

Instruction Manual

SYL-5352P(A) USB Ramp and Soak PID Temperature Controller

Version 1.17 (Feb, 2024)



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.
- **USB data cable on terminal 11 & 12 must be secured and isolated from the power input cable on terminal 9 & 10. Otherwise high voltage AC power from the power input cable may damage your USB adapter and/or your computer.**
- This controller carries a 90-day warranty. This warranty is limited to the controller only.

1. Features

- By provided software and USB adapter, user can get access to the controller via Windows computer.
- 32 programmable ramp steps and 32 programmable soak steps (total of 64 steps).
- High flexibility in program and operation. User can use its keypad to change the running status of program, such as run, hold and stop.
- This controller has two alarm relay outputs. Alarm relay 1 is used for temperature alarm. Alarm relay 2 is used for program ending alarm, to notify the operator that the whole program is completed.
- The safety-start feature may allow the program to run more efficiently. Four power-off/power-on event handling modes are available, which can prevent the program control from being adversely affected by unexpected power interruptions.

2. Specifications

Table 1. SYL-5352P specifications.

Input type	Thermocouple (TC): K, E, J, T, S, R; RTD (Resistance Temperature Detector): Pt100, Cu50
Input range	Please see section 5.3.10 for detail.
Accuracy	± 0.5% Full scale: RTD and thermocouple input with ice point compensation or Cu50 copper compensation. ± 0.5% Full scale or ± 2°C: Thermocouple input with internal automatic compensation.
Programming step number	32 ramp steps and 32 soak steps (for main output only)
Minimum ramp rate	0.1°C/min (144°C/day) or 0.3°F/min (432°F/day)
Ramp Rate Resolution	0.1°C/min increment or 0.3°F/min increment
Response time	≤ 0.5 s (when FILt = 0)
Display resolution	1°C, 1°F; or 0.1°C, 0.1°F
Control mode	Fuzzy logic enhanced PID control On-off control
Output mode	10V DC to drive external SSR

Alarm relay rating	Relay contact (NO): 250VAC/1A, 120VAC/3A, 24V/3A
Alarm function	Process high alarm, process low alarm, deviation high alarm, and deviation low alarm
Power supply	85 ~ 240 VAC / 50 ~ 60 Hz
Power consumption	≤ 5 Watt
Ambient environment	0 ~ 50°C, 32 ~ 122°F; ≤ 85% RH; No corrosive gas, no strong EMI
Dimension	48 x 48 x 100 mm (W x H x D)
Mounting cutout	45 x 45 mm

3. Terminal Wiring

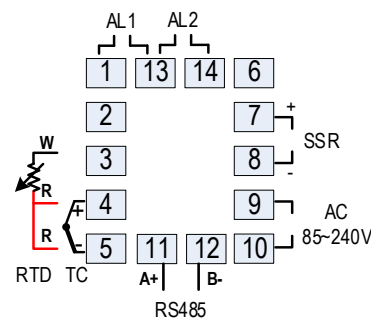


Figure 1. Wiring terminals of SYL-5352P.

3.1. Sensor connection

Please refer to Table 3 for the input sensor type (Sn) setting codes. The initial setting for input is for a K type thermocouple. Set Sn to the right 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.

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, i.e., 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 (PT100 / Cu50)

For a three-wire RTD with standard DIN color code, the two red wires should be connected to the terminals 4 and 5, and the white wire should be connected to terminal 3. For a two-wire RTD, the wires should be connected to terminals 3 and 4. Jump a wire between terminals 4 and 5. Set controller input type Sn to Pt1 or Pt2.

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 85-240V 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 9 and neutral to 10.

3.3. Control output connection

The control output of the controller SYL-5352P is 10Vdc supplied through terminal 7 (+) and 8 (-). It can be used to drive one or multiple DC triggered solid state relays (SSRs) in parallel. For applications that need two control outputs, such as one for heating and another for cooling, relays AL1 can be used for the second output with on/off control mode. Please see Figure 9 for details.

3.4. Connecting the load

Load to be controlled should be wired to the solid state relay (SSR) connected to the controller. Please see Section 7 in this manual for wiring examples.

3.5. USB computer cable connection (RS485 Port)

User needs to supply one two-lead cable (not included) for computer connection. 22-24AWG wire is good. User needs to connect this cable from the controller to the USB adapter (included). Terminal 11 on the controller needs to connect to pin A+ on USB adapter; terminal 12 on the controller needs to connect to pin B+ on the USB adapter. Incorrect polarity will not damage your controller, USB adapter nor your computer. Computer software only supports Windows OS platform currently.

Warning: RS485 terminals are close to the AC power input terminals on the controller. When you wire your controller, please keep this computer cable isolated from your AC power cable. Otherwise high voltage AC power may damage your USB adapter and/or your computer!

3.6. For the first time users without prior experience with PID controllers, the following notes may prevent you from making common mistakes.

Power to the heater does not flow through terminal 9 and 10 of the controller. The controller consumes less than 2 watts of power. It only provides a control signal to the relay. Therefore, wires in the 18 to 26 gauge range should be used for providing power to terminals 9 and 10. Thicker wires may be more difficult to install.

The relay outputs, AL1 and AL2, are “dry” single pole switches. They do not provide power by themselves. Please see Figure 7 and 8 for how they are wired when 120V power is supplied. The wiring diagram in Figure 8 can also be applied to situations where both the load and the controller are using 240V power supply. If the load of the relay requires a different voltage than that for the controller, another power source will be needed. See Figure 12 for examples.

The power is controlled by regulating the duration of on time for a fixed period of time rather than the amplitude of the voltage or current. This is often referred as time proportional control. For example, if the cycle rate is set for 100 seconds, a 60% output means controller will switch on the power for 60 seconds and off for 40 seconds (60/100 = 60%). Almost all high power control systems use time proportional control, because amplitude proportional control is too expensive and inefficient.

4. Front Panel and Display Mode

4.1. Front Panel

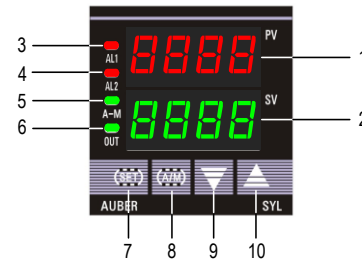


Figure 2. Front panel.

- ① PV window: Displays the sensor readout/process value (PV), or parameter /program name.
- ② SV window: Displays the set value (SV), or parameter/program value.
- ③ AL1 indicator: It lights up when AL1 relay is on.
- ④ AL2 indicator: It lights up when AL2 relay is on.
- ⑤ A-M indicator: The light indicates the controller operating status. When A-M is solid on, program is running. When A-M is flashing, program is paused. When A-M is off, program is stopped.
- ⑥ Output indicator: It is synchronized with main control output and the power to the load. When it is on, the heater (or cooler) is powered.
- ⑦ SET key: Press and hold for 3s to enter parameter settings. Press with A/M key to enter ramp/soak program settings.
- ⑧ A/M key: Programming key; digit shift key.
- ⑨ DOWN key ▼: Decreases numeric value of the setting value.
- ⑩ UP key ▲: Increases numeric value of the setting value.

