

Operation Instruction Manual

WS-1211H

Programmable Precision PID Temperature Controller

Version 1.0 (July, 2022)

Auber Instruments
5755 North Point Parkway, Suite 99
Alpharetta, GA 30022
770-569-8420
www.auberins.com

Introduction

Thank you for shopping the Auber WS series temperature controller. We sincerely appreciate your decision and trust that our controller will meet your expectations in both the quality of the result and the value of the product. While we are delighted that you may be anxious to operate the controller, please still spend a few minutes reading through this manual because this will serve to enhance your experience in the months and years ahead. In particular, we urge you to read through the safety warnings below. Although this plug-and-play controller is very easy to use, the process involves high temperature and high wattage appliances and your safety is paramount.



SAFETY WARNINGS

- This controller is designed only to be used with limited-power device and paring thermal cutoff protection such as a thermostat or thermal.
- Do not place any objects on the top of controller surface because that may prevent venting excess heat during its operation.
- The controller can handle a maximum current up to 12 Ampere. For 120 VAC in US or Canada, this limits the heater power to 1440 watts. Due to its compact size and the splash proof design for kitchen applications, the controller has a limited ability to dissipate the heat generated by the internal solid state relay during the initial heat up. The initial full power heat up process cannot be more than 90 minutes. If you system need take longer time to warm up, please read Appendix 1 “Managing the heat generated by the controller”
- **Always place the temperature sensor in your controlled subject (like your smoker) before you turn on your controller.** Leaving the temperature sensor outside of your

controlled subject will form an open loop operation. **If the sensor is left outside**, the controller will assume the temperature is low even if the controlled subject is already very hot. The controller will provide full power to the heater. It will not only overheat the controller, but also damage your appliance or even cause a fire. If the sensor is not permanently mounted on the system and left outside of the system, there is a potential problem. **If no sensor is connected to the controller**, as protection, this controller will turn off its output to your controlled subject.

- This controller is designed to control the devices recommended by Auber Instruments only. Using it to control a not recommended device can be dangerous and even cause fire. Auber Instruments is not liable for damages caused by misuse of the controller. If you are not sure the controller can be used, please contact Auber Instruments before usage.
- If an abnormal display or noise is observed, turn the controller off, unplug the power cord and contact the manufacturer before using it again.
- Clean the controller only when it is cool and unplugged.
- Do not allow children to operate the controller.

Specifications

Input voltage:	100 to 240 VAC 50 /60 Hz.
Output voltage:	The same as input voltage.
Maximum Current:	12A at 120V, 8A at 240V.
Fuse Size:	15A fast blow fuse (6x30mm).
Control Action:	Heating (reversed action) or cooling (direct action)
Control Mode:	PID (heating only), on/off (heating or cooling).
Output switching device:	Built-in optically isolated solid state relay (SSR) with zero voltage crossing switching.
Sensor type:	Pt1000 RTD sensor (two-wire).
Sensor tip dimensions:	4 mm diameter x 50 mm long.
Sensor cable length:	6 ft (915 mm).
Alarm:	High limit alarm and open loop alarm with LED and buzzer.
Timer Range:	1 to 9999 minutes for each step. 6 steps total.
Temperature resolution:	1 °C or 1 °F.
Temperature display range:	-50 to 400 °C or -58 to 752 ° F.
Temperature accuracy:	±1°C (±1°F).
Dimension (W x H x D):	6 x 3 x 8.3 inch (155 x 80 x 210 mm).
Weight:	3.2 lb (1.5 kg).
Warranty:	1 year for controller. 90 days for sensor

Operating Instructions

1. Description of the controller

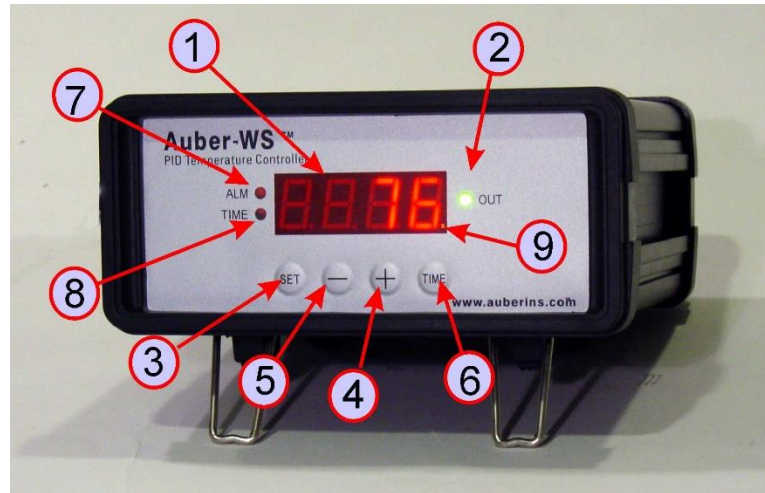


Figure 1. Front Panel.

The front panel of the controller is shown in Figure 1. The function of each item is described below:

- (1) **Parameter Window (LED)** - For displaying temperature values and controller's system parameters.
- (2) **Output status indicator** - In normal mode, this LED indicates the heater status. When it is on (lit), the heater is powered. When it is off, the heater power is off. When it is flashing, it means the heater is on and off intermittently to reduce the power output. It should be synchronized with the power light on the cooking device.
- (3) **SET Key** - For showing current temperature settings, entering parameters setting mode and confirming various actions taken.
- (4) **“+” Key** - To increase the value at parameter setting mode; toggle LED display between the current temperature and the current step number at normal operating mode.
- (5) **“-” Key** - To decrease the value at parameter setting mode.
- (6) **Time Key** - To toggle the LED display between the current temperature and the total running time at the normal operating mode.
- (7) **Alarm indicator** - Lit when the alarm is on.
- (8) **Timer status indicator** – Lit when Time key is pressed.
- (9) **Editing indicator** – A dot at the lower right corner. When the dot flashing, the value is editable; pressing the “+” or “-” key to change the value.

The layout of the controller back panel is shown in Figure 2.

