



# Air-Therm™ ATX

*Heater Controller for bioscience laboratories*

www.wpiinc.com

## INSTRUCTION MANUAL

Serial No. \_\_\_\_\_

031010

**World Precision Instruments**



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## INTRODUCTION

### Precision

Maintenance of the desired temperature set-point can now be achieved through the use of a precision, shielded temperature probe coupled to a peripheral Air-Therm heating unit. Noise is a major concern in any experimental application. WPI's Air-Therm™ is electrically quiet as well as acoustically quiet). Since the Air-Therm can be placed away from the incubator, any residual electrical and vibrational interference from the heater is virtually eliminated. Accuracy of  $\pm 0.1^{\circ}\text{C}$  can be routinely maintained at the sample site (using a fully programmable differential algorithm to automatically adjust the temperature on the Air-Therm unit). Air-Therm maintains a uniform temperature across the microscope stage (allowing for uniform heating of multiwell dishes). These tight tolerances result in minimal focal drift once sample/incubator equilibrium has been achieved.

### Glass bottom dishes

For high numerical aperture (NA) live-cell imaging, cells must be plated on glass (e.g., WPI's FluoroDish Glass Bottom Dishes, spotting 0.17 mm glass thickness) or standard cover slips. Since cover slips inherit other problems associated with sterility and accidental damage to expensive microscope condensers, WPI designed new and improved glass bottom dishes (35 mm x 10 mm or 35 mm X 22 mm) that are not cytotoxic. A special adhesive in conjunction with an advanced dish design makes the FluoroDish the only non-cytotoxic glass dish in the world. This means that cells can actually be cultured for 4 to 5 days in the same dish and then carry the complete cell culture with media from the incubator directly into the (Air-Therm controlled) recording chamber. This is a comfort level that hitherto was unattainable by scientists and clinical researchers since cells will have to be transported from the culture dishes on to cover slips just prior to imagery or attaching patch electrodes.



Figure 1—AirThermATX is available as 110V or 220V



## **Chamber**

The most problematic aspect of any live cell imaging procedure or patch clamp approach is the thermal drift of high magnification lenses caused by temperature fluctuations in the microscope's environment. It is necessary to constantly readjust the focus during image acquisition due to this thermal-drift, introducing artifacts during quantitative microscopy due to the photo-bleaching that occurs during refocusing. The optimal solution to this problem is to use WPI's Air-Therm temperature controller connected to a Plexiglas or acrylic chamber that encloses the entire imaging area (or at least the objectives and the stage). Using such a chamber will result in highly stable temperature control and minimal thermal drift.

### **Includes**

Two pieces of 4.5 ft. clear, coli-reinforced heater hose are included with Air-Therm.



## **OPERATION**

### **Power**

The power switch on the back panel controls the main power for fan, heater, and microprocessor controller. The heater switch on the front panel controls only the heater; when this switch is off and the power is on, the controller and fan will still be powered. Air-Therm may then be used as precision digital thermometer with better than 0.2 °C accuracy and 0.1 °C resolution.

### **Fan Speed Control**

The fan control knob on the front panel adjusts the airflow rate from 20 to 50 cubic feet per minute (CFM). Lower flow rate will offer a quiet operation and is suitable for most applications. However, the higher flow rate can generate more turbulence so that the temperature in the chamber will be more uniform. The higher air flow speeds up the heating process and makes it possible to heat larger chambers. For safety reasons, the fan can't be turned off unless the instrument is off.



**Caution: Avoid blocking the airflow.**

Although a built-in thermal cutoff switch is designed to reduce the hazard, a *fan failure or obstruction in the airflow has the potential for overheating the system and damaging the instrument or even causing a fire.*


### **Temperature Sensor**

The sensor is shielded and grounded with a stainless steel sleeve. The sensor can be directly inserted near sites that involve electric recording without introducing any interference from the heating unit. It can be safely placed in water, but it will ground the system unless a moisture-resistant coating is applied. We recommend using silicone or epoxy to coat the stainless steel portion of the sensor. The coating should not be applied unless it is necessary since it will slow the response time.

### **PID Control**

By selecting the proper parameters of the powerful microprocessor-based PID controller, Air-Therm can be used for many different applications. However, the user should try to use the preset parameters in the controller first (Pb.ht=3, It.ht=2.5, dE.ht=1.6). These parameters have been tested for controlling a regular size acrylic chamber that covers a microscope for live cell imaging. These users may skip this section and go directly to the "Applications" section. To properly use Air-Therm for other applications, some basic PID control knowledge will be useful.



