Instruction Manual

Distilling Controller, DSPR200

Version 1.1 (Jan 2016)

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	Thermocouple (TC): K RTD (Resistance Temperature Detector): Pt100
Accuracy	± 0.2% Full scale
Temperature range	-328°F ~ +1076°F, -200°C ~ +580°C
Response time	≤ 0.5s (when FILt = 0)
Display resolution	1°C or °F, 0.1°C or °F
Control mode	Manual control, ON/OFF
Alarm function	Process high alarm
Power supply	85~260VAC/50~60Hz
Power consumption	≤ 5 Watt
Ambient temperature	0~50ºC, 32~122ºF
Dimension	48 x 48 x 86 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 a Digital SSR Power Regulator (DSPR200).

1). Top display. This display will indicate the sensor read out value. When timer is activated, it will show timer value and sensor readout alternatively.
2). Bottom display. Boil Output Setting. This display will show the percentage of power been sent to the external SSR after the initial heat up phase.
3). 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 and hold it for 5 seconds to enter parameter settings. Press it briefly to reset the timer (if enabled). Please see section 6 for details.
4). Output indicator (OUT). It shows how much power the regulator is sending out (as a 12VDC control signal pulse through terminal 9 and 10). When it is on solid, the output is 100% on. You should be able to measure 12VDC between the terminals. The LED light on the SSR should also be on. When it is off, there should be no output. The LED light on the SSR should also be off. When it is flashing, the frequency of the flashing is an indication of high or low power output. Higher frequency means higher power output. However, the frequency of the flashing is not synchronized with actual pulse sending out, or the LED on the SSR. This is because the regulator switches the power at higher frequency than the human eyes can tell. The flashing rate of the indicator is generated at lower frequency to allow the operator to tell the level of the power output.
5). Acceleration indicator (ACC). When this indicator is lid, this regulator is operating under initial heating phase with high power output to accelerate the heating.

3. Wiring Terminals

The pin assignment of the back terminals of DSPR200 is shown in Figure 2.

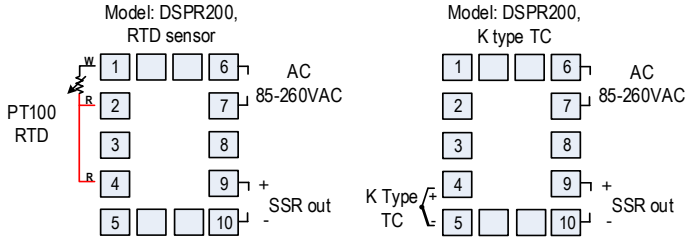

Figure 2. Terminals assignment of DSPR200.

3.1 Sensor connection

Please refer to section 6, note 7 for the input sensor type (Sn) setting codes. The initial setting for input is for a PT100 RTD (Pt). Set Sn to the correct sensor code if another sensor type is used.

3.1.1 Thermocouple

The thermocouple should be connected to terminals 4 and 5. Make sure that the polarity is correct. There are two commonly used color codes for the K type thermocouple. US color code uses yellow (positive) and red (negative). Imported DIN color code uses red (positive) and green/blue (negative). The temperature reading will decrease as temperature increases if the connection is reversed. Set controller input type, Sn to "K" (it looks like backwards "4").

When using ungrounded thermocouple that is in touch with a large conductive subject, the electromagnetic field picked up by the sensor tip might be too large for the controller to handle, the temperature display will change erratically. In that case, connecting the shield of thermocouple to terminal 5 (circuit ground of the controller) might solve the problem. Another option is to connect the conductive subject to terminal 5.

3.1.2 RTD sensor

For a three-wire RTD with standard DIN color code, the two red wires should be connected to the terminals 2 and 4. The white wire should be connected to terminal 1. For a two-wire RTD, the wires should be connected to terminals 1 and 2. Jump a wire between terminals 2 and 4. Set controller input type, Sn to Pt.

