

Instruction Manual

Instruction Manual for EZBoil® DSPR320

Version 1.1 (July, 2019)



Caution

- This controller is intended to control equipment under normal operating conditions. Failure or malfunction of the controller may lead to abnormal operating conditions, which result in personal injury or damage to the equipment or other property. Devices (limit or safety controls) or systems (alarm or supervisory) intended to warn of or protect against failure or malfunction of the controller must be incorporated into and maintained as part of the control system.
- Installing the rubber gasket supplied will protect the controller front panel from dust and water splash (IP54 rating). Additional protection is needed for higher IP rating.
- This controller carries a 90-day warranty. This warranty is limited to the controller only.

1. Specifications

Table 1. Specs of DSPR320.

Input type	RTD (Resistance Temperature Detector): PT100
Accuracy	± 0.2% of full scale
Sensor input range	0°F ~ 932°F, -17°C ~ 500°C
Response time	≤ 0.5 s
Display resolution	1°C or °F
Control mode	temperature, power
Program step	Up to 9 steps in each mode
Timer range	00 H 00 M to 99 H 00 M
Main output	12 VDC for solid state relay
Relay output	3 A for resistive load. 1 A for inductive load
Number of relays	2
Power supply	85 V ~ 260 V AC / 50 ~ 60 Hz
Power consumption	≤ 5 Watt
Working ambient temperature	0°C ~ 50°C, 32°F ~ 122°F
Dimensions	48 x 48 x 100 mm (W x H x D, from the front panel to the back)
Mounting cutout	45 x 45 mm

2. Front Panel



Figure 1. The front panel of DSPR320.

2.1. Display

Table 2. Front panel display.

#	Name	Descriptions
1	Top Display	<ul style="list-style-type: none"> ▪ Temperature reading and step-timer. ▪ Parameter names.
2	Bottom Display	<ul style="list-style-type: none"> ▪ Set value, step number, and program status. ▪ Parameter values.
3	Editing Indicator	<ul style="list-style-type: none"> ▪ This decimal point light up when the value in the bottom display is being edited and has not been saved.
4	AL1 Indicator (red)	<ul style="list-style-type: none"> ▪ Light up when Relay 1 (AL1) pulls in.
5	AL2 Indicator (red)	<ul style="list-style-type: none"> ▪ Light up when Relay 2 (AL2) pulls in.
6	MASH Mode Indicator (yellow)	<ul style="list-style-type: none"> ▪ Light up when controller is in MASH mode.
7	Output Indicator (green)	<ul style="list-style-type: none"> ▪ Light up when the controller is sending control signal to the SSRs. When it flashes, the percentage of time of it being lit up indicates the percentage of power that is being sent to the SSRs.

2.2. Key Functions

Table 3. Key functions

#	Key	Action	Functions
8	Knob	Short press	<ul style="list-style-type: none"> ▪ Press the knob to bring up the Quick Access Menu. ▪ Press the knob to select a parameter or to save the parameter value.
		Long press	<ul style="list-style-type: none"> ▪ Press and hold the knob 3 seconds to bring up the Main Menu.
		Rotate	<ul style="list-style-type: none"> ▪ Rotate the knob to browse and change parameter values.
9	RUN	Short press	<ul style="list-style-type: none"> ▪ Start the program. ▪ Resume the timer if timer is paused. ▪ Mute the on-board buzzer and/or cancel the relay action if temperature alarms are triggered.
10	HOLD/STOP	Short press	<ul style="list-style-type: none"> ▪ Pause the timer. ▪ Hold it down for 2 seconds to stop the program.
		Long press	<ul style="list-style-type: none"> ▪ End the program and stop all outputs.
Combination	RUN + KNOB	Hold down the RUN key and press the knob	<ul style="list-style-type: none"> ▪ Go back to the previous parameter in the menu list.

3. Wiring Terminals

The pin assignment of the back terminals of DSPR320 is shown in Figure 2 and the descriptions of each terminal are given in the table below.

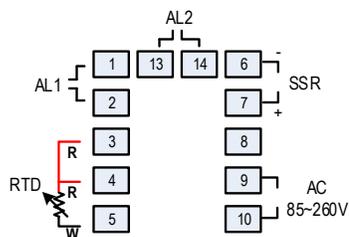


Figure 2. Terminal assignments of DSPR320.

Table 4. Back terminals of DSPR320.

Pin #	Descriptions
1	Relay 1 (AL1)
2	
3	Probe input (PT100 RTD). Two red leads should be connected to pin 3 and 4.
4	
5	
6	Control output (12 VDC), pin 7 is the positive and pin 6 is the negative.
7	
9	Power input (85 V ~ 260 V AC)
10	
13	Relay 2 (AL2)
14	

4. Getting Started

Before you start using this controller, please read the manual carefully. This section only provides a brief description on some of the most basic operations of this controller. Please read the later sections in this manual to understand how this controller works and learn more about each parameter.

4.1. Power Up

To test the unit and get familiar with all the features of this controller, please connect a PT100 RTD probe and then supply the 120 V or 240 V AC power.

4.2. Displayed Information

When the controller is powered up for the first time, the top display will show current probe reading, and the bottom display will show the program status "StoP".

When the program is running but the temperature has not yet reached the set-value of the current step (i.e., the step-timer has not started yet), the top window shows the current temperature reading, and the bottom display will flash between the current set-value and the current step number (Figure 3). When the step-timer has started, the top window will show the probe reading and the time alternatively, and the bottom window will still show the current set-value and the current step number alternatively (Figure 4). If the set-value has the letter "P" display on its left, that means this is a percentage value of power, not a temperature value.

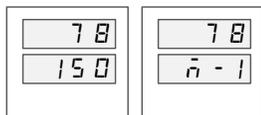


Figure 3. Two display screens when the step-timer has not started.

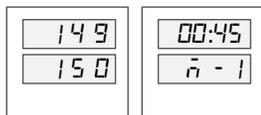


Figure 4. Two display screens when the step-timer has started.

There are four LED indicators on the left side. The top two red LED are synchronized with the relay AL1 and AL2 status respectively. The third LED is

yellow, and it lights up if the controller is at MASH mode. The last green indicator is synchronized with the output signal to the external SSR.

4.3. Understand the Menu Structure

The table below shows the menu structure of DSPR320 and how to access the menu.

Table 5. Menu structure of DSPR320.

Quick Access Menu	
(Short-press the knob to bring up the Quick Menu; rotate the knob to browse different options; press the knob again to select.)	
RST (n/y)	Reset the program
STEP (1 ~ 9)	Jump to the selected step
MODE (Mash/Boil)	Select mode
Main Menu	
(Hold down the knob for 3 seconds to bring up the Main Menu; rotate the knob to browse different menu items; press the knob again to select.)	
mPRG	Mash mode program
bPRG	Boil program
mSET	Mash-step settings
bSET	Boil-step settings
RELY	Relay configurations
SYST	System configurations

4.4. Select Mash or Boil Mode

There are two program modes: MASH and BOIL. By default, the controller is at MASH mode. If you want to run the program in Boil mode, please press the knob to bring up the Quick Access Menu. Next, rotate the knob clock-wise till you see "n o d E" in the top display and "b o i L" in the lower display. Then, press the knob again to confirm the selection. The MASH indicator will light up if the controller is in MASH mode, and it should turn off if the controller is in BOIL mode.