The output power of the heater (**Po.ht**) is proportional to the sum of the proportional (**ProP**), integral (**it**), and derivative (**dE**) terms (**Po.ht** is zero if the sum is negative). The way these terms respond to the measured temperature is determined by the proportional band (**Pb.ht**), integral heat (**It.ht**), and derivative heat (**dE.ht**). All of the above terms can be found in the operations menu (press  from the home page). Below is a short description of what the PID parameters do. The appendix contains a more detailed analysis.

**Proportional:** The magnitude of the proportional term (**ProP**) is proportional to the difference ( $\Delta T$ ) between the actual temperature and the set point. The parameter used for proportional control is the *proportional band* (**Pb.ht**). When the temperature is below the proportional band ( $\Delta T < \text{Pb.ht}$ ), **ProP** will be 100% (1.00). Above the proportional band ( $\Delta T > \text{Pb.ht}$ ) it is -100% (-1.00). When the temperature is within the band, the output power is proportional to  $\Delta T$ .

**Example:** Suppose only proportional action is turned on. If the setting is 37 °C and Pb.ht is set at 3 °C. The heater will be on 100% of the time when the temperature is below 34 °C and will be completely off when the temperature is above 37 °C. Within the band, each degree of temperature difference between the set temperature and reading temperature will correspond to 33% (1/3) of the total output power change. The proportional control alone cannot completely cancel  $\Delta T$  because without  $\Delta T$ , the output will be zero. They need an offset value to let  $\Delta T$  become zero. This can be achieved manually or automatically. The most widely used method for automatic offset is *integral control*.

**Integral:** The value of the integral term (**it**) is proportional to the integral of  $\Delta T$  with the time. In other words, the longer the  $\Delta T$  exists, the more the output power will change. In this controller, the parameter used for integral control is called *Integral heat* (**It.ht**), representing the time (in minutes) for the controller to increase the output power by 100%. The larger the **It.ht**, the smaller the integral action. The integral function effectively shifts the proportional band so that when the measured temperature reaches the set temperature, the output will not be zero.

**Example:** Suppose **It.ht** is set at 5 minutes, output is 20% of total power, and  $\Delta T = -1.0$  °C (in this example, derivative action is turned off). If  $\Delta T$  remains constant, the output will be 40% after 5 minutes and 60% after 10 minutes.

**Derivative:** The derivative term (**dE**), is proportional to the instantaneous rate of change of  $\Delta T$ . Derivative action helps the stability of the system in two ways. It slows the rate at which temperature is approaching the set point to prevent temperature overshoot, and it allows the system to respond quickly to any potential large changes before it is too late. When the door of the chamber is opened, the derivative function will detect the rapid loss of heat and turn the heater to full power in advance to prevent too much temperature drop. For this controller, derivative parameter is called *Rate Time* (**dE.ht**) in minutes. The larger the **dE.ht** number, the stronger the action.

**Example:** Suppose the proportional band (**Pb.ht**) is set to 3 °C, **dE.ht** is 2. The derivative term, **dE**, will subtract  $2/3=66\%$  from the heat output if the temperature is increasing at 1°C/minute, and 33% if the temperature is increasing at 0.5°C/minute.



The integral term will be in action only when the temperature is within the proportional band and resets to zero when the temperature goes outside this range. The derivative function will be in action when the temperature is within twice the proportional value. Too much integral action (when **It.ht** is too small) or too much derivative action (when **dE.ht** is too large) will cause the system to be unstable.

**NOTE:** Depending on the manufacturer, integral or (reset) action is set in either time/repeat or repeat/time. One is just the reciprocal of the other. Manufacturers are not consistent and often use reset in units of time/repeat or integral in units of repeats/time. We use the SI system so Integral is expressed in minutes (some manufacture also use seconds). It is identical to “minutes per repeat” or “Automatic reset time”. It is the reciprocal of Reset rate or Repeats per minutes, e.g., 2 minutes of Integral will equal to 0.5 repeats per minute. In our system, larger value of Integral means slower action. In the Repeat/minutes system, larger number means fast action. The Derivative function is referred to as either derivative or rate, but both of them are expressed in minutes and function the same. A larger value means faster action.