3.2 Power to the controller

The power cables should be connected to terminals 6 and 7. Polarity does not matter. It can be powered by 85-260V AC power source. Neither a transformer nor jumper is needed to wire it up. For the sake of consistency with the wiring example described later, we suggest you connect the hot wire to terminal 6 and neutral to 7.

3.3 SSR output connection

The SSR control output of the DSPR200 provides a 12V DC signal that can control up to 5 SSRs in parallel. Connect terminal 9 to the positive pole of the SSR (terminal 3 for Auber's SSR). Connect terminal 10 to the negative pole of the SSR (terminal 4 for the Auber SSR). Please make sure the SSR is installed on the heat sink with proper current rating.

4. Display Status

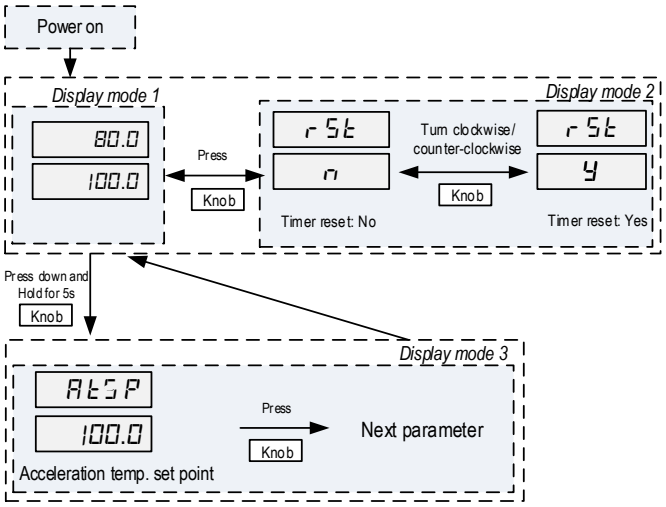

Figure 3. Display modes

Display mode 1: When power is turned on, the top display window shows the current reading temperature. When timer is activated, the top display will be switched between the current temperature and current time alternately, every 6 seconds. Bottom display window shows the percentage of power output at boil phase.

Display mode 2: (To reset the timer), press the knob down momentarily, the display will show "rSt" on top and "n" at the bottom, rotate the dial clockwise will change the bottom display to "y". Then press the knob down again will reset the timer. The reset button has two purpose. 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 (see Note 2 below). B) After timer is timed up and process ended, you can restart the boil process again by the reset button instead of power off the system and power it on again.

Display mode 3: Press down and hold the knob for 5 seconds to enter the display mode 3. This mode allows users to change the system parameters.