4.2. Controller display mode

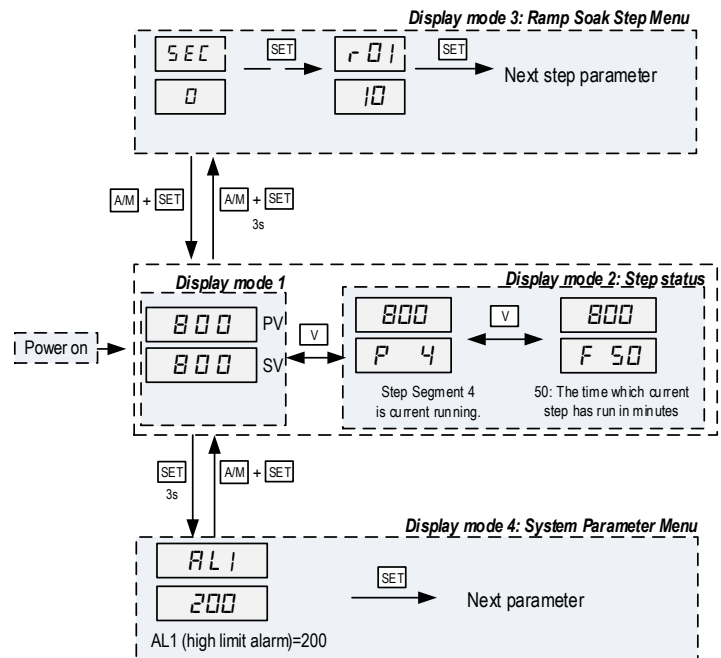


Figure 3-1. Display mode 1-4

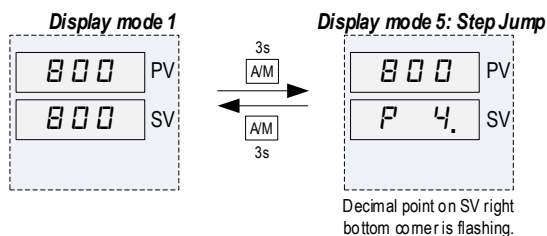


Figure 3-2. Display mode 5, showing how to jump steps manually.

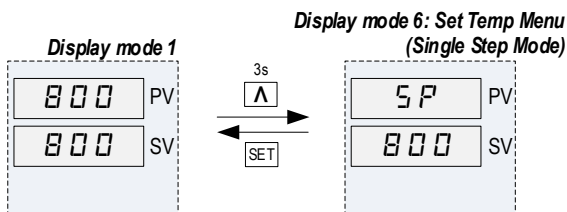


Figure 3-3. Display mode 6, showing how to change set temp in single step mode.

Display mode 1: normal operating mode. When the power is turned on, the upper display window shows the measured value (PV) and the lower window shows the four-digit set value (SV).

Display mode 2: checking the step status. Press the DOWN arrow key once to change the display from mode 1 to mode 2. The upper display window shows your current reading temp, and the lower window shows the current step segment number starting at “P”. Press DOWN arrow key to go back. Then press DOWN arrow key again to show the timer information. The upper display window shows your current reading temp, and lower window shows the time which current step has run starting at “F”. This timer unit depends on parameter SEC (note 5.3.16.). It can be either by minute (SEC = 0) or by second (SEC = 1). Press DOWN arrow key again to return to the display mode 1.

Display mode 3: Ramp soak step settings. Press and hold SET key and A/M keys together for 3 seconds to change the display from mode 1 to mode 3. This mode is used for step program settings and step control parameters.

Display mode 4: Parameter setting mode. Press and hold the SET key for 3 seconds to enter the display mode 4. The top window shows the name of a parameter and the bottom window shows its value. Use the UP and DOWN arrow key the change the value; use the SET key to save the change and go to the next parameter.

Display mode 5: Step jumping. Press and hold A/M key for 3 seconds and you will see current reading temp on the top and current step segment number on bottom. The decimal point on the right bottom display is flashing. Use UP and DOWN arrow keys to change the step segment number, then press and hold A/M key for 3 seconds to confirm and jump.

Display mode 6: Change set temp (single step mode only). For single step mode (RUN = 0), user can change set temperature by pressing and holding UP arrow keys for 3 seconds. Then use UP and DOWN arrow key to change its value. Press SET key once to confirm and exit.

5. Parameter Settings

5.1. Parameter setup mode

When the display mode is 1 or 2, press SET and hold for roughly 2 seconds until the parameter setup menu is displayed (display mode 3). Please refer to 5.3 for how to set the parameters.

5.2. Setup flow chart

While in the parameter setup mode, use ▲ and ▼ to modify a digit and use A/M to select the digit that needs to be adjusted. Press the A/M and SET key at the

same time to exit the parameter setup mode; otherwise, the instrument will automatically exit if no key is pressed for 10 seconds. Figure 4 is the setup flow chart. Please note that changed parameter will be automatically registered without pressing the SET key. If the controller is locked (see 7.16), only limited parameters (or no parameters) can be changed.

5.3. List of system parameters

Table 2. System parameters.

System Parameter Menu Press & Hold SET Key for 3s to Enter				
Code	Description	Setting Range	Initial Setting	Remarks
AL1	Alarm 1 Setting	-1999 ~ +9999	200	See 5.3.1
AL2	Alarm 2 Setting	0 ~ 200	10	
Pb	Input offset	±20.0	0	See 5.3.2
P	Proportional Constant	0 ~ 5000	0	See 5.3.3
I	Integral Time	0 ~ 3000	500	
d	Derivative Time	0 ~ 2000	100	
t	Cycle Time	2 ~ 120	10	See 5.3.4
FILt	Digital Filter	0 ~ 50	20	See 5.3.5
HY	Hysteresis Band	0.1 ~ 50.0	0.5	See 5.3.6
dP	Decimal Point Position	0 ~ 1	1	See 5.3.7
outH	Output High Limit	outL ~ 200	200	See 5.3.8
outL	Output Low Limit	0 ~ outH	0	
At	Auto Tuning	0 ~ 1	0	See 5.3.3, section 3)
LoCP	Configuration Privilege	0 ~ 50	0	See 5.3.9
Sn	Input Sensor Type		P	See 5.3.10
oP-R	Reserved		1	See 5.3.22
CF	Display Temp Unit	C, F	C/0	See 5.3.11
ALP	Alarm Output Definition	0 ~ 10	1	See 5.3.1
CoAL	System Function Selection	0 ~ 1	0	See 5.3.12
PuH	Display High Limit	PuL ~ 9999	1300	See 5.3.13
PuL	Display Low Limit	-1999 ~ PuH	0	
Addr	Communication address	0 ~ 255	1	See 5.3.14
baud	Communication baud rate		3 for 9600	

Set Temp Menu (Single Step Mode Only, RUN = 0) Press & Hold Up Arrow Key for 3s to Enter				
Code	Description	Setting Range	Initial Setting	Remarks
SP	Set Point	PuL ~ PuH	100	See 5.3.15

