Instruction Manual

EZboil, Power Regulator for Boiling Process Automation DSPR300

Version 1.3 (May, 2021)

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

Input type	RTD (Resistance Temperature Detector): Pt100
Accuracy	± 0.2% full scale
Temperature range	-328°F ~ +932°F, -200°C ~ +500°C
Response time	≤ 0.5s
Display resolution	1°C or °F
Control mode	Mashing, Boiling
Alarm function	Process/derivation high/low alarm, Acceleration and timer alarm, Latching/pulse action
Alarm output	Relay contact: 3A for resistive load. 1A for inductive load
Power supply	85~260 VAC/50~60 Hz
Power consumption	≤ 5 Watt
Working Ambient temperature	0~50ºC, 32~122ºF
Dimension	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 DSPR300.

1). Top display. This display indicates the temperature sensor read out value. When timer is activated, it will show time and temperature alternately.
2). Bottom display. In boiling mode, this display will show the percentage of power being sent to the external SSR after the initial heat up phase. In mashing control mode, this display will show the set temperature.
3). Temperature setting adjusting indicator. This is the small dot at the lower right corner. In mashing mode, when temperature set point is adjusted, it will start to flash. It reminds you that you need to press the knob to confirm the change. Otherwise, the temperature setting will return back in 2 seconds after you stop the adjustment.
4). AL1 indicator. This red LED indicates the status of Relay 1 (AL1). When it is on, the relay is closed; when it is off, the relay is open.
5). AL2 indicator. This red LED indicates the status of Relay 2 (AL2). When it is on, the relay is closed; when it is off, the relay is open.
6). Mashing mode indicator (MASH). This yellow LED light indicates the operation mode of the controller. When it is on, controller is in mashing mode; when it is off, controller is in boiling mode.
7). Output indicator (OUT). This green LED light is synchronized with output. It shows how much power the regulator is sending out (as a 12VDC control signal pulse through terminal 6 and 7). When it is on solid, the output is 100% on. When it is off, there should be no output. When it is flashing, the frequency of the flashing is an indication of high or low power output. Higher frequency means higher power output.
8). Rotary switch (knob). Turn it clockwise to increase the output power (or selected parameter value); turn it counter-clockwise to reduce the output power (or selected parameter value). Press it briefly to reset the timer (if enabled) and to switch between mashing and boiling mode. Press and hold it for 5 seconds to enter parameter settings menu. Please see section 6 for details.
9). Function key A & B. There are two Function Keys named "A" and "B" can be used to reset/cancel relays. Key "A" is for Relay 1, Key "B" is for Relay 2. Please check note 20.

3. Wiring Terminals

The pin assignment of the back terminals of DSPR300 is shown in Figure 2.

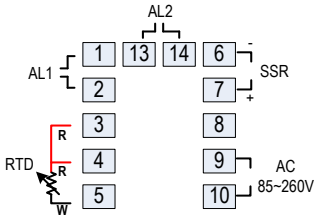

Figure 2. Terminal assignments of DSPR300.

3.1 Sensor connection

DSPR300 only accepts Pt100 RTD temperature sensor. For a three-wire RTD with standard DIN color code, the two red wires should be connected to the terminals 3 and 4. The white wire should be connected to terminal 5. For a two-wire RTD, the wires should be connected to terminals 4 and 5. Jump a wire between terminals 3 and 4.

3.2 Power to the controller

The power cables should be connected to terminals 9 and 10. Polarity does not matter. It can be powered by 85-260 VAC power source. Neither a transformer nor jumper is needed to wire it up. For the consistent with the wiring example described later, we suggest you connect the hot wire to terminal 10 and neutral to 9.

3.3 SSR output connection

The SSR control output of the DSPR300 provides a 12 VDC signal that can control up to 5 SSRs in parallel. Connect terminal 7 to the positive pole of the SSR (terminal 3 on Auber's SSRs). Connect terminal 6 to the negative pole of the SSR (terminal 4 on Auber's SSRs). Please make sure the SSR is installed on the heat sink with proper current rating.

4. Display Status

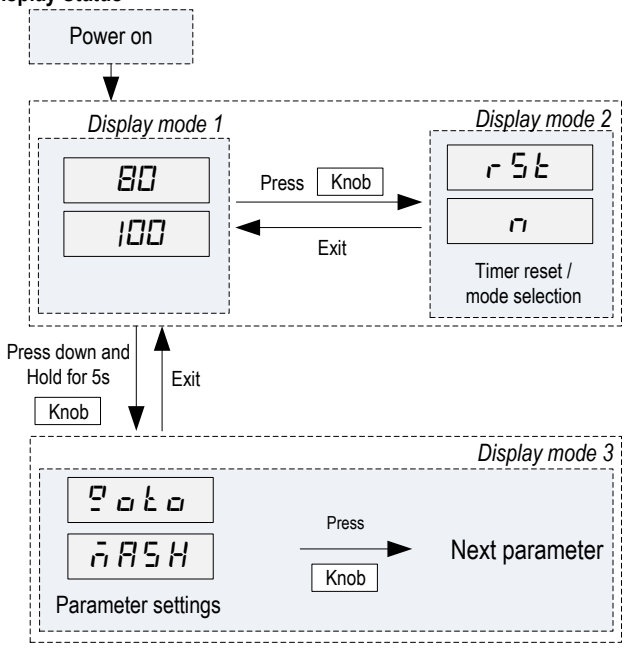

Figure 3. Display modes of DSPR300.

Display mode 1 (Normal operating mode): When power is turned on, the top display window shows the current sensor temperature reading. When timer is activated, the top display will be switched between the current temperature and current time alternately. In mashing mode, the bottom display will show your set temperature. In boiling mode, the bottom display will show your current output percentage (e.g. P50 for 50% power output). Please check section 5 for how to adjust set temperature/power.

Display mode 2 (Timer reset & Operation mode selection): This display mode allows you to reset the timer, or to switch between the mashing and boiling operation mode.

A short press of the knob will enter this display mode.

1) The display will show "rSt" on top and "n" at the bottom. This is the exit menu. If you enter this mode by accident, you can press the knob again to exit this display mode without changing anything.

2) Rotate the dial clockwise for one click will change the bottom display to "y". This menu is to reset the timer. Press the knob will reset the timer. It has two purposes. A) If you want to use the timer as regular timer without correlation to the temperature, you can start the timer at any time by the reset button. B) After timer is timed up and process ended, you can restart the process again by the reset button instead of power off the system and power it on again.

3) Rotate the knob with two clicks, the top display will change to "Mode" and bottom will show "Mash*". Rotate the knob again, the bottom display will change to "boil". These two menus are for setting the controller to either mashing control or boiling control mode. Press the knob will set the controller to the operation mode displayed. Please check section 5.1 for details.

Display mode 3 (Parameter settings): Press down and hold the knob for 5 seconds to enter the display mode 3. Please check section 6 for details.

5. Operation

5.1 Operation mode selection

This controller offers two operation modes, mashing and boiling. When the mashing mode is selected, the controller functions as a temperature controller. It automatically adjusts the power output to hold the temperature at set point. When boiling control mode is selected, the controller functions as a power regulator. It allows the user to manually adjusting the power to control the strength of the boil. Figure 4 shows how to select and switch between these two modes.

