# Bipolar Temperature Controller

## Model # HCT-10

**Ver. 2.0.0**
**6.15**


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# Safety

Do not use the device in a manner which is inconsistent with its intended function.

Do not expose the device to extreme conditions of humidity, hot or cold.

Do not use in a wet area or allow the power supply to become wet or submerged.

**Keep ventilation holes on the bottom of the unit clear from blockage at all times.**

Do not use if wires are damaged or conductors are exposed.

Monitor feedback sensors to be sure unit stays in parameters and heated devices do not overheat.

This device has no clinical application and may not be used with human subjects at all.

# 1.0 Introduction

The HCT-10 temperature controller was specifically designed for the demanding needs of the laboratory. Specifically built for use in electrophysiology it has features that make it a must for all types of labs where precision control of heated and/or cooled small apparatus is necessary. The HCT-10 is a single channel controller in that it can control one heating/cooling circuit. The system is designed to use two 2252 ohm thermistors. One thermistor is used to monitor the heating or cooling block (the component that does the heating or cooling itself), and the other sensor can be placed in the specimen. For example: The A sensor is built into the ALA HCPC (Heated/cooled perfusion cube) and the B sensor is placed in the recording bath. The control point for the temperature can be either sensor. A unique feature of the HCT-10 is that it can sense if the B sensor has been removed from the bath chamber, or if the chamber has run dry. If that happens, the control point will automatically switch to the A sensor located within the heating/cooling block, and the block will not over heat or freeze as would happen if proper closed loop feedback is lost. Thus the specimen as well as the equipment is protected from damage.

The HCT-10 is a heating or heating/cooling temperature controller. This means that it can operate a resistive device for heating, or a thermoelectric which can heat or cool. The power output is the same for whatever device you operate, but the polarity of the output voltage will switch when changing from heating to cooling. In a typical thermoelectric device, when power is applied, one side gets hot while the other side gets cold. If you want to cool an object, the side that gets cold is connected to the object that you want to cool. When the power is run for that configuration, the object will be cooled. The hot side of the thermoelectric must be connected to a heat sink to remove the excess heat. If you decide to heat the object, the voltage will be reversed and the thermoelectric will operate in reverse and the side exposed to the object will heat up and the other side will get cold.

The HCT-10 features a membrane display and 5 modes of operation which are simply selected with the up and down arrows on the front panel. Power is supplied by a 24V universal power supply. Components that are to be plugged in must have a 9 pin DIN connector. The B thermistor needs a 2mm standard mono jack. Accurate control is achieved via PID control. The HCT-10 allows the user to select three speeds of operation, the slowest will result in the least overshoot of set point, the fastest the most overshoot. In the Alarm Mode, an alarm will sound, and the control point will be switched to the A sensor automatically if the difference in temperature between the set-point and the B sensor is more than 7°C. Please note that this feature is default OFF, and must be initiated each time the unit is turned on.

# 2.0 Controller

## 2.1 Front Panel


### 2.1.1 LCD (A)

Displays sensor readings and parameters the user can modify.

### 2.1.2 Mode Control (B)

Three buttons to scroll through and select the parameters displayed on the LCD. Mode button scrolls through parameters displayed. UP/DOWN buttons are used to select through options within each parameter.

### 2.1.3 Command Input (C)

Input BNC to adjust the set temperature of the HCT-10. This function is only enabled when the EXT mode is selected. Control is 10mv/°C for entire temperature range of 0°C to 65°C.

### 2.1.4 Output A (D)

BNC output of Sensor A thermistor reading. Output is calibrated to 10mv/°C across the temperature range of the HCT-10. This signal can be sent to a data acquisition system or chart recorder.

### 2.1.5 Output B (E)

BNC output of sensor B thermistor reading. Output is calibrated to 10mv/°C across the temperature range of the HCT-10. This signal can be sent to a data acquisition system or chart recorder.