Ramp Soak Step Menu Press & Hold SET and A/M Keys Together for 3s to Enter				
Code	Description	Setting Range	Initial Setting	Remarks
LooP	Program Cycling	0 ~ 1	1	See 5.3.17
PdE	Power Outage Mode	0 ~ 3	2	See 5.3.18
SSb	Safety Start Band	0 ~ 100.0	100	See 5.3.19
run	Program Control	0 ~ 3	0	See 5.3.20
Pro	Program Step Jump	0 ~ 64	0	See 5.3.21
SEt	Timer Unit	0 ~ 1	0 for min.	See 5.3.16
r01	Ramp Time 1	0 ~ 2000	0	See Section 6
t01	Soak Time 1	0 ~ 9999	0	
Co1	Set Temp 1	PuL ~ PuH	0	
...				
r32	Ramp Time 32		0	

E32	Soak Time 32		0	
E32	Set Temp 32		0	

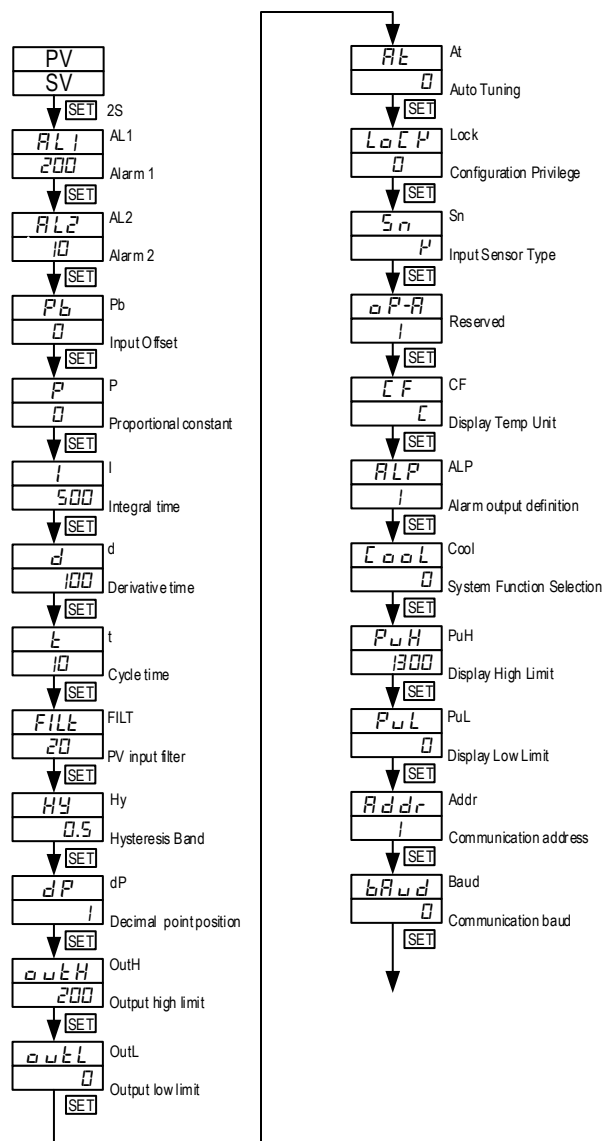


Figure 4. Flow chart for system parameter menu

5.3.1. Alarm function & parameters

This controller has two alarm output relays: AL1 relay (terminal 1 & 2) and AL2 relay (terminal 13 & 14). AL1 relay is temperature alarm. AL2 relay is program ending alarm.

This controller has three alarm parameters: AL1, AL2, ALP.

Parameter AL1: Temperature alarm value for AL1 relay. See ALP definition below.

Parameter AL2: Duration time for program ending alarm. Unit is per seconds. Available range is 0s to 200s. AL2 is set as 10s, it means once the ramp soak program is completed, AL2 relay will be triggered continuously for 10s. Then it will be dropped off.

ALP: Alarm output definition for AL1 relay. The temperature difference to release the triggered alarm is 0.5°F (parameter CF = 1) or 0.5°C (parameter CF = 0).

Table 3. ALP Definition

ALP Value	Alarm Type	Alarm ON Condition	Alarm OFF Condition
0	AL1 is disabled		
1 or 3	Absolute high alarm	PV > AL1	PV < AL1 - 0.5
2	Absolute low alarm	PV < AL1	PV > AL1 + 0.5
4	Derivation high alarm	PV > SP + AL1	PV < SP + AL1 - 0.5
5	Derivation low alarm	PV < SP - AL1	PV > SP - AL1 + 0.5
7	Band alarm, direct acting (out of range alarm)	PV < SP - AL1 or PV > SP + AL1	PV > SP - AL1 + 0.5 and PV < SP + AL1 - 0.5
8	Band alarm, reverse acting (in range alarm)	PV > SP - AL1 and PV < SP + AL1	PV < SP - AL1 - 0.5 or PV > SP + AL1 + 0.5

Legend:

PV: current reading temperature
 AL1: Value of parameter AL1
 SP: Set temperature in current step (SV)

5.3.2. Input offset "Pb"

Input offset Pb is used to add an offset value to compensate the sensor error or simply to shift the reading. For example, if the controller displays 2°C when probe is in ice/water mixture, setting Pb = -2, will make the shift the temperature reading to 0°C.

5.3.3. Control mode

1) PID control mode

Please note that because this controller uses fuzzy logic enhanced PID control algorithm, the definition of the control constants (P, I and d) are different than that of the traditional proportional, integral, and derivative parameters.

(1) Proportional constant "P"

Please note that the P constant is not defined as Proportional Band as in the traditional model. Its unit is not in degrees. A larger constant results in larger and quicker action, which is the opposite of the traditional proportional band value. It also functions in the entire control range rather than a limited band.

(2) Integral time "I"

Integral action is used to eliminate offset. Larger values lead to slower action. Increase the integral time when temperature fluctuates regularly (system oscillating). Decrease it if the controller is taking too long to eliminate the temperature offset. When I = 0, the system becomes a PD controller.

(3) Derivative time "D"

Derivative action can be used to minimize the temperature overshoot by responding to its rate of change. The larger the number, the faster the action.

2) On/off control mode

It is necessary for inductive loads such as motors, compressors, or solenoid valves that do not like to take pulsed power. It works like a mechanical thermostat. When the temperature passes hysteresis band (Hy, see section 5.3.6), the heater (or cooler) will be turned off. When the temperature drops back to below the hysteresis band, the heater will turn on again.

To use the on/off mode, set P = 0. Then, set Hy to the desired range based on control precision requirements. Smaller Hy values result in tighter temperature control, but also cause the on/off action to occur more frequently.

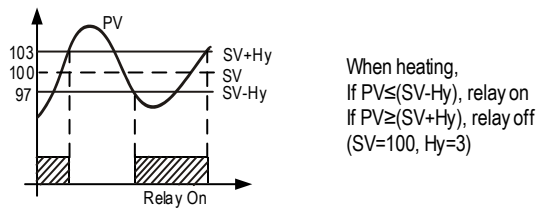


Figure 5. On/off control mode.