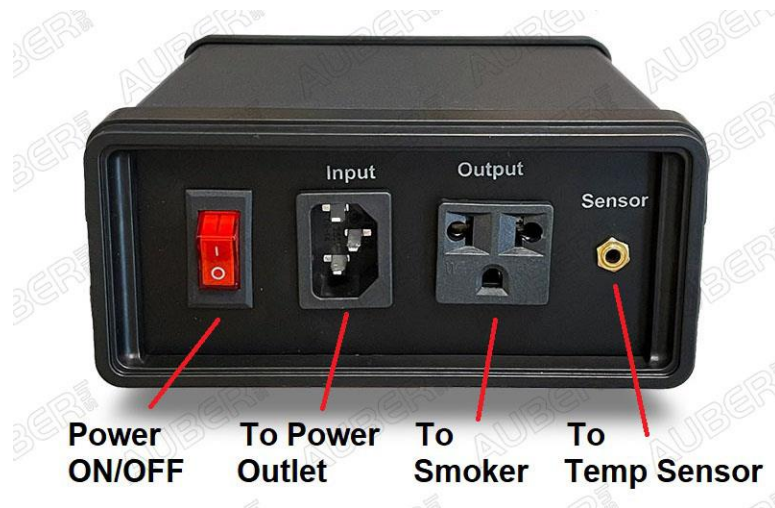


Figure 2. Back Panel.

2. Connecting the controller

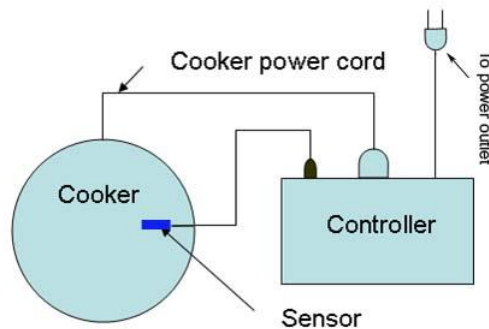


Fig 3. Typical connection between the controller and the heating device (in this example, the cooker).

The connection of controller should be done in the following steps.

- Plug the temperature sensor to the back of the controller.
- Plug the power cord to the back of the controller and the other end to the power outlet on the wall.
- Turn on the controller to make sure the controller powers up properly. The temperature display is in the range expected. Then, turn off the controller.
- Plug the heater to the back of the controller. If the heater has a switch, put it in the off position. **Put the sensor inside the container to be controlled.**
- Turn on the controller.
- Turn on the heating device.

Please refer Appendix 2 for Bradley Smoker wiring.

3. Programming the temperature profile.

A total of 6 steps can be programmed for this controller. Each step contains the temperature (C-X) and time duration (t-X) setting. They are represented by the symbol C-X and t-X, where "X" is the step number (e.g. temperature value of Step 4 is represented by C-4 and time value of step 4 is represented by t-4). The character, "t", is displayed as the symbol, "T". Time is defined as the duration between the last step and the next step. Please make sure the time is long enough for the heater to heat up the oven. If the time is set too short, the temperature may not be able to reach set temperature, before it jumps to the next step. The time unit is in minutes with 1 minute resolution. If the recipe only needs one step, you can program the time of the rest of the steps to zero.

To program the temperature profile, press SET key once. The display will show C-1 for one second and then display the temperature setting for step 1. Use "+" and "-" keys to change the setting. When finished, press the SET again to confirm the change. The display will show t-1 for a second and then change to the time setting for step 1. Use "+" and "-" keys to change the setting. When finished, press the SET again to confirm the change. The display will go to the step 2 setting. The following is the flow chart (Figure 4) for the setting procedure.

The temperature setting will not be changed if SET key is not pressed (confirmed). After programming the necessary cooking steps, you can finish programming by pressing the SET repeatedly until the display passes t-6 and displays the current temperature. You can also leave the controller alone. The display will return to the normal display mode if no key is pressed within 15 seconds.

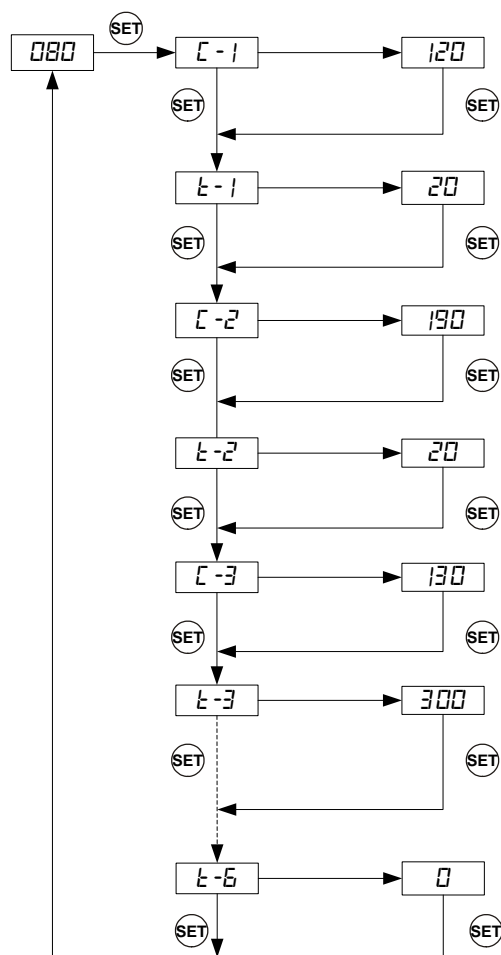


Figure 4. Temperature profile programming flow chart.

Here is the one step heating program. The temperature profile is programmed to start at 150 °F for 600 minutes of heating.

Table 1. Initial program setting.

Step #	Temp (F)	Step #	Time (min)
C-1	150	t-1	600
C-2	0	t-2	0
C-3	0	t-3	0
C-4	0	t-4	0
C-5	0	t-5	0
C-6	0	t-6	0

4. Checking the current step and the time

The user can check step number, total running time, and the time in the current step using the “Time” or “+” key. Please see the flow chart in Figure 5.

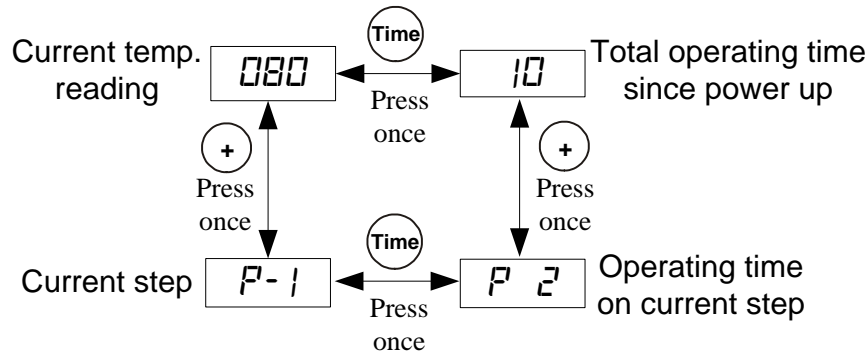


Figure 5. How to check current step and the time.

At normal operating mode, press the “+” key (item 4 in Figure 1) to toggle the display window between the current temperature and the current step number at which the program is running (P-X). At time displaying mode, press the “Time” key to toggle the display between the total time (in minutes) since the controller was powered up and the time past in the current step. For example, the controller has been running for 100 minutes in total, but currently it is at step 2 for 40 minutes. So when you first press “+” key, controller will show “P-2” in the window. If then you press “Time” key, the controller will show “P 40” with the Time Indicator lit.

