Operating the Rancilio Silvia after PID kit modification

Version 1.2

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 ±1 degree of SV **AND** the machine has been "on" for 45 minutes, it is ready to produce espresso.

Making Espresso.

After retrofitting with the PID controller kit, pulling the espresso shot needs to be operated differently than the original machine. Before pulling the shot, the Brew Switch on the Silvia should be turned to the on position. Press the ">" button on the controller to start the brewing. The display of the controller will change from displaying the boiler temperature to displaying the countdown time. The pump will give a small pulse of water to wet the coffee, wait for 2 seconds, then start the pump again for the brewing. When finished, the display will change back to display the temperature of the boiler.

The Brew Switch can be left at on position during steaming but needs to be turned off when pumping hot water.

There are two ways to pull the shot manually.

1) Keep the Brew Switch at the on position. Turn on the Hot Water switch to start the brew pump. Turn off the Hot Water switch to stop the pump.

2) Keep the Brew Switch at the on position. Set the timer to a longer time than you normally need for the shot. Press the ">" button on the controller to start brew pump. Press the ">" again to stop the pump.

After PID Kit modification, the method of producing hot water is not changed. To pump the hot water, make sure the Brew Switch is at off position. Turn on the Hot Water switch will allow you to pump the water to the steam wand.

Brew Water Temperature

It should be noted that this PID kit controls the temperature of the boiler. Due to the design of the Silvia, the brew water temperature that going through the filter basket is not the same as that in the boiler. It takes about 6 to 10 minutes for the boiler temperature to stabilize after machine is turned on from cold. However, it takes about 45 minutes for the brewing water temperature to get stabilized at a

constant temperature. In addition, the brew water temperature is about 25 F lower than the temperature of boiler.

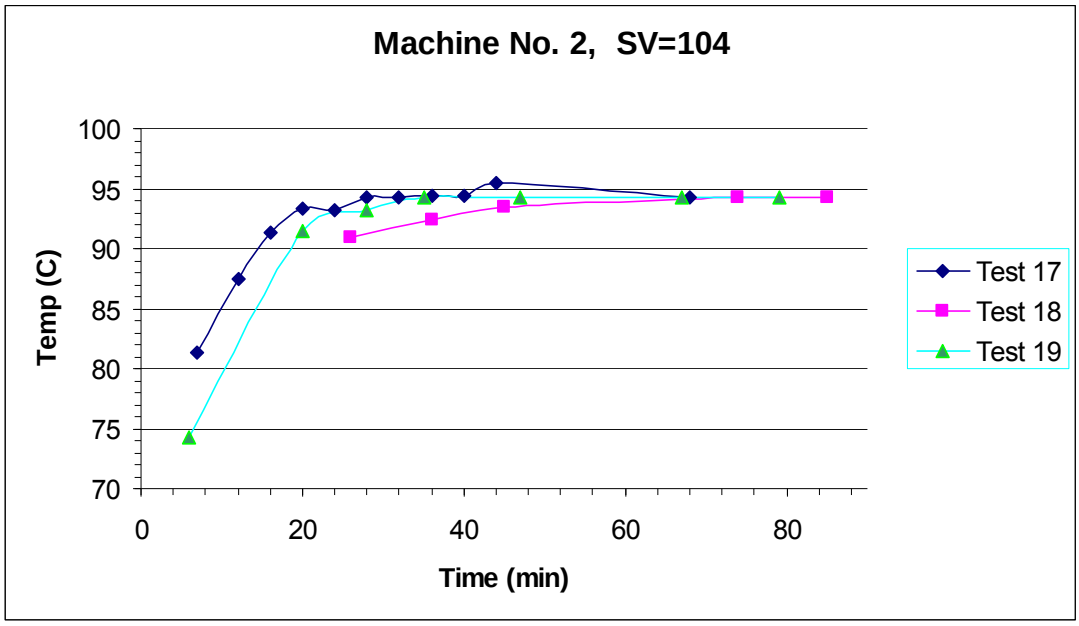

Figure 1 shows the brew water temperature changes with time. The reason for such delay is due to the structure of the Silvia machine. The boiler of the machine has only a thin section connected to the grouphead. It will take a while for the heat in the boiler to transfer to the grouphead. In general, it takes 25 to 45 minutes to get the brew water temperature stabilized. During the warming up period, we suggest user installs the empty portafilter on the machine. After the controller is stabilized at 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 ºC	SV value in ºF
KIT-RSNST	Rancilio retrofit kit	105	221