## APPLICATIONS

### Using Air-Therm with chambers that cover a live cell imaging microscope system

We recommend  $\frac{3}{8}$ " to  $\frac{1}{4}$ " thick acrylic (PMMA) sheet to for the construction of the chamber wall. It will allow the user to see through inside. It also has sufficient heat insulation so that a chamber with up to 50 cubic feet can be supported by the heater. The chamber should have two 2.5-inch ports for connecting the Air-Therm hose so that air can be circulated. The circulation of the heated air will make the temperature easier to control, keep the humidity in, and prevent potentially dangerous samples from polluting the laboratory environment. In order to achieve temperature uniformity, we recommend that the heated air to be introduced into the top of the chamber and cold air to be sucked out from the lower part of the chamber. The temperature can be made even more uniform by baffling the air flow. A simple baffle can be made with an air filter, such as those found in air conditioning vents. Use filters that are approximately the same size as the chamber and place them a couple of inches in front of the air inlets and outlets.

Connect the temperature sensor to the Air-Therm. Feed the temperature sensor into the chamber and place it at the desired position. Most common position is at the back stage of the microscope.

Turn on Air-Therm's power switch. Use ▲ and ▼ to adjust the temperature set point on the lower display to the desired value. The upper display shows the temperature reading from the sensor. Turn on Air-Therm's heater switch and the system will start to work. It might take 30 minutes for the fluid in a perfusion system to stabilize from room temperature to 37 °C.

### Using Air-Therm with other systems

Since controller parameters have been set for a normal acrylic chamber that covers the microscope, it might need to be readjusted if the application is very different. The controller can be adjusted manually or automatically.

**Automatic control:** This uses PID (Proportional, Integral, and Derivative) control to automatically find the heater power output necessary to reach and maintain the temperature set point. Three parameters can be adjusted to optimize it for different systems. These can be entered manually, or determined automatically by the controller.

**Auto tune :** The controller will evaluate the process and select the PID values to maintain good control. Once the user starts a learning process, the controller lets the temperature go up and down three to four times until good PID parameters are established. After auto tuning, it immediately begins regulating the temperature using these values.



## Manually setting PID values

### Manual input PID values (PID):

In this mode, user can manually adjust the PID values. Here are some examples:

**Slow response process:** Pb.ht=7, It.ht=10.0, dE.ht=1.67

**Normal response process:** Pb.ht =4, It.ht =3.5, dE.ht =0.58

**Fast response process:** Pb.ht =3, It.ht =1.5, dE.ht =0.25

**Air-Therm Default Settings:** Pb.ht=3, It.ht=2.5, dE.ht=1.6

An easy way to use this mode is to use the Auto tune first to get a preliminary value, then to manually fine tune the system. **Example:** if the accuracy is too low, reduce **Pb.ht**. If the time needed to reach the set temperature is too long, decrease **It.ht**; if the system is very unstable, reduce **dE.ht** or reduce the total power.

**Manual control:** The operator manually controls the percentage of the total power of heater that is used. Go into this mode by setting **Pb.ht** to **MAAn**. The lower display in the HOME position shows the output in percent.

## Using Air-Therm as a constant temperature blower

This is an easy method to provide a constant temperature for a small subject. To do this, leave both the air inlet and outlet hoses on the instrument. Set the controller parameters to **Pb.ht** =3, **It.ht** =2.1, **dE.ht** =0.06. (These parameters are determined by the auto-tune process for a typical condition. If the stability is poor, the user can use the auto-tune to adapt to the special condition.) Put the temperature sensor very close to the subject, and let the outlet hose blow the air directly onto the subject. Note that the heat output scale can be controlled with this system by simply adjusting the fan speed.

## Analog temperature read-out

The BNC connector on the rear of the Air-Therm case is for temperature read-out. It is set at slope 50 mV/C° and a range from 0 °C = 0 V to 200 °C = 10 V. For example, at 50 °C the read-out should be 2.5 V. Slope and range can be changed in the setup menu (see Appendix for details). Accuracy will be  $\pm 1\%$  of range. If greater accuracy is desired, adjust the sensitivity and offset of the recording device to match the reading on the Air-Therm panel.