At normal operating mode, press the “Time” key (item 6 in Figure 1) once to toggle the LED window between the current temperature and the total time (in minutes) since the controller was powered up. The Time Indicator (item 8 in Figure 1) will lit at same time. When the time is being displayed, press the “+” key will toggle the display between the total running time and the running time of the current step. For example, the controller has been running for 100 minutes in total, but currently it is at step 2 for 40 minutes. So when you first press “Time” key, controller will show “100” in the window with the Time Indicator lit. If then you press “+” key, the controller will show “P 40” while the Time Indicator still lit.

5. System configuration parameters

This section discusses how to configure the controller for a specific application. For most sous vide cooking users, there is no need to read this section. The controller’s default setting is for most common configurations of sous vide cooking.

5.1 The first group of parameter is related to the control performance. They need to be adjusted based on your application. Table 2 shows the list of these parameters, their range and initial set value.

Table 2. List of control parameters and its initial settings under code 166.

Symbol	Display	Description	Range	Initial
P	P	Proportional Band	1-9999	7
I	I	Integral Const. (Sec.)	0-9999	600
d	d	Derivative Const. (Sec.)	0-9999	150
AT	AT	Auto-tune	0=off, 1=on	0
t	T	Cycle Rate (Sec.)	2-9999	2

Details about each parameter

- **P**, Proportional band. It is in 1 degree units. This parameter controls the output of the controller based on the difference between the measured and set temperatures. The larger the P number means the weaker the action (lower gain). For example, if P=7, the proportional band is 7 degrees. When the sensor temperature is 7 degrees below the proportional band (7 degrees below the setting), the controller will have 100% output. When the temperature is 5 degrees below the set point, the output is 71%. When the temperature is equal to the setting, the controller will have 0% output (assuming integral and derivative functions are turned off). This constant also affects both integral and derivative action. Smaller P values will make both integral and derivative action stronger.

Note: The value of the P is temperature unit sensitive. If you find an optimized P value when operating the controller in Fahrenheit, you need to divide the P by 1.8 when changing the temperature unit to Celsius. The controller will adjust the P value automatically when you change the temperature unit.

- **I**, Integral time. The unit is in seconds. This parameter controls the output of controller based on the difference between the measured and set temperature integrated with time. Integral action is used to eliminate temperature offset. Larger number means slower action. e. g. assuming the difference between the measured and set temperature is 2 degrees and remain unchanged, the output will increase continuously with time until it reaches 100%. When temperature fluctuate regularly (system oscillating), increase the integral time. Decrease it if the controller is taking too long to eliminate the temperature offset. When I=0, the system becomes a PD controller. For very slow response system such as slow cooker and large commercial rice cooker, set I = 0 will significantly reduce the temperature overshoot.
- **d**, Derivative time. The unit is in seconds. Derivative action contributes the output power based on the rate of temperature change. Derivative action can be used to minimize the temperature overshoot by responding its rate of change. The larger the number is, the faster the action will be, e.g. when the door of oven is opened, the temperature will drop at very high rate. The derivative action change the controller output based on the rate of change rather than the net amount of change. This will allow the controller to act sooner.

It will turn the heater to full power before the temperature drops too much.

- **AT**, Auto-tuning. Every type of cooker has its own unique set of tuning parameters. For heating stability, it should have programmed with the tuning parameters for the cooker currently being used.

You should always write down your old PID parameters before auto-tuning the controller. If something goes wrong you can always restore your previous PID parameters. Basically, you must setup your cooking system close to your actual cooking environment. E.g, the water you use for auto-tune should be the same as your normally use.

To activate auto-tuning, please set AT to 1; then exit the menu. The display will start to flash alternately between AT and the current reading temperature, indicating the auto-tuning is in progress. When the display stops flashing, the auto-tuning is finished. The newly calculated PID parameters are set and ready to use. The new parameters will store in the memory even when the controller is rebooted.

The duration of auto-tuning depends on how fast the system is responding to the heating and cooling cycle. If the temperature of the cooker takes a long time to drop when the heater is off, the auto-tuning could be a very long tuning process, such as a well-insulated cooker. The auto-tuning should be able to tune most of your chosen heaters/smokers/cookers with great results.

- **t**, cycle rate. The unit is in seconds. This unit determines how long for the controller to calculate each action. For example, if T is set to 10 seconds, when the controller decides the output should be 10%, it will turn on the heater 1 second for every 10 seconds. This parameter should set at 2 second for heating with an electric heater. When controlling a solenoid valve or a compressor of refrigerator, the T should be set to 10-20 to reduce the frequency of on/off.

This group of parameters can be accessed by input code 166. Figure 6 is the flow chart that shows how they can be changed. Press and hold SET key for 3 seconds until LED displays "LoCK." Then release the SET key. The display will show "0". To get into parameters setting mode, you need to key in the pass code. Use "+" and "-" keys to adjust the display to 166 and press SET. The LED will show "P" for a second and then its P setting value, Use "+" and "-" keys to change the setting. When finished, press the SET again to confirm the change. The display will show the "I" for a second and its I setting value next, use the same "P" setting procedure to set the I value. When finished, press the SET again to confirm the change. The display will show the "d" for a second and its value next. Use the same "P" setting procedure to set the d value. When finished, press the SET again to confirm the change. The next setting is "AT", the auto-tune. Use "+" to set the value to 1 and press SET will activate the auto-tune. The next setting is the "T" setting, use "-"

and “+” to set the cycle time value. This value should be 2 for most application. After change the PID parameter, the controller needs to be turned off and on again for the best result.