### 2.1.6 EXT Sensor (F)

BNC connector I/O. Connect external sensor feedback signal (1mv/°C) from a different device as the control point for the HCT-10. In this mode without a feedback signal present the connector is an output voltage supply (2v – 12v DC).

### 2.1.7 Sensor A (G)

8 pin female circular connector for HCT-10 temperature controlled devices (HPC, HCPC). Connector provides power and thermistor feedback input to temperature controlled devices. Input calibrated for 2225 ohm thermistors.

### 2.1.8 Sensor B (H)

Thermistor feedback input. 2mm mono jack connector. Input is calibrated for 2225 ohm thermistors. (Optional accessory required- TS1M or TS-2M)

## 2.2 Rear Panel


### 2.2.1 Power (A)

Remote power supply input. (24 VDC @ 4A)

### 2.2.2 Switch (B)

Power rocker switch to turn HCT-10 ON or OFF.

### 2.2.3 Fan (C)

Internal cooling fan.

### 2.2.4 Fuse (D)

HCT-10 fuse housing. (2.5A 5x20mm FB)

### 2.2.5 Ground (E)

Banana jack connector for grounding HCT-10.

# 3.0 Packing List

The HCT-10 system comes with the following:

- HCT-10 Controller
- Universal Power Supply – 24 V DC Output
- Power Cord
- Instruction Manual

Carefully unpack the system from the shipping box and account for all parts listed above. Inspect all components for any signs of damage that might have occurred during shipping.

If there is damage to any component or a component is missing, immediately contact ALA Scientific Instruments.

If there is physical damage to any component of the system, do not dispose of any shipping materials (cardboard box, padding material). This will allow for a claim to be placed with the shipping company (UPS, FedEx).

# 4.0 Setup

The HCT-10 is designed to control ALA Scientific's Heat and/or Cool devices such as the HCPC, HPC, HCMIS and others. It is important to connect the device to the HCT-10 before turning HCT-10 ON.

## 4.1 AC Power Connection

The HCT-10 is designed to use a universal DC output power supply. Input AC voltage can vary from 100 VAC to 240 VAC 50/60 HZ.

a. Use the supplied AC three prong power cord and connect it to a wall outlet near where the HCT-10 will be located.
b. Plug power cable into universal power supply,
c. Ensure that all cables are placed using GLP.
d. If any cable is damaged (cut or damaged insulation) do not use. Replace with new cable.
e. Connect universal power supply output connector into the power connector on the rear panel of the HCT-10.

**NOTE:** If no device is connected to either the *Sensor A* or *Sensor B* connector, an audible alarm will sound.

## 4.2 Assemble HCT-10

The HCT-10 is a single channel bipolar temperature controller with a second thermistor feedback port. Using a second thermistor in the setup will allow for better monitoring of solution temperature in the bath. Adjustments to the HCT-10 can be more accurate with a second thermistor feedback.
The assembly process of the various temperature devices to the HCT-10 is as follows:

a. Connect the device's 8-pin circular connector to the ***Sensor A*** connector on the HCT-10 front panel. Use TC4-CABLE (optional) for devices without a built-in cable.

b. Connect thermistor TS-1/TS2 (optional) to ***Sensor B*** connector for bath temperature feedback.

c. Place thermistor into cell chamber. The thermistor cable will need to be restrained in place to ensure bead remains completely submerged in the solution.

d. Fill cell chamber to desired level making sure thermistor bead is completely submerged.

e. Turn ON HCT-10 using rocker switch on the rear panel.

f. HCT-10 will power up.

g. The HCT-10 display will ask to:


Use the UP/DOWN buttons on the front panel to select YES or NO. On the first time powering up the HCT-10 there is no data stored other than the default values.

Select either option. The default Screen will be displayed. The HCT-10 is ready to be programmed with your required parameters.