Please note that the input of the recording device should be off ground. The outside of the BNC connector, therefore, should not be grounded. Grounding the outer shell of the BNC may seriously interfere with proper recording.



## APPENDIX: WATLOW CONTROLLER FUNCTIONS

### Front Panel

- Up Key: Increments a value or changes a menu item.
- Down Key: Decrements a value or changes a menu item.
- Advance Key: Moves to next menu item.
- Infinity Key: Returns to Home page.

The controller starts out on the Home page. Press to enter the Operations page. Hold down and for 3 seconds to go into the Setup page. Press at any time to return to the Home page. The default values of the parameters are in parentheses after the parameter name.

### Home Page

**Temperature:** Current temperature of probe. Always present on the upper display.

**Set Value:** Temperature set point. Appears on the lower display when in Automatic mode.

**Percent Heat Output:** Appears on the lower display when in Manual mode. Can be set anywhere from 0% to 100%. If A-M is set to Auto, Po.ht can't be manually changed but it will still appear in the Operations page for diagnostic purposes

### Operations Page

**Po.ht Power Heat:** When A-M set to auto, shows instantaneous percent heat output.

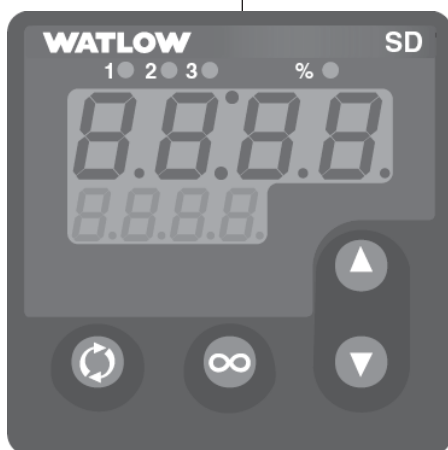


Figure 2—Front panel display

**A-M Auto-Manual Mode (Auto):** Set to Auto or MAn. In Auto mode, heat is controlled according to the ht.M setting. In manual mode, the user inputs the percent heat output.

**Aut Autotune (Off):** On/Off (appears if A-M set to Automatic). When turned on, the upper display on the Home page flashes "tune" until the unit is done auto-tuning.

**ht.M Heat Control Method (Pid):** OFF, Pid, or on.of

**Pb.ht Proportional Band Heat (3):** determines temperature band in which PID control is used. Proportional and integral controls are active within  $\pm$  **Pb.ht** of the set point, and derivative control is active within  $\pm$  2 **Pb.ht**. All PID parameters, including **Pb.ht**, only appear when **ht.M** set to Pid control

**It.ht Integral Heat (2.5):** minutes per repeat. Used in SI system. The Unit parameter in the setup page changes the temperature controller from the SI to the US system.



**rE.ht Reset Heat:** repeats per minute. Used in US system. It is equal to 1/**It.ht**.

**dE.ht Derivative Heat (1.6):** derivative time in minutes. Used in SI system

**rA.ht Rate Heat:** rate time in minutes. Used in US system. It is exactly the same as **dE.ht**

**h.hyS Heat Hysteresis:** How far the temperature goes below the set point before the heat turns on. Used only when heat control method is set to on/off.




**ProP Proportional Term:** View the active proportional term for PID diagnostics.

**it Integral Term:** View the active integral term for PID diagnostics

**dE Derivative Term:** View the active derivative term for PID diagnostics

Notes: The PID parameters are only visible if the heat control method (ht.M) is set to Pid. Others are only used when the controller is in US or SI mode (see the Unit parameter in the Setup page).

## Setup Page

Hold down  and  for 3 seconds to get to setup menu.  moves from one parameter to the next.

The setup page contains settings that are not needed as often as those in the Operation page. This section of the manual will list the parameters that are relevant to the operation of the Air-Therm. Any which do not appear in the list should not be changed. Parameters are grouped into categories in this list in order to make them easier to find.

## Temperature Input Options

**Sen (rtd):** Sets the temperature type that is being used. Always keep this at its default value (**rtd**).

**C-F Celsius-Fahrenheit (C):** Sets the temperature units used by the Air-Therm. When this is changed, all temperature settings are automatically converted.

**S.dEC Set Decimal Places (0.00):** Decimal places of precision to display (temperature can be measured up to .1 degree resolution).