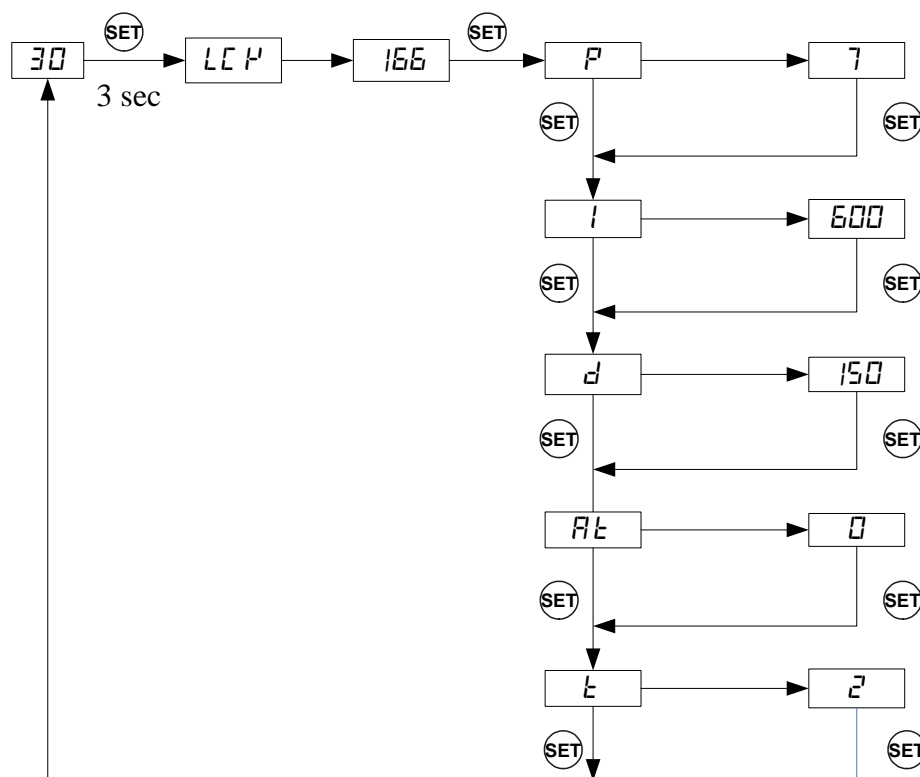


Figure 6. Parameter setup flow chart (Code 166).

5.2 The second group is about the system configuration and set up. Once they are set, they normally do not need to be changed. This group of parameters can be accessed by access code 155. If you don't want your system to be altered by others, do not let other people know this code. Table 3 shows the list of the parameters, their range and initial set value.

Table 3. List of control parameters and the initial settings under code 155.

Symbol	Display	Description	Range	Initial
SC	5C	Offset (Degree)	-40~+40	0
OUT	OUT	Output Power Reduction (%)	0-100	100
C-F	C-F	Temperature Unit	°C or °F	°F
Mod	Mod	Mode Selection	PID, Cool, Heat	PID
Hy	Hy	Hysteresis Band	0-9999	3
AS	AS	Anti-short Cycle Delay (only for cooling mode)	0-200	6

Details about each parameter.

- **SC:** Calibration offset. The parameter is used to make the input offset to compensate for the error produced by sensor. Each unit is 1 degree. e.g. if the temperature displays 2 °C in ice water mixture, set SC=-2 will make the display to shown 0 degree.
- **OUT:** Output power reduction. It is expressed as a percentage value. This function will allow you to control the maximum output power delivered by the heater. For example, if you set Out=50 and your heater is 1000 watts, the output will use 50% of the 1000 watts as the full output. It treats the 1000W heater as a 500W heater. When the PID algorithm determines 50% output value, the actual power output will be 250 watts. This function can be used in two situations.
 - 1) When you have a very powerful heater and are using a very small pot of water to cook at very low temperature, for example, a 1400 watts heater with a one liter (1 qt) pot of water at 130 F. The heater is too powerful for the small water volume. The moment it is on, it releases too much energy and overshoots the temperature. Although it is still possible to stabilize the temperature with proper PID parameters, it is much easier to control if you limit the maximum output to 25%. Ideally, an optimized temperature control system should consume about 25% of the heater power at set temperature (steady state), for example, if you found out that only 50 watts of energy is needed to maintain the temperature at 60 °C (141 °F), ideally you should use only a 200 watts heater for the job. Too much power will make the system over react too quickly. Too little power will make the system too slow in response. By using the OUT parameter, you can make a 1400 watts heater to act as a 200 watt heater for stable temperature control.
 - 2) When the cooker consumes more power than controller can handle, for example, if you have a 12A, 120V AC heater and your cooker contains more than 38 liter (10 gallon) of water. It might take more than 90 minutes of full power heating for controller to heat up the pot. Long time of full power operation might cause the controller overheating. You can set the output to 80%. It will prevent overheating the controller from staying a full power for a long time.
- **C-F:** Temperature unit setting. You can set the display to either Celsius or Fahrenheit.
- **Mod:** Mode selection setting. Three control modes are available: **PID** (PID mode for heating); **Cool** (on/off mode for cooling), and **Heat** (on/off mode for heating).
- **Hy:** Hysteresis band (or dead band). This parameter is valid only on/off control mode. In the on/off heating mode, the controller will stop sending power to the heater when temperature T is above the set value (SV), and start sending power again to the heater if T drops below (SV-Hy). For example, if SV=100 °C. Hy=3 °C, the heater will be turned off when the temperature rise above 100 °C; it will be turned on again as the temperature drops below 97 °C. For the on/off cooling mode, the compressor will be

turned off when $T < SV$. It will be turned on again when $T > SV + Hy$.

- AS:** Anti-short cycle delay. The Anti-short is the delay time to turn on the cooler (E.g, refrigerator). If the cooler is compressor based, compressor should not be turned on immediately when it is at high pressure (just after turned off). Otherwise, it may shorten the life of compressor. The anti-short cycle delay function can be used to prevent the rapid cycling of the compressor. It establishes the minimum time that the compressor remains off (after reaching cutout) before turns on again. The delay overrides any controller demand and does not allow the compressor to turn on until the set delay-time has elapsed. It gives time to release the refrigerant pressure through evaporator. It typically set to 6 (minutes). The unit is in minutes. This setting is only valid for cooling mode control.

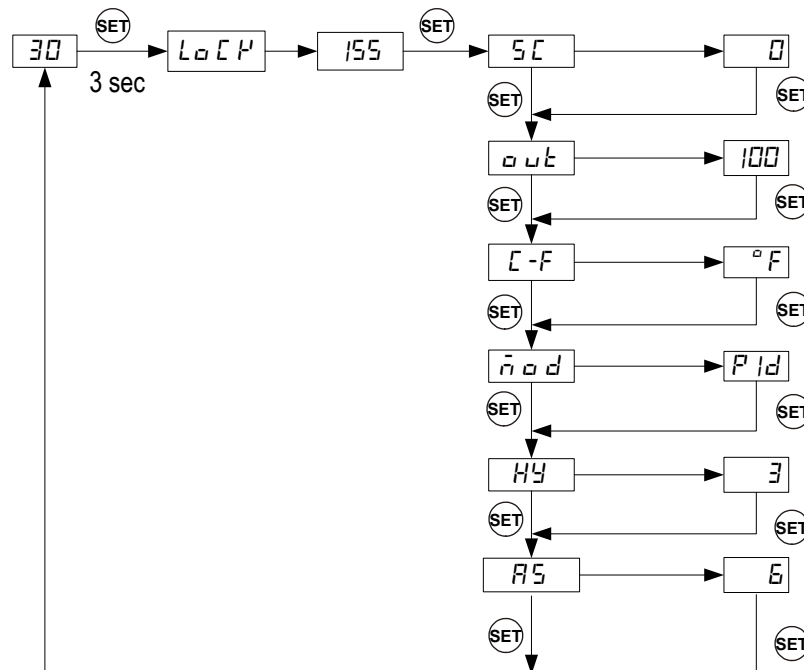


Figure 7. Parameter setup flow chart (Code 155).

