36	24.4	35.5	36.1	1	3.55
36	24.4	32	36.2	0.5	2.35
40	24.4	37.1	40.3	0.5	3.4

This chart gives an example of how much voltage is necessary to maintain a particular temperature, in this case 36°C at the output under different flow rates from 0.5 to 5ml/min. The last line shows that the internal set-point must be 40°C to get an output of 37°C when the flow rate is 0.5ml/min., illustrating the loss of heat that occurs at small flow rates. This point is further illustrated by the second to last line where the set-point is 36°C, the internal temp. is 36°C but the output is only 32°C. There is a much better match up between internal and output temperature at 1ml/min. and above.

Direct Mode data (no feedback) using npi TC-10

Initial Temperature of the Solution (°C)	Output solution Temperature (°C)	Temperature of Solution Inside the Temperature Controller(°C)	Flow rate (mL/Min)	Voltage (V)
23.5	23.3	23.5	1	10% (1.2)
23.5	25.2	25.6	1	20% (2.4)
23.5	30.3	32	1	30% (3.6)
23.5	37.9	41	1	40% (4.8)
23.5	46.4	50.2	1	50% (ALARM) (6.0)

The above chart gives examples of how the input power in Volts changes the output temperature for a set flow rate, in this case 1ml/min. At 50% power the unit was already over-heating at the 1ml/min. rate.

- **HPC's recommended use is with 0.5-5 mL/Min at 30%-80% of full power, which is 12V for all npi controllers.**

Care and Maintenance

The Heated Perfusion Cube must be washed out after every usage. Never leave salt solutions in the Cube for an extended period of time. For best performance and maximum life span the HPC should be flushed out with distilled water after every use. At least 10ml should be flushed through for proper rinsing. It is best to blow out excess water and store it dry.

If heavy cleaning is necessary, the heat exchanger can be disassembled as per the instructions below.. The inside parts should be carefully wiped clean with soft materials, soap and water. Do not use metal tools. It should then be re-assembled carefully. Any torn o-rings should be replaced.

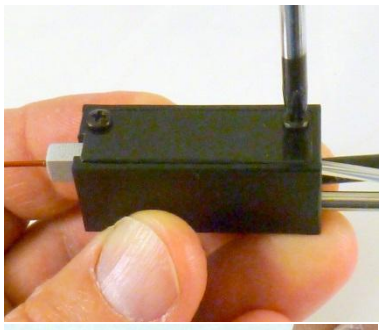
Never let the unit heat up above 60°C. It may be possible to heat sterilize the HPC on its own, by letting the unit run hot for a period of time. Please consult the factory for that procedure.

Never submerge the unit, it is not water proof. If a leak is detected, shut down all power immediately and contact your distributor or the factory as soon as possible.

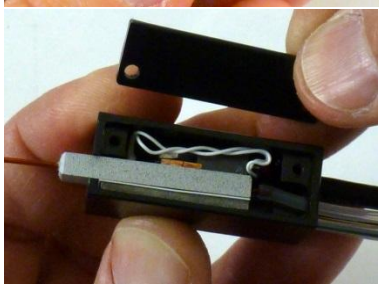
Disassembly and cleaning instructions

Flow and Volume Adjustment

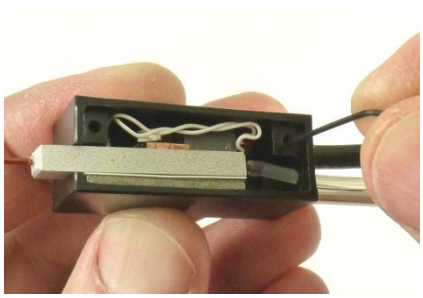
The following section explains how to disassemble the HPC to clean it and how to adjust the volume and flow. The adjustment for volume and flow is internal and so the Heat Exchanger element must be removed from the chassis for this adjustment.



Remove the two screws that secure the top of the cover to the chassis.