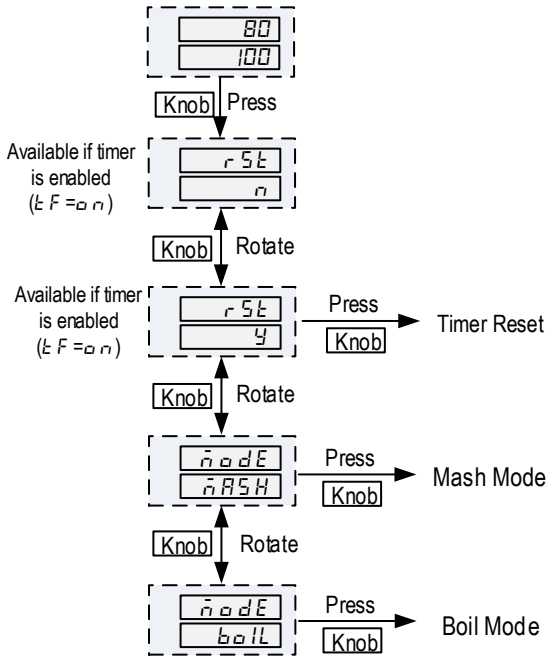

Figure 4. Flow chart for timer reset & operation mode selection.

Press the knob once. The display will show "rSt". Rotate the knob with two clicks, the top display will change to "Mode" and bottom will show "Mash*". Press the knob will set the controller to mashing mode. When mashing mode is selected, the yellow indicator on the top left corner of the panel will lit. This indicator will be off if the boiling mode is selected.

Note: due to the limitation of 7 segment LED display, the letter "M" is displayed as "n".

5.2 Mashing Operation

When first powered up, make sure the controller is in the mashing mode: The yellow colored mashing mode indicator on the upper left corner should be on, and the bottom display has no "P" on the left. If not, please change the control mode to mashing mode as discussed in section 5.1 above. If you were using the controller in the mashing mode when powered off last time, the controller will start in mashing mode.

After controller is powered up, the top LED displays the current temperature reading from the sensor. If temperature sensor is not connected, it will show "orAL". The bottom LED displays your set temperature. To adjust its value, just rotate the knob. Once the value of the setting is changed, a small dot on the right bottom corner will be flashing. It tells you that the setting has been changed but not confirmed. After you adjust the temperature to the desired number, **push the knob to confirm the change**. After confirmation, the new setting will remain on the display and the dot will be turned off. If you forgot to push the dial, the display will return to original set temperature after 2 seconds. The set point will remain unchanged. This mechanism is for preventing temperature set point change by accident.

The Output indicator will stay on solid right after powered up. This mean the controller is heating up the kettle at maximum speed. Once the temperature is getting close to the set point, the output indicator will start to flash at slower rate or take a pause. It indicates the controller is trying to modulating the power to hold the temperature stable.

For how to set up the timer in mashing mode, please read section 6.2.

5.3 Boiling Operation

When first powered up, make sure the controller is in the boiling mode: the mashing mode indicator on the upper left corner is off and bottom display has a "P" on the left. If not, change the control mode to boiling mode as discussed in section 5.1 above. If you were using the controller in the boiling mode when powered off last time, the controller will start in boiling mode.

The top LED displays the current temperature reading from the sensor. If temperature sensor is not connected, it will show "orAL". The controller will not turn on the heater if the sensor is not connected. The bottom LED displays the boiling output in percentage of the power. For example, if you use a 5500 Watts heater, "P50" mean the heater is running at 50% of power, or 2750 Watts (5500 x 50% = 2750). The symbol "P" on the left is for making sure that the display does not get confused with temperature setting of the mashing mode. You can rotate the knob to adjust the output value. The new setting will take effect automatically. There is no need to push the knob to confirm as the temperature setting change in the mashing mode. For the first time use, while the controller is still in the acceleration phase, you should set the boiling output to a value below 60%. Once the controller finished the acceleration, it will switch to this power level automatically. After getting familiar with your system, you can set to a higher value that produce a rolling boil without boiling over.

When the controller is powered up, the output indicator will stay on solid. This mean the controller is in the acceleration phase. Once the temperature rise above the acceleration phase, the power output will be reduced to the value as shown on the bottom display. The Output indicator will start to flash at slower rate.

Note, when adjusting the boiling output setting while the controller is still in the acceleration phase, the new setting will be shown on the bottom display. However, it will not take effect until the acceleration phase is finished. If you want to manually control the power output during the entire boiling process, set **bAST** to zero (see section 6.3 for details).

For how to set up the boiling mode, please read section 6.3.

6. Control Parameters

Parameters are divided into four groups (figure 5): **MASH** for mashing control**, BOIL** for boiling control, **ALAM** for alarm settings and **SYST** for system configuration. The same type of parameter may have slightly different names when used in different mode. For example, the timer setting in mashing mode is called "**t**", while this parameter is called "**bt**" in the boiling mode.

To enter parameter setting mode, press and hold the knob for at least 5s. Then you will see "GOTO" on the top display. Rotate the knob, you will see the bottom display changes with three different names: **MASH** (for mashing parameters, figure 7), **BOIL** (for boiling parameters, figure 8), **ALAM** (for alarm settings, section 7) and **SYST** (for system settings, figure 6). The parameter values are stored in the controller memory. All the settings remain unchanged if you power it off.

Push the dial to enter the selected parameter group. Then top display shows the current selected parameter name, and the bottom display shows its value/options. Rotate the knob clockwise to increase the value, and rotate it counter-clockwise to reduce the value. Faster rotating speed will change the value rapidly. Once finished, press knob again to confirm and go to next parameter. You can press the knob repeatedly to exit the setting quickly.

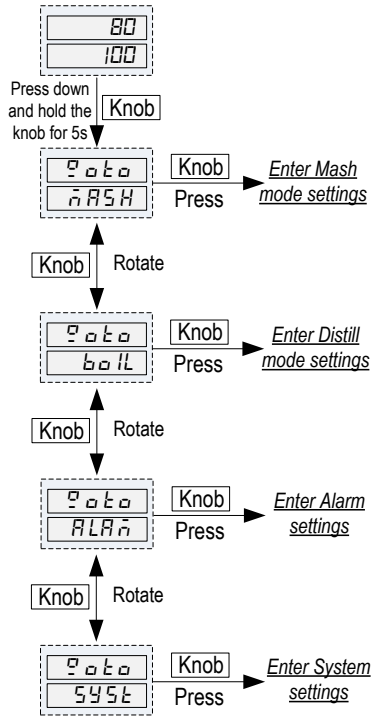

Figure 5. Parameter group selection

6.1 System settings

Parameters that configure this controller and the relays are grouped under this menu.

Table 1. System configuration parameters.

System Configuration					
Display	**Code**	**Description**	**Setting Range**	**Initial Setting**	**Remark**
tF	tF	Timer function	ON, OFF	ON	Note 1
tdIr	tdIr	Timer counting direction	dn, uP	dn	
Pb	Pb	Temperature reading offset	-100~+100 °C or °F	0	Note 2
C-F	C-F	Temp. display unit	°C, °F	°F	Note 3
rL1	RL1	Please check Section 7.			
Lgc1	Lgc1				
LAt1	LAt1				
SiL1	SiL1				
rL2	RL2				
Lgc2	Lgc2				
LAt2	LAt2				
SiL2	SiL2				
Key	Key				

Note 1. Timer settings: tF, tdIr

tF. The **timer function** is controlled by a master parameter **tF**. When it is set to **ON**, the timer function (for both mashing and boiling modes) is enabled. When **tF** is set to **OFF**, the timer function is disabled.

tdIr: Timer direction parameter. Set it to **up** for timer counting up and **dn** for timer counting down.