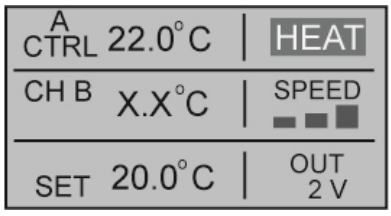
# 5.0 Modes of Operation


The HCT-10 single channel bipolar temperature controller has many modes of operation to facilitate the control of the device connected. The *MODE* button is used to scroll through the various modes displayed. Once highlighted, the *UP/DOWN* buttons are used to scroll through each mode's options.

## 5.1 Temperature Mode

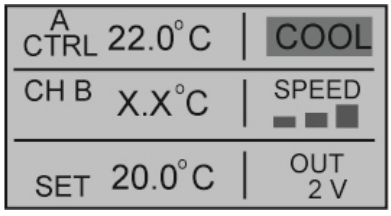
Heating and cooling can be set to heat, cool, or both. Press mode button until the heat is highlighted, as shown below. The default setting is heat when the HCT-10 is turned ON.

### 5.1.0 Heat Mode




The default Heat mode for the HCT-10 is *HEAT.* Upon powering up theHCT-10 for the first time, the *HEAT* display will be highlighted. The Heat mode is used with devices that are designed to be maintained above room temperature. Devices using resistive elements such as ALA Scientific's In-line heater (HPC), objective heater (OBJHEATER), or stage heater (HCS) can be used in this mode.

### 5.1.1 Cool Mode




The *COOL* mode is the second option in the temperature mode display field. Use the UP button to scroll to the *COOL* mode from the *HEAT* mode. Only devices having thermo-electric based modules (peltier) can be used in this mode. Such devices include ALA Scientific's HCPC and HCMIS. Use the COOL mode for systems that need to be kept below room temperature.

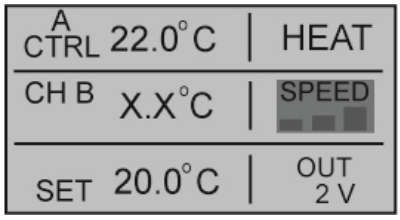
### 5.1.2 Heat/Cool Mode

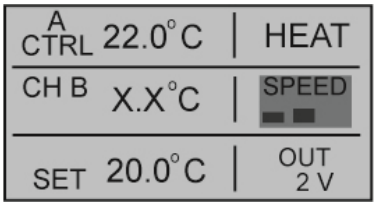
The H/C mode is used with thermo-electric based devices that will be actively heated or cooled. Although the UP/DOWN buttons can be used to change temperatures it is recommended that the external command feature be used. An input analog COMMAND signal can quickly change temperatures.

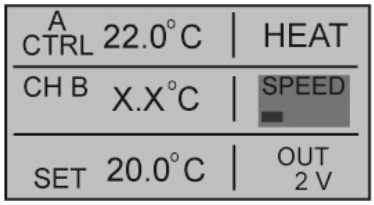
***Note:*** *The Heat/Cool feature is only applicable to devices that can heat and cool. If the device being used only heats, the H/C feature should not be used. Serious damage to your device can occur.*

## 5.2 Speed Mode

The speed of response of the system can be adjusted with three levels; low, medium and high. Press the *MODE* button until the speed function with the three bars is highlighted. The default speed setting is high. Use the UP/DOWN buttons to change speed mode. The slow setting gives the most accuracy to limit overshoot, the high setting gives the fastest response, but the most overshoot.



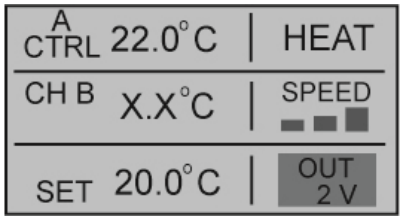




***Operational Note**: Changing the speed setting modifies the PID algorithm that regulates the controller.*

## 5.3 Voltage Mode

The voltage that the HCT-10 outputs to the connected device can be changed by pressing the *MODE* button until the *OUT* display is highlighted. Use the UP/DOWN buttons to change the voltage output. The voltage ranges from 2 to a maximum of 12 volts. Upon start up, default voltage is 2V to prevent damage to heating/cooling devices. For best results, heating and cooling, this setting should be set on the maximum voltage your device can handle.