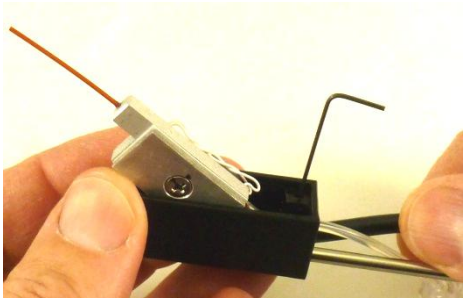


Remove the cover to expose the heat exchanger assembly.

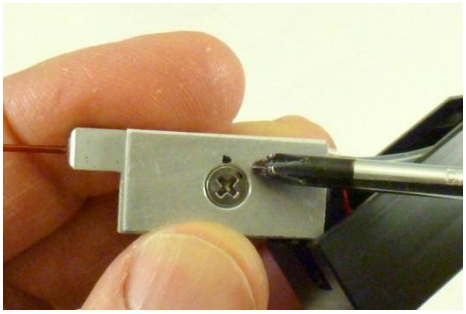


The rear screw hole has a set screw in it that secures the power cable, it must be loosened to allow the cable to slide in so the Heat Exchanger Assembly can be removed.

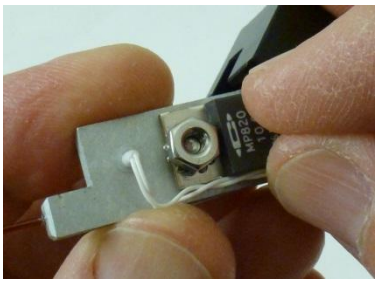
Use .050” Allen key, turn counter clockwise to loosen the set screw.

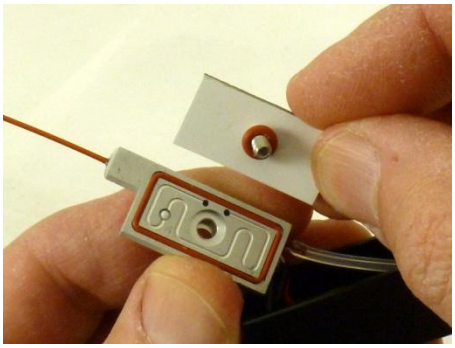


Push in the cable at the same time you remove the assembly



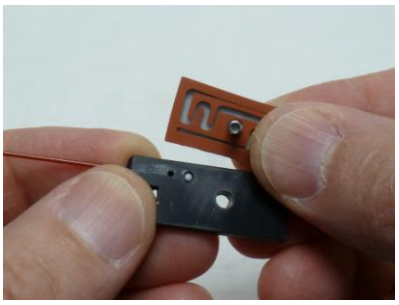
Loosen the screw until the cover comes off the heat exchanger. You may need to hold the nut on the back. The heating resistor will come loose although it may stick because of the heat sink compound.



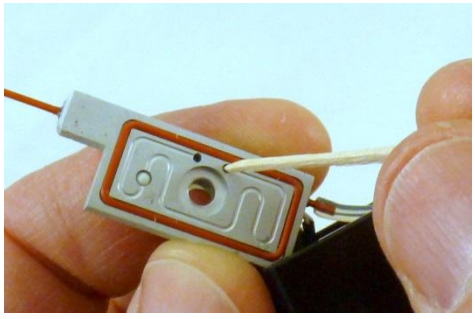


Remove the cover to reveal the heat exchanger.

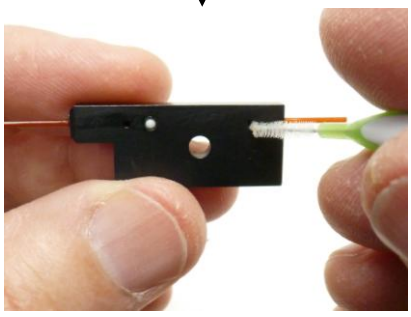
Inspect it for dirt in the channel and at the in/out ports

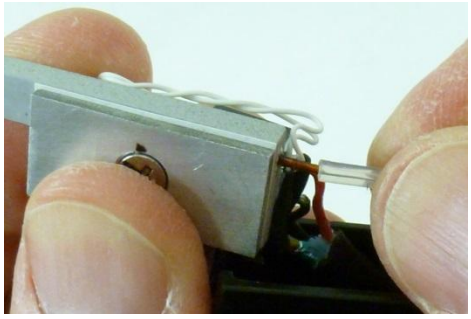


(Gasket version: Jan. 2020 and later)