Note 2. Input offset: Pb

Pb is used to set an input offset to compensate the error produced by the sensor or input signal itself. For example, if the controller displays 2ºC when probe is in ice/water mixture, setting Pb = -2, will make the controller display 0ºC.

Note 3. Temperature unit setting: C-F

C-F determines the temperature unit. It can be set to **C** (Celsius, ˚C) or **F** (Fahrenheit, ˚F).

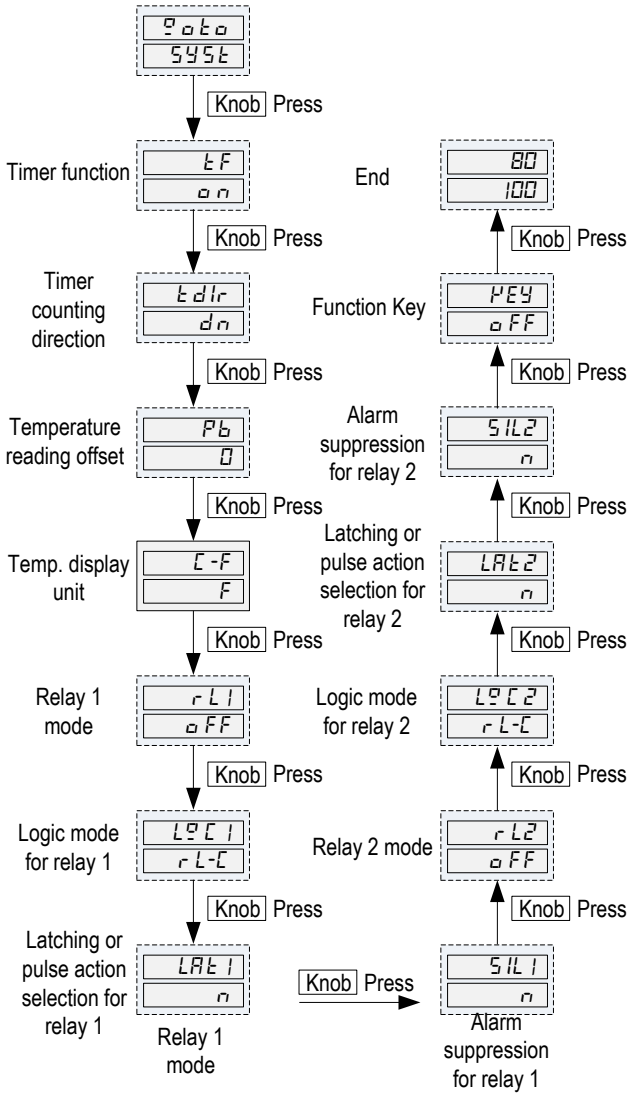

Figure 6. Flow chart of setting system parameters.

6.2 Mashing Parameters

Table 2. Mashing parameters.

Mashing Mode Parameters					
Display	**Code**	**Description**	**Setting Range**	**Initial Setting**	**Remark**
t	t	Mashing time set value	00:00~99:59 (hour: minute)	1:00	Note 6
tSP	tSP	Mashing timer start temp.	-999~+9999 °C or °F	151	
ALH	ALH	Mashing alarm set temp.	-999~+9999 °C or °F	150	Note 7
Eo	EO	Mashing ending options	ON, OFF	OFF	Note 6
oScr	oScr	Overshoot correction	-50~+50	0	Note 8
AttE	AttE	Attenuation constant	-2~+2	0	

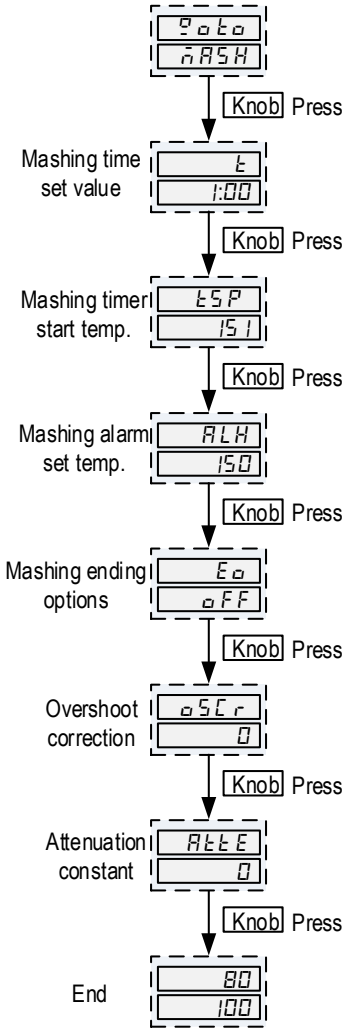

Figure 7. Flow chart of setting mashing parameters.

Note 6: Timer Function: t, tSP, EO

This timer function allows the controller to show the mashing time. It makes a beeping sound when timed out and will display the process is ended. It can also automatically shut off the controller's power output after time out. The **time duration** is set by the **t** parameter for mashing mode. The unit is hour: minutes.

When timer function is enabled, the timer counting will be started by **timer start temperature, tSP**. When temperature reaches timer start temperature, the timer starts to count. After timer started counting, it will continue even if the temperature drops below this start temperature. The timer can be reset to start from beginning again. To reset the timer, press the knob momentarily, the display will show **rSt** on top and **"n"** at the bottom, rotate the dial clockwise will change the bottom display to **"y"**. Press the knob again will reset the timer (Figure 4)

After the timer starts, the top display will be switched between the current temperature and current time alternately in every 6 seconds. The temperature and time display can be easily differentiated with their appearance. The temperature reading has two or three digits. For example, 212 degrees will be displayed as "212". The timer display has four digits with flashing colon in the middle. For example, "01:20" for 1 hour 20 minutes.

When time counting ends, the controller will generate six long beeps. The top display will switch between the current temperature and "**End**" alternately. After timer ends, the power output can be configured either to continue heating, or shut off. It is controlled by the parameter called **ending options, EO**. Set it to **ON** for continue heating, set it to **OFF** to turn off the output.

If you want to use the timer as a regular timer without correlating to the temperature setting, you can set the tSP below the ambient temperature (or zero). The timer will start as soon as the regulator is powered up. You can use the reset button (rSt) to reset the timer at any time.

Note 7: Alarm Function: ALH
EZboil has a built-in buzzer that can be programmed to beep when temperature reaches the **alarm set temperature, ALH.** The alarm will generate four short beeps every time the temperature rise from below ALH to higher than ALH. The alarm function can be used to notify the operator when temperature is approach the boil. The alarm function does not affect the heating or the time function, it only provides the alarm sound.