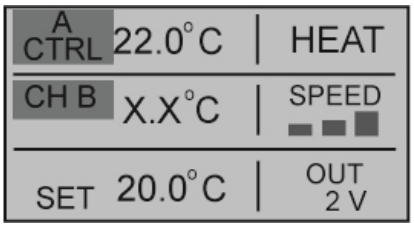




***Note:** Be aware of the maximum voltage your device can tolerate. Read the specifications of the devices being used and do not exceed the maximum voltage permitted.*

## 5.4 Control Feedback Mode

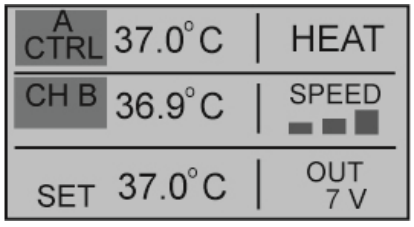
Feedback for temperature control can come from one of three sensor inputs. Thermistors connected to *SENSOR A*, *SENSOR B* or *EXT SENSOR* bnc port can be used as feedback.
Press the MODE button until both A and B are highlighted. Use the UP/DOWN buttons to change the input source.




**Note:** If Channel B is not being used (nothing is plugged in) then the B control will not work, and will appear as X.X°C.

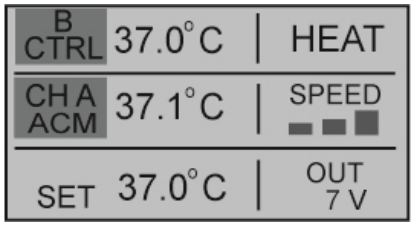
### 5.4.3 CTRL A

The HCT-10 default temperature control feedback is *SENSOR A* (*A CTRL*). CH B can remain unused or a thermistor (TS-1M or TS-2M) can be connected and used to monitor the temperature in the cell bath or any other point of interest. Channel A will follow the set point requested.




### 5.4.2 CTRL B (ACM Mode)

When *SENSOR B* is selected as the temperature control point, channel B will follow the requested in the set point temperature.

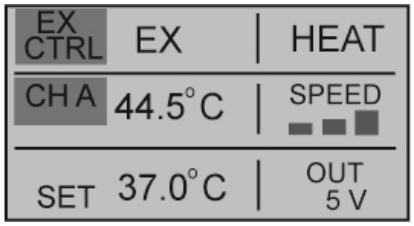



Since *SENSOR B* is primarily used for measuring temperature in a cell bath, there is the possibility that it can fall out of the bath or that the bath can dry up, losing the feedback link with the HCT-10. This may cause your system to overheat as it tries to heat a dry bath while the sensor keeps reporting only room temperature. For this reason the HCT-10 is automatically set into ACM mode or Automatic Control Mode when *SENSOR B* is the control point. This mode is designed to protect your sample and equipment from overheating or freezing.
In ACM mode, if the temperature difference between A and B is more than 7°C the system will sound an alarm and automatically switch control from B, back to Sensor A (at the B set point level). To silence the ACM alarm, scroll through the modes using the MODE button.

Before resetting the HCT-10 check the positioning of the thermistor and the solution level to assure proper feedback.

**Note:** Be aware that ACM is only available in HEAT, and COOL mode, it will not function in H/C Heat/Cool mode since driving that mode with an External input might force a more than 7° difference between A and B.

### 5.4.3 EXTERNAL Sensor Mode




The HCT-10 can operate with feedback from an external device as the control point. Devices that have a 1mv/°C output such as temperature meters can be used. This mode allows for the use of various thermocouples (PT-100). The temperature from the external sensor will not be shown on the display of the HCT-10. Even though the HCT does not display the value, it will interpret the input and use it as the feedback point. Use the external device to read the temperature.

