Instruction Manual

SYL-5850 Dual Channel PID Temp Controller with Dual SSR Outputs

Version 1.0 (Sept, 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.
- For warranty details, please check auberins.com.

1. Features and limitations

- Compact size. Two separate PID controllers in the size of one 1/16 DIN controller.
- Two SSR outputs (12V DC). One for each channel.
- Dual line display. It can show the temp readouts from both channels at the same time.
- No manual mode. Only PID mode and ON/OFF mode.
- Both channels need to use the same type temp sensors.
- No alarm dry relay output, only 12V DC SSR alarm output.

2. Specifications

Table 1. Specifications.

Input type	Thermocouple (TC): K, E, J, T, S; RTD (Resistance Temperature Detector): Pt100, Cu50
Input range	Please see section 5.3.10 for detail.
Accuracy	± 0.5% full scale. Cold junction compensation error ≤ ±2ºC
Response time	≤ 1 s (when FP = 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	2 x 12V DC, 30 mA max (each)
Alarm mode	2 x 12V DC, 30 mA max (each)
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 ~ 50ºC, 32 ~ 122ºF; ≤ 85% RH; No corrosive gas, no strong EMI
Dimension	48 x 48 x 107 mm (W x H x D)
Mounting cutout	45 x 45 mm

3. Terminal Wiring

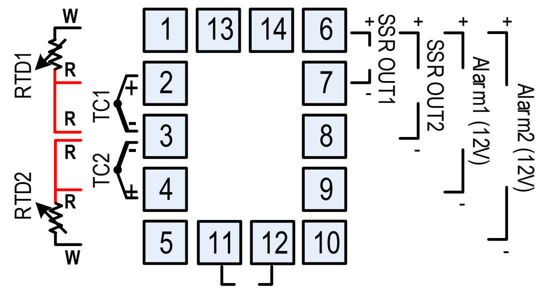

Figure 1. Wiring terminals.

3.1 Sensor connection

Please refer to Table 4 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.

Note: you need to use two same type sensors with this controller. For example, you can use two type K thermocouple or two PT100 RTD sensors with this controller. <u>You cannot use two different types of sensor with this controller.</u>

3.1.1 Thermocouple

The thermocouple should be connected to terminals 2 & 3 (for channel 1), and 3 & 4 (for channel 2). 2 and 4 are positive terminals. 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 (backwards "4").

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 2 & 3 (for channel 1), and 3 & 4 (for channel 2). The white wire should be connected to terminal 1 (for channel 1), and 5 (for channel 2). Set controller input type Sn to Pt.

For a two-wire RTD, the wires should be connected to terminals 1 & 2 (for channel 1), and 4 & 5 (for channel 2). Jump a wire between terminals 2 & 3 (for channel 1), and 3 & 4 (for channel 2). Set controller input type Sn to Pt.

3.2 Power to the controller

The power cables should be connected to terminals 11 and 12. 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.

3.3 Control output connection

The SSR control output of the controller is 12V DC supplied through terminal 6 & 7 (for channel 1), and 6 & 8 (for channel 2). Terminal 6 is positive for both channels. It can be used to drive one or multiple DC triggered solid state relays (SSRs) in parallel.

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 Alarm outputs

This controller has two 12V DC (SSR) alarm outputs. Terminal 6 & 9 for channel 1, and 6 & 10 for channel 2. Terminal 6 is positive.

Please be advised, the amp rating for alarm output is only 30 mA max each. To drive a large alarm/load, you may need to use an external SSR and/or heat sink. This controller doesn't have dry relay alarm outputs.

4. Front Panel and Display Mode

4.1 Front Panel

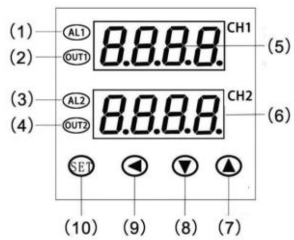

Figure 2. Front panel.