Note 8: Temperature Control Tuning Parameters: oScr, AttE
The mashing control mode utilizes AI algorithm instead of the commonly used PID or On/off control algorithm. The program is optimized for beer mashing. For most system, there is no need to tune. It allows the system to heat up at maximum speed, then hold the temperature stable with one-degree precision. If you are not satisfied with the control result, these two parameters will help you to fine tune the system. The **overshot correction, oScr** is for adjusting the temperature overshot during the initial heat up. For example, if the temperature overshot 3 degrees, set oScr = 3 should remove the overshoot. This parameter has no effect after the temperature reach the set point. The **attenuation constant, AttE** is for adjusting the temperature stability during mashing. The value is from -2 to +2. The default value is 0. If the temperature fluctuates more than one degree, user can increase the value. If the controller takes too much time to correct the temperature drop, user can reduce the AttE to make the system more responsive.

6.3 Boiling Parameters
For the easy of discussion, we divide the boiling mode into two phases, the **initial heating phase** and **boiling phase**. During the initial heating phase, power output is set high to accelerate the temperature rise. During the boiling phase, the power output is lowered to prevent the boiling over. We name the output setting for the boiling phase as "**Boil Output**" setting. Its value is always displayed on the bottom LED display and can be adjusted by turning the knob.

The acceleration power output setting is not displayed at bottom display during initial heating, because it rarely set to less than 100%.

Table 3. Boiling parameters.

Boiling Mode Parameters					
Display	**Code**	**Description**	**Setting Range**	**Initial Setting**	**Remark**
bASt	bAST	Boiling acceleration set temp.	-999~+9999 °C or °F	200	Note 9
boUt	bOUT	Boiling acceleration output power	0~100%	100	
bt	bt	Boiling time set value	00:00~99:99 (hour: minute)	1:00	Note 10
btSP	btSP	Boiling timer start temp.	-999~+9999 °C or °F	208	
bALH	bALH	Boiling alarm set temp.	-999~+9999 °C or °F	200	Note 11
bEo	bEO	Boiling ending options	ON, OFF	OFF	Note 10

Note 9: Acceleration heating function: bAST, bOUT
EZboil accelerates heating speed of the initial heating phase by running the heater at high power, then reduce the power once the temperature is getting close to the boil. The heating acceleration is controlled by two parameters, **Boiling acceleration set temperature, bAST** and **Boiling acceleration output power, bOUT**. The bAST set the temperature limit that below this temperature, the controller will output at a power determined by the bOUT. When temperature rise to the bAST, the output will automatically reduce to a lower level to prevent a messy boiling over. The boiling over is caused by several factors including the amount of foam on the surface and the power of the heater. The more foams there is, the easier it is to boil over. The vigorous the boil is, the easy it is to boil over. To preventing the boiling over, operator should skim the foam out and reduce the power as the temperature approaching the boiling. Since the heater power and liquid volume varies between each application, we suggest the bAST to be set at least 5 degree (Fahrenheit) below the boiling point for the first time use. As you getting familiar with your system, you can change this setting to higher or lower. The bOUT is the power used during initial heating phase. The unit is in percent of power. It should be set to 100% unless you have a very powerful heater with very small amount of liquid. The bOUT setting does not limit the power regulation range for boiling phase. **If you don't need to use this feature, set bAST to 0, so this controller will work as a manual mode controller over the entire temperature range.**

Note 10: Timer Function: bt, btSP, bEO
This timer function allows the controller to show the boiling time. It makes a beeping sound when timed out and will display the process is ended. It can also automatically shut off the controller's power output after time out. The **time duration** is set by **bt** parameter for boiling mode. The unit is hour: minutes.

When timer function is enabled, the timer counting will be started by **timer start temperature, btSP**. When temperature reaches timer start temperature, the timer starts to count. After timer started counting, it will continue even if the temperature drops below this start temperature. The timer can be reset to start from beginning again. To reset the timer, press the knob momentarily, the display will show **rSt** on top and **"n"** at the bottom, rotate the dial clockwise will change the bottom display to **"y"**. Press the dial again will reset the timer (Figure 4)

After the timer starts, the top display will be switched between the current temperature and current time alternately in every 6 seconds. The temperature and time display can be easily differentiated with their appearance. The temperature reading has two or three digits. For example, 212 degrees will be displayed as "212". The timer display has four digits with flashing colon in the middle. For example, "01:20" for 1 hour 20 minutes.

When time counting ends, the controller will generate six long beeps. The top display will switch between the current temperature and "**End**" alternately. After timer ends, the power output can be configured either to continue heating, or shut off. It is controlled by the parameter called **ending options, bEO**. Set it to **ON** for continue heating, set it to **OFF** to turn off the output.

If you want to use the timer as a regular timer without correlating to the temperature setting, you can set btSP below the ambient temperature (or just zero). The timer will start as soon as the regulator is powered up. You can use the reset button (rSt) to reset the timer at any time.

Note 11: Alarm Function: bALH
EZboil has a built-in buzzer that can be programmed to beep when temperature reaches the **alarm set temperature, bALH.** The alarm will generate four short beeps every time the temperature rise from below ALH to higher than ALH. The alarm function can be used to notify the operator when temperature is approaching the boil. The alarm function does not affect the heating or the time function, it only provides the alarm sound.

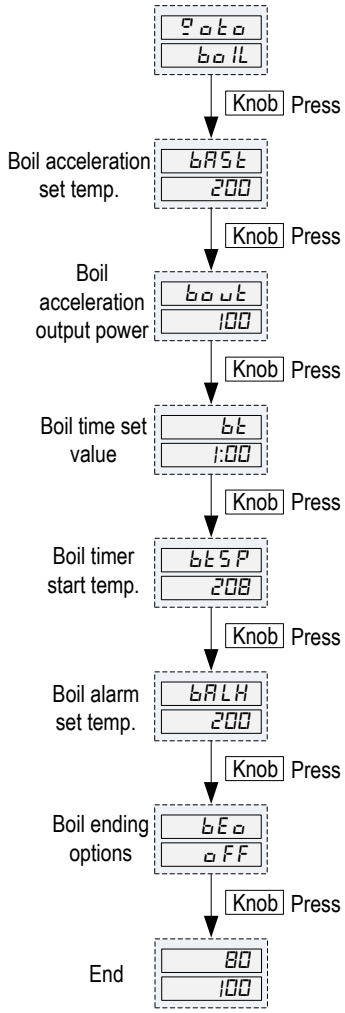

Figure 8. Flow chart for boiling mode settings

7. External Relay Settings

7.1 Introductory

This controller contains two normally open (N.O.) relays that can be used for controlling external devices such as buzzers, contactors, and valves. The relays are dry switches that can handle a 3 Amps of resistive loads or a 1 Amp of inductive loads. These relays can be programmed as process (absolute) alarms, deviation alarms, or act in synchronization with the controller's timer as well as the acceleration phase. There are a few advanced features of these relays. The action of a relay can be synchronized with alarm conditions, can be a single pulse for a pre-determined time duration, or can be latched action that can only be turned off by human intervention. The relays can be set either to close the contacts, or to open the contacts when alarm condition meets. In addition, Relay 1 (AL1) can be set to act in synchronization with the acceleration heating phase of the main control output. This feature enables the user to control external contactors and so to employ extra heating elements during acceleration phase. The Relay 2 (AL2) can be set to act in synchronization with the timer for mashing or boiling. User can use this Relay 2 to drive an external indicator or a valve that need to be turn on when the time is up.

Parameters for configuring relays are divided into two groups. The first group of parameters is for determining the functions of relays. They are nested under the system configuration settings (see Table 4). Once they are set for a particular application, there is no need to change them. The second group of parameters is for alarm on/off temperatures and alarm durations. These parameters are nested under alarm configuration settings (see Table 7).