5. Setting flow chart

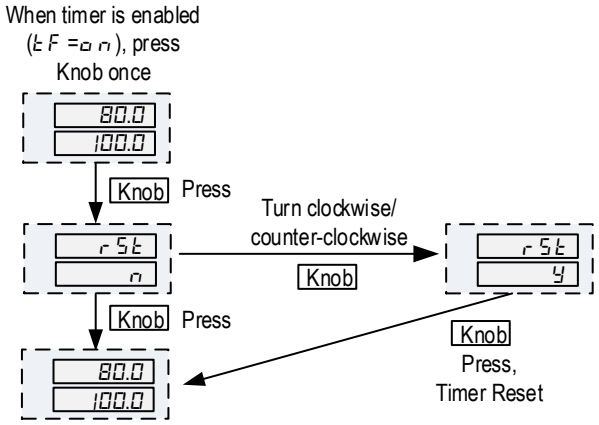

Figure 4. Timer reset flow chart

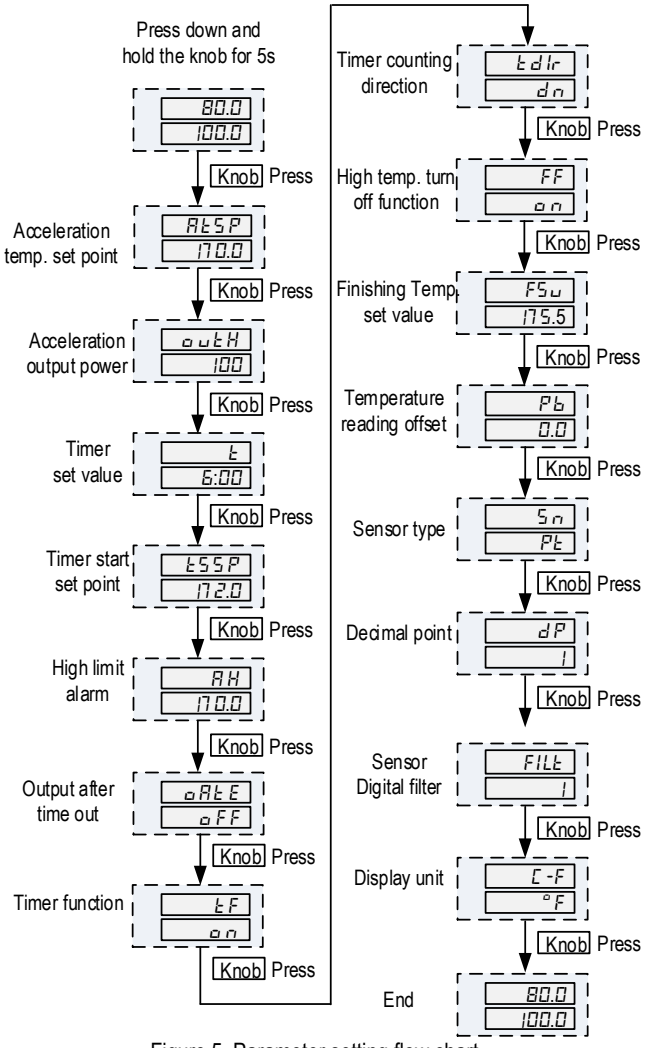

Figure 5. Parameter setting flow chart

To enter parameter setting mode, press down and hold the knob for at least 5s. Then you will see on the "AtSP" on top display. The top display shows the current selected parameter name, and the bottom display shows the parameter value for the selected parameter. Turn the knob clockwise to increase the value, and turn the knob counter-clockwise to reduce the value. Faster rotating speed will change the value quickly. Once finished, press down knob again to confirm and go to next parameter. You can keep pressing down the knob repeatedly to exit the setting quickly.

6. Parameter Settings

For the easy of discussion, we divide the entire distilling process into two phases, the **initial heating phase** and **boil phase**. During the initial heating phase, power output is set high to accelerate the temperature rise. We name the output setting for the initial heating phase as **acceleration power output setting**. It is set by parameter **outH**. During the boil phase, the power output is lowered to prevent the evaporation of unwanted component. We name the output setting for the boil phase as "**Boil Output**" setting. Its value is always displayed on the bottom LED display and can be adjusted by turning the knob (either in the initial heating phase or in the boil phase). The acceleration power output setting will not be displayed at bottom display during initial heating, because it rarely changes once the system is set up. You can tell that the regulator is in the initial heating phase, if the red LED indicator (at the up left corner of front panel) is on.

Table 1. System parameters.

Code	Description	Setting Range	Initial Setting	Remark
Press the knob momentarily (Figure 4)				
rSt	Timer reset	n,y	N	Note 3
Push down the knob for 5s (Figure 5)				
AtSP	Acceleration temperature set point	0~+9999°C or °F	170.0	Note 2
outH	Acceleration power output Setting	0~100%	100	
t	Timer set value	00:00~99:99 (hour: minute)	6:00	Note 3
tSSP	Timer start set temperature	-999~+9999 °C or °F	172.0	
AH	High limit alarm	0~+9999°C or °F	170.0	Note 4
oAtE	Output after time out	on, off	Off	Note 3
tF	Timer function enable	on, off	On	
tdIr	Timer counting direction	dn, uP	Dn	
FF	High temperature turn off function	on, off	On	Note 5
FSV	Finishing Temperature set value	0~+9999°C or °F	175.5	
Pb	Temperature reading offset	-100~+100 °C or °F	0.0	Note 6
Sn	Input type	Pt, K	Pt	Note 7
Dp	Decimal point	0,1	1	Note 8
FILt	Digital filter	1-6	1	Note 9
C-F	display unit	°C, °F	°F	Note 10
Push down the knob for 15s (Note 11)				