① Channel 1 alarm indicator (AL1): It lights up when channel 1 alarm is on.
② Channel 1 output indicator: It is synchronized with main control output for channel 1 and the power to its load. When it is on, the heater (or cooler) connected to channel 1 is powered.
③ Channel 2 alarm indicator (AL2): It lights up when channel 2 alarm is on.
④ Channel 2 output indicator: It is synchronized with main control output for channel 2 and the power to its load. When it is on, the heater (or cooler) connected to channel 2 is powered.
⑤ Channel 1 window (PV1): Displays the channel 1 sensor readout value (PV1), or parameter name.
⑥ Channel 2 window (PV2): Displays the channel 2 sensor readout value (PV2), or parameter value.
⑦ UP key ▲: Increases numeric value of the setting value.
⑧ DOWN key ▼: Decreases numeric value of the setting value.
⑨ Shift key: Digit shift key.
⑩ SET key: Enter parameter settings.

4.2 Controller display mode

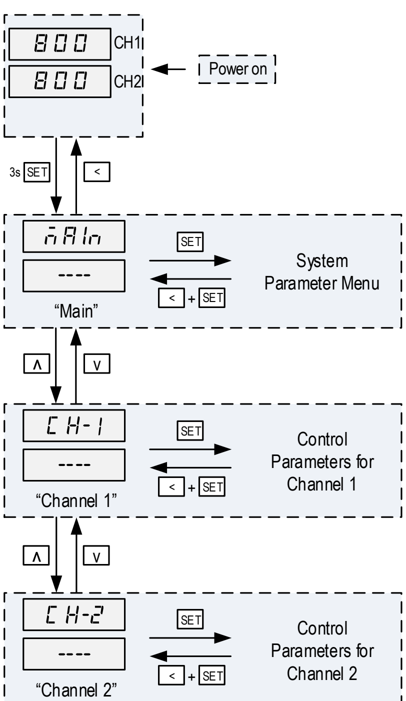

Figure 3. Flow chart for menu selection

Display mode: normal operating mode. When the power is turned on, the upper display window shows the channel 1 measured value (PV1) and the lower window shows the channel 2 measured value (PV2).

Display mode: Menu selection mode. Press and hold the SET key for 3 seconds to enter the menu selection mode. The top window shows the menu name the bottom window shows "- - - -". You can use up and down arrow keys to change the top display to a different menu. "MAIn" for system parameter menu, "CH-1" for channel 1 menu and "CH-2" for channel 2 menu. Press SET key again to enter the target menu. Press left arrow button (shift key) to exit to the normal operating mode.

Display mode: Parameter settings mode. Once you enter the any sub-menu, 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. Press SET key + left arrow key (shift key) together to exit to the menu selection mode.

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 5.1.1), no parameters can be changed.

5. Parameter Settings

5.1 List of system parameters

Table 2. System parameters.

System Parameter Menu Press & Hold SET Key for 3s, then choose "MAIn" to enter				
Code	**Description**	**Setting Range**	**Initial Setting**	**Remarks**
LocK	Configuration Privilege	0 ~ 50	18	See 5.1.1
Sn	Input Sensor Type		K	See 5.1.2
OPb	Reserved		Off	-
Addr	Reserved		1	-
bAud	Reserved		9600	-
CF	Display Temp Unit	C, F	C	See 5.1.3