Figure 5. Select Program Mode on DSPR320.

4.5. Adjust Parameters

All parameters are divided into four groups in the Main Menu: mSET (mashing step settings), bSET (boiling step settings), RELY (relay settings), and SYST (system settings). Press the knob for 3 seconds to go the Main Menu and turn the knob to select the desired parameter group to edit. Please refer to Section 7 of this manual for the detailed explanation of each parameter.

4.6. Enter the Program

Press down the knob for 3 seconds to go the main menu, the first two items are mPRG (Mash Mode Program) and bPRG (Boil Mode Program). Rotate the knob to select which program to enter and press the knob again to confirm.

There are maximum 9 steps can be entered in each mode. For each step, the user will be asked to enter the set-value and the step-timer. The Figure 6 below shows the operations for how to enter the set-value of the Step 1 of the Mash Program. And the Figure 7 shows the same operations for Boil Program.

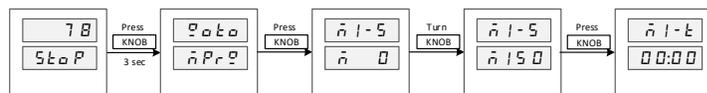


Figure 6. Entering the Mash Program.

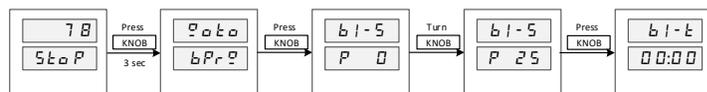


Figure 7. Entering the Boil Program.

The set-value can either be a temperature value (with letter “n” display on the left) or a percentage number (with letter “P” displayed on the left) of the power output. The user can rotate the knob to select from 0% to 100% power and from 0 to 932 °F/°C. Press the knob to confirm the value and go to the timer setting.

The step-timer can be set in the HH:MM format, ranging from 00:00 to 99:00, or a special code which can be **SKIP**, **HOLD**, **END**, or **CONT**. Please see later sections for details. If the step-timer a step is set to **END** or **CONT**, the user won't be prompted with the next step.

4.7. Start the Program

Simply press down the RUN key to start the program. The top window will show “run” shortly and then show probe reading and start running the first valid step.



Figure 8. The top window shows “run” when the program starts.

4.8. Make Adjustment On-the-Fly

This controller offers a quick way for users to adjust the set-value and the step-timer of the current step without going back into the programming menu. It also allows the program to be jumped from the current step to any other valid step in the program.

a) Change the set-value. When the lower display shows the current set-value, simply turn the knob in either direction to start editing the value. A flashing dot will appear at the lower right corner to indicate the set value is being editing. Keep turning the knob till the desired set-value is shown in the lower window. Then press the knob to confirm the change, otherwise the new value won't be saved.

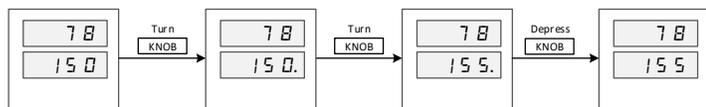


Figure 9. Changing the set-value while the program is running.

b) Change the step-timer. When the lower display shows the current step number, turn the knob in either direction to start editing the step-timer. A flashing dot will appear at the lower right corner to indicate the new value hasn't been saved yet. Press the knob again to confirm the change, otherwise the new value won't be saved. The Figure 10 below shows this operation when the temperature is still being ramping up to the step's set-value. So, the top window only shows the current probe reading. If the step-timer had started, the top window will show the current time.

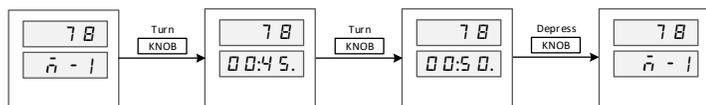


Figure 10. Changing the step-timer while the program is running.

c) Pause the timer. When the temperature reaches the timer-start-point, the step-timer will start counting down time. The user can manually pause the timer by short-pressing the HOLD key. When the timer is paused, the top window will show “Hold.” To resume the current step-timer, press the RUN key shortly and the controller will show “run” in its top window. The Figure 11 shows how to pause the timer.

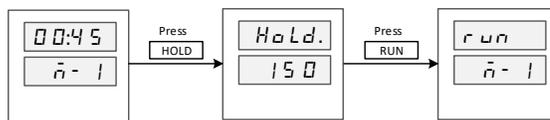


Figure 11. Operations to pause and to resume the step-timer.

When the timer is paused from the key pad, a dot will also appear in the right corner of “Hold.” indicates that the timer is temporarily paused and it can be resumed. This is different from setting/changing the step-timer to **HOLD**, where the timer display is “Hold” (no dot) and pressing the RUN key will make the program continue to the next step.

d) Jump to another step. While the program is running, it can be jumped from the current step to another step in the program. This operation is not valid if the program is ended or stopped. The operation is shown in Figure 12. Press the knob to bring up the Quick Access Menu. The top window will show “STEP” and the current step number will be shown in the lower window. Turn the knob to find the desired step number and press down the knob to confirm. If you select a valid step number, the controller will jump to the selected step and executing the new step. If you select the current step number or a non-valid step number, the controller will take no action and simply return to the main operation interface. Here, a non-valid step refers to a step whose step-timer is set to SKIP or a step behind the last step of a program.

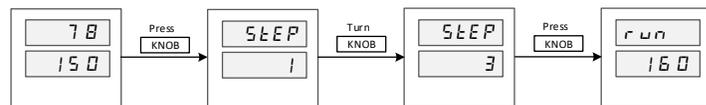


Figure 12. Jumping from one step to another while the program is running.

Please note that all changes that the user makes from the main interface are temporary. It doesn't affect the programs that have been saved in the **mPRG** or **bPRG**. The controller will always retrieve the set-value and the step-timer value of the next step from the saved program.

4.9. End or Stop the Program

In DSPR320, **End** and **Stop** are different status. When a program has come to its end, whether the controller will enter the **End** or the **Stop** status depends on the parameter **EO** (Ending Option for Mash Mode) and **bEO** (Ending Option for Boil Mode). Please refer to section 5.7 for details.

Ways to **End** a program:

- a) Wait till the controller finish executing all the programmed steps.
- b) Change the step-timer to “END”. The program will come to its end when the temperature reaches the timer-start-temperature.