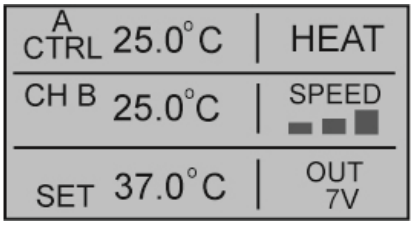

To activate this mode, use the UP/DOWN buttons to select *EX*. Connect your external monitor to the front panel bnc labeled *EXT SENSOR*.

**Note:** ACM mode is not enabled in this mode. Take care to monitor sensor placement and solution levels.

## 5.5 Set Temperature Mode


The HCT-10 has 2 ways to change the temperature set point; manual and external modes. To enter the set point temperature mode, press the *MODE* button until *SET* is highlighted. The HCT-10 default set point is 20°C @ 2V.

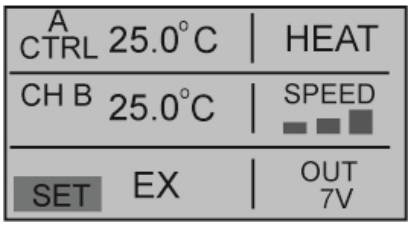
### 5.5.1 Manual Set




The HCT-10 temperature set point can be adjusted manually from the controller front panel. With the *SET* point mode highlighted, press the *MODE* button once to manually adjust the temperature set point. Use the UP/DOWN buttons to move to the desired temperature set point. A maximum temperature of 64.9°C can be set in manual mode.

### 5.5.2 EXternal Set

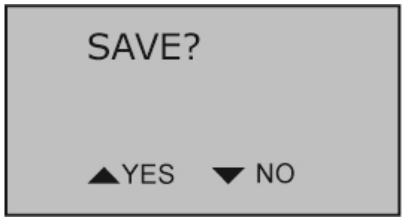
The HCT-10 temperature set point can be controlled via an external analog voltage. To change to **EX** control mode with the ***SET*** mode highlighted, press the UP arrow button until EX is displayed.




Connect a bnc cable from an analog source to the *COMMAND* input on the HCT-10. Command input maximum voltage is 5 volts. Each movement of 10mV will shift the control point 1°C to a maximum of 50°C.


### 5.5.3 Save Data

The HCT-10 will save the parameters set in the mode screens. As you scroll through the modes, the HCT-10 will as whether to save the data or not.

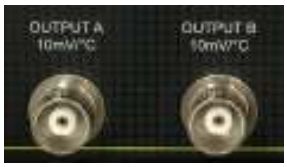



Continue scrolling if to continue using the current parameters without saving them or press the DOWN button. Press the UP button to save the parameters for future use. Any changes made after this screen will have to be saved prior to turning the HCT-10 off.

Next time the HCT-10 is turned ON, the display will ask whether to retrieve the data saved. Press the UP button to load the saved parameters. Press the DOWN button to start from the default settings.


**Note: For safety reasons the output voltage parameter is always defaulted to 2V.**

# 6.0 Output temperature Monitor

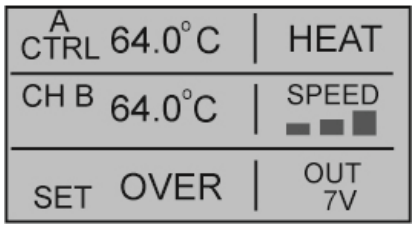



The HCT-10 has analog voltage output ports for each sensor input. ***OUTPUT A*** and ***OUTPUT B*** bnc connectors can be used to monitor temperature via a data acquisition system.

Each 10mV output corresponds to a 1°C temperature reading. For example, a *SENSOR A* temperature reading of 45°C translates to a 0.45V (450mV) output.

# 7.0 Error Messages (Alarms)

The HCT-10 has audible alarms when certain parameters or feedback signals are outside of specifications. These alarms are meant to alert the user of improper connections and to protect the device from overheating.