3) Auto-tune

In most cases the fuzzy logic enhanced PID control is very adaptive and may work well without changing the initial PID parameters. If not, users may need to use auto-tune function to let the controller determine the parameters automatically. If the auto tuning results are not satisfactory, you can manually fine-tune the PID constants for improved performance. Or you can try to modify the initial PID values and perform auto tune again. Sometimes the controller will get the better parameters.

Before auto-tune, please make sure this controller is wired correctly. Temperature sensor, relay, heater are connected to the controller correctly. Also confirm your hysteresis band Hy is set to a small number such as 0.5 (default value). The auto-tune can be started by setting parameter At = 1, then auto-tune will start automatically. In this ramp/soak controller, user can start the auto-tune any time when a program is running, on hold, or stopped. When auto-tune is running, the lower window will flash between "At" and the current set temperature.

During auto tuning, the instrument executes on/off control at the current set temperature. After 2-3 times on/off action, the microprocessor in the instrument will analyze the period, amplitude, waveform of the oscillation generated by the on/off control, and calculate the optimal value for the P, I, and D.

When auto-tune is finished, the lower window will stop flashing "At"; only the set temperature will be shown in the lower window. Controller will resume running the program. Generally, you will only need to perform auto tuning once. After the auto tuning is finished, controller will set parameter "At" to 0 automatically.

To manually stop auto-tuning, please set AT to 0.

For this controller, the auto-tune should not be activated when the controller is ramping because the result obtained at one temperature is optimized for that temperature only. The auto-tune should be activated at the most critical temperature where you need to hold the temperature in tight precision. User should program a long soak step for the critical temperature and only activate the auto-tune after the process temperature has reached the set temperature.

For example, if 500°F is the most important temperature you need to hold in tight, set r01 = 2000, t01 = 30, C01 = 500, r02 = 0, t02 = 0, C02 = 0. When temperature reaches 500°F, set AT = 1 to activate the auto-tune. When auto-tuning is finished, set the steps back to the original program. The PID parameters obtained at 500°F may work fine at temperatures higher than 500°F (but it may be a little slow). But these parameters may not work well at lower temperature range.

5.3.4. Cycle time "t"

It is the time period (in seconds) that the controller uses to calculate its output. The default cycle time is 10 seconds. This controller has output for solid state relay/resistive load, so user reduces cycle time as low as 2s for higher precision control.

For example, when t = 2, if the controller decides output should be 10%, the heater will be on 0.2 second and off 1.8 seconds for every 2 seconds.

5.3.5. Input digital filter "FILt"

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 0 to 50. Stronger

filtering increases the stability of the readout display, but causes more delay in the response to change in temperature. FILt = 0 disables the filter. Default FILT is set to 20.

5.3.6. Hysteresis band "Hy"

The Hysteresis Band parameter Hy is also referred as Dead Band or Differential. It permits protection of the on/off control from high switching frequency caused by process input fluctuation. Hysteresis Band parameter is used for on/off control and auto-tune.

Please note that the cycle time can also affect the action. If the temperature passes the Hy set point right after the start of a cycle, the controller will not respond to the Hy set point until the next cycle. If cycle time is set to 20 seconds, the action can be delayed as long as 20 seconds. Users can reduce the cycle time to avoid the delay.

5.3.7. Decimal point setting "dP"

dP is used to define temperature display resolution.

When dP = 0, temperature display resolution is 1° (C or F).

When dP = 1, temperature display resolution is 0.1° (C or F). The temperature will be displayed at the resolution of 0.1° for input below 1000° (C or F), and 1° for input over 1000° (C or F).

5.3.8. Output range limits "OUTL" and "OUTH"

OUTL and OUTH set the minimum and maximum power output ratios. OUTL is the minimum power output ratio and OUTH is the maximum power output ratio. OUTL/OUTH has doubled value than the actual output percentage (see examples below).

OUTL is a useful feature for a system that needs to have a minimum amount of power as long as the controller is powered. For example, if OUTL = 20, the controller will maintain a minimum of 10% power output even when the PID wants to send 0% output.

OUTH can be used when you have an overpowered heater to control a small subject. For example, if you set the OUTH = 100, the 5000 Watts heater will be used as 2500W heater (50%) even when the PID wants to send 100% output.

5.3.9. Configuration Privilege "Lock"

To prevent the parameters and the program being changed accidentally, you can completely or partially lock the parameters and the program after the initial setup. The configuration privilege is determined by "lock". It can be set to any value between 0 and 50.

The factory default setting for lock is 0, which means all parameters are unlocked. It allows all parameters and program steps being viewed and edited during operation.

When Lock is set to any other value from 1 to 50, all the parameters are locked and cannot be edited.

Note: In any situation that parameters that are locked, you can always view and change the "lock" value after you view all field parameters. Change the value will immediately change the privilege level.

5.3.10. Input selection code for "Sn"

Please see Table 4 for the acceptable sensor type and its range.

Table 4. Code for Sn and its range.

Sn code	Sn Value	Input device	Display range (°C)	Display range (°F)
P	3	K (thermocouple)	-30 ~ +1300	-22 ~ +2372
E	4	E (thermocouple)	-30 ~ +700	-22 ~ +1292
J	5	J (thermocouple)	-30 ~ +900	-22 ~ +1652
t	6	T (thermocouple)	-199.9 ~ +400	-328 ~ +752
S	7	S (thermocouple)	-30 ~ +1600	-22 ~ +2912
r	8	R (thermocouple)	-30 ~ +1700	-22 ~ +3092
Cu50	0	Cu50 (RTD)	-50 ~ +150	-58 ~ +302
Pt1	1	Pt100 (RTD)	-199.9 ~ +200.0	-328 ~ +392
Pt2	2	Pt100 (RTD)	-199.9 ~ +600.0	-328 ~ +1112

5.3.11. Temperature Unit Selection, Celsius or Fahrenheit, “C, F”

This parameter sets temperature units, C for Celsius, F for Fahrenheit. In the Windows program settings, 0 is Celsius and 1 is Fahrenheit.

5.3.12. “COOL” for System Function Selection

Parameter “COOL” is used to set the controller main output mode for heating or cooling.

COOL = 0 is for reverse action control mode, heating control.

COOL = 1 is for direct action control mode, cooling control.

5.3.13. Limiting the control range, “PuH” and “PuL”

“PuH” and “PuL” values define the set value range. PuL is the low limit, and PuH is the high limit. For example, sometimes you may want to limit the temperature setting range so that the operator can’t set a very high temperature by accident. If you set the PuL = 100 and PuH = 130, operator will only be able to set the temperature between 100 and 130. For high temperature application (like kiln), please set PuH to a large number, like 2500.

5.3.14. Communication parameters “Addr” and “baud”

Two important parameters are used for data communication feature from this controller to your computer.

Addr: Unit address or unit ID. Available range is 0 ~ 255. Default value is 1.

Baud: Baud rate. Available values and definition are below:

Table 5. Baud Rate Table

Parameter value	Definition
0	Baud rate is 1200
1	Baud rate is 2400
2	Baud rate is 4800
3	Baud rate is 9600

Default value is 3 for 9600 baud rate.