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

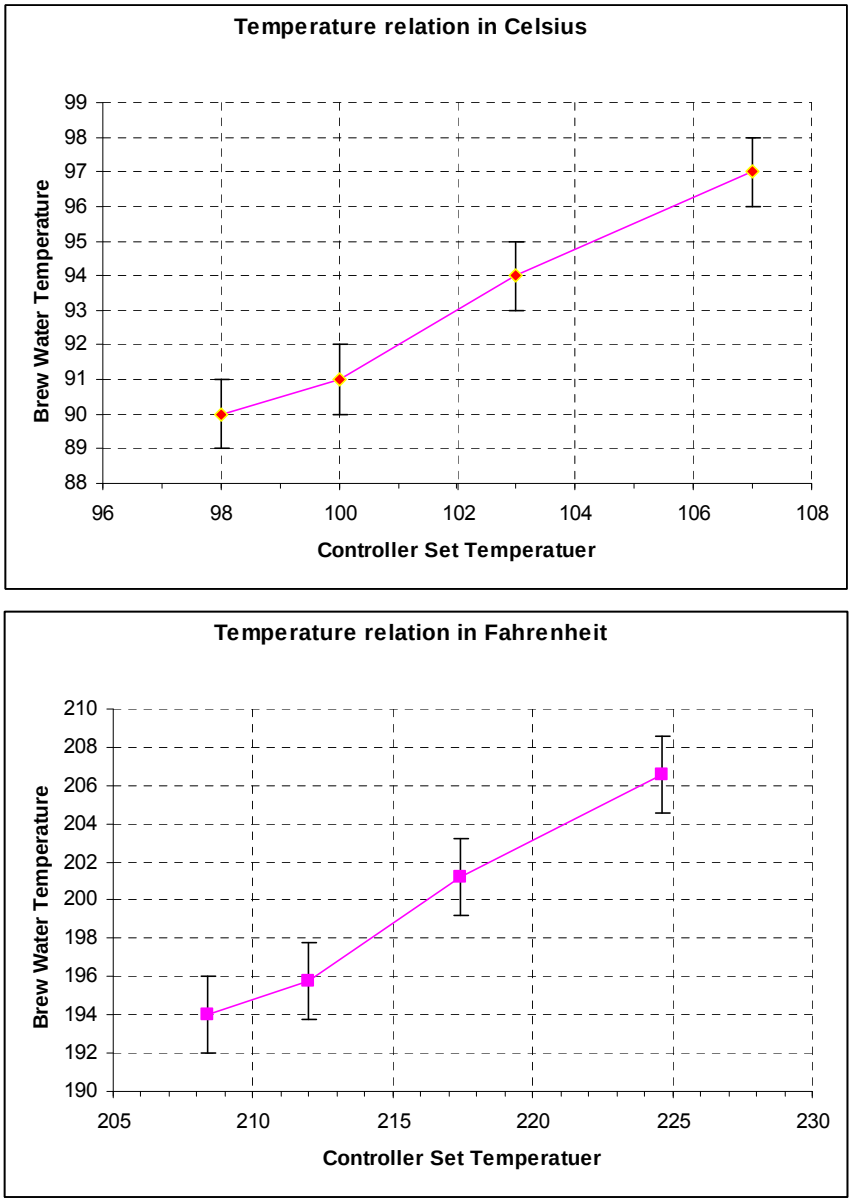

Figure 2 Correlation between PID controller set temperature and brew water temperature detected at grouphead measured by Scace Thermofilter. Top, display in degrees Celsius. Bottom, Display in degrees Fahrenheit.

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 3.5 (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-RSNST-F	KIT-RSNST-C
Code 0036		
P	2	2
I	60	60
d	15	15
Code 0001		
SV	221	105
AH1	283	139
AL1	284	140
tp	1.2	1.2
td	2.5	2.5
tb	25	25
Code 0089		
Inty	PT100	PT100
Outy	3	3
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 ± 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 over temperature 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.