## 7.1 No Sensor Connected

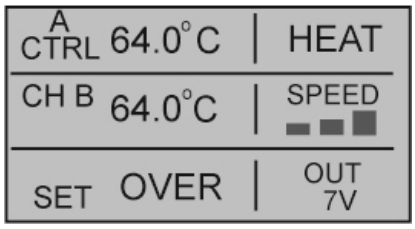
An audible alarm will sound when the HCT-10 is powered ON and no device is connected to *SENSOR A.*

An audible alarm will sound if channel B is set as the control feedback and there is no sensor connected into the *SENSOR B* port.

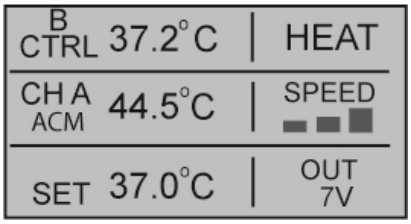
To turn OFF the alarm, connect the sensor to the appropriate input. Once the HCT-10 receives a feedback signal the alarm will shut off.

## 7.2 Out of Range

An alarm will sound when the set point is set too high or too low. The range for the set point is from 0°C to 65°C. If the set point is set above or below this range, an alarm will sound and the display will show ***OVER*** in the *SET* mode.



## 7.3 ACM Temperature Difference



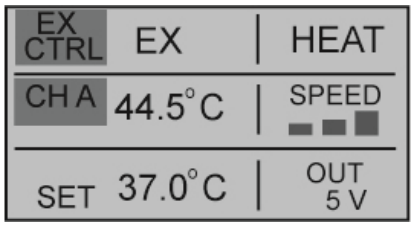

When *SENSOR B* is selected as the temperature control point, the HCT-10 will go into Automatic Control Mode (ACM mode).

An audible alarm will sound in ACM mode if the difference in temperature between *SENSOR A* and *SENSOR B* is greater than 7°C.

The alarm will stop if the temperature difference falls below 7°C. If the temperature difference remains for more than 10 seconds, the alarm will be louder and the HCT-10 will revert to *SENSOR* A as the control point.

Check that SENSOR B is properly placed and solution levels are appropriate before resetting the HCT-10. Use the MODE button to scroll back to the control feedback mode to reset the HCT-10 back to *SENSOR B* as the control point.

# 8.0 Power Supply Mode




When the HCT-10 is setup for External sensor feedback but no sensor is connected in the *EXT SENSOR* port, that port becomes a power supply output.

Use the MODE button to highlight the feedback control display. Use the UP/DOWN buttons to select *EX*.


If this mode is selected and no input is used at the EXT SENSOR then the HCT-10 can be used as a constant voltage power supply with a range of 2-12V. The voltage level can be adjusted by highlighting the *OUT* screen and scrolling to the desired voltage.

The *SENSOR A* will continue to read temperature.

# 9.0 Temperature Control Devices

The HCT-10 is a bipolar temperature controller designed to control various types of devices. ALA Scientific's has temperature devices that can be used to heat or cool various parameters within an experiment such as the cell solution, perfusant, stages, microscope objectives and much more.

## 9.1 HCT-10 and Resistive Heating Devices

The HCT-10 is designed to control various types of resistive element heaters. All of ALA Scientific's resistive element heating devices such as the HPC (Heated Perfusion Cube), HCS (Heated Chamber Stage), OBJHEAT (Objective lens Heater) and HEATINGPad (Heated silicone pad) are able to be controlled and monitored by the HCT-10.

If a third party device is used with the HCT-10 it must follow certain criteria as to not damage the HCT-10 or not be properly controlled. The resistance of the device must not be below 5 ohms and the feedback thermistor must be a 2252 ohm @ 25°C type.

