

## Operating the Rancilio Silvia after PID kit modification

Version 1.1

After retrofitting the Rancilio Silvia with the PID controller kit, the espresso machine should be operated in the same manner as the original machine with the exception that you should now pull the espresso shot when the boiler temperature is within  $\pm 1$  degree of your chosen set temperature (set value or SV).

When the machine is turned on, the controller will display the boiler temperature in the machine. The temperature reading will start to increase after 30-60 seconds. As the temperature approaches the set value, you will notice that the panel light next to the power switch will start to flash. This flashing indicates that the controller is cutting the power to the heater such that the temperature will not overshoot as it approaches SV. After the temperature has stabilized within  $\pm 1$  degree of SV **AND** the machine has been “on” for 45 minutes, it is ready to produce espresso.

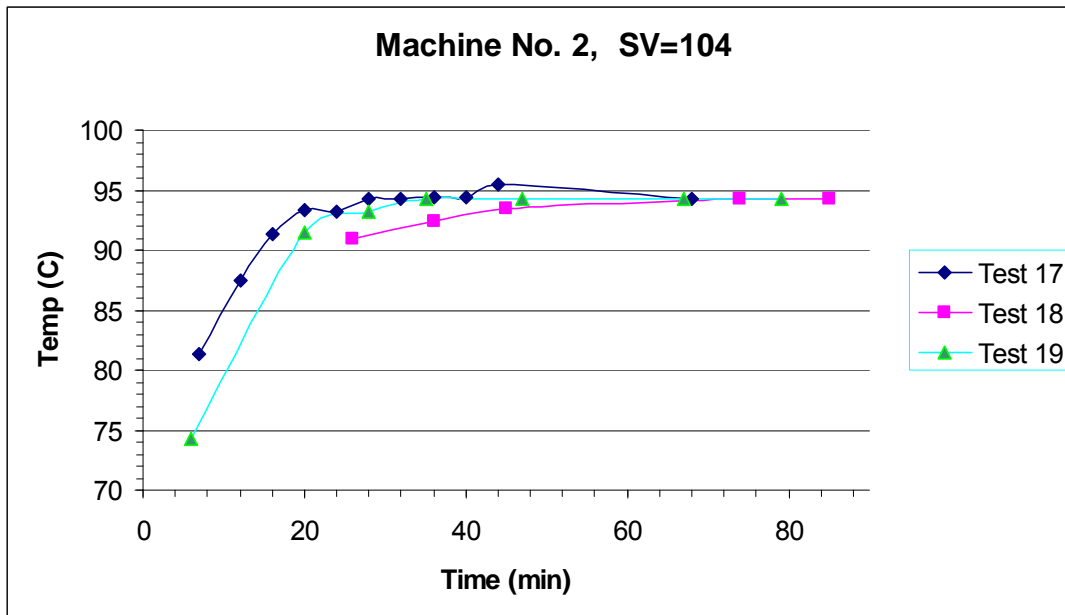


Figure 1

Figure 1 shows the brew water temperature changes with time. The reason for such delay is due to the structure of the Silvia machine. The boiler of the machine has only a thin section connected to the grouphead. It will take a while for the heat in the boiler to transfer to the grouphead. In general, it takes 25 to 45 minutes to get the brew water temperature stabilized. During the warming up period, we suggest the user installs the empty portafilter on the machine. After the controller is stabilized at the SV, run the pump for 4 to 6 fluid oz of water (120-180 ml) to flush the grouphead and portafilter. That will speed up the warming up process.

## Brew Water Temperature Setting

**Table 1. SV for different kit**

Part Number	Description	SV value in °C	SV value in °F
KIT-RSRTD	Rancilio retrofit kit with RTD sensor	105	221
KIT-RSTC	Rancilio retrofit kit with Thermocouple sensor	105	221

Table 1 lists default settings for the SV of the controller.

