



ATC1000

Animal Temperature Controller

www.wpiinc.com

INSTRUCTION MANUAL

Serial No. _____

011907



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DECLARATION OF CONFORMITY

We: World Precision Instruments, Inc.
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as the distributor of the apparatus listed, declare that the product:

Title: ATC-1000 Temperature Controller


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

- Safety:** EN 61010-1: 2001, EN 61010-2-010: 2003
- EMC:** EN 61326-1: 2006
EN 55011: 1998 + A2: 2002
EN 61000-3-2: 2000
EN 61000-3-3: 2001
EN 61000-6-2: 2001

and therefore conforms with the protection requirements of Council Directive 89/336/EEC relating to electromagnetic compatibility and Council Directive 73/23/EEC amended by Council Directive 93/68/EEC relating to safety requirements.

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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.

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scale range is between 1 ~ 999, never set to zero. The default value is 3. Press and hold the SET key for 5 seconds to enter advanced setting mode. This setting is the second one in the advanced setting mode. Press the SET key briefly to change the setting mode. When $\boxed{\text{---} \cdot \text{---} \cdot \text{---} \cdot \text{P}}$ is shown in the upper LED display, use the SHIFT and the UP or DOWN keys to change the setting. Again press and hold the SET key for 5 seconds to save the setting and exit to normal working condition.

b. Integral Time

The integral function eliminates the residual difference between the set temperature and measured temperature.

$$\text{Controller Output} = (\text{Error Time}) / (\text{Integral Time})$$

The controller output is proportional to the amount of time the error is present and inversely proportional to the integral time. The integral time range is 0 ~ 3600 seconds. The default is 7. The smaller the integral time, the stronger the integral effect. Zero integral time will shut off the integral function. Press and hold SET for 5 seconds to enter advanced setting mode. This setting is the third one in the advanced setting mode. Press SET briefly to switch between different settings until $\boxed{\text{---} \cdot \text{---} \cdot \text{---} \cdot \text{I}}$ is shown in the upper LED display. When $\boxed{\text{---} \cdot \text{---} \cdot \text{---} \cdot \text{I}}$ is shown in the upper LED display, use the SHIFT and the UP or DOWN keys to change the setting. Again press and hold the SET key for 5 seconds to save the setting and exit to normal working condition.

c. Derivative Time

The derivative parameter has two main functions. It provides fast action when the system has a large disturbance, and reduces oscillation in the system.

$$\text{Controller Output} = (\text{Derivative Time}) \times d(\text{Error}) / dt$$

The controller output is proportional to both the rate of the error change and the derivative time. The derivation time range is 0 ~ 3600 seconds. The default value is 3. The larger the derivative time, the stronger its effect. Zero derivative time has no effect. Press and hold SET for 5 seconds to enter the advanced setting mode. This setting is the fourth one in the advanced setting mode. Press SET briefly to switch between different settings until $\boxed{\text{---} \cdot \text{---} \cdot \text{---} \cdot \text{D}}$ is shown in the upper LED display. When $\boxed{\text{---} \cdot \text{---} \cdot \text{---} \cdot \text{D}}$ is shown in the upper LED display, use the SHIFT and UP or DOWN keys to change the setting. Again press and hold SET for 5 seconds to save the setting and exit to normal working condition.

5. Parameter Lock

Press and hold SET for 5 seconds to enter the advanced setting mode. This setting is the seventh one in the advanced setting mode. Press SET briefly to switch between different settings until $\boxed{\text{---} \cdot \text{L} \cdot \text{O} \cdot \text{F}}$ is shown in the upper LED display. When $\boxed{\text{---} \cdot \text{L} \cdot \text{O} \cdot \text{F}}$ is shown in the upper LED display, use the SHIFT and UP or DOWN keys to change the setting to 0 (all parameters adjustable), 1 (temperature adjustable only), or 2 (no parameter change allowed including auto-tuning). Again press and hold SET for 5 seconds to save the setting and exit to normal working condition.

2. Sensor Calibration

The instrument is calibrated before shipping. It does not need calibration before use. However, if a new sensor is replaced or the accuracy of the reading needs to be confirmed, the user can calibrate the system with an equilibrated ice and water mixture. The controller provides a calibration function. First set PRESET temperature at 0.0°C to avoid heating output. Put the probe in the ice water. The ratio of ice and water should be 2:1 and be stirred by a magnetic stirrer. The reading should be taken at least 10 minutes after it is immersed in the stirred ice water mixture. Press and hold the SET key for 5 seconds, then press the SET key briefly seven times or until 0.0 is shown in the PROBE LED display. When 0.0 is shown, use the SHIFT, UP and DOWN keys to change the setting. The last digit also changes the temperature above zero or below zero. For example, the probe measures 0.5°C in the ice water, enter -0.5°C in the calibration to correct the reading to zero. The maximum calibration range is ±9.9°C. Again press and hold the SET key for 5 seconds to save the setting and exit to normal working condition.