Note 1: Automatic shut off function

The distillation process can be automatically shut off to prevent the collection of feints/tails. There are two criteria to determine if the distillation is finished. One is by check the temperature (FSV, note 5). If the temperature starts to rise when the power is not changed, it indicates that the component is depleted. Operator can set a temperature that when reached, the system will be turned off. The other is by time (t, note 3). Some operator just wants to run at the set temperature for a specific time. Once the time is reached, they want to turn off the heater. For this controller, user can set both the temperature and time shut off function. The system will turn off whichever criteria (temperature or time) is reached first.

Note 2: Acceleration heating function

DSPR200 can 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, **Acceleration temperature set point, AtSP** and **acceleration power output setting, outH**. The AtSP set the temperature limit that below this temperature, the controller will output at a high power determined by the **outH**. When temperature rise to the AtSP, the output will automatically reduce to a lower level to prevent the temperature overshot. Since the heater power and liquid volume varies between each application, we suggest the **AtSP** to be set at least 10 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 **outH** 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 **outH** setting does not limit the power regulation range for boil phase.

Note 3: Timer Function

The timer function allows the controller to showing the boil 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 **timer function** is controlled by parameter **tF**. When it is set to **ON**, the timer function is enabled. When tF is set to **OFF**, the timer function is disabled. The **time duration** is set by the **t** parameter. The unit is hour: minutes.

When timer function is enabled, the timer counting will be started by **timer start set temperature, tSSP**. When temperature reaches **tSSP**, the timer starts to count. After timer started counting, it will continue even if the temperature drops below the **tSSP**. 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, every 6 seconds. The temperature and time display can be easily differentiated with their appearances. 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. After the timer is activated, the bottom display still shows the boil output setting. User can set the time display to count up, or count down with parameter **timer counting direction, tdIr.** Set it to **up** for counting up and **dn** for counting down. When time counting ends, the controller will generate six long beeps. The top display will be switched between the current temperature and "**End**". After timer ends, the power output can be configured either to continue heating, or shut off. It is controlled by the parameter called **output after time out, oAtE**. 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 tSSP below the ambient temperature. 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 4: Alarm function for remove the foreshot/heads

DSPR200 has a built-in buzzer that can be programmed to beep when temperature reaches the alarm set temperature, AH. The alarm will generate four short beeps every time the temperature rise from below AH to higher than AH. The alarm function can be used to notify the operator to remove the foreshots/heads at specific temperature close to the component boiling point. The alarm function does not affect the heating or the time function, it only provides the alarm sound.

Note 5: High temperature turn off function

This regulator has an automatic shut off feature, when the actual temperature is over the limit temperature you set. The automatic output power shut off mechanism is latched just like a limit controller. Once it is shut off, the heater will not turn on unless the system is reset.

This feature is controlled by two parameters: **High temperature turn off function, FF** and **finishing temperature set value, FSV.** If FF is set to on, this feature is enabled. The FSV set the turn-off temperature limit. When the reading temperature is below FSV temperature, the controller will work as normal. When the temperature rise over the FSV, the output will be automatically turned off until you reset the system (please refer figure 4 to reset). The built-in buzzer will beep

6 times to notify the user. The top display will show “END” and current reading temperature alternatively. OUT light will be off.

Note 6: 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 7: Input selection code for “Sn”
Sn is the sensor input selection for this controller. Two available options:
Pt: PT100 RTD sensor
K: K type thermocouple

Note 8: Decimal point setting
dP is used to define temperature display resolution.
dP = 0, temperature display resolution is 1 ºC (ºF).
dP = 1, temperature display resolution is 0.1ºC (ºF). The temperature will be displayed at the resolution of 0.1 ºC (ºF) for input below 1000ºF, and 1 ºC (ºF) for input over 1000ºF.