This group of parameters is accessed by input code 155. Figure 7 is the flow chart that shows how they can be changed. Press and hold SET key for 3 seconds until the Parameter Window displays “LoCK”. Release the SET. The display will show “0”. Use “+” and “-” keys to adjust the display to 155 (another pass code) and press SET. The display will show the parameter for a second and then its value, use “+” and “-” keys to change the setting. When finished, press the SET again to confirm the change. The next parameter will be displayed then.

5.3 The third group of parameters is about the alarm setting with access code 188. Table 5 shows a list of the parameters, their range and initial set value when left the factory.

Table 5. List of control parameters and its initial settings under code 188.

Symbol	Display	Description	Range	Initial
AH	AH	Probe High Limit Alarm	-99-9999	290
AL	AL	Probe Low Limit Alarm	-99-9999	0
ASt	ASt	Step Finish Alarm	on, off	on

Details of each parameter.

- **AH:** High limit alarm for probe. User can set the temperature so that if the system is out of control, the buzzer will be turned on. For example, if AH set to 290, the buzzer will be on at 291 and off at 290. When the buzzer is on, the display window will flashing between AH1 and the current temperature.
- **AL:** Low limit alarm for probe. For example, if AL is set to 100. The buzzer will be on when temperature drop to 100. It will be turned off when temperature rise to 101. This alarm is suppressed when first powered up. It will only function after the temperature has reached set point once. When the buzzer is on, the display window will flashing between AL1 and the current temperature.

ASt: Step ending alarm. When ASt is turned on, the buzzer will beep 4 times when each step is finished. It is useful to notify the user the cooking step is finished. User can turn it off if no buzzer sound is wanted at the finish of each step.

Note: Temperature alarms can be muted by pressing the “-” key. The Step Finish Alarm cannot be muted; it can only be turned off by the ASt setting.

The flow chart in Figure 8 shows how they can be changed. Press and hold SET key for 3 seconds until the Parameter Window displays “LoCK”. Release the SET. The display will show “0”. Use “+” and “-” keys to adjust the display to 188 (another pass code) and press SET. The display will show the parameter for a second and then its value, use “+” and “-” keys to change the setting. When finished, press the SET again to confirm the change. The next parameter will be displayed then.

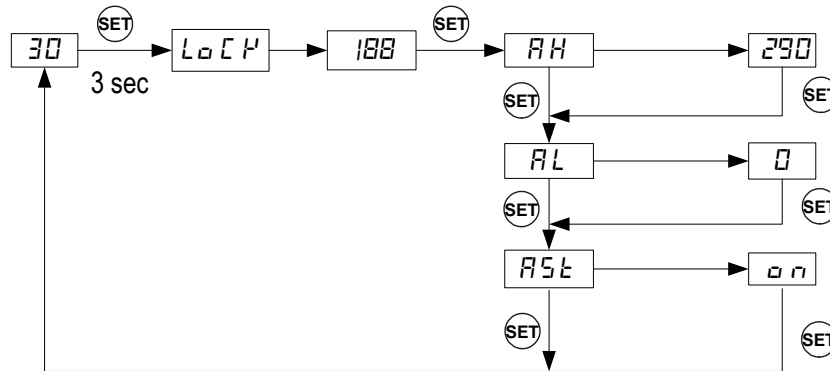


Figure 8. Parameter setup flow chart under (code 188).

6. Save and recall recipes

General introduction for the recipe function for this controller

This controller has two “memories” to store the programming steps. One is the current running “memory”. This controller will run the programming steps from this running “memory”, like C-1, t-1, C-2, t-2, etc. Another is called recipe “memory”. You can “save” your current running memory into this recipe memory with different recipe names, or recall the recipe memory into the current running memory. In that case, the previous steps in running memory will be overwritten. You cannot run the programming steps from the recipe “memory” directly.

This controller can save up to 8 pieces of smoking recipe (programs). Each recipe file can have up to 6 steps (C-1 to C-6). For convenience, we have pre-named these 8 pieces of recipe files as B1 (beef), B2, C1 (chicken), C2, F1 (fish), F2, P1 (pork), and P2. These recipe files are all the same except their names, so you can store your special recipe to any of them. These recipes can be stored in the memory of the controller even when it is powered off. You can overwrite the exist recipe with a new one.

6.1 Save a recipe.

After a program has been entered, the user can save this current program as a recipe for future use. Under the normal operating mode, press and hold SET key for 3 seconds until the Parameter Window displays “LoCK”. Release the SET. The display will show “0”. Use “+” and “-” keys to adjust the display to 2 and press SET. The display will show “SAVE” for a second and then the value “End”. If press SET key now, you will exit this mode without overwriting any existing programs. Use “+” or “-” key to select the name of recipe to which you want to store the program. If you press “+” (or “-” key) repeatedly, you will see “End”, “b1”, “b2”, “C1”, “C2”, “F1”, “F2”, “P1”, “P2” one by one. Press the SET key again to store your current program under the selected recipe name. This process will overwrite the current recipe data to the saved recipe data. Figure 9 shows

the flow chart of how to save a recipe.

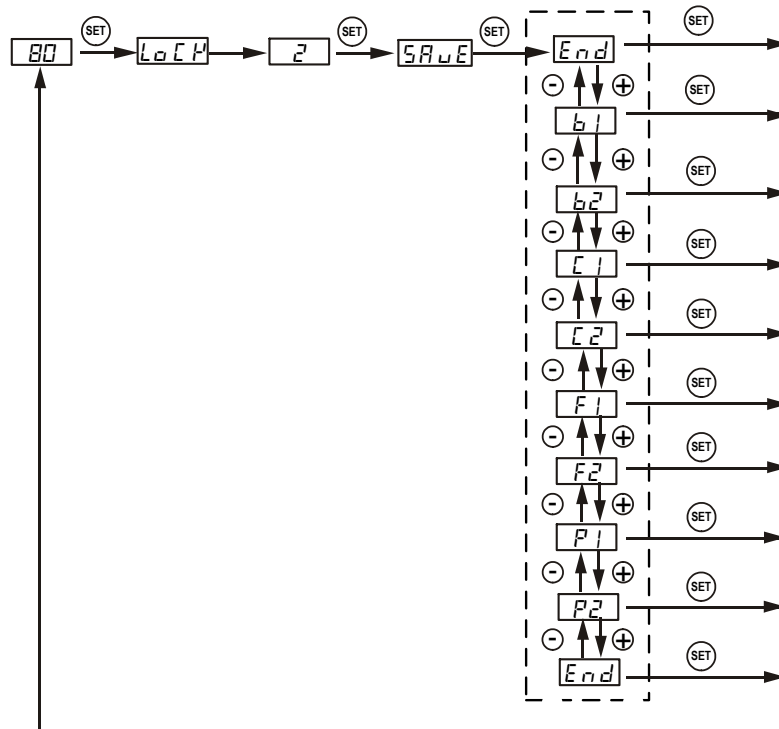


Figure 9. Flow chart of saving a recipe.