**ISEn (no):** Option not used on Air-Therm. Always have it set to no.

**SP.Lo Set Point Low (-20):** minimum temperature set point

**SP.hi Set Point High (60):** maximum temperature set point

**Ftr.E Input Filter (Cont):** OFF: no filtering, diSP: filter only the display value, Cont: filter the control input values, both: display and input values are filtered. If a system has a lot of random temperature fluxuations (Ex: sensor is in a box with turbulent air flow), the derivative term in PID control will not give appropriate feedback unless the input is filtered.

**FLtr Filter Value (2):** 0 to 60 seconds



## Power Output Options

**Ot 1 (hEAt):** Output function set to heater. Do not change.

**Ctr1 (Ftb):** Control method set to fixed time base. Do not change

**Ftb1 (.1):** Time base set to .1 seconds. Since a solid state relay is used to control the heater, it is not necessary to change this from its minimum value.

**PL 1 Power Limit (100):** maximum heat (0 to 100%) (if set to 80%, a PID calculated output of 80% or 100% will both give 80%. Value of 50% will also give 50%)

**PSL 1 Output Power Scale Low (0):** actual power output when the controller is set to 0%

**PSH 1 Output Power Scale High (100):** actual power output when the controller is set to 100%. If the low scale is set to 20 and high is 40, then a PID calculated output of 50% will give an actual output of 30%. If the power output that is required to maintain the temperature set point is not between 25% and 75%, either adjust the scale parameters, or change the fan speed appropriately.

**nLF1(OFF):** Not used by Air-Therm. Do not change.

## Ramping Control

Ramping limits the rate at which the temperature approaches the set point.

**rP Ramping mode (OFF):** OFF: no ramping, Str: ramp at startup, On: ramp at startup and when the set point changes.

**rP.Sc Ramp Scale:** hours or minutes

**rP.rt Ramp Rate:** degrees per unit (hour or minute as chosen in **rP.Sc**).

## Temperature Re-Transmit

**A01.U Analog Output Units (volts):** volts or milli-amps (volT or MA). This determines what sort of output is re-transmitted through the BNC connector on the back panel of the Air-Therm.

**03.Lo Analog Output Scale Low (0)**

**03.hi Analog Output Scale High (10)**

**r1.So Retransmit Source (Proc):** current temperature or temperature set point (Proc or SP)

**r3.Lo Retransmit Scale Low (0)**

**r3.Hi Retransmit Scale High (200)**

**r3.CO Retransmit Offset (0)**

Example: Set **r1.So** = Proc and **A01.U** = volt to make it retransmit the measured temperature in volts. Set **03.Lo** = 0, **03.hi** = 10, **r3.Lo** = 0, and **r3.Hi** = 100 to make 0 to 100 degrees translate to 0 to 10 volts.



## Miscellaneous Parameters

**Unit Units of Measurement (SI):** Determines PID units (US or SI).

**LErr (nLAt):** Do not change.

**FAIL (bPLS) :** Do not change.

**DSP (nor):** Do not change.

**RP (OFF):** Do not change.

**LOC (0):** Do not change.

## PID Control

The Total heat power is the sum of the three PID terms:

$$\text{Power Heat (Po.ht)} = 100(\text{ProP} + \text{it} + \text{dE})\%$$

The proportional and derivative terms range from -1 to 1 and the integral term goes from 0 to 1. The PID controller determines the magnitude of each term from temperature measurements and the values of three PID parameters **ProP**, **it**, and **dE**. In the following table  $\Delta T = T - SV$  where T is the current temperature and SV is the temperature set value.

| Term                | Parameter                     | Parameter Units | Equation  |
|---------------------|-------------------------------|-----------------|---|
| Proportional (ProP) | Proportional Band Heat(Pb.ht) | Degrees C       | $\text{ProP} = -(1/\text{Pb.ht}) \Delta T$                          |
| Integral (it)       | Integral Heat (It.ht)         | Minutes         | $\text{it} = -(1/\text{It.ht})(1/\text{Pb.ht}) \int \Delta T \, dt$ |
| Derivative (dE)     | Derivative Heat (dE.ht)       | 1/Minutes       | $\text{dE} = (\text{dE.ht})(1/\text{Pb.ht}) \, d(\Delta T)/dt$      |