Note 9: Digital sensor filter
If measurement input fluctuates due to noise, then a digital filter can be used to smooth the input. “FILt” may be configured in the range of 1 to 6. Stronger filtering increases the stability of the readout display, but causes more delay in the response to change in temperature. By default, FILt is set to 1 (weakest filtering).

Note 10: Temperature unit setting C-F
You can set the regulator’s display to either Celsius or Fahrenheit.
C: Celsius display
F: Fahrenheit display

Note 11: Factory reset
To restore all the parameters back to factory default, please press down and hold the knob for 15s. Then reset menu will show up.

7. Application examples:

A. Timer operation example:
The timer can be used for several ways to help the boil process.
1) Use it to automatically control the boil time.
Set the parameter as following
tF=on, tSSP=210, tdIr=dn, oAtE=OFF, t=1:30, FF=off
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 clock.
Set tSSP 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 boil. The counting direction should be up. Use the reset button (rSt) to reset the timer at any time
tF=on, tSSP=50, tdIr=up, oAtE=on, t=5:00, FF=off

B. Using it as an ON/OFF controller.
This controller can also be used as an advanced ON/OFF controller. The **AtSP** is equivalent to the set temperature (SV). The **outH** is the power output when it is “On” phase. The Boil Output it is “off’ phase. If you set outH = 100, and Boil Output = 0, it will be the same as standard ON/OFF control with one-degree hysteresis band. However, this controller allows you to reduce the power of the ON phase so that overshot can be minimized. This is done by setting the outH to less than 100%. With a little tuning, you can easily optimize the outH so that the temperature overshot is controlled to be less than two degrees. You can also increase the Boil Output to more than zero for a more stable control. However, for most applications, leave the Boil Output at zero is sufficient unless the system has very slow response time and the heater is under powered.

Example: AtSP=173.0, outH=30, Boil Output=0. It will hold the wash between 173Fand 174F.

C. Using it as a manual mode controller.
DSPR200 can be set to pure manual mode controller (similar to DSPR1), with temperature readout. Here are the settings you need to change:
Change AtSP to 0; (turn off acceleration heating phase)
Change tF to OFF; (turn off timer function)
Change FF to OFF. (turn off over-temperature shutoff function)

D. Example for alcohol distilling
Set the high power accelerated heating limit to 170.0°F (76.7°C) and power output to be at 100% of the element capacity, set distilling power at 30%. Set the foreshots/heads alarm at 172°F. Set the distillation ending criterial to be either when temperature rise to 175.0 °F or when the time is more than 3 hours. When the controller is powered up, it will heat the wash with full power. After the wash temperature reaches 170°F, the power is automatically reduced to 30%. When temperature reaches 172°F, the alarm will beep four times to notify the operator that temperature is close to the alcohol boil temperature so that he can remove the heads. Soon the temperature rise to 173.0°F, the timer is activated. After distilling for a while the content of alcohol is depleted and temperature starts to rise. Once the temperature reaches 200.0°F, the heater is turned off and the controller will send long beeps and flashing "End" on the display. if the temperature does not rise to 200.0°F after 3 hours, the heater will also be turned off. During the distillation, the user can use the rotary knob to fine tune the boil at any time. The figure below shows how the power is correlated to the temperature and time.