6.2 Recall a recipe.

WARNING: Your current program will be overwritten by the selected recipe. Please write it down somewhere if it is important to you.

To recall a recipe, press and hold SET key for 3 seconds until the Parameter Window displays "LoCK". Release the SET. The display will show "0". Use "+" and "-" keys to adjust the display to 1 and press SET. The display will show "rC" for a second and then the value "End". If press SET key now, you will exit this mode without overwriting any existing programs. This can prevent your current program been accidentally overwritten by a recalled program. Use "+" or "-" key to locate recipe you want to recall. If you press "+" key repeatedly, you will see "End", "b1", "b2", "C1", "C2", "F1", "F2", "P1", and "P2" one by one. After you locate the recipe that you want to recall, press the SET key to select. Current program will be overwritten by the selected program. Figure 10 shows the flow chart of how to recall a recipe.

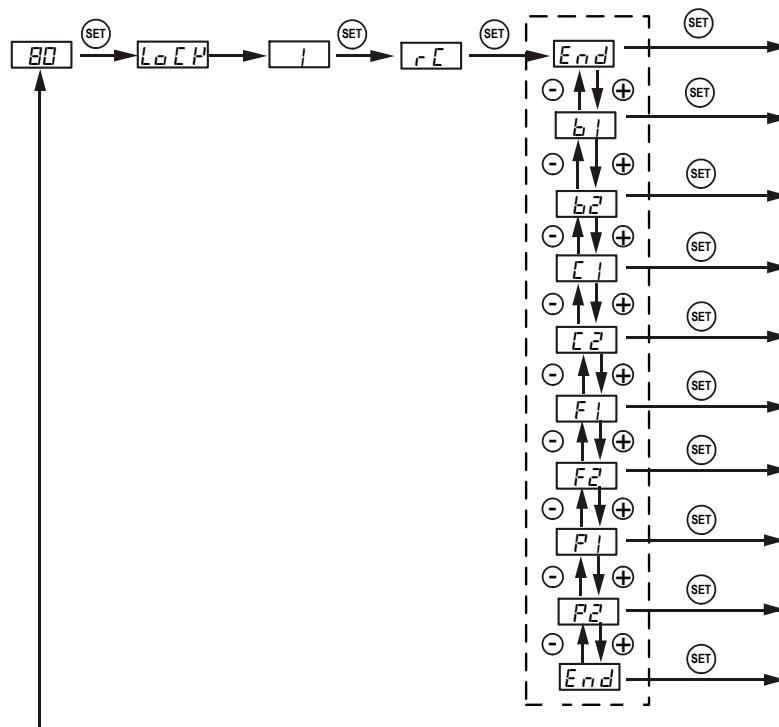


Figure 10. Flow chart of recalling a recipe.

7. Single-step mode

In this mode, the controller will hold temperature at one set value (C-1) continuously as long as the controller is powered on. Even if the controller is powered off and turned on again, it will resume working in this mode. You do not need to enter any other program steps in this mode.

To enter the single-step mode, the user need to set the parameter “PrG” to “off”. Under the normal operating mode, to recall a recipe, press and hold SET key for 3 seconds until the Parameter Window displays “LOCK”. Release the SET. The display will show “0”. Use “+” and “-” keys to adjust the display to 3 and press SET. The display will show “PrG” for a second and then the value “on”. Use “+” or “-” key to toggle between “on” to “off”. Select “off” and press SET key if you want to enter the single-step mode. Otherwise, select “on” and press SET key to enter the program mode. The controller will go back to the normal operating mode. To set the temperature, press SET key once, and the left window will show “C-1”. Use “+” or “-” key to adjust the temperature in the right window, then press SET to save and exit. Figure 11 shows the flow chart of how to switch to the single-step mode.

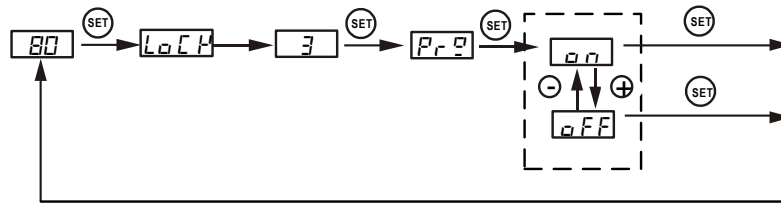


Figure 11. Single-step mode flow chart.

In single-step mode, the save and recall function (Section 7) still work. But the change can only be applied to C-1, i.e., you can only store your current set temperature to the C-1 in a selected recipe, or recall the C-1 temperature from a selected recipe to the current set temperature. Other data will remain in the memory of controller but is not accessible under the single-step mode. To exit the single-step mode, you only need to change the “PrG” value to “on”.

Please note: In older versions, it may show PrG options as “y” or “n”, instead of “on”, “off”. To enter single-step mode, please select “n”.

8. Examples

8.1 Store your program as a recipe (Program Mode)

Before you input your program, check the PrG = on (accessed by LoCK code “3”). Press SET briefly, and enter the program below:

C-1=120, t-1=2.0;

C-2= 290, F-2=160;

C-3=130, F-3=30.0.

You can leave the rest of steps as their default values.

To store in program to recipe b1, long press SET key, set LoCK=2, choose b1, and press SET again to confirm and exit. Now the controller is back to the normal operating mode. It will run on this current program, which has just been saved as recipe b1.

8.2 Recall a recipe to the current program (Program Mode)

Before you input your program, check the PrG = on (accessed by LoCK code “3”). Long press SET, set LoCK=2, choose b1, press set to exit.

Then recipe b1 is recalled back as the current program. The controller is back to the normal operating mode and will start run the current program.

8.3 Store your program as recipe (Single-step Mode)

Before you input your set temperature, check the PrG = off (accessed by LoCK code “3”).