The proportional term looks at the current value of  $\Delta T$ , the integral term evaluates how long it has been there, and the derivative term depends on how fast it is changing. The heat power is always 100% if  $\Delta T < -2 * \text{Pb.ht}$  and 0% if  $\Delta T > 2 * \text{Pb.ht}$ . When  $|\Delta T|$  is less than twice the proportional band, the derivative term slows down the approach rate to help keep the temperature from overshooting the set point. When  $|\Delta T| < \text{Pb.ht}$ , the other two terms are activated. The proportional term can bring the temperature within a few degrees of the set point by itself, but not all the way since **dE** = 0 when  $\Delta T = 0$ . The integral term adds the necessary offset by continuously increasing at a rate proportional to  $\Delta T$ . If the system starts losing heat (example: the chamber door is opened), the derivative term will detect the rapid drop in temperature and increase the power output accordingly.

The heat output is usually zero above the set point since the proportional term is negative in this region and the integral term is usually zero. However, the integral term will still be positive if the temperature has just passed the set point and the derivative term will be positive if the temperature is approaching the set point from above. In some cases the sum of these other terms will be greater than the proportional term so the Air-Therm will still be heating the chamber even though it is already hotter than the set point! This situation makes more sense if we remember that heat has to be constantly added in order to cancel out the heat lost to the air surrounding the chamber. If 40% heat is required to maintain the temperature at the set point, then 39% will cool it down.



Here is an example of a possible PID setting:

Temperature Set Point (**SP**): 37 °C

Proportional Band (**Pb.ht**): 5 °C

Integral Heat Time (**It.ht**): 4 minutes

Derivative Time (**dE.ht**): 0.5 minutes

Suppose that the current temperature is 32°C and is rising at 2 °C/minute. At this point, the proportional term is  $-(1/\mathbf{Pb.ht}) \Delta T = -(1/5) (32-37) = 1.0$  and the derivative term is  $(\mathbf{dE.ht}) (1/\mathbf{Pb.ht}) d(\Delta T)/dt = (.5)(1/10)(-2) = -0.1$ . The integral term is zero since it resets every time the temperature passes outside the proportional band. Therefore, the total heat output is  $1.0+0.0-0.1 = 90\%$ . After one minute the proportional term has changed to  $-(1/5) (34-37) = 0.6$  and the integral term has increased to  $= -(1/\mathbf{It.ht})(1/\mathbf{Pb.ht}) \int \Delta T dt = -(1/4)(1/5) (-4) = 0.2$ . The new heat output is  $0.6+0.2-0.1 = 70\%$ .

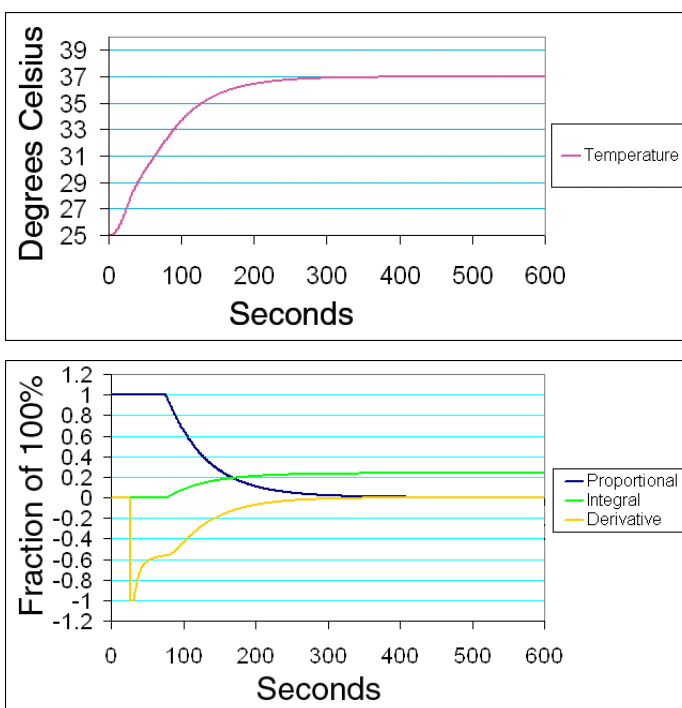


Figure 3—Temperature and PID parameters as the setpoint is tuned

Of course, this is assuming a constant  $d(\Delta T)/dt$ . A real system is more complicated since the decrease in heat output as the set point is approached will slow down the increase in temperature. The diagrams at left show the temperature and PID parameters as the set point is approached in a well tuned system. The temperature is in degrees Celsius and time is in seconds (600 seconds = 10 minutes).