5.3.15. Temperature Set Point “SP”

When this controller is set to single step mode (RUN = 0), user can use parameter SP to adjust current set temperature. When RUN = 1 ~ 3, SP parameter is not accessible. It is the same as SV.

5.3.16. Timer Unit “SEC”

SEC is used to set ramp soak timer to be minute timer or second timer.

SEC = 0, ramp soak timer is counting by minutes (default).

SEC = 1, ramp soak timer is counting by seconds.

5.3.17. Program Cycling “LOOP”

LOOP defines whether to loop the program when all ramp soak program steps have been executed.

LOOP = 0: No program loop. Once all the program steps have been executed, the program will be stopped. No power output in this mode.

LOOP = 1: Program loop is enabled. Once all the program steps have been executed, the program will execute from the beginning of the current program.

5.3.18. Power Outage Mode “PdE”

PdE defines the power outage/startup event handing modes, when controller lost power during the operation.

PdE = 0: After power is turned on, this controller will hold the program from the original break point. To resume the program, push and hold up arrow key for 3s manually.

PdE = 1: After power is turned on, this controller will jump to the beginning of the program (step 1) and hold there. To resume the program, push and hold up arrow key for 3s manually.

PdE = 2: After power is turned on, this controller will continue the program from the original break point. This mode is suitable for the applications in which power failure does not affect production.

PdE = 3: After power is turned on, this controller will jump to the beginning of the program (step 1) and run from there automatically.

5.3.19. Safety Start Band “SSb”

When the difference between the PV and SP is larger than SSb band during the soak steps, the controller will put program on hold automatically, until the difference is small than SSb. By default, SSb is set to 100 degree. If you need more tight temperature control, please set SSb to a small number, like 5 or 10 degree. **Please note SSb parameter is only applicable in soak steps.**

5.3.20. Program Control “RUN”

RUN indicates the current running mode/status of this controller.

RUN = 0: single step mode. User needs to adjust parameter SP to adjust the set temperature. Parameters in ramp soak steps are not in use. The controller will maintain at set temperature (SP) forever.

RUN = 1: program is stopped (ramp soak mode). The controller has no output under this mode. User can get access and adjust all steps & settings. When all the program steps have been completed and if program loop is disabled (LOOP = 0), RUN parameter will be automatically changed to 1.

RUN = 2: program is on hold (ramp soak mode). The controller is regulating the output based on the current set temperature, but timer is paused.

RUN = 3: program is running (ramp soak mode). The controller is running based on set ramp soak program.

5.3.21. Program Step Jump “Pro”

Pro indicates current step segment number and also used for manually jump. The number used here is actually step segment number, not step programming number. Step segment number can be any steps in the program (1 to 64). This parameter can also be used for manually jumping steps. If Pro value is changed to different step number, the program will automatically jump and run from that step. For details, see section 6.1.

5.3.22. Reserved Parameter “OP-A”

This parameter is not used in this controller. Its default value is 1 and please do not change it. Changing this parameter may cause this controller function/display incorrectly.

6. Program Ramp/Soak on the Controller

6.1. Terminology

Note 1: The terminology of this controller is different than Auber’s popular ramp soak controller SYL-2342P/SYL-2352P. For easy understanding, please check examples in section 8.

Note 2: The ramp soak feature is only applicable for the main output of this controller. Ramp soak feature does not apply on alarm outputs AL1 & AL2. AL1 alarm is a temperature alarm which can only work as ON/OFF mode. AL2 is a program ending timer alarm.

Program step (STEP): is a control step with its set value and set time are specified. Every step has two segments: ramp segment and soak segment. Ramp segment has higher priority and it will be executed at first. Soak segment has lower priority and it will be executed later.

Step programming number n: is the n-th step in the step programming. The step programming number (n) can range from 1 to 32. Its set temperature is expressed as C[n]; its set time is expressed as t[n]. For example, for the 1st step, the set temperature is C01 (E D I), the ramp time is r01 (r D I) and soak time is t01 (t D I). Please note, this parameter is used for temperature & time programming. For checking step status and step jump, step segment number n is used instead.

Step segment number n: The step segment number (n) can range from 1 to 64. Here is the relationship between step number and step segment number:

Ramp segment step number = actual step number * 2 - 1.
Soak segment step number = actual step number * 2.

For example, step 1 has step segment 1 (ramp segment) and step segment 2 (soak segment). To jump to the soak step of 2nd step, change Pro to 4.

Step set temperature (C[n]): is the set point of step n (soak step) or end temperature of step n (ramp step).

Step timer r[n] & t[n]: This controller has two separate timers for every steps. Step ramp timer (r[n]) is the ramp up time from previous step (n - 1) to current step n. Step soak timer (t[n]) is the time to hold at current step set temperature C[n]. Step ramp timer has higher priority than step soak timer, so this controller will run ramp timer at first (if enabled) then run soak timer.

Running time: Running time is how long the current step has been running. When the running time reaches the total step time (r[n] + t[n]), the program will jump to the next step automatically.

Jump: Go to a specified program step. This step can be any ramp or soak steps in the program. The number used in jump function is step segment number (1-64).

Run (run): The program is being executed. When the program is under the "run" status, the "A/M" indicator is solid on, the timer counts down, and the set point value may change according to your set program.

Hold (Hold): The execution of the program is paused. When the program is on "hold", the "A/M" indicator should be blinking, the temperature is still being controlled by your current set temperature, but the timer is paused.

Stop (STOP): Execution of the program is stopped. When the program is stopped, the lower window will flash between "stop" and the current set value, the timer and the output control will stop.

Power interrupt: It means the power has turned off or an unexpected power failure has occurred during running status. Four handling modes are available to the user. Please see 5.3.18 for details. Manually powering off the controller while the program is running is also considered as an occasion of power interrupt.

Safety-start: If the difference between the PV and SV is larger than safety-start band (SSb) during the soak step, controller will put program to a special "hold" and the timer won't start running until PV falls within the SSb. A-M indicator will be blinking but the SV display will not flash "HOLD". When safety start is triggered, controller will try to bring the temperature to the SV of the current step as fast as possible. This safety-start feature is useful when the user is very strict about the temperature and the time of a critical step.

6.2. Program

6.2.1. Program Setup (RUN ≠ 0, default mode)

Press and hold both SET key and A/M key together for 3s to bring the controller into the program setup mode. The controller will show the current step number in the top window "C XX" and show the set temperature in the lower window. Use the A/M key to choose which digit to edit (indicated by a flashing decimal point), and use the UP or DOWN arrow key to adjust the set temperature (-1999 to +9999). Then press SET key to save the change and go to the step ramp time. The top window will show "r XX", and the lower window will show the default time. Use the UP, DOWN, or A/M key to change the value, then press SET key to confirm and go to the step soak time. The top window will show "t XX", and the lower window will show the default time. Use the UP, DOWN, or A/M key to change the value, then press SET key to confirm and go to the next step. At each program step, the set temperature, the set ramp timer and soak timer are displayed in turn. Repeat this operation until all steps in your program have been entered. You don't have to use/edit all 32 steps.