### 9.1.1 In-Line Heaters - HPC

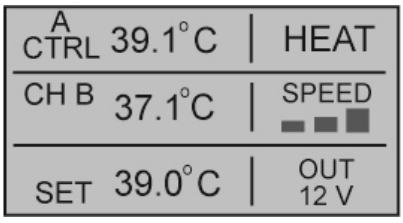
The HCT-10 *HEAT* mode is designed to control and monitor in-line heaters such as ALA Scientific's Heated Perfusion Cube (HPC).
The HPC is a device for heating up a perfusion flow to a cell bath. It is typically used for a flow rate of up to 5ml/min.

Suppose you want it to heat a 2ml/min flow into a 36°C 1.5ml cell bath.

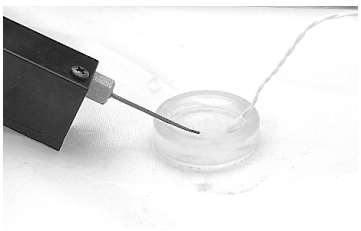
Follow the setup instructions (section 4.0) to assemble the HCT-10 system.

Connect the 8-pin cable from the HPC to the *SENSOR A* circular connector on the HCT-10.

When the unit is powered ON, ***HEAT*** and **high SPEED** will be the default settings displayed. Do not change these settings. Proceed to change the *OUT* voltage to 10 or higher. The HPC works best at 12V.




If a TS-1M or TS-2M (optional) is available, connect it to *SENSOR B* and enable the display of CH B.



Once all the desired functions are set, go to the *SET* mode and either chose the manual or EXTernal mode to adjust the temperature set point. In manual mode, use the UP/DOWN buttons to change the **set point (SET)** to the desired temperature.

Depending on the flow rate, once the internal cube temperature, as read on *Sensor A* is stable, it may be possible to switch control to the *SENSOR B* which can be placed in the cell bath for more accurate temperature control. Once the *SENSOR B* is positioned, control can be switched to the *SENSOR B*. The ACM mode will prevent more than a 7° difference between the two sensors. If it is necessary to heat the HPC much hotter than the desired temperature in the bath (high flow rate), switch off the ACM mode and adjust the set point for A to a point where the B sensor reads the desired temperature. Often a flowing bath perfusion will need to be heated more than 10° hotter than the desired bath temperature because there is so much heat loss. Just note that in these circumstances the ACM mode and thus *SENSOR B* as the control point cannot be used.

### 9.1.2 Heated Stages – HCS

It is often necessary to heat the stage housing a cell chamber in order to maintain a unified temperature control of the experiment. The HCS connects to the HCT controller with the TC4-CABLE (optional).

The HCS has a steel outer ring allowing for magnetic tools to be used. The inner ring contains the heater and feedback sensor.

The HCT-10 parameters are set to Heat only and it is recommended to use the maximum voltage (12V) in the *OUT* setting.

## 9.2 Peltier Devices

The HCT-10 is a bipolar temperature controller. It is well suited to control ALA Scientific's Heated Cooled Perfusion Cube (HCPC) and the HCMIS micro incubator stage.

Setup for a peltier device:

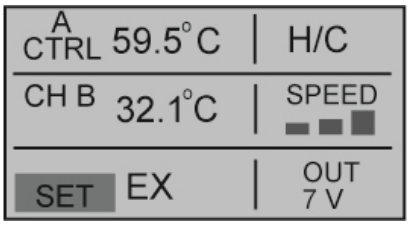
- Connect the peltier device to the HCT-10.
- Turn ON HCT-10.
- Change the temperature mode to H/C mode.

- Select the SPEED mode. Fast is recommended.
- Change the *OUT* voltage to 7V or less. The maximum voltage permitted before damage may occur to the thermoelectric module is 7V.
- The temperature feedback is already defaulted to *SENSOR A*. At this point if SENSOR B is also used change the temperature feedback mode to also read CH B. place the SENSOR B thermistor into the cell bath and secure in place.
- Once all the desired functions are set, go to the *SET* mode and either chose the manual or EXTernal mode to adjust the temperature set point. In manual mode, use the UP/DOWN buttons to change the **set point (SET)** to the desired temperature.
- Both the HCPC and the HCMIS peltier devices have water cooled heat sinks to help remove heat generated during cooling. This helps in reaching lower temperatures. When cooling make sure water or coolant is flowing through the heat sink.