Ways to **Stop** a program:

- a) Press and hold the “STOP” key for about 3 seconds to end the program and stop all outputs.
- b) Reset the program by going to the Quick Access Menu and select “RST/Y”.
- c) Switch the Operation Mode from one to another will also end the current program.
- d) Power off the controller and power it on again.

5. Understand the Controller DSPR320

5.1. Program Mode

In DSPR320, a Program Mode, or a Mode, can save a program with up to 9 steps. There are two Modes on DSPR320: **MASH** and **BOIL**. The Program Mode is indicated by the MASH LED indicator. The intended use of **MASH** Mode is to control water or wort temperature during a mashing process. The default set-values of all steps in MASH Mode are 0 degree. The temperature unit depends on

the **C-F** setting in the **SYST** menu. The intended use of **BOIL** Mode is to bring water or wort to its boiling point and remind the user to add hops. The default set-values of all steps in **BOIL** Mode are 0% of power. It is displayed as "**P** \square ", where the letter **P** indicates this is a percentage value of power.

Despite the difference in the default set-values, the DSPR320 controller does allow the user to change set-values freely from temperatures to power percentages, or vice versa. Any step in **MASH** mode can be a power-control step (boiling step), and any step in **BOIL** mode can be a temperature-control step (mashing step). This feature gives users a great flexibility to customize the desired heating profiles per their brewing recipes and control automation needs.

Please note that switching Program Mode while a program is running will result in the program being terminated immediately. This operation is not recommended.

5.2. Program

A Program refers to a series control steps that has been saved under a Program Mode (**MASH** or **BOIL**). A program can have no more than 9 steps. When the user edits a program, if a step's step-timer is set to **END**, the user won't be asked to enter settings for the next step.

When the controller runs a program, it always starts from Step 1 or the first valid step and ends at either at the step where the step-timer is set to **END** or at Step 9 if it exists.

The **MASH** Mode has a special feature that allows the controller to continue to run the program saved in **BOIL** Mode automatically when the Mash program is finished. To use this feature, the last step in the **MASH** Mode should be set to **CONT** instead of **END** by turning the knob counter-clockwise for a full turn.

The user can go to **mPRG** (**MASH** mode program) and **bPRG** (**BOIL** mode program) in the main menu to enter or edit the programs.

Step settings in **mPRG** and **bPRG** are named in this format: **aX-B**, where:

a: can either be letter **m** or **b** to indicate **MASH** mode or **BOIL** mode.

X: a numeric number ranging from 1 to 9.

B: can either be letter **S** or **t** where

- **S**: set-value.
- **t**: step-timer.

For example, the parameters of the Step 1 of **MASH** mode are **m1-S** and **m1-t** while the parameter of the first step of **BOIL** mode are **b1-S** and **b1-t**.

5.3. Step

A **step** can be considered as one of many sections that consist a program. It defines the temperature or power percentage that the controller should maintain for a certain duration of time. A step is exclusively referring to the time period when the temperature has reached a pre-defined timer-start-point and the step-timer is counting time. The beginning of a step is when the step-timer starts and the end of a step is when the step-timer ends. In a program, the sections between steps are transition sections, or called ramp sections. The controller doesn't regulate the ramp-up or ramp-down speed.

The settings of a step consist of the set-value and the step-timer. The step-timer only starts counting when the temperature has reached a pre-defined timer-start-point (see section 5.6 for details).

5.4. Ramp Sections

In DSPR320, program sections between steps are called ramp sections. Some of the relay functions are closely associated with the ramp sections, hence a clear definition of each section is necessary. A **STEP** section is exclusively referring to the time period when the temperature has reached a pre-defined timer-start-point and the step-timer is counting time. The section prior to the start of a **STEP** as well as its step-timer is referred as the **RAMP** section of a step. A ramp section where the temperature needs to be ramped up is called **HEAT** section. A ramp section where the temperature needs to be cooled down is called **COOL** section. A **RAMP**

section and a **STEP** section together are referred as an **Extended Step (EXTN)** section. The plot in Figure 13 shows a short two-step program to illustrate what the different sections are. The description of each section is given in the table.

Please note that the controller determines whether a section is **HEAT** or **COOL** by comparing the current probe reading and the step's set-value instead of comparing the set-values of two steps.

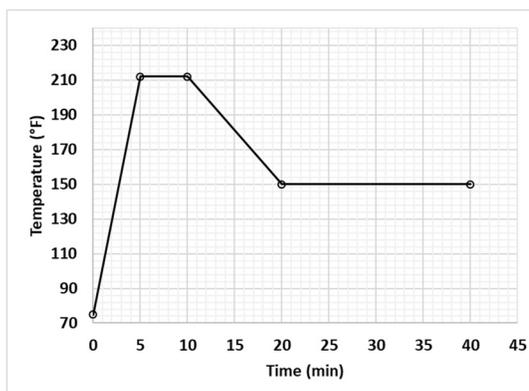


Figure 13. A two-step program to illustrate different program sections.

Table 6. Program sections of the two-step example program.

Step #	Time Range	Description	Section Type
1	0 ~ 5 min	Ramp section of Step 1, which is a HEAT section	RAMP, HEAT
	5 ~ 10 min	Step 1	STEP
	0 ~ 10 min	Extended Step 1	EXTN
2	10 ~ 20 min	Ramp section of Step 1, which is a COOL section	RAMP, COOL
	20 ~ 40 min	Step 2	STEP
	10 ~ 40 min	Extended Step 2	EXTN

To determine whether a transition section is **HEAT** or **COOL**, the controller compares the current probe reading against the step's set-value instead of comparing the set-values of two steps. This comparison only happens when the program is in a transition section, i.e., when the step-timer of the next step hasn't yet started.

However, the boiling steps (power-control steps) are handled differently since there is no set-value for boiling steps. For boiling steps, the controller uses the **bTSP** (boiling timer-start-point) for comparison purpose. Table 7 listed the different situations of how the controller determine **HEAT** or **COOL** of a ramp section.

Table 7. Determine **HEAT** or **COOL** between two steps.

		To Step (n+1)	
		Mashing Step	Boiling Step
From Step (n)	Mashing Step	PV vs SV	PV vs bTSP
	Boiling Step	bTSP vs SV	bTSP vs bTSP (N/A)

5.5. Step-Control Mode

The **step-control mode**, or control mode, refers to how the power is regulated at a step, which can either be **temperature-control** or be **power-control**. In temperature-control mode, the goal is to raise and maintain the water or wort temperature at the specified value. The steps that have set values in temperature (0 ~ 932 °F/°C) use **temperature-control** mode and these steps are sometimes referred as **mashing steps** for convenience. In the **power-control** mode, the goal is to bring water or wort to boil by raising the water or wort temperature above

certain threshold and then let the user to adjust the power output percentage manually. Steps that have set values in percentage (0% ~ 100%) use **power-control** mode and these steps are sometimes referred as **boiling steps** for convenience.