Note 1: The above operation is inhibited if this controller is locked. Please see section 5.3.9 for the details of LOCK parameter. Even the controller is under single step mode (RUN = 0), user can still get access to all the ramp soak settings, though they are not in use.

Note 2: To exit the program editing mode, (1) press and hold both SET key and A/M key together for 3s, or (2) leave the key pad untouched for 10 seconds.

6.2.2. Step Timer

Every program step has two different sections: ramp section and soak section. Both sections are using the same set temperature C[n], but both sections have different timers. Timer for ramp section is r[n]; timer for soak section is t[n]. Ramp section has higher priority than soak section. The controller will run ramp section at first (if available), then run soak section later (if available).

Timer units for both timers are in minutes or seconds (see parameter SEC, section 5.3.16). The valid range for step ramp timer r[n] is from 0 to 2000. If it is set to 2000, it means it will ramp up to C[n] as fast as possible (step 1 ramp timer r01 needs to be 2000). The valid range for step soak timer t[n] is from 0 to 9999.

6.2.3. Program Ramp

Ramp means change the temperature from one point to another during a specified time. To program a ramp, you need to set the start temperature C[n-1], the end temperature C[n], and the ramp section timer r[n]. The ramping speed is:

$$V = (C[n] - C[n-1]) / r[n].$$

During this ramping step, the displayed set temperature will linearly change from C[n-1] to C[n] in proportion to the time that has been past in this step. For example, at step 3, you want the controller to ramp up from 200 to 300 degrees in 50 minutes, then you'll need to set C02 = 200°F, C03 = 300°F, r03 = 50min. The ramp up speed is 2°F/min. If this step has been run for 10min at same speed, C03 needs to be 220°F.

The ramping speed should be less than or equal to the maximum ramping speed that the current system can achieve at full power. In other words, the ramping time should be longer than the minimum time needed for the system to jump from C[n-1] to C[n]. Otherwise, the process temperature will gradually fall behind the schedule. For example, the maximum heating speed of an electric water kettle is 20°F/min, but the ramping step is set as C01 = 90°F, C02 = 212°F and r02 = 1min. The controller will not be able to achieve this goal. In the end of this step, the water temperature is probably at 110°F.

Note for step 1: r01 is the ramp up timer for step 1. r01 needs to be 2000, it means controller will ramp up to C01 (step 1 set temperature) as fast as possible.

Note for ramp rate: The actual ramp rate needs to be the multiples of 0.1 (°C/min, if displayed in °C), or multiples of 0.3 (°F/min, if displayed in °F). So if displayed in °C, the actual ramp rate (°C/min) can be 0.1, 0.2, 0.3 or higher. If displayed in °F, the actual ramp rate (°F/min) can be 0.3, 0.6, 0.9, 1.2 or higher. If your actual rate is 0.2°F/min or 0.12°C/min, it will be automatically rounded up.

To achieve higher ramp rate resolution, user can use RS485 protocol to update SV in a certain period of time. See RS485 supplementary manual for details.

6.2.4. Program Soak

The soak section maintains the temperature for a specified time. The soaking time is specified by soak timer t[n]. To program a soak, you need to set the step soak timer t[n], so this controller will soak at step set temperature C[n] for a duration of t[n]. For example, at step 3, the user wants the parts to be soaked in the oven at 200°F for 60 minutes, then the program for this step should be C03 = 200°F, t03 = 60min.

6.2.5. Safety Start

When the program is running (soak steps only), this controller will check whether the reading temperature is within the safety start band (SSB, see section 5.3.19 for definition). If the temperature falls within this range, the program will continue to run and timer will be counting normally. If the reading temperature is out of this range, the program will pause. This controller will try to reach the set temperature but timer will be paused until this condition is satisfied. This feature is called "safety-start". This feature is enabled when soak timer t[n] ≥ 1.

If the maximum speed of a system is unknown or varies with environmental conditions, users can use the "safety-start" feature to ensure that the temperature and the time during a ramp/soak step are kept within a reasonable range required by the process.

For example, a user wants to preheat a small oven from room temperature to 400°F and maintain it for 10min before preceding to the next step; the acceptable deviation is +/- 3°F. So the program can be set as C01 = 400°F, r01 = 2000, t01 = 10, SSB = 3. So the temperature to start the timer is 400°F - 3°F = 397°F. After the program is started, the controller will start bringing up the temperature with paused timer. Once the reading temperature reaches 397°F, the controller will start the soak timer t01 and counting down for 10 minutes.

Tip: If you want to use safety start feature in a very long ramp steps, you can consider splitting this long ramp steps into multiple short ramp steps, and put soak timer as 1 in every short ramp steps. So the temperature difference will be checked in those steps.

6.2.6. Program Run

When the program is running, the A-M indicator should be solid ON. To start running a program or resume a program, press and hold the UP arrow (▲) key for 2s. The A-M indicator will be solid ON. This function can be used when controller is on "Hold" (RUN = 2) or "Stop" (RUN = 1).

6.2.7. Program Hold

"Hold" means the program is being temporarily stopped. When the program is on hold, the A-M indicator will blink, the lower display window will flash "H L D" and set temperature. The controller will maintain at your current set temperature. Two ways to hold the program manually:

- 1) Press and hold the UP arrow (▲) key for 2 seconds until the lower window shows "H L D".
- 2) Change parameter RUN = 2 (see note 5.3.20)

Note1: You cannot program the step to hold it for indefinite time. An alternative solution is, you can set the soak timer to a large number like 9999. Then you can manually jump to the next step. See section 6.2.9 for how to manually jump steps.

Note2: When the program is on hold due to safety-start, A-M indicator will be flashing but the SV display will not flash "HOLD". It is a special hold condition

and you cannot hold up arrow key to "hold" the program again. If you like, you can enter its parameter settings and manually change RUN to 2 to hold the program.

6.2.8. Program Stop

When a program is stopped, the output is turned off. The lower display window will show "S L P", and the A-M indicator is off. To stop the program manually, change parameter RUN to 1. But the step will not go back to step segment 1 automatically. You can use Pro parameter for manually jump, or use display mode 5 to manually jump. When all the program steps have been completed and if program loop is disabled (LOOP = 0), RUN parameter will be automatically changed to 1.

(For SYL-5342PA/SYL-5352PA or later), To stop the program on the controller, user can press and hold down arrow key for 3s. The lower display window will show "S L P". The program is stopped and jumped back to step 1.

6.2.9. Program Jump

To jump the program from the current step to step x, press and hold A/M key for 3s. Bottom display will show letter "P". Press up and down arrow keys to change the step number you want to jump to, then press and hold A/M key for about 3s to save and jump.

6.2.10. First Step & Last Step

For the first step, please set r01(step 1 ramp timer) as 2000, t01 as 0 and C01 as your ambient temp (like 80F).

For the last step, assuming step n is your last step, please set r[n+1] as 0 so the controller will know step n is your last step. If LOOP = 0 (no looping), the controller will stop the output. The lower display window will show "S L P", and the A-M indicator is off. If LOOP = 1 (looping is enabled), the controller will run from step 1 automatically.