Pre-infusion

When making the espresso shot, one of the potential problems is that the abrupt water pressure increase applied on the dry coffee powder can forms preferential routes for the water flow. When the problem is minor, the powder is not used uniformly, resulting in a poor coffee yield. When the problem become severer, the extraction flow rate becomes faster than 60ml/25 second even you have the proper grinding. The result is low extraction and high dilution. In the worst situation, water can form very low resistance channels with very fast flow and almost no extraction.

A common technique to avoid this problem is to make a uniform and tight coffee matrix with a good tamper. However, a good tamping takes a lot of practice and is difficult for some users. To solve this problem, espresso machine manufactures developed a special feature called pre-infusion. There are two main approaches for the pre-infusion. One is a mechanical approach. A pressure

arrester device is used to slow down the pressure increase speed. This is more close to the manual extraction method. The other is electronic approach. Special programmable timer is used to pump small amount of water on the coffee powder and let is soak in first. The wet coffee power will form an uniform matrix that allow the high pressure water flow evenly across the coffee powder. This method is also called pumped pulse pre-infusion. Auber PID kit uses this method.

The Auber pre-infusion function is achieved by setting the pump control timer in three sections. The first section activates the pump briefly to spray a small amount of water on the coffee powder. The parameter used is called pulse time, or Tp. The second section holds off the pump to let the water soak into coffee powder and form a tight matrix. The parameter used is called dwell time, or Td. The third section starts the normal brew extraction. The parameter used is called brew time, or Tb. The relationship of these parameters is show in Fig 3.

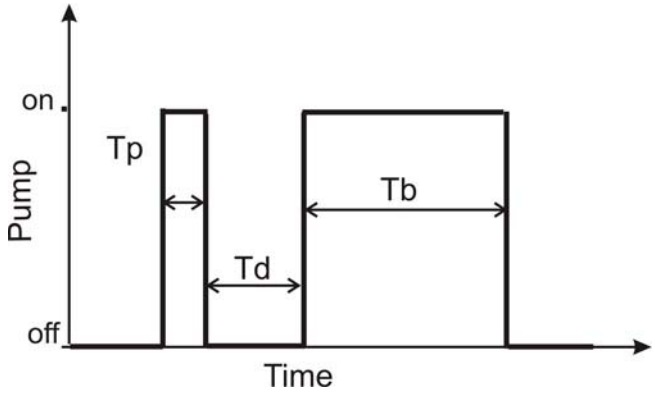

Fig 3. The relationship of Tp, Td and Tb.

The setting of pre-infusion parameters

1) Tp. the pulse time. We think the pulse time should be just long enough for the water to wet ½ to2/3 thickness of the coffee. There is no need to wet through the entire coffee. Excess water might cause the coffee powder to float. Base on our test with a properly grinded and tampered basket mounted on a bottomless portafilter, the time needed for water to went through a single shot basket is about 0.9 second, For the double shot basket, it is 1.6 second. We suggest you to set the Tp=0.7 s for single shot and 1.2 s for double shot basket. The Tp is preset to 1.2 second before shipping.

2) Td, the dwell time. This the time to let the water soak the through the coffee. We set it to 2.5 second so that total extraction time (including wetting and soaking) is less than 30 second…… the generally accepted espresso extraction time. It is not clear if longer soaking time will produce a bad taste for the coffee. Some American Coffee brewing machine with programmable pump uses much longer time. User can try it with different time to see if there is any improvement with longer soaking time.

3) Tb, the brew time. This time is set to 25 second. Some user might prefer a longer brew time. It can be changed by user.

To change the pre-infusion settings, press the SET key and enter the code 0001. The controller will display SV. Press the ▲ key until it displays “tp”. Press SET again. It will display the current time setting in 0.1 second resolution. Use the▼, ▲, and **>** keys to change the Tp to the desired value. Press the SET again. Then use the ▲ keys to change the display to “td”. Press SET again. It will display the current time setting in 0.1 second resolution. Use the▼, ▲, and **>** keys to change the Td to the desired value. Press the SET again. Then use the ▲ keys to change the display to “tb”. Press SET again. It will display the current time setting in 0.1 second resolution. Use the▼, ▲, and **>** keys to change the Tb to the desired value. Press the SET again. Use the ▲ key until the controller displays “END”. Press SET to complete the process.