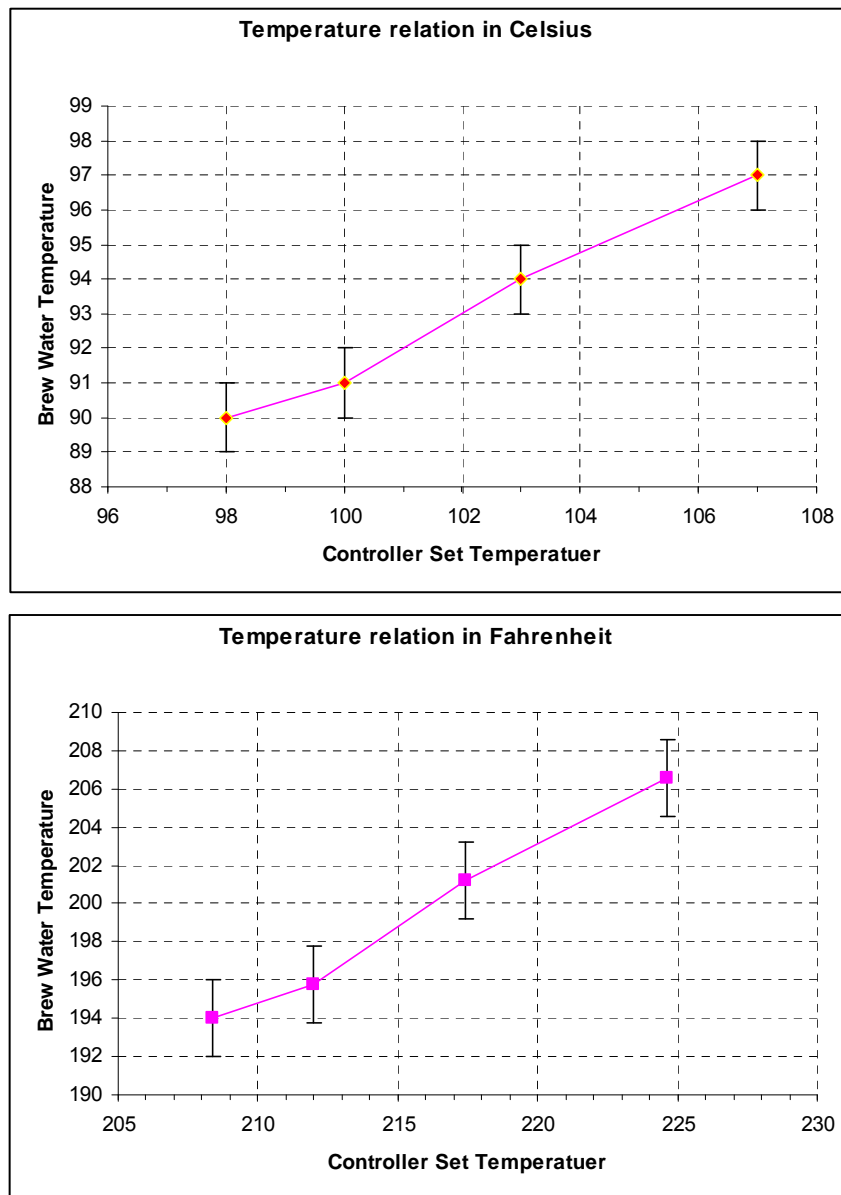


Figure 2 Correlation between PID controller set temperature and brew water temperature detected at grouphead measured by Scaze Thermofilter. Top, display in degrees Celsius. Bottom, Display in degrees Fahrenheit.

Figure 2 shows the correlation between the PID controller set temperature and brew water temperature. The controller in the Auber instruments' PID kits has been calibrated with its sensor to the accuracy of 1 degree C before shipping. However, due to the machine structure variations, the brew water temperature of different machine can have 1-2 C difference when controlled by the same PID controller kit. For detailed relationship between the PID setting temperature and brew water temperature, please read the file named "Temperature Performance Study" in the CD that came with the kit.

It should be noted that the temperature setting we recommended is lower than some people have suggested on the internet forums. As SV can be easily changed, it will up to the user to decide what the best temperature is for their espresso.

### **Changing Brew Water Temperature Setting**

There are two ways in which SV may be changed:

- 1) Press the ▼ or ▲ key once and release it. The display will change from measured temperature (process value, PV) to flash the SV. Then press the ▼ or ▲ key to change SV until the desired value is displayed. There is no need to press the SET key as the display will change back to reading the boiler temperature automatically after no keys are pressed for 8 seconds.
- 2) Press the SET key and enter the code 0001. Press SET again. The controller will display the current setting for SV. Use the ▼, ▲, and > keys to change the SV to the desired value. Press the SET again. Then use the ▼ and ▲ keys until the controller displays "END". Press SET to complete the process. While this setup method is more complicated than the previous method, it is faster and more reliable when the temperature change is very large. However, this would not typically be required in an espresso machine installation.