For any step in a program, the control mode can be either temperature-control or power-control. The MASH or BOIL mode doesn't impose any constraint on the control mode of any step in its program. When entering the set-value for a step, the user can simply select either a power percentage number or a temperature value as the set-value.

Please note that **"mashing step"** or **"boiling step"** refers to how the power is controlled for a particular step, while the **"mash mode"** or **"boil mode"** refers to the program mode that is intended to be used for the mash or boil process.

5.6. Set-Value

The set-value of a step can be either a power percentage value (from 0% to 100%) or a temperature value (from 0 to 932). The percentage numbers and the temperature values together make up a combined list of available set-values:

0%, 1%,...,99%, 100%, (bo) (ma), 0, 1, 2, ... 931, 932.

When editing the set value, the user can rotate the knob to select the desired value. Turning the knob clockwise will increase the value, and turning the knob counter-clockwise will decrease the value. When the value changes from percentage to temperature, the lower window will show "nR" shortly to remind the user the set value is temperature value for mashing. Conversely, when turning the knob counter-clockwise and as the value changes from temperature to percentage, the lower window will show "bo" shortly to remind the user the set value is power percentage for a boiling step. All temperature values have the letter "n" displayed on the left side, and all percentage values have the letter "P" will be display on the left side to indicate these are percentage values. For example, 0% is displayed as "P 0" and 0 degree is displayed as "n 0".

When the program is running, temperature set-values will NOT have the letter "n" displayed on the left, but the percentage values do have the letter "P" on the left.

5.7. Step-Timer

The step-timer defines the time duration of a step where the temperature or the power should be maintained at its set-value. The timer can be set to anywhere between 0 minute to 99 hours. The time duration is displayed in the format of HH:MM.

The step-timer setting can also be a special command which tells the controller how to handle this step instead of counting down time. The special command can be **SKIP**, **HOLD**, **END**, or **CONT**. The meaning of a command is explained in the table below. Please note that "CONT" is not available to the BOIL program mode.

Table 8. Special commands of step-timers.

Command	Description
SKIP	Bypass this step.
HOLD	Hold the program at the current step. Press RUN key to continue to the next step.
END	End the program.
CONT	End the MASH Program and continue to execute the first step of the BOIL program. Only available to MASH Program.

When the controller executes a step, it won't start the step-timer or execute the special command until the probe reading has reached a timer-start-point. For temperature-control steps (mashing steps), the timer-start-point is determined by **tSP**, which defines a two-sided deviation band around the set-value (see Figure 14). For power-control steps (boiling steps), the timer-start-point is determined by **bTSP**, which defines an absolute temperature value above which the timer should start. Once this temperature is reached, the controller will start counting down time until the time is reached, or execute the special command. Once the timer starts,

it won't stop nor pause because of the probe temperature drops output of the timer-start-point. However, the user can manually pause the timer by pressing the HOLD key, and then resume the timer by pressing the RUN key.

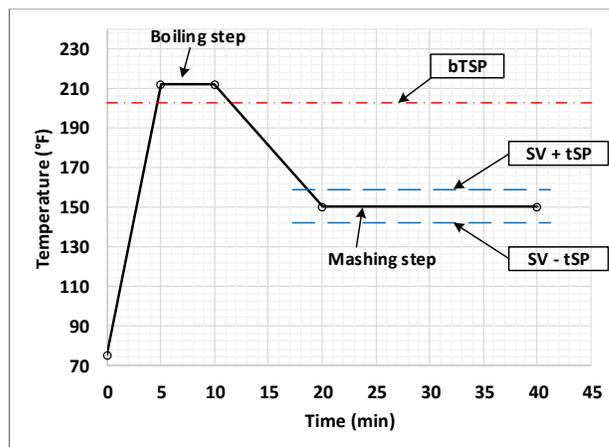


Figure 14. The timer-start-point of boiling steps and mashing steps are defined differently.

5.8. End or Stop the Program

When the last step of a program is executed, the program ends and controller will either show "End" or "StoP". In DSPR320, **End** and **STOP** are different status. **STOP** means the controller has turned off all outputs, including the main SSR output as well as both relays. **END** means the program has come to an end, but the controller will continue to regulate the temperature or the power per the set-value of the last step. See Table 9 for a comparison between these two statuses.

Table 9. The differences between END and STOP.

	END	STOP
Main Output	Yes	No
Relay Output	No	No
Alarms	No	No

When a program has come to its end, whether the controller will enter the **END** or **STOP** status depends on the parameter **EO** (Ending Option for Mash Mode) and **bEO** (Ending Option for Boil Mode).

By default, both **EO** and **bEO** are set to OFF, which means that once a program has ended, there will be no output from the controller. The controller will show current probe reading in the top window and show "StoP" in the bottom window (Figure 15).

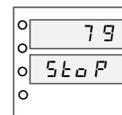


Figure 15. DSPR320's display when a program is stopped. All outputs are turned off.

If **EO** and/or **bEO** is set to ON, the controller will continue to regulate the temperature if the last step is a temperature-control step, or to regulate power if the last step is a power-control step. The controller will show the current probe reading and "End" alternatively in the top bottom window. The bottom window will show the set-value of the last step in the program (in Figure 16, the set-value is 80). The OUT indicator will show the output status accordingly.

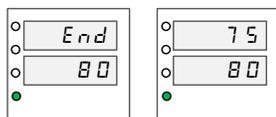


Figure 16. DSPR320's display when a program is ended. The OUT indicator is on as the controller still tries to maintain the temperature at set-value.

Once the program has ended or stopped, pressing the RUN key won't start the program again. The user needs to reset the controller, by either going to **RST** in the Quick Access Menu or cycle the power supply to the controller, before the program can be started again.

5.9. Use Relays to Assist the Brewing Process

The DSPR320 is equipped with two build-in relays, Relay 1 (labelled as AL1) and Relay 2 (labelled as AL2). They are identical in terms of their capability and specifications. There available Relay Mode settings are: **ALAM**, **BEEP**, **ALBE**, **RAMP**, **HEAT**, **COOL**, **STEP**, and **EXTN**. Please see section 5.3 and 7.5 for more details.

The functions of the relays can be divided into three main groups:

- a) Temperature alarms: ALAM and ALBE.
- b) Event reminder: BEEP.
- c) Program-section control: RAMP, HEAT, COOL, STEP, and EXTN.

For the first two groups, temperature alarms or event reminder, the main application is to use the relay to drive an external buzzer.

With the functions in the third group, the controller can complete more complexed home brewing automation tasks, such as turning on an additional heater during the ramp-up section of certain steps, turning on the wort pump during all mashing steps, or turning on a circulation pump for chiller during ramp-down sections when wort needs to be cooled down. An example of how to use the replay to control pumps are given in the section 10.1 of this manual.

6. Quick Access Menu

The Quick Access Menu has three functions as shown below.

- **RST** -- reset the program
- **STEP** -- jump to another step
- **MODE** -- select Program Mode

Table 10. Quick Access Menu.