Table 3. Control parameters for channels

Control Parameter Menus for channel 1 and 2. Press & Hold SET Key for 3s, then choose "CH-1" for channel 1 or "CH-2" for channel 2. "n" is the channel number. For example, SP1 is the set value for channel 1				
Code	**Description**	**Setting Range**	**Initial Setting**	**Remarks**
SP(n)	Set Value	Sensor range	100.0	See 5.1.4
Hy(n)	Hysteresis Band	0.1 ~ 50.0	0.5	See 5.1.5
ALH(n)	Alarm Settings	PuL ~ PuH	400	See 5.1.6
AL-(n)			300	
Hy-(n)	Derivation Alarm Band	0.1 ~ 50.0	0.5	
SC(n)	Input offset	-50.0 ~ 50.0	0	See 5.1.7
P(n)	Proportional Constant	0 ~ 200.0	0.0	See 5.1.8
I(n)	Integral Time	0 ~ 9999	240	
D(n)	Derivative Time	0 ~ 250	30	
T(n)	Cycle Time	1 ~ 120	10	See 5.1.9
Uo(n)	Initial Power Output Limit	0-100	10	See 5.1.10
At(n)	Auto Tuning	On, off	Off	See 5.1.11
PbH(n)	Reserved		9999	-
PbL(n)	Reserved		0.0	
oP(n)	System Function Selection	0 ~ 8	0	See 5.1.12
ALP(n)	Alarm Output Definition	0 ~ 8	1	See 5.1.6
PF(n)	PV Digital Filter	0-80	20	See 5.1.13
PSH(n)	Reserved		9999	-
PSL(n)	Reserved		0.0	
dP(n)	Decimal Point Position	0 ~ 1	1	See 5.1.14
UtH(n)	Reserved		20.0	-
UtL(n)	Reserved		4.0	

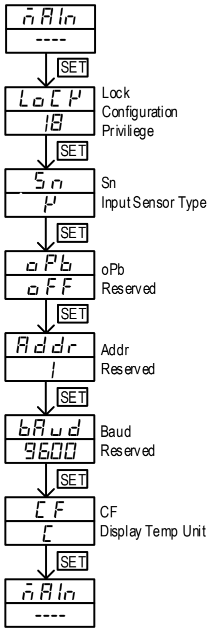

Figure 4. Flow chart for system parameter menu

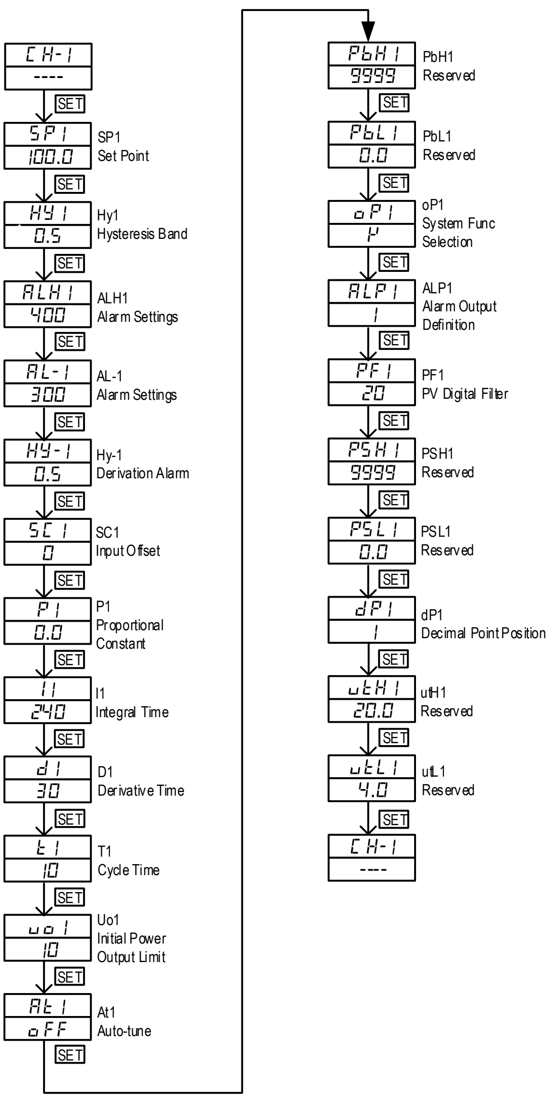

Figure 5. Flow chart for control parameter menu

5.1.1 Configuration Privilege: Lock

To prevent the parameters and the program being changed accidently, 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 18, which means all parameters are unlocked. It allows all parameters being viewed and edited during operation.