An easy way to use this mode is to use the Auto tune first to get a preliminary value, then to manually fine-tune the system.

If the integral action is too small (large **It.ht**) or the proportional band (**Pb.ht**) is too big, the temperature will take a long time to reach the set point. However, making the values of **It.ht** or **Pb.ht** too small will make the system unstable, causing oscillations about the set point.

Oscillations about other points besides the set point are usually caused by derivative action. If reducing **dE.ht** does not make the system more stable, try increase the input filter value (make sure **Ftr.E** is set to **Cont** and adjust **FL.tr** to desired number of seconds. See the "Temperature Input Options" section of the **Setup** page in the appendix).

If it is particularly difficult to stabilize your system, try decreasing the heat output range. The heat output range should be adjusted so that it takes about 25% to 75% of the heater power (as shown by the **Po.ht** parameter) to maintain the temperature set point. The heat output range can be adjusted with parameters in the "Power Output" options section of the **Setup** page (see Appendix).





Here are some examples of PID parameters for systems with varying response times:

**Slow response process** : Pb.ht=7, It.ht=10.0, dE.ht=1.67

**Normal response process**: Pb.ht =4, It.ht =3.5, dE.ht =0.58

**Fast response process** : Pb.ht =3, It.ht =1.5, dE.ht =0.25

## Changing the temperature sensor

The controller starts out on the Home page. Air-Therm ATX's temperature sensor, a Pt 100 DIN RTD, has been matched with the controller. If the sensor must be replaced, the system should be recalibrated. To recalibrate, fill a beaker with distilled water and ice made of distilled water. It should be at least 2/5 filled with ice. Put in a magnetic stirrer bar and stir the ice water beaker on a magnetic stirrer. Connect the sensor to the instrument, place the sensor in the beaker of water, and wait for 15 minutes or until the temperature reading on the instrument stabilizes. The reading should be zero. If it is not zero, get into the Programming page by holding down  then pressing  and holding both for about 6 seconds. Press  to scroll to P4 and change it from "none" to "Cal". Press  to return to the Home page and scroll through the Operations page till you get to the newly inserted calibration offset parameter. Adjust the calibration offset until the temperature reads zero. Afterwards, it is a good idea to go back into the Programming page and remove CAL from the Operations page so that it is not accidentally changed.



## SPECIFICATIONS

|   |   |
|---|---|
| <b>Air Flow Rate</b>  | 20 to 50 CFM<br>(0.55 to 1.4 cubic meter/minute)          |
| <b>Control Temperature Range</b>  | Ambient to 60 °C  |
| <b>Temperature Resolution</b>   | 0.1 °C  |
| <b>Temperature Accuracy</b>   | 0.2 °C  |
| <b>Control Modes</b>  | Auto (PID) or Manual Control                              |
| <b>Analog Output For Chart Recorder</b><br>(default, adjustable via controller) | 0.5 °C resolution; 0-10V goes to 0 to 200°C               |
| <b>Heating Volume</b>   | More than 50 cubic feet (1400 liters),<br>non-circulating |
| <b>Power</b>  | 300 W, 95-135 V or 220-240 V, 50/60 Hz                    |
| <b>Dimensions</b>   | 6½ x 8 x 7½ in. (15.5 x 21 x 19 cm)                       |
| <b>Shipping Weight</b>  | 10 lb (4.5 kg)  |

## ACCESSORIES

|               |  |
|---------------|--|
| <b>15590</b>  | Clear hose, 2.5" diameter, 4.5'        |
| <b>300276</b> | Replacement platinum temperature probe |
| <b>3491</b>   | 5' (1.5m) probe extension cable        |



**Air-Therm™**



**WORLD PRECISION INSTRUMENTS, INC.**

175 Sarasota Center Boulevard  
Sarasota, FL 34240-9258 USA  
Telephone: (941) 371-1003 Fax.: (941) 377-5428  
e-mail: [wpi@wpiinc.com](mailto:wpi@wpiinc.com)

**DECLARATION OF CONFORMITY**

We: World Precision Instruments, Inc.  
175 Sarasota Center Boulevard  
Sarasota, FL 34240-9258 USA