Top Disp.	Bottom Disp.	Functions (Rotate the knob to browse, press the knob to confirm the selection.)
RST	N	<ul style="list-style-type: none"> ▪ No effect. Return to the normal operation mode.
	Y	<ul style="list-style-type: none"> ▪ Reset the program, stop all outputs. The user can start the program again by press down the RUN key.
STEP	1 ~ 9	<ul style="list-style-type: none"> ▪ When a program is running, select a valid step number to jump to the selected step. ▪ Selecting the current step number has no effect. ▪ Selecting non-valid step number, i.e., a step that doesn't exist in the current program or a step has been set to SKIP, has no effect.
MODE	MASH	<ul style="list-style-type: none"> ▪ Stop all output and switch to MASH mode if current mode is BOIL. ▪ No effect if current mode is MASH.
	BOIL	<ul style="list-style-type: none"> ▪ Stop all output and switch to BOIL mode if current mode is MASH. ▪ No effect if current mode is BOIL.

To bring up the Quick Access Menu, simply press the knob shortly. When the controller is not executing any program, i.e., the controller is at the END or the STOP status, press the knob will bring up the **RST** function. If a program has been started, press the knob will bring up the **STEP** function. The user can rotate the knob to select the desired function. To confirm the selection, press the knob again. The table below listed the details of each function in the Quick Access Menu.

7. Main Menu

Program settings and parameters are grouped into 6 submenus.

- **mPRG** – the program of Mash Mode.
- **bPRG** – the program of Boil Mode.
- **mSET** – settings for all mashing (temperature-control) steps.
- **bSET** – settings for all boiling (power-control) steps.
- **RELY** – settings for relay AL1 and AL2.
- **SYST** – system parameters.

To bring up the Main Menu, press down the knob for 3 seconds. Then the top window will show "go-to" and the bottom window will show the first item in the menu list, which is "mPRG". Turn the knob to find the correct sub-menu, and then press down the knob to select the item. The parameters in each sub-menu are listed and explained below.

7.1. mPRG – Mash Program

The user can enter or edit the Mash Program in this sub-menu. Only the settings for Step 1 is listed and described in Table 11. Steps in the rest of the program are identical to Step 1.

Table 11. mPRG menu.

Display	Name	Description	Range	Default	Note
m1-S	m1-S	Set-value	0% ~ 100%, 0 ~ 932 °F/°C	0 °F/°C	1
m1-t	m1-t	Step-timer	CONT, END, HOLD, SKIP, 00:00 ~ 99:00.	00:00	2
...
m9-S	m9-S	...	...	...	...
m9-t	m9-t	...	...	...	...

Note 1. Set-value can be a percentage value or a temperature value, corresponding to a boiling step or a mashing step respectively. The unit of set temperatures is decided by the **C-F** setting in the **SYST** menu.

Note 2. When the temperature has reached the timer-start-point of a step, the controller will start the step-timer or execute the special command. The special commands are explained below:

- CONT** – Continue executing the Boil Program when the Mash Program is over.
- END** – End the program.
- HOLD** – Hold the program at the current step till the user press the RUN key.
- SKIP** – Bypass this step.

However, the special command **SKIP** is an exception. If a step-timer is set to **SKIP**, this step will be bypassed when running the program, and the step number will become invalid in the current program. For example, in a 4-step mashing program, if the user changes the **m2-t** to **SKIP**, the controller will only execute Step 1, 3, and 4, and the user can't not jump to the Step 2 of this program.

The command **CONT** is only available in MASH program mode. To select **CONT**, turn the knob counter-clockwise for a full turn when you see **END**. If the step-timer is set to **END** or **CONT**, the controller won't ask the user to enter settings for the rest of steps. And so, the rest steps don't exist to this particular program.

7.2. bPRG – Boil Program

The user can enter and edit the BOIL program in this sub-menu. The settings of the BOIL program are the same as the MASH program, except that the command CONT is not available in the BOIL Program. Only the settings for Step 1 is listed and described in Table 12. Steps in the rest of the program are identical to Step 1.

Table 12. bPRG menu.

b P R G					
Display	Name	Description	Range	Default	Note
b 1-S	b1-S	Set-value	0% ~ 100%, 0 ~ 932 °F/°C	0%	1
b 1-t	b1-t	Timer	END, HOLD, SKIP, 00:00 ~ 99:00.	00:00	2
b 9-S	b9-S	...	...	...	...
b 9-t	b9-t	...	...	...	...

Note 1. Set-value can be a percentage value or a temperature value, corresponding to a boiling step or a mashing step respectively. The unit of set temperatures is decided by the C-F setting in the SYST menu.

Note 2. Please refer to the Note 2 of section 7.1.

7.3. mSET -- Mashing (temperature-control) Step Settings

Most of the parameters in this submenu defines how the controller runs all the mashing steps (temperature-control steps) in both the MASH program and the BOIL program. However, EO is a parameter that only applies to the MASH program.

Table 13. mSET menu.

m S E T					
Display	Name	Description	Range	Default	Note
t S P	tSP	Mashing step timer-start-point	0 ~ 932 °F/°C	1°F	1
E O	EO	Mashing program ending option	ON, OFF	OFF	2
o S C r	oScr	Overshoot correction	-50 ~ +50	0	3
m O U T	mOUT	Mashing acceleration output power	0% ~ 100%	100%	4
A t t E	AttE	Attenuation constant	-2 ~ +2	0	5

Note 1. tSP, timer-start-point for mashing steps, defines a two-sided deviation band between the probe reading and the set temperature, within which the step-timer should start. For example, if tSP = 1 and m1-S = 150°F, then it means that when the probe reading reaches the range between 149°F and 151°F, the Step 1 timer will start.

Note 2. EO, ending-option of the MASH program, defines whether the controller will send out the power after the Mash Program ends. If EO = OFF, no output will be sent after the Mash Program ends; controller will show "S t o P" at the bottom display. If EO = ON, controller will continue to send out power per the set value of the last step after the program ends; controller will show "E n d" at the bottom display. To completely turn off the output, the user can hold down the STOP key until the bottom display shows "S t o P".

The difference between STOP and END are explained in the section 4.9 and 5.8.

Note 3. oScr, overshoot correction, is a parameter that helps users to correct the temperature overshoot if it happened during the initial heat up. For example, if the temperature overshoot 2 degrees, set oScr = 2 to remove this overshoot. Some users may want to set oScr as negative number to purposely impose a temperature overshoot, which can reduce the temperature response delay between the hot liquor tun and the mash tun. Please note that oScr affects the initial heating

up phase as well as the transition phase between steps. It has no effect on how the controller stabilize the temperature at the current set temperature.

Note 4. mOUT, acceleration output power for mashing steps, determines the maximum output power can be sent during the acceleration stage of heating up the water or wort toward the set temperature of the next step.

