Using Relay 1 on EZboil for Accelerated Heating

For DSPR300 / DSPR400

Version 1.0 (August, 2016)

Background

When selecting or designing a water heating system for beer brewing or other similar applications, it is ideal to have both the speed in ramping up the temperature and the stability in maintaining the temperature. To achieve this balance, the power of the heating element(s) should be in an appropriate proportion to the volume of water to be heated. Most water heating systems have a power to volume ratio in the range of 300 to 400 watt/gal. To raise the temperature of one gallon of water by one Fahrenheit degree, it takes 0.0244kWh of power. In such systems, it usually takes about 36 min to 27 min to heat water from room temperature (R.T.) to mashing temperature (~152˚F), or it takes about 66 min to 49 min to rise from R.T. to boiling temperature (212˚F). For a system that has power to volume ratio of 200 watt/gal, it takes will take 54 minutes to bring water from room temperature to mashing temperature, or it will takes 98 minutes to rise from R.T. to boiling temperature. It might be too long for boiling, but still okay for mashing control.

Table 1. Time needed to bring water from room temperature to typical mashing or boiling temperature.

Power/Volume Ratio (kWh/gallon)	Time to Reach Mashing Temp. (min)	Time to Reach Boiling Temp. (min)
400	27	49
300	36	66
200	54	98

When comes to selecting a switching device for precision temperature control, most people prefer solid state relays (SSR) over electromechanical relays (contactor). A SSR can be switched at high frequency (fast on/off speed) and it doesn't wear out since there is no moving parts in it as appose to mechanical relays/contactors. However, one of the problems of using SSR is that it generates heat due to internal resistance. The heat must be removed from the SSR to prevent itself being melted down. In general, when a current passing through a SSR, each ampere of current generates about 1.3 to 1.5 watts of heat. For instance, when a SSR pass a 100 ampere current at 120Vac, more than 130 watts of heat will be generated. A heat sink that is capable of removing such heat is large in size, and it may also need a cooling fan to improve the efficiency in dissipating heat. Such a design increases the complicity of the control panel and reduces its reliability.

However, the heat dissipation issue of the SSR exists mainly during the initial heat up process when the heater draws full power over an extended period. Once the temperature has reached the set point, the power consumption drops down greatly, hence the heat generated in the SSR is greatly reduced. We have noticed that for most of water heating devices, the power needed to hold the temperature stable is normally about 15 to 30% of the total power capacity of the heater.

With that in mind, user can introduce a secondary heating element switched by a contactor dedicated to speed up the initial heating up process. And so a less powerful heating element can be used with a SSR as the primary heating element, which will be used for the entire heating process, and it will be the only element used for maintaining temperature. Then there is no heat dissipating issue on the secondary element and heat generated from the SSR is also reduced. Therefore dissipating issue become less complicated.

New Method: Using Relay 1 on EZboil

A new feature in Auber's DSPR300/DSPR400 is designed to accomplish this control idea on one unit. The newly added relay mode, acceleration mode (RL1 = ACC), provides a simple solution for making a compact and more reliable high power multi elements system. One (or more) heating element will be connected to SSR(s) that is controlled by the main output of EZboil. This element is called primary heating element, and it will be used throughout the entire heating process. Another (or more) heating element will be connected to a contactor controlled by Relay 1 (AL1). This element is called secondary heating element, and it will only be used for the initial heating up process. But please note the name primary or secondary doesn't necessarily suggest which element should have more power.

This approach has several advantages: 1) the system is more compact because it reduces the requirement of big heat sinks and eliminate the need for a cooling fan; 2) the cost can be lower because switching the same amount of power by a contactor costs less switching by a SSR; 3) it is more reliable because less heat generated in the control panel. Since the contactor only needs to be switched once for each heating up process, its life is not an issue. In addition, this approach will give you a better control result because the wattage of heater on the SSR is closer to what is needed at a steady state. It reduces the chances for temperature overshot. For the ease of discussion, we call this method as "RL1+SSR" method. And we'll call the method of using controller's main output with SSRs to control all heating elements as traditional method.

Using the RL1+SSR method for boil or distill control is not so different from using traditional method because the operator has to manual tune the output power sent to the Primary element. But when using the RL1+SSR method for mashing control, a new parameter PR (Power Ratio) must be introduced for the AI program in EZboil in order to keep the temperature stable. This parameter PR is defined as the ratio of the power controlled by the SSR over the total power, i.e., PR = power of primary

element / (power of primary element + power of secondary element). For instance, PR = 0.3 means the power controlled by the SSR is only 30% of the total power used for heating the water; PR = 1 (default) means the all of the heating elements are controlled by the SSR. In many commonly seen water heating devices, the power needed to maintain mashing temperature is less than 30% of the full power.

For this particular application, we define the "typical" water heating system should have the power to water volume ratio in the range of 200 to 400 watt/gal, where the power is the summary of power of heating elements controlled both by contactors and SSRs, and the volume is the actual volume of water instead of the volume of the container. When you design a multi-element water heating system, it's recommended to keep that power to volume ratio in the range of 300 to 400 kWh/Gallon, and make sure the power controlled by SSR is no less than 30% of its total power, i.e., keep the PR between 0.3 and 1.0.

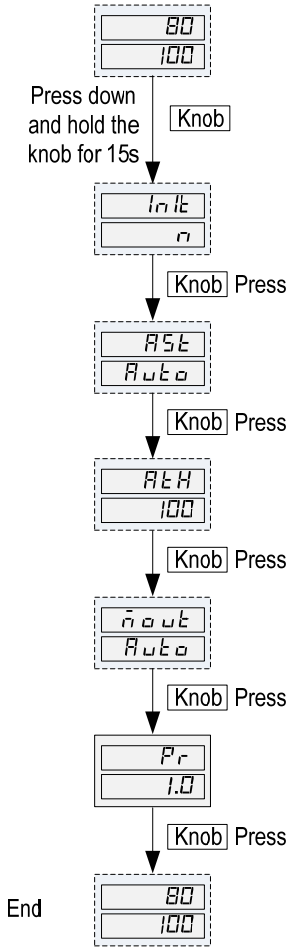

Figure 1. Flow chart of how to change parameter PR.

When an operator use the RL1+SSR method on EZboil to control a multi-element heating system, PR setting should be adjusted accordingly. For a given "typical" water heating system, calculating PR is straight forward. If the power/volume ratio of your system is significantly greater than 400 watt/gal, please contact us for how to adjust the system.

The parameter PR is in a hidden menu not mentioned in the user manual. Press and hold the button for 15s to enter this menu, and then follow the flow chart in Figure 1. PR is the last parameter in this menu. Please do not change other parameters.

(End)

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