7.2 Relay related parameters in system settings

In the menu for system settings, there are five pairs of parameters for configuring relays.

Table 4. Alarm Parameters in System Configuration.

System Configuration (Alarm parameters part 1)					
Display	**Code**	**Description**	**Setting Range**	**Initial Setting**	**Remark**
tF	Please refer to Section 6.1				
tdir					
Pb					
C-F					
rL1	RL1	Relay 1 mode	Pr, De, Acc, Off	Off	Note 12
LGC1	Lgc1	Logic mode for relay 1	RL_C, RL_O	RL_C	Note 13
LAt1	LAt1	Latching or pulse action selection for relay 1	Y, PUL, N	N	Note 14
SiL1	SiL1	Alarm suppression for relay 1	Y, N	N	Note 15
rL2	RL2	Relay 2 mode	Pr, De, Time, Off	Off	Note 12
LGC2	Lgc2	Logic mode for relay 2	RL_C, RL_O	RL_C	Note 13
LAt2	LAt2	Latching or pulse action selection for relay 2	Y, PUL, N	N	Note 14
SiL2	SiL2	Alarm suppression for relay 2	Y, N	N	Note 15
KEY	Key	Function Key	On, Off	Off	Note 16

Note 12: RL (Relay Mode), determines which mode a relay should be working at. **RL1** is for Relay 1 and **RL2** is for Relay 2. Each relay has three modes. Process Alarm Mode (**Pr**) (also called Absolute Alarm) and Deviation Alarm Mode (**De**) are available for both Relay 1 and Relay 2. In addition, Acceleration Mode (**Acc**), which set the relay to synchronize with the acceleration phase of the main control output for the SSR, is only available to Relay 1. Timer Mode (**Time**), which set the relay to synchronize with the timer function, is only available to Relay 2.

When a relay is set as a Process Alarm, it can either be triggered by a process high alarm, by a process low alarm, or by both.

When a relay is set as a Deviation Alarm, it can be triggered by a deviation high alarm, by a deviation low alarm, or by both. Deviation alarms are only available in Mashing Mode. There is no set temperature in Boiling Mode or in Distilling Mode, and hence no deviation alarms.

When Relay 1 is set to work in Acceleration Mode, the relay action will be synchronized with the Acceleration Set Temperature. It can be set to pull-in either when the temperature is in the acceleration zone, or when the temperature is out of the acceleration zone. For details on how this can be used, please contact customer support.

When Relay 2 is set to work in Timer Mode, the relay action will be synchronized with the Mashing/Distilling Timer Start Temperature. It can be set to pull-in either when timer counting is finished, or when during the timer is counting. For details on how this can be used, please see note 6 & 10.

Table 5. Conditions of Relays Become Active or Inactive.

Relay Mode	Mashing Mode		Boiling/Distilling Mode	
	Active	Inactive	Active	Inactive
Process Alarm	PV < AL or PV ⩾ AH	AL ⩽ PV < AH	PV < AL or PV > AH	AL < PV < AH
Deviation Alarm*	PV ⩾ (SV + AH), or PV < (SV - AL)	(SV - AL) ⩽ PV < (SV + AH)	NA	NA
Acceleration	PV < SV**	PV ⩾ SV	PV < bAST	PV ⩾ bAST
Timer***	PV < tSP, or Preset Mashing Timer (t) is reached	PV > tSP	PV < btSP, or Preset Boiling Timer (bt) is reached	PV ⩾ btSP

Note *: Deviation Alarms are not available in Boiling Mode because there is no temperature set point.

Note **. The precise turning off point is determined by the AI program.

Note ***: Timer function **tF** should be set to ON if user wants to set Relay 2 to Timer mode (**RL2** = Time). If timer function **tF** was set of OFF, Relay 2 will remain active.

Note 13: 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 NO relay, it stays open when it is inactive; the relay contacts close (pull-in) when alarm conditions are met. When a relay is set to **RL-O**, the relay is essentially a NC relay, it stays closed when it is inactive; the relay contacts open up (drop-out) when alarm conditions are met. For most applications, the relay should be set to Logic Close (**RL-C**), which is the default setting. The Logic Open (**RL-O**) configuration is useful if user want to turn on a device when the temperature is not in the alarm zone.

Note 14: LAt (Latching, Pulsing, or Non-Latching Relay Action), determines the relay actions when alarm conditions are met and/or then removed. It can be set to **Y** for Latching Mode, **PUL** for pulsing mode, or **N** for Normal Mode.

When **LAt** is set to **Y** (Latching Mode), the relay action is latched. It will not release even if the alarm condition is removed. To release the relay, user must reboot the controller or use the Reset Key to cancel the relay action (see note 20 for details).

When **LAt** is set to **PUL** (Pulsing Mode), the replay action is a timed single pulse. When the alarm condition is met, relay will be activated only for a pre-determined period of time. User can set the pulse duration by the **AP** parameter in the menu of alarm settings; it ranges from 1 to 100 seconds. This feature is useful in situations where a user only need to ring the buzzer for a short time or want to drive an external load for a fixed amount of time duration.

When **LAt** it is set to **N** (Non-Latching), the relay action will follow the alarm condition. The relay stops its action when the alarm condition is removed.

Note 15: SiL (Relay Silence, also called **Alarm Suppression)**, determines whether a relay action should be suppressed when controller is just powered up. When SiL is set to Y, Relay Silence is enabled; when SiL is set to N, Relay Silence is disabled.

Relay Silence/Alarm Suppression is only supposed to work when: 1) controller is just powered up, and 2) the condition that deactivates the Relay Silence is not met yet. This feature is available in all relay modes, however, the deactivation condition varies.

Table 6. Conditions to Deactivate the Relay Silence/Alarm Suppression.

Relay Mode	Mashing Mode	Boiling Mode
Process Alarm	PV ≥ SV	PV ≥ btSP
Deviation Alarm	PV ≥ SV	NA
Acceleration	PV ≥ SV	Mashing Set Point (SV)
Timer*	NA	NA

For example, if a controller is working in mashing mode and the relay is set as a process alarm, then alarm suppression will apply to the low limit alarm until the process temperature reaches the mashing temperature. For another instance, if a controller is working in boiling/distilling mode, Relay 1 **RL1** = **ACC**, **Lgc1** = **LC-C**, **LAt1** = N**.** If **SiL1** = **N,** Relay 1 should pull-in when **PV** < **bAST** and drop-out when **PV** >= **bAST**. But when **SiL1** = **Y**, Relay 1 will not be activated when **PV** < **bAST** unless PV has reached mashing temperature.

This feature is useful for the following two situations: A) When a relay is set as low limit alarm or deviation alarm, and you don't want the relay to pull in when you just power up the controller as the start-up temperature will be in the alarm zone. B) When Relay 2 is set to Timer Mode and it is supposed to trigger a buzzer when the timer is up. Without Alarm Suppression, the relay would pull in when controller is just powered up before the timer starts counting.

Note 16: Function Key

There are two function keys named "**A**" and "**B**" which can be used to reset/cancel the action of the corresponding relays when they are activated. Key "**A**" on the lower left corner is for Relay 1, Key "**B**" on the lower right corner is for Relay 2. They only work in Latching Mode or Non-Latching Mode (**LAt** = **Y** or **N**), and they have no effect in Pulsing Mode (**LAt** = **PuL**). By default, Function Keys are disabled. To enable these two keys, set the parameter "**Key**", which is the last parameter listed in the menu of system configuration, to "on" (**Key** = **on**).