Note 5. ATTE, attenuation constant, is parameter to adjust the temperature-control stability in mashing steps. The value ranges from -2 to +2. The default value is 0. If the temperature fluctuates more than 1 degree, user can increase the value of this parameter. If the controller takes a long time to eliminate the gap especially when temperature drops below the set temperature, the user can reduce the ATTE value to make the system more responsive.

7.4. bSET -- Boiling (power-control) Step Settings

All parameters, except bEO, in this submenu defines how the controller runs all the boiling steps (power-control steps) in both the MASH program and the Boil Program. The parameter bEO only applies to the BOIL program.

Table 14. bSET menu.

b S E T					
Display	Name	Description	Range	Default	Note
b A S T	bAST	Boiling acceleration set temp.	0 ~ 932 °F/°C	200°F	1
b O U T	bOUT	Boiling acceleration output power	0% ~ 100%	100%	2
b T S P	bTSP	Boiling timer start temp.	0 ~ 932 °F/°C	208°F	3
b E O	bEO	Boiling ending options	ON, OFF	OFF	4

Note 1. bAST, boiling-acceleration set temperature, defines a set point of temperature below which the controller will use the maximum power percentage, which is defined by parameter bOUT, to heat up the water or wort. When the temperature rises above bAST, the controller will change the power percentage to the step's set-value saved in the program. By default, bAST is set at 200°F, which means when the temperature hasn't reached 200°F yet, the controller will send the maximum power percentage that is allowed by parameter bOUT.

Note 2. bOUT, boiling-acceleration output percentage, defines the maximum power percentage that the controller is allowed to use during the boiling-acceleration phase of every boiling step. By default, this parameter is set to 100%.

Note 3. bTSP, timer-start-point of boiling, defines a temperature above which the step-timer of a boiling step (power-control step) should start. By default, this parameter is set at 208°F, which means that once the water or wort temperature the step-timer will start.

Note 4. bEO, ending-option of BOIL program, defines whether the controller will send out the power after the BOIL program ends. If EO = OFF, no output will be sent after the Boil Program ends; controller will show "S t o P" at the bottom display. If EO = ON, controller will continue to send out power per the set value of the last step after the program ends; controller will show "E n d" at the bottom display. To completely turn off the output, the user can hold down the STOP key until the bottom display shows "S t o P".

7.5. RELY -- Relay Configurations

This controller has two relays: Relay 1 (labelled as AL1) and Relay 2 (labelled as AL2). Parameters to configure each relay are identical. Those parameters that have the number "1" in their names are for Relay 1, and the parameters that have the number "2" in their names are for Relay 2. In this section, we'll explain these parameters in general, not particularly for Relay 1 nor Relay 2.

Table 15. RELY menu.

r ELY					
Display	Name	Description	Range	Default	Note
r L	rL	Relay mode.	OFF, ALAM, BEEP, ALBE, RAMP, HEAT, COOL, STEP, EXTN	OFF	1
r r	rRG	Relay working range.	MASH, BOIL, ALL	ALL	2
L P	LGC	Relay logic	rL-C, rL-O	rL-C	3
r LP	rLP	Relay programming.	None, 0 ~ 511, ALON	ALON	4
L R E	LAT	Relay latching mode	N, PUL	N	5
S IL	SIL	Relay silence/suppressing	ON, OFF	OFF	6
R H	AH	Absolute high alarm	OFF, 0 ~ 932 °F/°C	OFF	7
R L	AL	Absolute low alarm	OFF, 0 ~ 932 °F/°C	OFF	7
d H	DH	Deviation high alarm	OFF, 1 ~ 100 °F/°C	OFF	8
d L	DL	Deviation low alarm	OFF, 1 ~ 100 °F/°C	OFF	8
H Y	HY	Alarm hysteresis band	1 ~ 100 °F/°C	1	9
R P	AP	Pulsing duration	1 ~ 100 seconds	5	10

Note 1. rL, relay mode, determines how the relay works. The available modes are explained in the table and the figure below. Please refer to section 5.3 for details of program-sections.

Table 16. Relay Mode menu.

r L			
Display	Name	Descriptions	Note
o FF	OFF	Disable the relay.	
R L R	ALAM	Relay activated by temperature alarms, which are determined by parameter AH, AL, DH, and DL.	1.1
b E E P	BEEP	Relay is synchronized with on-board buzzer.	1.2
R L B E	ALBE	Relay activated by temperature alarms. The on-board buzzer also beeps when temperature alarms are triggered.	1.3
r R P	RAMP	Relay activated during ramp-up and ramp-down sections.	1.4
H E A T	HEAT	Relay activated during the ramp-up sections only.	1.5
C O O L	COOL	Relay activated during the ramp-down sections only.	1.6
S T E P	STEP	Relay activated during the step section only, i.e., timer-counting sections.	1.7
E X T N	EXTN	Relay activated during the extended-steps, which includes the ramp section and the step section.	1.8

Note 1.1 ALAM, temperature alarm, the relay will be activated when the alarm conditions defined by AH, AL, DH, or DL are met.

Note 1.2 BEEP. The relay is synchronized with the on-board event buzzer. The on-board buzzer goes off when an event happens, which are start of a program, end of a step, start of a step-timer, end of a program, pause of a step-timer, and resume of a step-timer.

Here is a special case. If a relay's, for example Relay 1, rL1 is set to **BEEP** and the other relay's mode rL2 is set to **ALBE**, that means the on-board buzzer will go off whenever the temperature alarms are triggered Relay 2 alarm settings, hence the Relay 1 will also pull-in as the buzzer goes off. When the on-buzzer is triggered by temperature alarms, the user can mute the buzzer by pressing the RUN key. Once the buzzer is muted, the Relay 1 will also drop out.

Note 1.3 ALBE, both the relay and the on-board buzzer will be activated when the temperature alarm conditions are met.

Note 1.4 RAMP. Relay will be activated during RAMP sections, i.e., the transition sections when the previous step has ended and before the next step starts. A ramp section is essentially a section between two steps when step-timer isn't counting time.

Note 1.5 HEAT. Relay will be activated during the HEAT sections, i.e., ramp sections where heating is needed.

Note 1.6 COOL. Relay will be activated during the COOL sections, i.e., ramp sections where cooling is needed.

Note 1.7 STEP. Relay will be activated during the STEP sections, i.e., when step-timer has been started and has not yet ended.

Note 1.8 EXTN. Relay will be active during Extended Step section, which include a STEP and its RAMP section.

Note 2. rRG, relay range, defines whether this relay works in MASH program only, BOIL program only, or in all programs. This parameter can be set to **MASH**, **BOIL**, and **ALL**. By default, it is set to **ALL**.

Note 3. LGC, relay logic, determines relay status before and after the alarm conditions are met. It can be set to Logic-Close (**RL-C**) or Logic-Open (**RL-O**). When a relay is set to **RL-C**, the relay is a normally open (NO) relay, i.e., the relay stays open when it is inactive; the relay pulls in (close) when it is activated. When a relay is set to **RL-O**, the relay is essentially a normally closed (NC) relay, i.e., it stays closed when it is inactive; the relay contacts open up (drop out) when the relay is activated. By default, **LGC** = RL-C, which should be used for most applications.