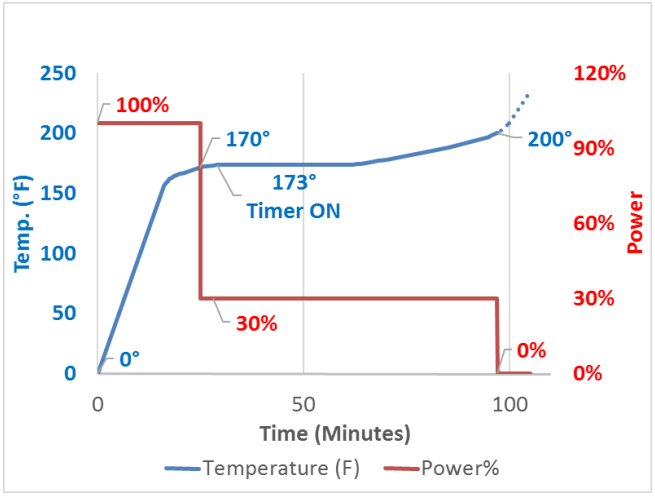

Figure 6. Example for alcohol distilling (Power output correction with temperature and time.)

E. Example for liquid boiling
Set ATSP = 200°F (96°C) and OUTH = 100%, set boiling output dial to 65%, and the timer to start at 210°F (99°C) for 60 minutes. Set FF=off (high temperature turn off function). When the controller is powered up, it will heat the liquid with full power capacity of the heating element. After the water temperature reaches 200°F, the power is automatically reduced to 65%. Soon the temperature claims to 210°F, the timer is activated. Sixty minutes later, the power will be turned off and the controller will send long beeps and flashing "End" on the display. During the boil, the user can use the rotary knob to fine tune the boil at any time. There is also a programmable alarm that can be set to an important temperature to notify the user to take action. The figure below shows how the power is correlated to the temperature and time.

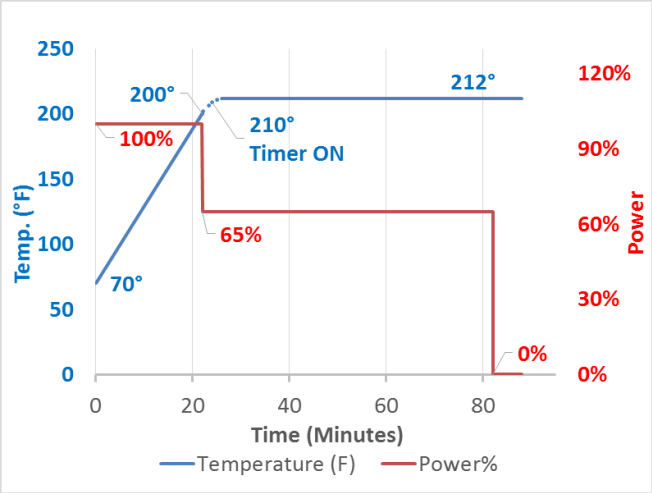

Figure 7. Example for boiling (Power output correction with temperature and time.)

8. Wiring Examples

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

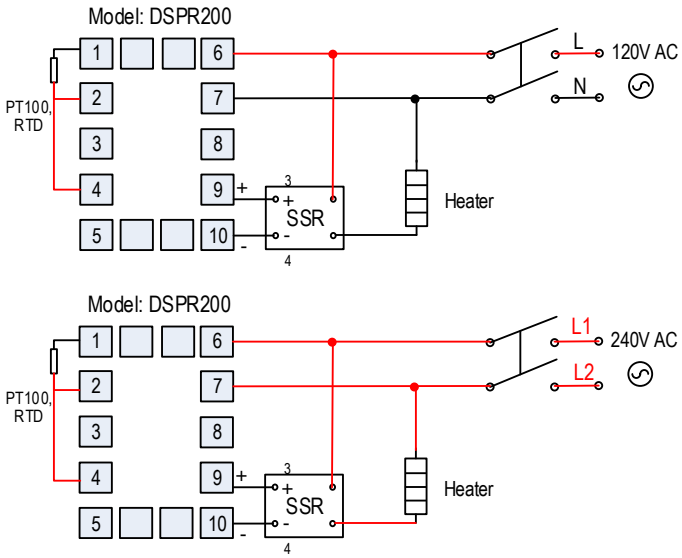

Figure 8. Wiring examples of controlling a heater with SSR and DSPR200 in a 120VAC system (upper) and in a 240VAC system (lower).

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