3. Auto-tuning

The controller is shipped with PID parameters that should work in most conditions. However, when changing to a different heating plate or trying to warm a subject that is significantly different from a regular sized animal, the current setting of the controller might not hold the temperature as stable as the user wants. One way to solve this problem is using the Auto-tuning feature to let the controller find the best parameters for the system. The Auto-tuning program will heat the subject up and let it cool several times. Based on the heating and cooling speed, the program will optimize the PID parameters for the system. Auto-tuning is the sixth setting mode in the advanced setting mode. Press and hold the SET key for 5 seconds to enter advanced setting mode, then press the SET key briefly to switch between different settings. When 0.0 is shown in the upper LED display, use SHIFT along with the UP and DOWN keys to change the setting to either 0 or 1. When auto-tuning is set to 1, the controller will erase all existing parameters, find the optimal parameters, and save these parameters to memory. When auto-tuning is set to 0, the parameters can be changed manually as in the following section.

4. PID Controller Parameters

If auto-tuning does not adequately stabilize the system or the ideal settings for a particular heater are already known, the user might want to manually adjust the PID parameters. We don't recommend changing these parameters manually unless you are familiar with the functions of each PID parameter.

a. Proportional Scale

$$\text{Controller Output} = (\text{Temperature Deviation}) * 100 / (\text{Proportional Scale})$$

The power output is inversely proportional to the proportional scale and directly proportional to the temperature deviation. Smaller scale means higher gain, faster response, and tighter temperature control. However, the system can become unstable if the value is too small. The

Introduction

The ATC1000 DC temperature controller is a low noise control system for an external heater. The controller and the compatible heating device are designed to maintain the animal body temperature during experiments. The DC control is extremely quiet in terms of electromagnetic radiation, which is essential in experimental procedures such as electrophysiologic recording. The controller has dual temperature sensing inputs, which measure the temperature of both the animal and the heater in order to prevent localized overheating. The controller features an advanced proportional, integral, and derivative (PID) control algorithm that provides temperature control with high resolution, high precision and high stability. The PID control parameters can be set manually or by the built-in fuzzy-logic auto-tuning function.



Specifications

Temperature Range..... 0 °C ~ 45 °C
 Resolution..... 0.1 °C
 Accuracy ± 0.3 °C
 Sensor RTD, OD 2.0 mm tube with Ø3.5 mm ball head.
 Maximum DC Output..... 32V, 1A
 Proportion Scale (P) 1 ~ 999
 Integral Time (I) 0 ~ 3600 seconds
 Derivative Time (D)..... 0 ~ 3600 seconds
 Power..... 90 - 240 V, 50 - 60 Hz
 Dimensions..... 45x30x7 cm (17.7 x 11.8 x 2.76 in.)
 Weight 5 kg (11 lb)
 Fuse..... 5 A