Note 4. rLP, relay programming, is a parameter that determines at which steps in a program the relay is allowed to function per its relay mode (rL, see note 1 in this section) setting. This parameter has a numeric value ranging from 0 to 511, where "0" means the relay is not allowed to function at any step in a program, and "511" means the relay is enabled for all 9 steps in a program. Any other value in between 0 and 511 indicates that the relay is only allowed to function at certain specified steps. The calculation method is explained later in this section.

Two special codes, **NONE** and **ALON**, are added to the rLP values, where "none" is equivalent to "0", and "ALON" is equivalent to "511". By default, rLP = ALON, which allow the relay functioning for the entire program.

To use this feature, the user should decide at which steps the relay is enabled, and then use the equation below to calculate the value of rLP:

$$rLP = A \times 1 + B \times 2 + C \times 4 + D \times 8 + E \times 16 + F \times 32 + G \times 64 + H \times 128 + I \times 256,$$

where the letter A, B, C, and etc. are binary numbers, 0 or 1, representing whether the relay function is allowed at a particular step. The Table 17 shows the letter code, the code value, and the multiplier of each step. For instance, if the user wants to enable the relay function only at step 1 and 5, the rLP value should be 17 (rLP = A×1 + E×16 = 1×1 + 1×16 = 17). The value of rLP can be calculated by this online relay programming calculator [here](#).

Table 17. rLP calculation table.

Step #	Letter Code	Letter Code Value		Multiplier
		Disabled	Enabled	
1	A	0	1	1
2	B	0	1	2
3	C	0	1	4
4	D	0	1	8
5	E	0	1	16
6	F	0	1	32

7	G	0	1	64
8	H	0	1	128
9	I	0	1	256

Special Note

1) This parameter **rLP** imposes a hard constraint on at which steps the relay function is enabled. However, whether the relay will be actually activated depends on the relay mode (**rL**) setting and whether the activating condition is met. This parameter applies to all relay modes.

2) The "step" here refers to the "extended step", which includes a step and the ramp section prior to the step. Please see section 5.4.

Note 5. LAT, latching mode, determines how should a relay returns back to its deactivated status once it is activated. It only affects the relay if the Relay Mode **rL** is set to **ALAM** or **ALBE**. This parameter can be set to **N** (normal/non-latching) or to **PUL** (pulsing).

When **LAT = N** (normal), the relay will be activated when the alarm condition is met, and it will be deactivated when as the alarm condition is removed. When **LAT = PUL** (pulsing), once the alarm is triggered, the replay will stay in the activated status for a pulse duration that is defined by parameter **AP** (please see Note 10 in this section). This function is useful in situations where the user only needs to energize the buzzer for a short period of time once the alarm is triggered.

Note 6. SIL, alarm-silence/suppression, determines whether to suppress the Absolute Low Alarm (**AL**) when the controller just starts running the program and the water or wort temperature is still lower than the Absolute Low Alarm (**AL**). By default, **SIL** is set to OFF. If **SIL = ON**, controller will suppress the relay action at the very first time that the Absolute Low Alarm (**AL**) is triggered. If the Absolute Low Alarm (**AL**) is turned off, the **SIL** setting has no effect on the relay actions.

Note 7. AH (Absolute High Alarm) and **AL** (Absolute Low Alarm), defines the high and low temperature alarms that applies to the entire control process from the beginning of a program till the end of a program. When the temperature is higher than **AH**, the alarm relay will be activated; it will be deactivated when temperature drops below (**AH - HY**). Similarly, when the temperature is lower than **AL**, the alarm relay will be activated; and it will be deactivated when the temperature rises above (**AL + HY**). However, please note, absolute alarms won't work in situations where a program is ended or stopped.

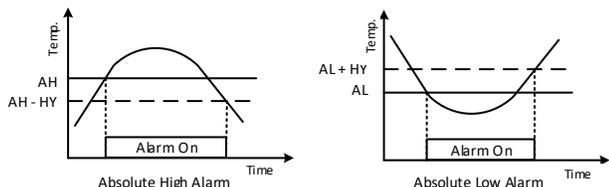


Figure 17. Absolute alarms.

Note 8. dH (Deviation High Alarm) and **dL** (Deviation Low Alarm), defines the how much temperature deviation from the set temperature (**SV**) is allowed before the alarm is triggered. For mashing steps, the set values are temperatures. When the temperature is higher than (**dH + SV**), the alarm relay will be activated; it will be deactivated when temperature drops below (**dH + SV - HY**). Similarly, when the temperature is lower than (**SV - dL**), the alarm relay will be activated; it will be deactivated when the temperature rises above (**SV - dL + HY**).

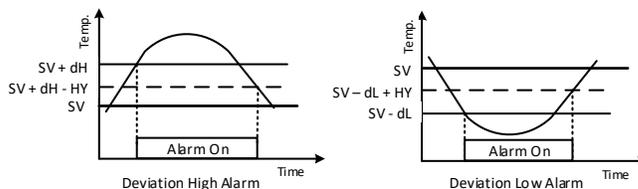


Figure 18. Deviation alarms.

Special Note: deviation alarms only applies to mashing steps and only when the step-timer has started; it doesn't apply to the ramp sections of a program nor applies to boil-steps.

Note 9. HY, hysteresis/differential band, determines the difference between the temperatures of activating and deactivating an alarm. By default, **HY = 1**.

Note 10. AP, alarm pulsing duration, determines the time duration of which a relay should stay activated if a relay's **LAT** is set to **PUL**. The unit is in second, and the range is from 1 to 100 seconds.

7.6. SYST – System Settings

System parameters for the controller.

Table 18. SYST menu.

SYST					
Display	Name	Description	Range	Default	Note
Pb	Pb	Probe offset	-20.0 ~ 20.0	0.0	1
E-F	C-F	Temperature unit	°F, °C	°F	2
PUS	PUS	Power-up setting.	INST, DELY	DELY	3
ART	ART	Auto-return time, unit in seconds	10 ~ 60 sec	30 sec	4
Knob	KNOB	Knob operation.	y / n	y	5
MUAL	MUAL	Mute alarm relay.	n / y	n	6
VER	VER	Firmware version. Display only.			7
INIT	INIT	Initialization, factory reset.	n / y	n	8

Note 1. Pb, probe offset. **Pb** is a value added to the probe reading to compensate the error produced by the sensor or input signal itself. Normally it should be left at zero. For example, if the controller reads 33°F from a probe immersed in well prepared ice bath which is supposed to be 32°F. Set **Pb = -1.0** and so the controller should show 32°F. The resolution of **Pb** is 0.1°F or °C, which enable the user to calibrate the probe reading with high resolution thermometers.