For a relay whose logic mode is set to Logic Close (**Lgc** = **RL-C**), press the function key when the relay is activated (close) will cancel the relay action, i.e., the relay will drop out (open). For a relay whose logic mode is set to Logic Open (**Lgc** = **RL-O**), press the function key when the relay is activated (open) will cancel the relay action, i.e., the relay will pull in (close).

7.3 Parameters in Alarm Settings

In the menu of alarm settings, there are four sets of parameters for each relay: **AH**, **AL**, **HY** and **AP**.

Table 7. Alarm Parameters Listed in Alarm Setting Menu.

Alarm Configuration (Alarm parameters part 2)					
Display	**Code**	**Description**	**Setting Range**	**Initial Setting**	**Remark**
AH1	AH1	Alarm 1 high limit	OFF, 1 ~ 9999	OFF	Note 17
AL1	AL1	Alarm 1 low limit	OFF, 1 ~ 9999	OFF	Note 18
HY1	HY1	Alarm 1 hysteresis band	0.1-100.0	0.3	Note 19
AP1	AP1	Alarm 1 pulse length	1-100	5	Note 20
AH2	AH2	Alarm 2 high limit	OFF, 1 ~ 9999	OFF	Note 17
AL2	AL2	Alarm 2 low limit	OFF, 1 ~ 9999	OFF	Note 18
HY2	HY2	Alarm 2 hysteresis band	0.1-100.0	0.3	Note 19
AP2	AP2	Alarm 2 pulse length	1-100	5	Note 20

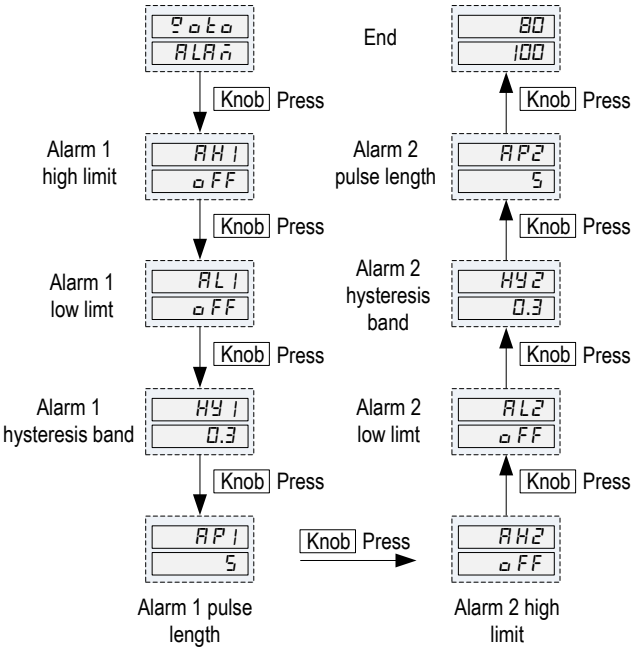

Figure 9. Flow Chart of Setting Alarm Parameters.

Note 17: AH (High Alarm), determines at what temperature that is higher than the set temperature the alarm relay will be activated. This setting applies to both process and derivation alarms. The unit is in degree C or F. **AH1** is for Relay 1 and **AH2** for Relay 2. It can be set to any temperature that the controller is capable to reading, or set to "**off**". If a relay is set to process alarm, the value of **AH** represents the absolute high alarm; the relay will be activated when PV >= AH. If a relay is set to deviation alarm, the value of AH represents the temperature deviation above the set value; the relay will be activated when PV >= (SV+ AH).

Note 18: AL (Low Alarm), determines at what temperature that is lower than the set temperature the alarm relay will be activated. This setting applies to both process and derivation alarms. The unit is in degree C or F. It can be set to any temperature that the controller is capable of reading, or set to "**off**". If a relay is set to process alarm, the value of AL represents the absolute low alarm; the relay will be activated when PV <= AL. If a relay is set to deviation alarm, the value of AL represents the temperature deviation below the set value; the relay will be activated when PV <= (SV- AL).

Tip 1: In Process Alarm Mode, **AL** should always be less than **AH** (AL1 < AH1, AL2 < AH2), otherwise, the alarm relay will stay activated all the time.

Tip 2: A relay can be set to work for process/deviation high alarm only (i.e., set **AL** = **off**), for low alarm only (i.e., set **AH** = **off**), or for both high and low alarm.

Tip 3: Deviation alarm settings are not valid for Boiling Mode (on DSPR120 or DSPR300) where there is no set temperature.

Note 19: HY (Hysteresis Band), determines the hysteresis band between temperature of activating and deactivating alarms. It is also called differential band by some manufacturer. The unit is degree F or C. For example, Relay 1 is set as a non-latching process alarm with relays settings **RL1** = **Pr**, **Lgc1** = **RL_C**, **LAt1** = **N**, **AH1** = 200, **AL1** = 100 and **HY** = 3 (temperature unit is F). For the high limit alarm, when the process temperature is greater and equal to 200˚F, the relay will pull in; and when process temperature is less than 197˚F, relay will drop off. For the low limit alarm, relay will pull in when process temperature is less than 100˚F; and the relay will drop off when process temperature is greater or equal to 103˚F.

Note 20: AP (Alarm Pulse), determines the time duration of which a relay stays activated. The unit is second. Pulse length can be set from 1 to 100 seconds. This setting is only valid when the Relay Latching Mode is set to Pulsing, i.e., **LAt** = **P**.

8. Application Examples

8.1 Timer operation example

The timer can be used for several ways to help managing mashing or boiling process.

1) Use it to automatically control the boiling time (boiling mode).
Set the parameter as following
tF=on, btSP=210, tdIr=dn, bEO=OFF, bt=1:30,
The timer will start to count when temperature reaches 210 degrees. The timer will count down from 1:30, when time out, the controller will stop heating, beeps, and flash "End".

2) Use the timer as a regular timer (boiling mode).
Set btSP below the ambient temperature so that timer is available, set bt to a very long time so that it will not end before operator decide to end the boil. The counting direction should be up. Use the reset button (rSt) to reset the timer at any time
tF=on, btSP=50, tdIr=up, bEO=on, bt=60:00.

3) Use the timer as a regular timer (mashing mode).
Set tSP below the ambient temperature so that timer is available, set t to a very long time so that it will not end before operator decide to end the mash. The counting direction should be up. Use the reset button (rSt) to reset the timer at any time
tF=on, tSP=50, tdIr=up, EO=on, t=60:00.

4) Use EZboil as a manual regulator (similar to DSPR1)
To use it as manual regulator with temperature reading, please set it to boiling mode. Disable timer, and set boiling acceleration set temperature below ambient temperature (or just zero).
Mode=boiling, tF=off, bAST=0

9. Wiring Examples

Example 1. Here are two wiring diagrams of how to connect a DC triggered AC SSR with this power regulator.