Packing List

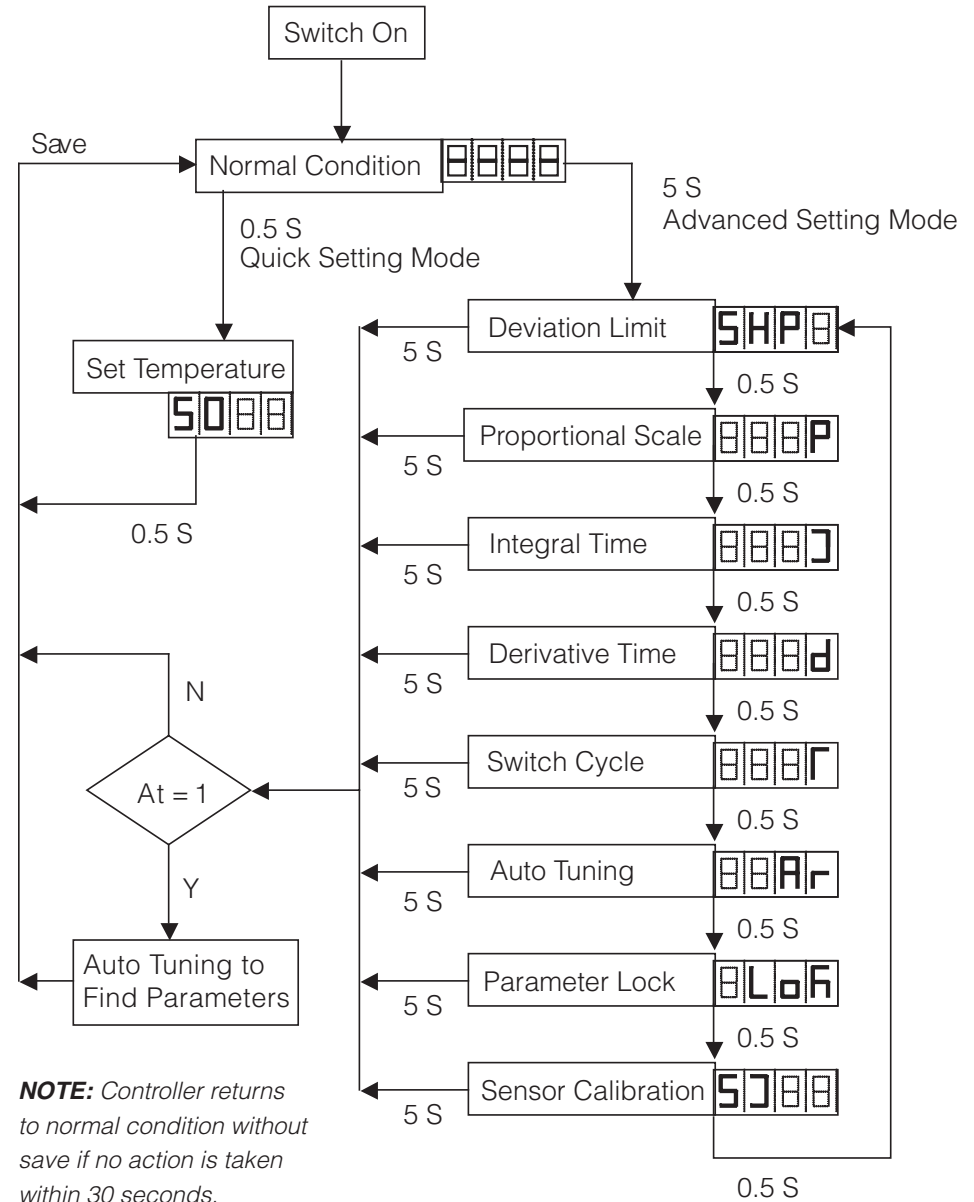
- **ATC1000** Animal Temperature Controller
- **502197** Rectal Probe, 2 mm diam.
- **502195** Small Heating Plate with built-in RTD sensor, 10 x 15 cm
OR
- **502196** Medium Heating Plate with built-in RTD sensor, 15 x 25 cm

Optional Accessories

- ATC** Animal Temperature Controller with rectal probe
- 502195** Small Heating Plate with built-in RTD sensor, 10 x 15 cm
- 502196** Medium Heating Plate with built-in RTD sensor, 15 x 25 cm
- 502197** Rectal Temperature Probe, 2 mm diam.

Appendix

1. Program Flow Chart



for 5 seconds to save the setting and exit to normal working condition. The temperature controller can maintain the temperature within less than $\pm 0.3\text{ }^{\circ}\text{C}$ in most situations. Thus, the alarm limit should be larger than $0.3\text{ }^{\circ}\text{C}$ so that it is not triggered unnecessarily.

When using the heating plate, there is an internal sensor built in to monitor localized heating. When the temperature inside the plate is over $45\text{ }^{\circ}\text{C}$, the alarm will also be triggered to alert the user. The heater, however, will remain on.

Troubleshooting

No power

Check power cable connection. Check the 5A fuse, which is inside the power input module. Change the fuse if it is blown.

Temperature too low

The maximum power output on the heating device is 30 watts. In most situations, the power is sufficient to keep the animal warm up to $40\text{ }^{\circ}\text{C}$. Heating loss can be minimized by insulating the bottom of heating plate and covering the animal with a small blanket to keep it warm.

Temperature unstable

Since the heating output of the ATC1000 is automatically PID-controlled, the temperature can swing back and forth if the environmental temperature varies dramatically. Set the deviation limit to be small so that the temperature swing will be minimized. Note, however, that the alarm will be triggered more frequently each time the temperature reaches the upper limit.