### **Fine tuning the PID Constants**

The parameters for the PID controller have been optimized for Rancilio Silvia with extensive testing. For most users, there is no need to fine tune the machine. For some machines, the temperature might oscillate 2 degrees occasionally. The recovery time might increase to 3-4 minutes when it is cold. These differences are not critical to most users because it might take that much time to prepare the next shot. As the machine warms up, the performance will improve. A warmed up machine could take less than 40 seconds to recover after pulling a shot. We found the most noticeable performance differences were between new machines and some old, poorly maintained machines. This is believed to be due to internal scale build-up in older machines which slows the response time. If you are

technically adept and willing to read through the controller instruction manual, below are some hints that may help you fine tune the controller. Should you ever want to set the controller to its original state, Table 2 lists the default settings that come with the controller.

1) Changing the P constant **MAY** improve performance. We found for kits using the RTD sensor the P value should be between 1.8 and 2.5 (the default is 2.0). In general, a lower P value will speed up the recovery after a shot. However, a lower P value can also cause the temperature to oscillate. For older machines, 2.5 may provide better results. For kits using the K type thermocouple, the P value should be between 0.9 and 1.4 (the default is 1.1).

2) For older machines, changing the integral constant, I, from 60 seconds to up to 75 seconds may improve performance. However if I is set too short the temperature will oscillate and when I is set too long the recovery speed will be slower.

**Table 2. Controller Parameters For Silvia**

	KIT- RSRTD-F	KIT- RSRTD-C
Code 0036		
P	2	2
I	60	60
d	15	15
Code 0001		
SV	221	105
AH1	283	139
AL1	284	140
Code 0089		
Inty	PT100	PT100
Corf	1	0

### **Controller Instruction Manual**

A copy of the instruction manual for the controller is included in the kit. For most users, there is no need to read it. If you decide to read the manual we want to point out that this is not a complete manual. We have added two control parameters to balance the requirement for cold start speed, shot recovery speed and long term stability. These parameters are proprietary and are not accessible by the user. In addition, the dampening factor, SovF, has been deactivated. Other than that, the remaining control functions are the same.

### **Change the Display to 0.1 Degree Resolution.**

For the kits with RTD sensor, it is possible to display the temperature in 0.1 degree (F or C) resolution. The controller will be able to hold the temperature at  $\pm 0.1$  degree range. However, with 0.1 degree resolution, the machine will take much longer to reach the set point. Should you decide to use the 0.1 degree resolution, you will need to use the code 0089 to change the Inty parameter from PT100 to PT10.0. Then, use code 0001 to reset SV, AH1 and AL1.

### **Frothing the Milk by Steam.**

Frothing should be done in the same way as before the PID kit was installed. The boiler temperature will be held at a much tighter range than before. The heater will kick on much sooner when the steam is released. Without surfing the temperature, you will still get a good frothing result.

It should be pointed out that the main purpose of controlling the steam temperature is not to stabilize the steam temperature but to turn on the heater sooner when the frothing starts. When frothing the milk, the heater of Silvia does not have enough power to maintaining a stable temperature. Even when the heater is powered 100% on; the temperature of the boiler will still drop. The original thermostat of the Silvia is designed to turn off the heater when the temperature reaches 284 F (140C) and on again when temperature drops to below 265 F (130C). After the thermostat is turned off at 284 F, no new steam will be generated until the temperature drops further below 265F because of the delay in heat transfers. With this controller, the heater will turn off at 284 F (140C) and on again when it drops to 1 degree below that (283F or 139C). That allows the heater to be kicked on much sooner than the original machine.

The steam temperature is controlled with on/off mode instead of PID mode for fast action. It is normal to see temperature oscillating as much as 10F (6C) around the setting point. The on/off temperature is set by the AH1 and AL1 parameters listed in table 2. The value of AH1 has to be less than that of AL1. User might want to change the setting to different temperature (at their own risk). Some users set the temperature to 295/294F (reported on internet). Silvia has an overheat protection thermostat (the one mounted on the side of boiler with a red reset button). It will shut the machine power off at 329F (165C) to prevent any damage to the machine. If this thermostat is triggered, the machine will not heat even if the panel heater light by the power switch is on. To reset the switch, press the red button on the thermostat.

Setting AH1 and AL1 too high will trigger the overheat protection thermostat. In addition, our customers reported several occasions when the thermostat was triggered.

- 1) Boiler is near empty when the steam switch was turned the on. The temperature rose too quick and triggered thermostat.
- 2) Some customers like to offset the temperature displayed to display the temperature of brew water (by set PSb with a negative value). If they forgot to offset the AH1 and AL1 to the same amount, the thermostat was triggered.