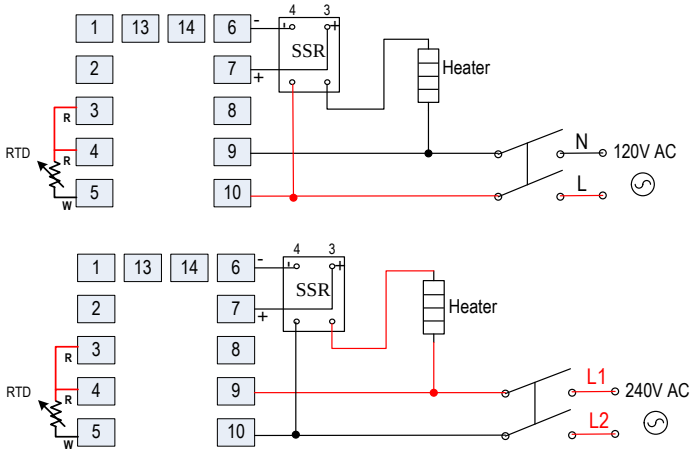

Figure 10. Wiring examples of controlling a heater with SSR and DSPR300 in a 120VAC system (upper) and in a 240VAC system (lower).

Example 2. Here is the wiring diagram of how to wire an auxiliary heating element to the controller via a contactor (for acceleration period only).

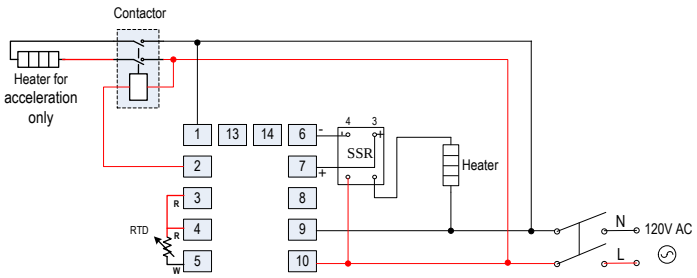

Figure 11. Wiring examples for auxiliary heater. Power supply is 120V AC. Coil voltage to the contactor is 120V AC. Auxiliary heater and its contactor need to be wired to AL1 relay output.

Example 3. Here is the wiring diagram of how to wire two external buzzers to the controller.

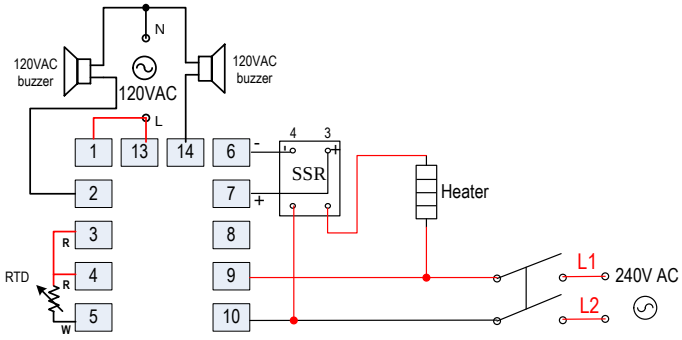

Figure 12. Wiring example of external buzzers. Power supply for the controller and heater is 240V AC. Power supply for two buzzers is 120V AC. AL1 buzzer is for temperature alarm. AL2 buzzer is for timer alarm.

10. Common sensor errors:

This regulator will display error message or incorrect temperature reading if your sensor is not connected, or your sensor is bad. Top display will flash “orAL” and “932” alternately, if you set it to Fahrenheit display (C-F = °F); or “orAL” and “500” alternately, if you set it to Celsius display (C-F = °C).

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Appendix

Technical Talk -- How does it Work? v1.1

There are three commonly used methods for AC power control.

1) **Phase angle firing**. In this method, the AC power control is achieved by firing the SCR at different phase angle. This is how our SSVR works. This method offer the most uniform power output. But the output is very difficult to be adjusted linearly due to the shape of the sine wave. Because of the sharp cut off, there is a potential electromagnetic interference (EMI or RFI) if there are inductive devices on the power line. Some of the inductive devices cannot be controlled by this method.

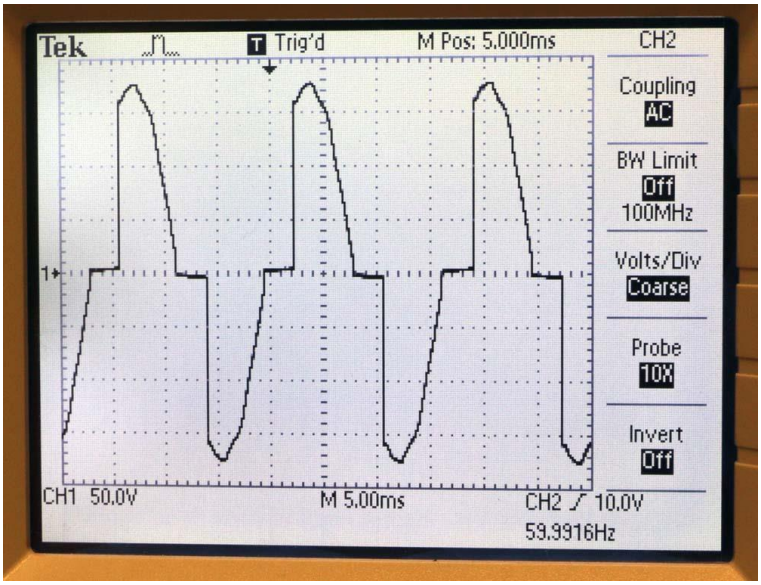

Figure 4. SSVR and TRIAC use phase-angle firing to regulate the power.

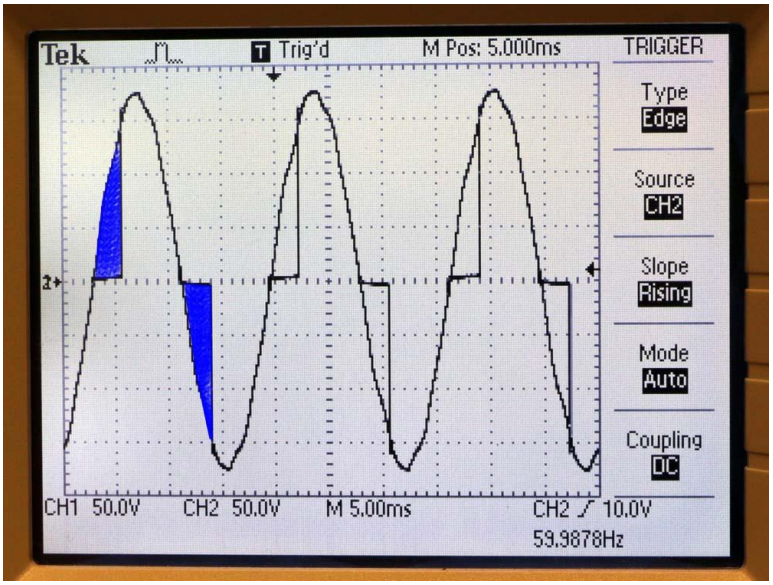

Figure 5. Original AC sine wave is overlaid with SSVR output wave form. The blue colored area shows the power output that has been blocked.

2) **Time proportional firing**. A fixed cycle time needs to be defined in this method. Then, the controller or regulator adjusts the on time during each cycle to achieve the power control. For example, if the cycle time is 1 second, turn on the power for 0.25 second for every 1 second means a 25% power output. Most of PID controllers use this method to control SSRs. This is also how the manual mode of Auber's PID controller works, except the cycle time has to be 2 second or longer.
Using this method, the user can linearly adjust output. But the power output is pulsed at each cycle. The shortest cycle time for most PID is either 1 or 2 second. Therefore, power is pulsed at 1 or 2 seconds. When heating a liquid, heat is not transferred as smooth as the phase-angle fire method.