6.2.11. Check the Step Number and Jump the Program

To check at which step the program is running, press the down arrow key once. The upper display window shows your current reading temp, and the lower window shows the current step segment number starting at "P". Press DOWN arrow key to go back. Then press DOWN arrow key again to show the timer information. The upper display window shows your current reading temp, and lower window shows the time which current step has run starting at "F". This timer unit depends on parameter SEC (note 5.3.16.). It can be either by minute (SEC = 0) or by second (SEC = 1). Press DOWN arrow key again to exit. See Figure 3-1 for details.

To jump step manually, press and hold A/M key for 3 seconds. You will see current reading temperature on the upper display window and current step segment number on the lower display window. The decimal point located on the right bottom corner of lower display window is flashing. Use UP and DOWN arrow keys to change the step segment number, then press and hold A/M key for 3 seconds to confirm and jump immediately. See Figure 3-2 for details.

This is a convenient feature when you want to skip the current step and manually jump to another step. For example, if you want to jump to step 5 while the program is running, press and hold A/M key for 3 seconds. Then change the step number to 5, and then press and hold A/M key for 3 seconds to confirm.

7. Wiring Examples

7.1. Controlling heater by SSR

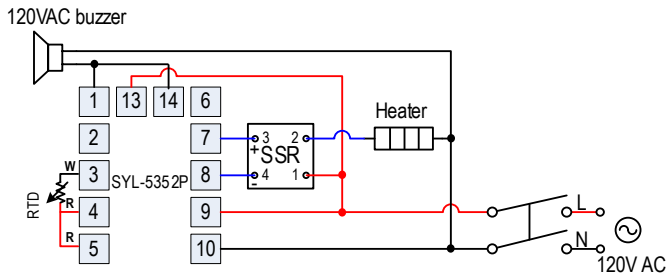


Figure 6. SYL-5352P with RTD input. This is a typical wiring for controlling the temperature of a tank of liquid with high precision.

The RTD sensor can offer accuracy within a fraction of a degree. The SSR allows the heater to be switched at higher frequency for better stability. It also has longer life time than the electromechanical relay. A proper heat sink is needed when the SSR switches > 8A of current. For wiring a 240V heater, please see 5.2. AL1 and AL2 alarm relay outputs are connected to one same 110V buzzer.

7.2. Controlling the load via SSR, 240VAC power.

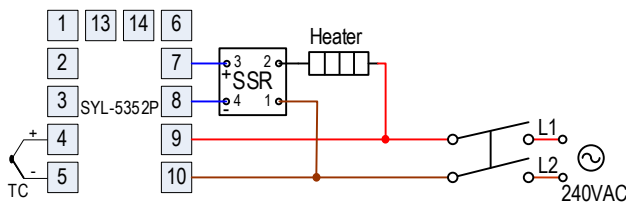


Figure 7. This is essentially the same wiring example as 7.1, except the heater and controller are powered by 240V AC and the temperature sensor is a thermocouple. Alarms are not installed in this example.

7.3. Heating and cooling with the same controller

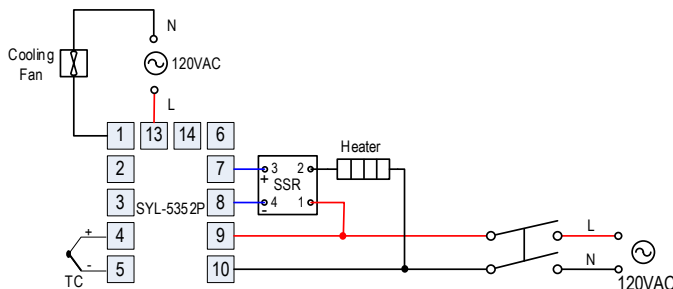


Figure 8. Control a heating element and a cooling fan using SYL-5352P. Heating element control can be set as ramp soak mode or single step mode. Cooling fan uses the AL1 alarm output and you can only set one temperature to turn it ON/OFF.

7.4. Controlling a 120VAC valve.

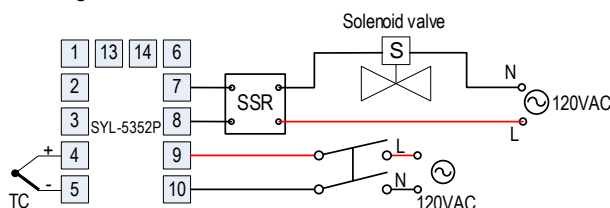


Figure 9. SYL-5352P can be used to control a solenoid valve with an SSR.

8. Programming Examples

Programs in the SYL-53X2P series controllers (including SYL-5342P and SYL-5352P) have a uniform format of ramp time-soak time-temperature. The temperature set point of the last step will linearly ramp to the set point of the current step over the ramp time of current step. Then the set point of current step will be held over the soak time of current step (optional). Due to the parameter SSb, even your program a ramp step that is faster than what is the system capable of achieving, which will result in actual temperature fall behind the schedule, this controller will automatically pause its timer to wait (see note 5.3.19). The time units are in minutes by default. To change timer unit in seconds, please see note 5.3.16.

8.1. Example 1: holding the oven temperature at 800°C for 2 hours.

Assuming that the heater is able to heat the oven from ambient (25°C) to 800°C within 30 minutes, we can write a program like this:

- Step 1:** r01 = 2000, t01 = 0, C01 = 25. Initial step.
- Step 2:** r02 = 30, t02 = 120, C02 = 800. Ramp up from 25°C to 800°C in 30 minutes, then hold there for 120 minutes.
- Step 3:** r03 = 0, t03 = 0, C03 = 0. End of the program.

The temperature profile is shown below in Figure 11.

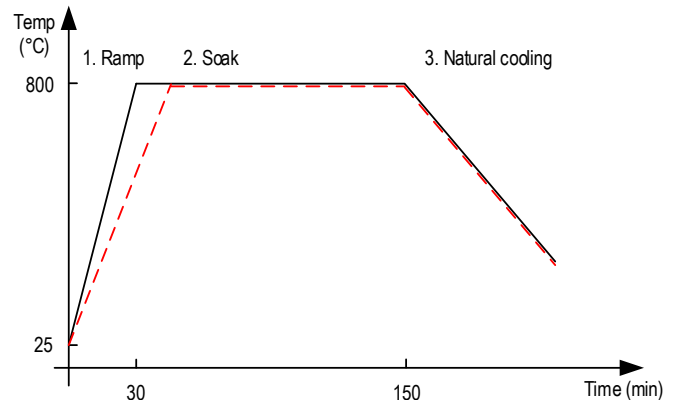


Figure 10. Temperature profile of an oven that is programmed to hold temperature at 800°C for 2 hours. The solid line is the temperature when the oven is capable of ramping up from 25°C to 800°C in 30 min; the dashed line is the temperature profile when the oven needs longer time to ramp up to 800°C.

Note 1: To turn off the heater after the program, change LOOP to 0, so the program will not auto restart.

Note 2: The value of C[n] is the end temperature of step n. For instance, C01 is always the temperature at the end of step 1, and C02 is the end temperature of step 2. Usually C01 should be the ambient temperature, and r02 is the ramp time from step 1 to step 2.