Press SET key once, and then set C-1=150, press set again to confirm and exit. The controller will go back to the normal operating mode and start running on this single-step program.

To store current program back to recipe b2, long press SET, set LoCK=2, choose b2, press set to confirm and exit. Now your current program is stored as recipe b2.

8.4 Recall your recipe to current program (Single-step Mode)

Before you input your set temperature, check the PrG = off (accessed by LoCK code "3").

Long press SET, set LoCK=1, choose b2, press set to confirm and exit.

Now the C-1 from the recipe b2 is recalled back to your current program. The controller will start run at this temperature setting.

8.5 Advanced examples

This example will show you how the PrG mode can affect the saved and current recipe/program.

1) Set PrG = on, select "b1" recipe:

C-1=120, t-1=2.0;

C-2= 290, F-2=160;

C-3=130, F-3=30.0;

2) Change PrG = off, now the current single-step program is:

C-1: 120.

3) Set current C-1 to 200, then store current program back to recipe b1. Now the b1 recipe is:

C-1: 200.

4) Change PrG = on, current b1 recipe is:

C-1=200, F-1=2.0;

C-2=190, F-2=160;

C-3= 130, F-3=30.0.

9. Factory reset function

WARNING! This function will restore all the parameters (including receipts in the memory) back to factory default. Please write all the necessary settings down.

To reset, under the normal operating mode, press and hold SET key for 2 seconds until LED display "LoCK", and then release the SET key. The display will show "0" then. Use "+" key to adjust the number to 666 and press SET key again to confirm. The display will show as "InIE", then it will show as "off". Press "+" key once to change "off" to "on". Press SET key to confirm factory reset. The display will show "---" then "8.8.8.8." When you see this display back to normal operating mode, factory reset completed. Please check Figure 12 for reset flow chart.

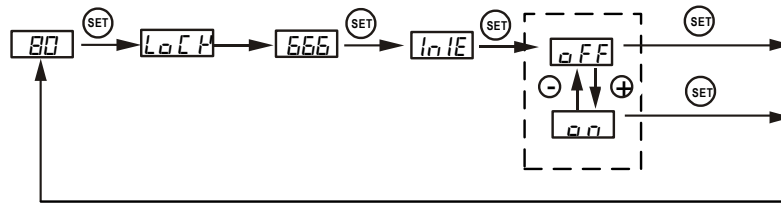


Figure 12. Factory reset flow chart. “on” is to confirm reset, “off” is to cancel reset.

Please note: In older versions, it may show InIE options as “y” or “n”, instead of “on”, “off”. To reset, please select “y”.

Appendix 1

Managing the heat generated by the controller

The heat dissipation of the controller is directly related to the electric current drawing power of the heater. If your cooker consumes less than 10 ampere of current or your pot is less than 5 gal (19 liters), you do not need to worry about the heat generated by the controller.

Sometimes, the AC current requirement might not be marked on the cooking appliance. To find out how much current it will draw, divide the power (in wattage) by the line voltage, for example, an 1800 watts 120V heater will draw 15A. A 2000 watts 240V heater will draw 8.3 Ampere.

Why the heat becomes an issue?

The solid state relay (SSR) used in the controller is a critical component for the precision temperature control. With the SSR, the power can be switched at high speed with no noise and no life time limitation. However, compared to electromechanical relays, the SSR has one drawback. It generates heat when passing the current. SSRs are made of semiconductors that have a limited conductance. When passing current, the heat will be produced from the resistance. Each ampere of current will produce about 1.3 watts of heat. When 12 Amp is passing through the controller, 16 watt of heat is produced in the controller. As more heat is produced, the temperature inside the controller will rise. If it reaches to higher than 70 °C, it can shorten the life or even damage some other components in the controller. The temperature inside of the controller depends on the amplitude of the current, how long the controller needs to run at full power and the ambient temperature.

The heat is only an issue during the start of the heating when the heater is running at full power. Once the temperature is close to the set point, the controller will probably need less than 50% of the power to maintain the temperature. Since the heat is directly related to the current passing the controller, the heat produced at steady state will be insignificant and can be ignored.

When the heat becomes an issue?

This controller can run at 10A continuously without worry of the temperature of the controller. At 12A, the temperature of the controller will increase with time. The bottom of the controller where the heat sink is located can rise by 63 °F (35 °C) from ambient if running at full power continuously for 90 minutes. For this reason we don't recommend running the controller at full power for more than 90 minutes. For 120 VAC, 15 A for 90 minutes will provide enough energy to heat 10 gallons (38 liters) of water up by 108°F (60 °C). If you have a pot that is bigger than 10 gallons and the heater is drawing 15 A, and you need to raise the temperature by 108 °F, you better use one of the methods mentioned below to reduce the heat in the controller. Otherwise, you might damage the controller.

Please note that when the ambient temperature is hot, as it often is the case in some commercial kitchens, the temperature of the controller will get hotter. This is because the heat dissipation is mostly determined by the temperature gradient (the temperature difference between the ambient and the controller) instead of absolute temperature of the controller itself. If the controller reaches 50 °C when the ambient is at 20 °C, it will reach 70 °C when the ambient is at 40 °C.

Solutions to reduce the heat stress on the controller.

1) Use hot water. If you fill the pot with hot water that has a temperature close to the set temperature, the heat dissipation of the controller is not an issue. As we have mentioned, once the temperature is close to the set point temperature, the controller starts to pulse (PWM) the power. The effective current is much lower, making heat not an issue.

2) Limit maximum output power. If you set output reduction parameter to 80%, then, a 15A heater will become a 12A heater. It will take 25% longer time to heat up the pot, but the controller will not over heat.

In addition to these solutions, following information will also help you to manage the heat. Place the controller in the right place. The SSR of Auber WS series controller is mounted in the bottom of chassis. The chassis is made of 3 mm thick aluminum for good heat dissipation. Do not cover the controller with any insulation. If you are running at 15 A with a large pot, placing the controller in a well ventilated area and tilting the instrument up with its front legs will help it to remove heat more efficiently. However, the tilted position may result in water collected at the back frame. Although the controller is splash proof, you should avoid water to be dripped on the controller when you open the lid of the cooker.

Increase the P value. This can only provide limited help for reducing the heat. P is the proportional band. $P=200$ means the proportional band is 20.0 degrees. When the temperature is raised to less than 20 degree from the set point temperature, the controller will start to reduce the power sooner. But if the integration time is set to very short, the controller might start to run at full power again soon.

Appendix 2

Controlling the Temperature of Bradley Smoker

1) Connecting the controller

There are two ways to power up the controller and smoker.

a) Using two power cords and a power strip. This set up is good for the “Original”, Stainless Steel, and Digital Bradley Smoker.