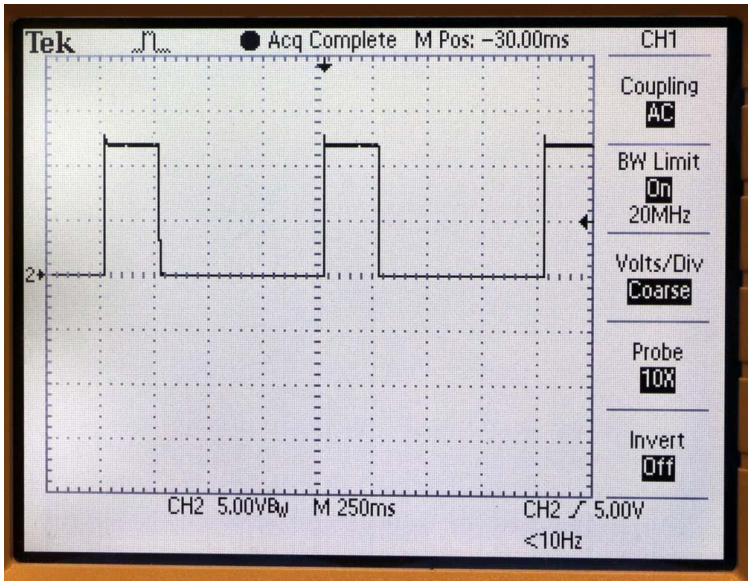

Figure 6. A 25% output control signal from a PID controller in the time proportional firing mode. Cycle time is 1 second. The output signal is 250 millisecond (ms) on, and 750 ms off during each cycle period.

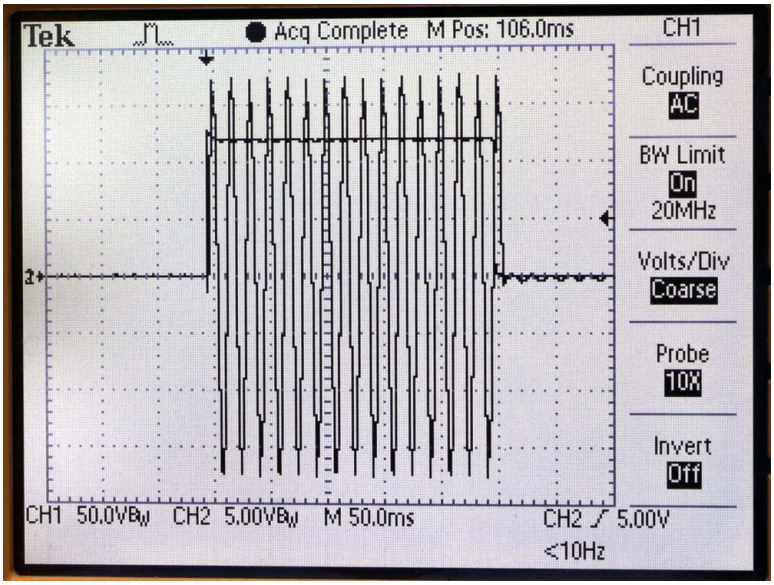

Figure 7. The control signal and SSR output waveform overlaid. When the DC signal (Channel 2, square wave) is on, the AC power can go through (Channel 1). When the DC signal drop to zero, the AC power is blocked.

3) **Burst firing**. This method is similar to time proportional firing (section 2). But in contrast to the time proportional mode, where the SSR is fired once for each fixed cycle period (which are usually 2 seconds or longer), the regulator will find the minimum cycle time to achieve the desired output percentage. The on pulse can be as short as one AC cycle. So power is distributed more evenly over cycle time. This leads to of a more uniform power output. Several PID controllers on the market use this mode. Our DSPR also uses this approach as the default mode to regulate power.

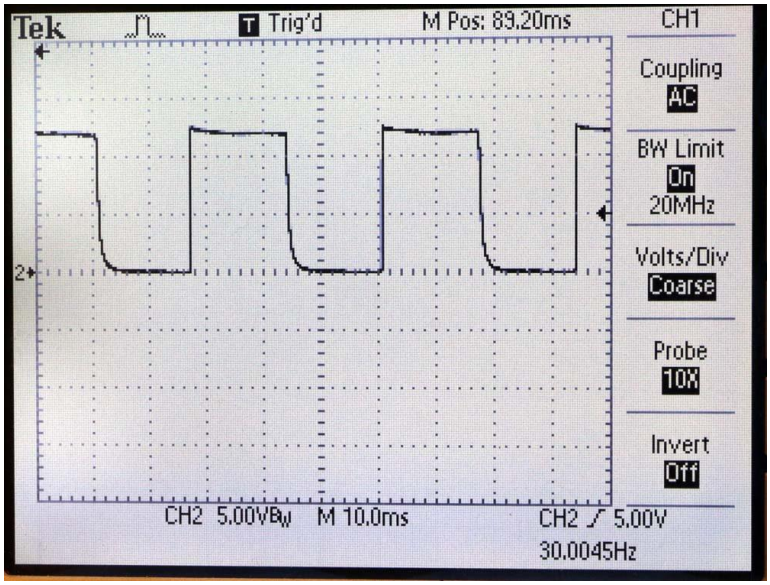

Figure 8. A 50% output control signal from DSPR when it is operating in the bust firing mode. Each pulse is 16.67 ms long, which is the same as a 60 Hz AC cycle. So one pulse on and one pulse cycle off is equal to 50% output.

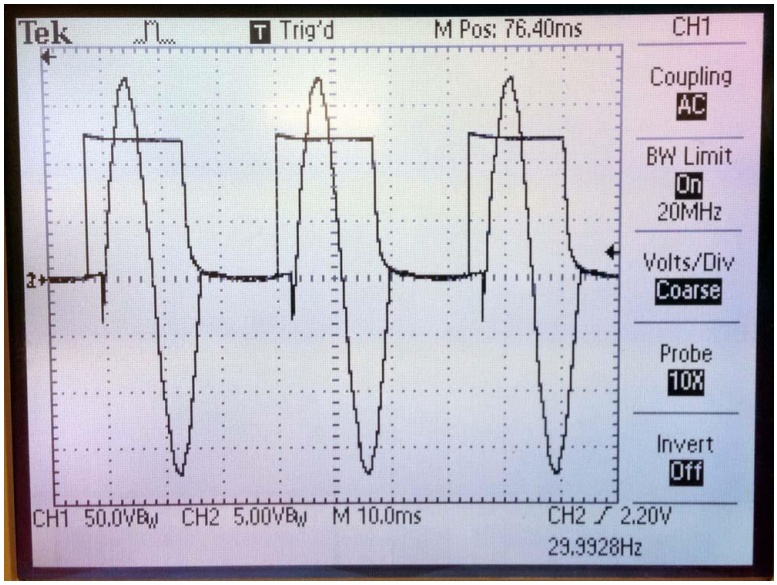

Figure 9. The DSPR control signal and SSR output waveform overlaid. The DSPR detects the frequency and phase of the AC power line, so that the pulse width and firing time is synchronized with AC cycle.

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