Note 3: If the heater is not capable of heat the oven from 25°C to 800°C in 30min, the actual oven temperature can fall behind the schedule. Safety start band will be triggered to pause the timer until the reading temperature gets close. The timer for step 2 (the soak section) will start even when temperature is still a little bit below 800°C; and so the actual soaking time will be less than 2 hours. Please see the dashed line in Figure 10.

8.2. Example 2: program alarm relay actions

The following example includes 4 steps: linear temperature heating, maintaining a constant temperature, linear temperature cooling and maintaining a constant temperature. At the end of all steps, the controller will jump to step 1 and restart the program.

Steps:

Step 1: r01 = 2000, t01 = 0, C01 = 100. Initial step

Step 2: r02 = 30, t02 = 60, C02 = 400. Ramp up from 100°C to 400°C in 30 minutes (ramp speed is (C02 - C01) / r02 = 10°C /minute), then maintain at 400°C for 60 minutes.

Step 3: r03 = 120, t03 = 60, C03 = 160. Ramp down from 400°C to 160°C in 120 minutes (ramp speed is (C03 - C02) / r03 = -2°C /minute), then maintain at 160°C for 60 minutes.

Step 4: r04 = 0, t04= 0, C04 = 0. End of the program

Parameters:

SSb = 5. Safety start band is set to 5 degree.

LOOP = 1. Program automatically looping is enabled.

ALP = 1. Alarm 1 is set to absolute high alarm.

AL1 = 420°C. Alarm 1 will be activated when reading temperature is over 420°C

AL2 = 10. Program ending alarm is set to 10s. Once all the steps have been executed, alarm 2 will be activated for 10s.

Note: When the program jumps back to step 1, the oven temperature is still at 160°C, the program will pause until the temperature drops within the deviation alarm range of the new set point. As the deviation high alarm is set to 5°C, the program will resume (from the beginning) as soon as the temperature drops below SV + SSb = 105°C.

The temperature control block is shown below.

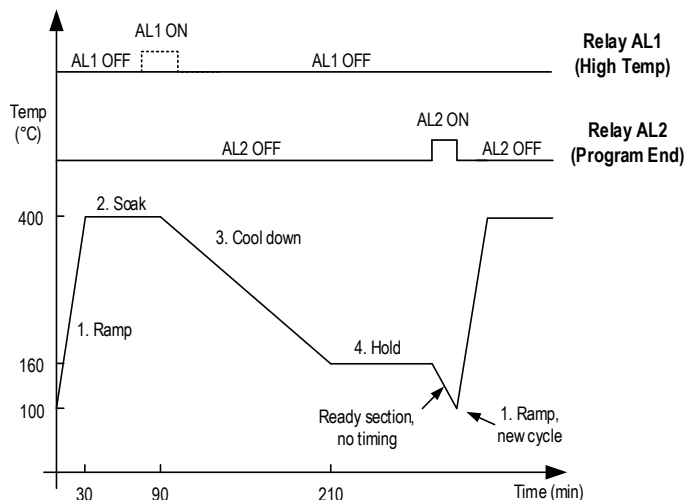


Figure 11. Temperature profile and relay AL1 & AL2 actions in the example program.

8.3. Example 3: heat treatment oven

A heat treatment oven needs to heat up to 375°F at its maximum speed. Then hold the temperature for 20 minutes. After that, pull in the AL2 relay for 2 minutes. If the temperature is higher than 450°F, trigger the AL1 relay. This application needs a controller SYL-5352P, a solid state relay (SSR), a thermocouple and a two buzzers with a 12V DC power source.

a. Wiring

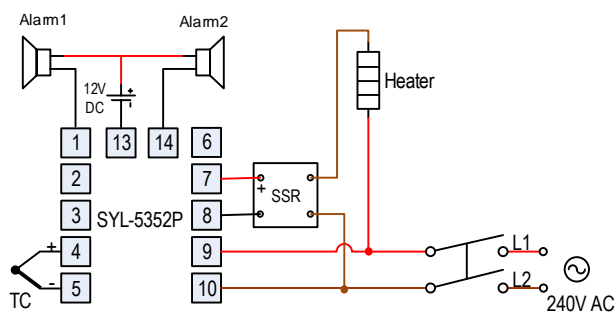


Figure 12. Wiring diagram for the oven in example 3.

b. Parameter setting and program

SSb = 5. Safety start band is set to 5 degree.

LOOP = 0. Program automatically looping is disabled.

ALP = 1. Alarm 1 is set to absolute high alarm.

AL1 = 450. Alarm 1 will be activated when reading temperature is over 450

AL2 = 120. Program ending alarm is set to 120s. Once all the steps have been executed, alarm 2 will be activated for 120s.

The program:

r01 = 2000, t01 = 20, C01 = 375. Heat up to 375 as fast as possible, then soak at 375 for 20 minutes

r02 = 0, t02 = 0, C02 = 0. End of the program.

9. Win software/RS485 connection FAQs

1). I cannot get my controller connected to my computer. How to troubleshoot?

Step 1: After you connect your USB adapter to the Windows PC, please open Windows device manager (by press Win key + X key together). Under Ports (COM & LPT) section, there should be a port named as "USB-SERIAL CH340", which is from our USB adapter. If it has a different name, you need to manually install the driver for this adapter. You can find the driver files in the zip file you downloaded together with the communication software from auberins.com.

Step 2: If no help or if your software is stuck at scanning the port under auto-select tab, please disable all the other unused COM ports and LPT ports under the device manager, then try again.

Step 3: If no help, please power down your PID and remove your USB adapter from the computer. Then use a multimeter to confirm the connection/continuity between the PID and the USB adapter. Please double check the polarity on the USB adapter and on the back of the PID.

Step 4: If still no help, please try a different computer. English version Windows is preferred. If still no help, please contact Auber support.

2. How to input the ramp soak profile in the Windows software?

After you login the software, for first timer user, please click "Auto Select" on the right top of the screen. Click "Detect" button on the right, then this software will automatically scan your connected PID controller. Once finished, you will see SYL-53X2P-S is detected (if you PID model is SYL-5342PA / SYL-5352PA). Then click "Apply" button. Then you will see "Program" button showing on the right top. You can use "Program" button to write a program.

Please note, the program is stored in the Windows computer by default. You need to manually download/transmit your program into your PID. For details, please see the tutorial video for this product.

3. How to use the data logging feature in the Windows software?

For the data output function, you need to click on "Start Monitor" and "Record" buttons on the top at first. Under the "record" mode, the real-time data can be stored and for future purposes. It is not saved as separate file in Windows file systems.

Please be noted, "report" button will only report the pre-saved data before you click this "report" button. In that word, if you are under the "Report" view and "Record" is ON, you cannot find your latest data. What you need to do is, you need to jump to any other views at first (like Panel view), then jump back to "Report" view. You can find it there.

4. How to connect more than one PID to the computer at the same time?

Multiple PIDs need to be connected in parallel to the same RS485 adapter, then plug in this adapter into your computer. You also need to set different unit addresses (parameter name: addr) in all the connected PIDs.

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