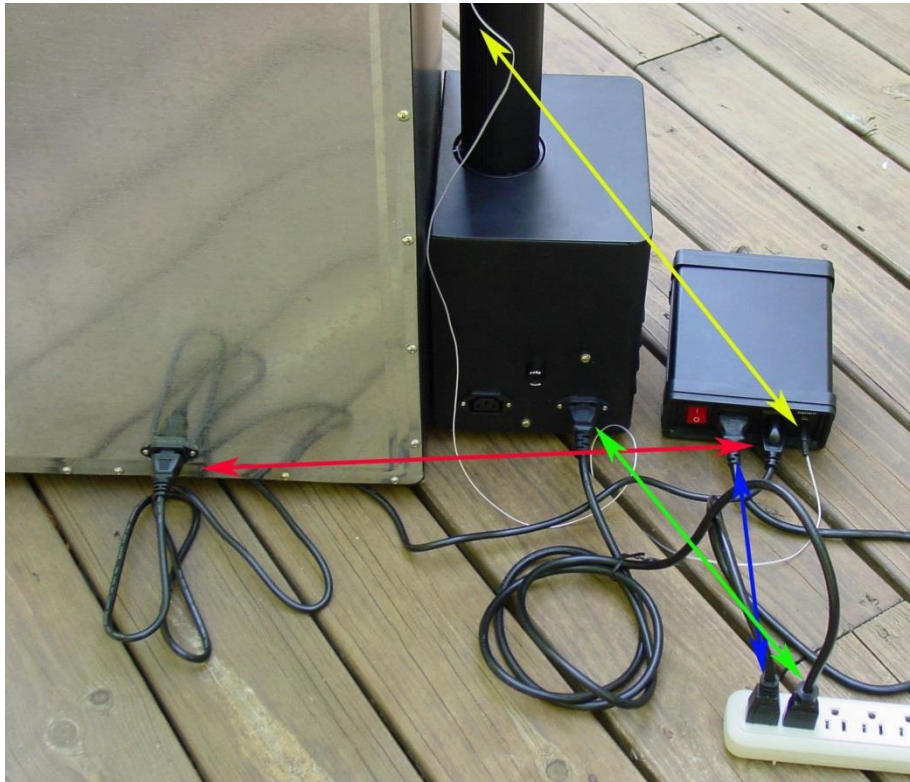


Fig 13. Power connection of the controller and smoker. The input of the controller is connected to the power strip by the 16 AWG power cord supplied (blue arrows). The generator is connected to the power strip by the power cord from Bradley (green arrows). The controller output is connected to the smoker by an 18 AWG computer power cord (red arrows, not supplied). The sensor is connected to the sensor port on the controller (yellow arrows).

b) Using one power cord. This set up is good for the “Original” and Stainless Steel Bradley Smokers only.



Fig 14. Power connection of the controller and smoker. The generator is connected to the power strip by the power cord from Bradley (green arrows). The input of the controller is connected to the female receptacle on the generator by the power jumper cord provided by the Bradley (blue arrows). It is the cord that used to connect the generator to smoker. The controller output is connected to the smoker by the power cord (red arrows).

Install the sensor. The sensor is plugged into the sensor port on the controller (yellow arrows)(Fig 14). The tip of the sensor is dropped into the damper hole. It is held in place by a piece of tape on the top of the smoker tower. (Fig 15)

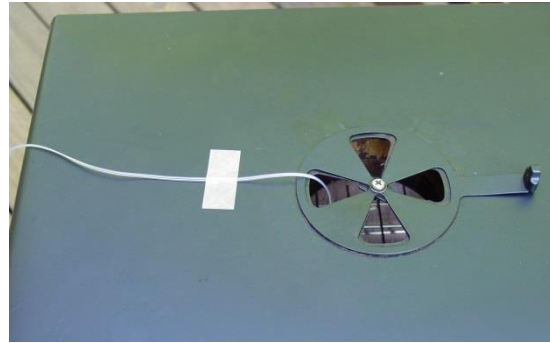


Fig 15. Sensor position. Left, the sensor should be placed close to the food but high enough so that it does not touch the food. Right, hold the sensor in place with a piece of tape.

For the “Original” and Stainless Steel Bradley smoker, the Temperature Heat Control Switch on the smoker tower should be slid to the Hi position (Most right).

For the Bradley Digital Smoker, the original sensor cable from the smoker should be connected between the generator and smoker.

The controller is ready to power up.

2) Important consideration for better control results.

The following is a list of things that could affect the result of temperature control.

a) The smoker and controller location. The smoker should not be placed directly under the sun. Direct sun light can heat the smoker to above 140 °F in the summer time, making controlling the temperature at 140 °F impossible. This is especially the problem for the Bradley Original Smoker because of its black color. The controller should be placed away from direct sun light also. Although the controller uses a high intensity LED display, it will still be difficult to read when sun light is directly shined on its surface. Users should also avoid exposing the controller to water and rain, which could damage the controller.

b) Low temperature control. The control result for temperature below 125 °F will not be as good as higher temperatures when the smoker generator is on. This is because there are two heaters in the smoker tower. One is the smoker heater controlled by PID controller. The other is the heater from generator that is not controlled. Our test shows that the heater in the generator itself can raise the temperature of the smoker tower by 60 °F (2 hours, in the shade with the damper open). That means when the ambient temperature is at 70 °F, the smoker can be heat up to 130 F in 2 hours by the heater of the generator (without using the heater of the smoker).

c) Damper position. Keeping the damper open will result in better temperature stability because more heat loss is created. This is important when the temperature is set below 140 °F. When the

damper is closed, the temperature will take a longer time to drop if it is overshoot during initial heat up. At higher temperatures, closing the damper will not affect the performance much because the heat loss from the wall of the tower is increased,

d) Temperature uniformity of the smoker tower. Our test showed that when all the shelves were empty, the temperature inside the smoker tower is fairly uniform except in the back half of the lowest shelf that is close to the heater. Users should avoid placing the sensor too close to the heater because it does not represent the temperature of the rest area. When the shelves are filled, temperature variation might depend on how the foods were placed. The bottom shelf can become hotter if more food is placed in it to block the hot air from going up.

e) Operating the controller when ambient temperature is below 32 ° F (0 ° C). The controller reading is only accurate for temperature ≥ 32 ° F (0 ° C). In addition, if the ambient temperature is below 14 ° F (-10 ° C), the controller will not function because it can't read the temperature correctly. In that case, users can warm the sensor by holding it with their hands. Once the sensor is above 14 ° F (-10 ° C), it will turn on the heater. Once the inside of the smoker is heated to above 32 ° F, the controller will run by itself.

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