Front Panel



1. LED Displays

1.1 PROBE LED display

The PROBE LED display shows either the probe temperature in normal working mode or one of the setting modes. Press the SET key to enter the temperature setting mode as described in the “Operation” section. If the SET key is pressed for 5 seconds, the controller enters the PID setting mode, which is described in the Appendix.

1.2 PRESET LED display

The PRESET LED display shows the temperature setting in the normal working mode. It shows the parameter value when the controller is in setting mode.

1.3 HEAT LED indicator (green)

The green LED indicates the heating power. The lighting time is proportional to the output voltage. Continuous lightening means full power. It turns off when there is zero output.

1.4 AUTO tuning LED indicator (orange)

The yellow LED flashes when auto-tuning is on.

1.5 ALARM LED indicator (red)

The red LED lights up when the measured temperature of the probe is higher than the upper limit (the set temperature plus the deviation limit). An audible alarm is also turned on to indicate overheating.

2. Front Panels

2.1 POWER

Turns the temperature controller on and off.

2.2 SET key

Press the SET key to set the control parameters.

2.3 SHIFT key

When the controller enters the setting mode, press the SHIFT key to save the

current digit value (flashing digit), move to the next digit, and make the new digit ready to change.

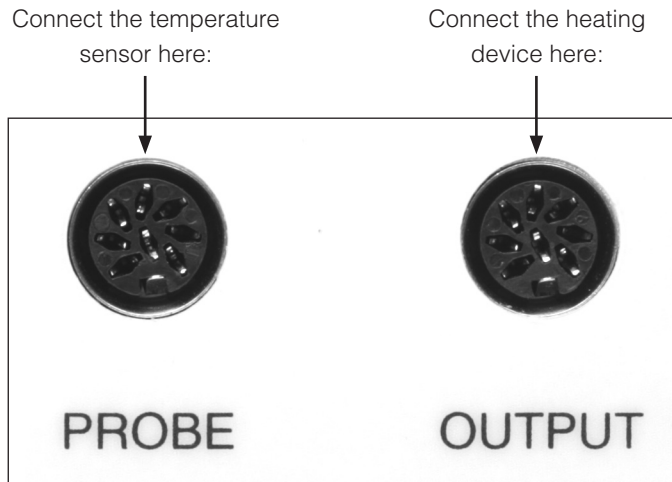
2.4 DOWN key

Press the DOWN key to decrease the displayed digit by 1 if it is not 0, otherwise it changes to 9.

2.5 UP key

Press the UP key to increase the displayed digit by one if it is not 9, otherwise it changes to 0.

2.6 Connectors



Back Panel

The BNC connector on the rear panel provides temperature sensor output with voltage corresponding to temperature — 20 mV/°C.

The power input module, also on the rear panel, contains a 5-amp fuse.



Operation

The temperature controller provides very quiet control over a heating device such as a heating plate or heating pad. The heating device is connected to the OUTPUT connector. The top surface of the heating plate is a uniform flat platform where an animal can be placed. There is a rectangular seal near the bottom edge of the plate. The connector of the temperature sensor is connected to the PROBE connector. The sensor can be inserted into an animal's rectum to monitor its body temperature.


The controller's PID algorithm uses the measured temperature and the preset temperature to determine the correct heater power output. When the instrument is turned on, the control parameters last used are loaded, and the probe temperature is shown on the PROBE LED display. Wait for the heating device to warm up to the animal's body temperature before the sensor is inserted into the animal's rectum. Otherwise, it takes much longer for the heating device and animal to reach equilibrium.

1. Turning On/Off


When the POWER key is pushed, it takes several seconds for the controller to initialize and come to a normal working condition. The parameters loaded are the same as those last used. The PROBE LED display shows the temperature measured by the sensor. The PRESET LED display shows the temperature setting. If any connection is loose, the controller will sound an alarm.

Switch the POWER key again to turn the temperature controller off. After the power is switched off, wait at least 30 seconds before turning the unit on again or the controller may not initiate the control parameters correctly.

2. Setting the Temperature

Press the SET key to enter the setting mode. When  shows, use SHIFT and the UP or DOWN key to change the temperature. The controlled temperature range is between 0 °C ~ 45 °C. Press the SET key again to save the temperature and exit to normal working condition.

3. Alarms

When the measured temperature exceeds the temperature limit, an audible alarm is triggered, the red LED flashes, and the heater is shut off completely. The upper temperature limit is the target temperature plus the deviation limit which is set according to the following procedure: Press and hold the SET key for 5 seconds. When  is shown in the upper LED display, use the SHIFT, UP and DOWN keys to change the setting, for example to 2°C. Again press and hold the SET key