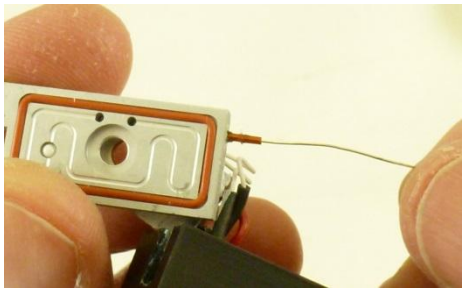


If a port is clogged, use a soft tool such as a wood or plastic toothpick to remove it. Avoid hard metal tools that can scratch the protective coating. A toothbrush can also be used. The heat exchanger can be cleaned with soap and water, do not use strong detergents, but some films can be removed with mild bleach, vinegar or contact lens cleaning solution.



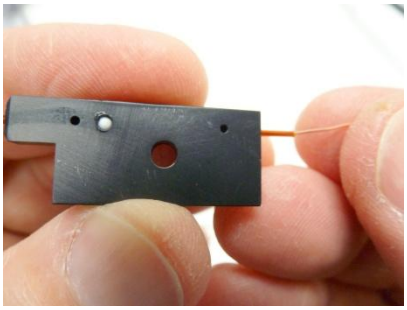


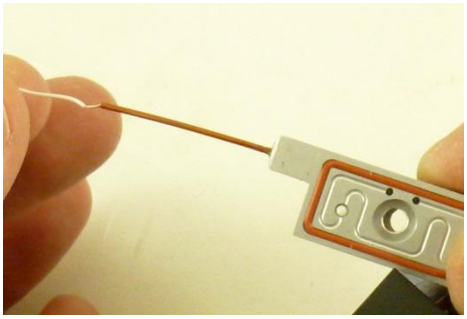
To clean the in/out tubes, remove the silicone tube for the input—it is glued on at the factory.



Insert a Tungsten wire and observe that it goes all the way to the in/out port hole, indicating that the pathway is clear.

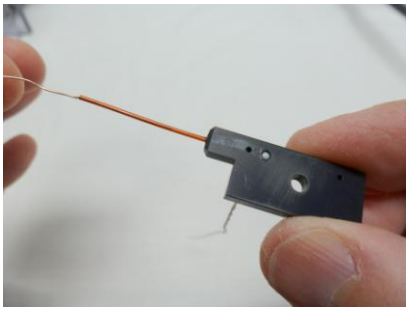
Observe that the wire reaches this port.





Follow the same procedure for the output tube.

Observe that the wire reaches this port.

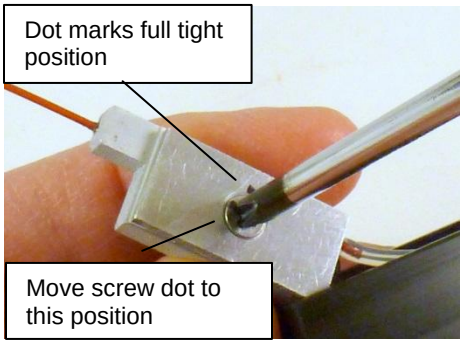


Adjusting flow and volume

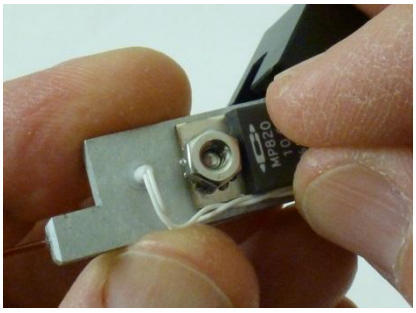
The volume of the HPC and thus the flow rate can be adjusted to some extent. The factory adjustment gives maximum flow rate, but will also give a larger internal volume. If you wish to reduce the internal volume to reduce dead volume in solution applications, you can tighten the screw. The factory setting will be 1/8 to ¼ turn counter clockwise from the full tight position as indicated by the black dots.