Note 2. C-F, temperature unit, can be set to °F (Fahrenheit) or °C (Celsius). Changing the temperature unit only affects the probe reading. The numerical values of set temperatures and other temperature related settings will not be changed or converted.

Note 3. PUS, power-up setting, determines how should the controller start the program and send out control signal. When **PUS = INST**, controller starts executing its program once it is powered up. **PUS = DELY**, program won't be executed until the user press the RUN key to start the program.

Note 4. ART, auto-return time, determines how long should be the controller wait, if no key is pressed, before it returns from the menu list to the normal operation mode. The unit is in seconds, and the default value is 30 seconds.

Note 5. KNOB, knob operation, determines whether the controller allows the user to change the set-value and the step-timer using the knob from the main interface while the program is running. When **KNOB = Y**, this operation is allowed. When **KNOB = N**, this operation is not allowed.

Note 6. MUAL, mute alarm-relay option, determines whether the user can cancel the relay action by pressing the RUN key when a relay is activated by temperature alarms. This setting only applies to Relay Mode **ALAM** and **ALBE**. And this parameter setting only affects the relay action, not the on-board buzzer. In situations where the on-board buzzer is triggered by temperature alarms, i.e., one of the relay's **rL** is set to **ALBE**, pressing down the RUN key will always mute the on-board buzzer.

Note 7. VER, firmware version.

Note 8. INIT, initialization, allows all parameters to be reset back to factory default values if the user select **INIT = Y**.

8. On-board Buzzer Sound

The on-board buzzer will give different sound at different program events. The table below listed different sounds and the corresponding events. The program-related sound cannot be muted. When the buzzer is triggered by temperature alarms, the user can use the RUN key to temporarily mute the on-board buzzer. The alarm buzzer will be re-activated once the temperature moves out from the alarm-zone.

Table 19. Buzzer sound.

Buzzer Sound	Event
One short beep	<ul style="list-style-type: none"> Start of a program Pause/resume a step-timer
Three short beeps	<ul style="list-style-type: none"> Temperature reaches the timer-start-point, i.e., a step-timer starts counting down time.
Two long beeps	<ul style="list-style-type: none"> A step-timer is reached, i.e., the end of a step.
Four long beeps	<ul style="list-style-type: none"> A program is ended or stopped.
Long beeps, continuously	<ul style="list-style-type: none"> Temperature alarm is triggered (only applies to situations where Relay Mode, RL1 or RL2, is set to ALBE.

9. Sensor Error

If there is no sensor connected or the sensor input signal is out of range, the controller will show Out of Range Alarm on the top window, i.e., flash "o r R L" and 932°F (or 500°C) in the top window. When the controller detects sensor error, it will stop all outputs and pause the program if a program is running. The program will be resumed if the sensor error is removed.

10. Application and Wiring Examples

10.1. Using DSPR320 for low-oxygen brewing in a BIAB setup.

In this example, a DSPR320 is used to control the heater in a BIAB kettle. The Relay 1 will be used to control the wort-circulation pump during mashing, and the Relay 2 will be used to control a smaller pump for circulating cold water through an immersion chiller to cool the wort. The program we used in this example is fictional but based on a real recipe.

In the Main Menu, go to **mPRG** and enter the MASH program.

Step #	mX-S	mX-t	Note
1	P 25%	00:05	Boil water for 5 min.
2	P 25%	HOLD	Prepare a mineral/additive addition.
3	200	00:01	Reminder for adding mineral/additive.
4	150	00:00	Cool water temperature to 150°F, add grain.
5	144	HOLD	Stop heater while adding grain.
6	144	00:45	Mashing at 144°F for 45 min.
7	160	00:45	Mashing at 160°F for 45 min.
8	170	00:15	Mash-out rest.
9	170	CONT	Continue to the Boil Program.

Then, go to **bPRG** and enter the BOIL program.

Step #	bX-S	bX-t	Note
1	P 25%	00:30	Add hops for bittering, boiling for 60 min.
2	P 25%	00:15	Add hops for flavoring, boiling for 30 min.
3	P 25%	00:10	Add hops for flavoring, boiling for 15 min.
4	P 25%	00:05	Add hops for aroma, boiling for 5 min.
5	80	END	Cool the wort.

In the **RELY** menu, the following parameters need to be changed from their default values. Other unchanged parameters are not listed in this table.

Name	Value	Note
rL1	EXTN	Relay 1 controls the wort pump, which runs during step 6, 7, 8, and 9 in Mash Mode.
rRG1	MASH	
rLP1	480	
rL2	COOL	Relay 2 controls a small pump to circulate cold water through a chiller during all the ramp-down sections of both Mash and Boil programs.
rRG2	ALL	
rLP2	ALON	

10.2. Wiring Examples

Example 1. Using DSPR320 with 120 VAC or 240 VAC to drive a DC triggered AC SSR to control a heater.

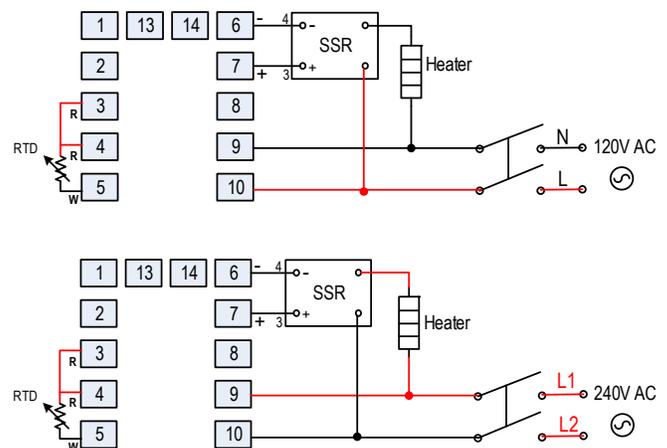


Figure 19. Using DSPR310D in a 120 VAC system (top) and in a 240 VAC system (bottom) to drive an SSR and control a heater.

Example 2. Using the Relay 1 and Relay 2 on DSPR320 to drive an external buzzer.

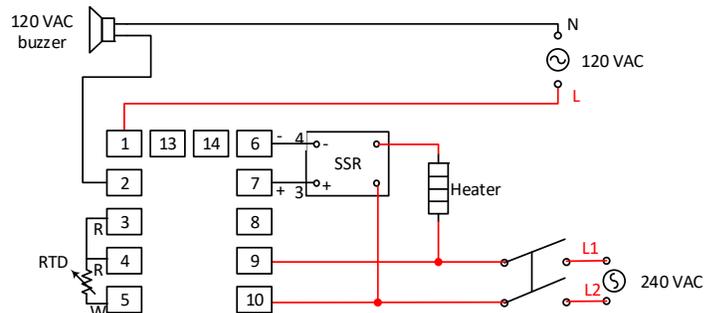


Figure 20. Use the Relay 1 (pin 1 and 2) on DSPR320 to drive an external buzzer.