As the manufacture of the apparatus listed, declare under sole responsibility that the product(s):

**AIR-THERM ATX**

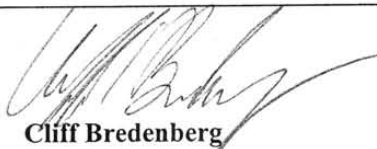
To which this declaration relates is/are in conformity with the following standards or other normative documents:

**Safety:** EN 61010-1:1993 (EC 1010-1:1990)

**Emc:** EN 50081-1: 1992  
EN 50082-1: 1992

And therefore conform(s) with the protection requirements of Council Directive 89/336/EEC relating to electromagnetic compatibility and Council Directive 73/23/EEC relating to safety requirements:

**Issued on: May 11, 2005**

  
**Cliff Bredenberg**  
**President**

World Precision Instruments, Inc.  
175 Sarasota Center Boulevard  
Sarasota, FL 34240-9258 USA

  
**Suyi Liu, PhD.**  
**Vice President of Research**  
World Precision Instruments, Inc.  
175 Sarasota Center Boulevard  
Sarasota, FL 34240-9258 USA



## WARRANTY

WPI (World Precision Instruments, Inc.) warrants to the original purchaser that this equipment, including its components and parts, shall be free from defects in material and workmanship for a period of one year\* from the date of receipt. WPI's obligation under this warranty shall be limited to repair or replacement, at WPI's option, of the equipment or defective components or parts upon receipt thereof f.o.b. WPI, Sarasota, Florida U.S.A. Return of a repaired instrument shall be f.o.b. Sarasota.

The above warranty is contingent upon normal usage and does not cover products which have been modified without WPI's approval or which have been subjected to unusual physical or electrical stress or on which the original identification marks have been removed or altered. The above warranty will not apply if adjustment, repair or parts replacement is required because of accident, neglect, misuse, failure of electric power, air conditioning, humidity control, or causes other than normal and ordinary usage.

To the extent that any of its equipment is furnished by a manufacturer other than WPI, the foregoing warranty shall be applicable only to the extent of the warranty furnished by such other manufacturer. This warranty will not apply to appearance terms, such as knobs, handles, dials or the like.

WPI makes no warranty of any kind, express or implied or statutory, including without limitation any warranties of merchantability and/or fitness for a particular purpose. WPI shall not be liable for any damages, whether direct, indirect, special or consequential arising from a failure of this product to operate in the manner desired by the user. WPI shall not be liable for any damage to data or property that may be caused directly or indirectly by use of this product.

## Claims and Returns

- Inspect all shipments upon receipt. Missing cartons or obvious damage to cartons should be noted on the delivery receipt before signing. Concealed loss or damage should be reported at once to the carrier and an inspection requested. All claims for shortage or damage must be made within 10 days after receipt of shipment. Claims for lost shipments must be made within 30 days of invoice or other notification of shipment. Please save damaged or pilfered cartons until claim settles. In some instances, photographic documentation may be required. Some items are time sensitive; WPI assumes no extended warranty or any liability for use beyond the date specified on the container.
- WPI cannot be held responsible for items damaged in shipment en route to us. Please enclose merchandise in its original shipping container to avoid damage from handling. We recommend that you insure merchandise when shipping. The customer is responsible for paying shipping expenses including adequate insurance on all items returned.
- Do not return any goods to WPI without obtaining prior approval and instructions (RMA#) from our returns department. Goods returned unauthorized or by collect freight may be refused. The RMA# must be clearly displayed on the outside of the box, or the package will not be accepted. Please contact the RMA department for a request form.
- Goods returned for repair must be reasonably clean and free of hazardous materials.
- A handling fee is charged for goods returned for exchange or credit. This fee may add up to 25% of the sale price depending on the condition of the item. Goods ordered in error are also subject to the handling fee.
- Equipment which was built as a special order cannot be returned.
- Always refer to the RMA# when contacting WPI to obtain a status of your returned item.
- For any other issues regarding a claim or return, please contact the RMA department

**Warning: This equipment is not designed or intended for use on humans.**

*\* Electrodes, batteries and other consumable parts are warranted for 30 days only from the date on which the customer receives these items.*

## **World Precision Instruments, Inc.**

International Trade Center, 175 Sarasota Center Blvd., Sarasota FL 34240-9258

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