Do not loosen the screw too much or you may cause a leak, you may wish to test the unit with liquid before re-assembly to be sure it is not leaking.

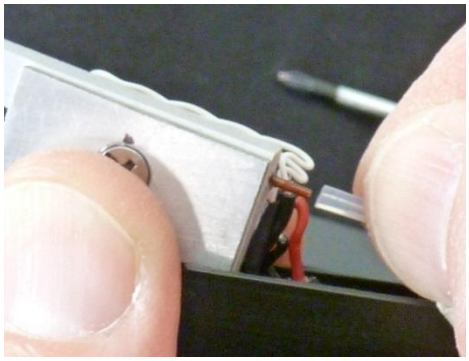
Also, do not over-tighten the screw or damage to the internal part of the heat exchanger flow path may occur and flow may be stopped.



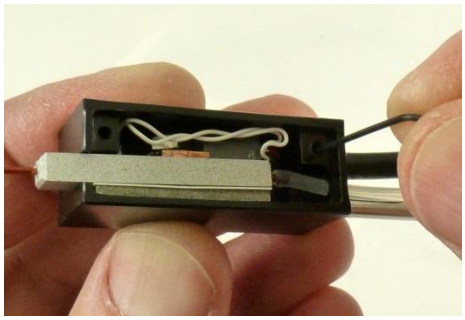
Upon tightening the screw secure the nut on the back. The nut can be tightened with the two dots lined up so that the full tight position is marked. Then you can back off the screw 1/8 counter clockwise to restore the original factory setting. Be sure the nut does not move when turning the screw.



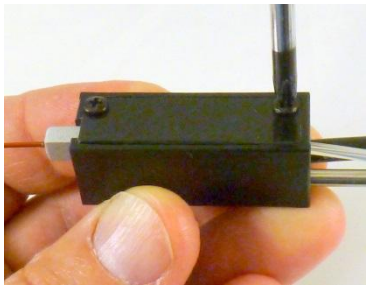
After cleaning, re-assembly is the reverse order as shown above.



Replace the tubing and apply a small amount of cyanoacrylate glue (super glue) to be sure the silicone tube stays on the barb. Do not get glue in the hole!



Carefully replace the silicone tube in its place. Tighten the set screw to secure the cable—just until the cable can't turn in the socket.



Replace the cover. Make the screws just finger tight, do not over-tighten.
Your HPC is ready to go back into service!

SPECIFICATIONS:

Weight:	75g with cable
Cable length:	1.2m
Connector:	8 pin DIN
Thermistor:	2252 Ohms at 25°C
Power:	Max. 12V, resistor is 10 Ohms, Max output at 12V = 14 Watts
Volume:	Factory set to approx. 200uL, adjustable down to 100uL
Flow rate:	Factory set to approx. 5ml/min at 1m gravity feed, adjustable down to 0.5ml/min.
Max. Temperature:	75°C
Materials:	Wetted: Aluminum oxide ceramic, polyimide, silicone seals, silicone connection tube with female polycarbonate Luer to barb fitting.
Dimensions:	L 40, W 14, H 19 mm
Mounting Rod	70 x 3.25mm or with 7mm sleeve.

Warranty

ALA Scientific Instruments, Inc. agrees to warranty this product against defects in material and workmanship for one year from date of shipment. Remedy shall be limited to replacement or repair of the item(s) at ALA's discretion. The usage of this product by the user will indicate the users understanding of the use of this product as set forth in this manual. Neither ALA Scientific Instruments, Inc., nor any of its affiliates will be held responsible for damage to laboratory equipment, including microscopes, resulting from the use or misuse of this product, including damage resulting from inputs exceeding specified limits that result in malfunction. This warranty does not cover corrosion or failure of this device due to oxidation of wetted materials resulting from use.

In the event that instrument repairs are necessary, shipping charges to the factory are the customer's responsibility. Return charges will be paid by ALA Scientific Instruments.

This instrument is not for clinical use. It is strictly for basic research in a laboratory setting. It has no clinical application whatsoever and cannot be used on human subjects.