**Note:** Be sure to check the maximum voltage whenever using thermoelectric devices as these are usually lower than heat-only devices with resistive heaters.

# 10.0 Using the Heat/Cool Feature

Certain devices can both heat and cool, like ALA's Heating/Cooling Micro-Incubation System (HCMIS) or Heated/Cooled Perfusion Cube (HCPC).
The H/C feature is designed for keeping a cell bath around room temperature.




To set up the heat cool feature:

- Turn the controller on.
- Press the mode button until the heat section is highlighted (heat is default).
- Press the up/down buttons to change it to H/C (heat/cool) mode.
- Set the *SPEED* of the system. If the temperature oscillates too much, the speed may be too fast. If so, adjust the speed by pressing the *MODE* button until speed is highlighted and use the UP/DOWN buttons to adjust speed.
- Set the OUT voltage for the device. ALA Scientific's peltier devices have a maximum voltage rating of 7V.
- Set the second thermistor CH B if one is available using the MODE button to highlight the control point section.

- The *SET* temperature can be manually adjusted or the *EX* mode can be used. The Heat/Cool mode may be desirable when commanding the HCT from an external source for creating increasing and decreasing temperature ramps.

**Note:** To lower the temperature past room temperature of about - 5°C or less, use the cool feature, not H/C mode.

# 10.0 Specifications

| | |
|---|---|
| **Maximum Output Voltage** | 12 VDC |
| **Maximum Output Current** | 2.0 A |
| **Minimum Load Resistance** | 2.0 Ω |
| **Manual Voltage Range** | 2 to 12 VDC |
| **Maximum Output Power** | 24 W @ 10 ohm load |
| **Universal AC adapter** | Input 100 – 240 VAC 50/60 Hz<br>Output 24 VDC @ 4.0 A max output |
| **Power Fuse (5 x 20 mm)** | 2.5 A Fast Blow 250V |
| **Sensor Type** | 2252 ohm Thermistor |
| **Front Panel Input/output** | A Sensor (output) – Thermistor (2252) DIN<br>B Sensor (Input) – Thermistor (2252) 2mm mono jack<br>Command Input – BNC 10mV/°C<br>Output A - BNC 10mV/°C<br>Output B - BNC 10mV/°C<br>EXT SENSOR (input) – BNC 1mV/°C |
| **Temperature Range** | 0°C to 65°C |
| **Enclosure (W x H x D)** | 21.59 x 19.05 x 9.53 cm (8.50 x 7.50 x 3.75 in) |
| **Enclosure Weight** | 3.20 Lbs. |

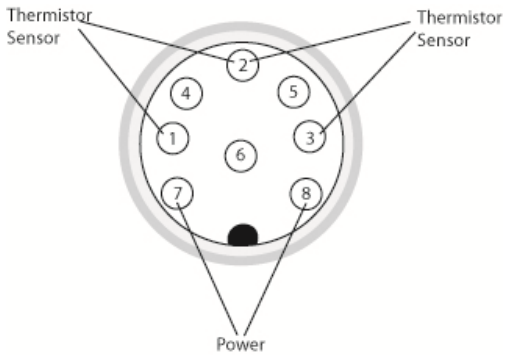
# 11.0 Cable Pin Outs

DIN Connector as seen from the front panel:

Pin 1 and 2 are for sensor.

Pins 1 & 3 are connected internally.

Pin 7 and 8 are power out



# 12.0 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 to or from this device. The user asserts that he/she is aware of the electrical output and that he/she will insure that it does not exceed manufacturers' recommendation for heat/cool devices used in conjunction with the HCT.

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

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.

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