When Lock is set to any other value from 0 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. Change the value will immediately change the privilege level.

5.1.2 Input selection code: Sn

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

Table 4. Code for Sn and its range.

Sn code	Input device	Display range (°C)	Display range (°F)
Cu	Cu50 (RTD)	-50 ~ +150	-58 ~ +302
Pt	Pt100 (RTD)	-199.9 ~ +600.0	-328 ~ +1112
K	K (thermocouple)	0 ~ +1300	32 ~ +2372
E	E (thermocouple)	0 ~ +700	32 ~ +1292
J	J (thermocouple)	0 ~ +1200	32 ~ +2192
t	T (thermocouple)	0 ~ +400	32 ~ +752
S	S (thermocouple)	0 ~ +1600	32 ~ +2912

Please note, this controller can only read two same type sensors at one time. This Sn parameter controls the sensor type for both channels. This controller cannot read two different type sensors.

5.1.3 Temperature Unit Selection, Celsius or Fahrenheit, CF

This parameter sets temperature units, C for Celsius, F for Fahrenheit.

5.1.4 Temperature Set Point: SP

Set temperature. Its range is limited by the sensor input range mentioned in table 4 above.

5.1.5 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. Hy 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.

Note: This controller has two very similar parameters Hy1 & Hy-1, Hy2 & Hy-2. Hy1/Hy2 parameter is used for ON/OFF control and auto-tune. See section 5.3.8 for details. Hy-1/Hy-2 is used for derivation alarm. See section 5.3.6 for details.

5.1.6 Alarm function & parameters: ALH, AL, Hy, ALP
This controller has two alarm outputs (12V DC, SSR output): AL1 output (terminal 6 & 9) and AL2 output (terminal 6 & 10). AL1 is for channel 1 and AL2 is for channel 2.

This controller has four alarm parameters for each channel: ALH(n), AL-(n), Hy-(n) and ALP(n). "n" is the channel number.
Parameter AL-(n): Temperature alarm set value.

Parameter ALH(n): Temperature alarm upper limit, only for band alarm types (ALP = 5 or 6)

Parameter Hy-(n): Derivation alarm set value.

ALP(n): Alarm definition. See the table below for ALP1 (Channel 1).

Table 5. ALP1 Definition

ALP1 Value	Alarm Type	Alarm ON Condition	Alarm OFF Condition
0	AL1 is disabled		
1	Absolute high alarm	PV1 ⩾ AL-1	PV1 < (AL-1 – Hy-1)
2	Absolute low alarm	PV1 ⩽ AL-1	PV1 > (AL-1 + Hy-1)
3	Derivation high alarm	PV1 ≥ (SP1 + AL-1)	PV1 < (SP1 + AL-1 – Hy-1)
4	Derivation low alarm	PV1 ≤ (SP1 – AL-1)	PV1 > (SP1 - AL-1 + Hy-1)
5	Band alarm, direct acting (out of range alarm)	PV1 ⩽ AL-1 or PV1 ⩾ ALH1	(AL-1 + Hy-1) < PV1 < (ALH1 – Hy-1)
6	Band alarm, reverse acting (in range alarm)	AL-1 ⩽ PV1 ⩽ ALH1	PV1 < (AL-1 – Hy-1) or PV1 > (ALH1 + Hy-1)
7	Temp diff high alarm (PV1 & PV2)	PV1 – PV2 ⩾ AL-1	(PV1 – PV2) < (AL-1 - Hy-1)
8	Temp diff low alarm (PV1 & PV2)	PV1 – PV2 ⩽ AL-1	(PV1 – PV2) > (AL-1 + Hy-1)

Legend:
PV1: current reading temperature of channel 1
SP1: Set temperature of channel 1

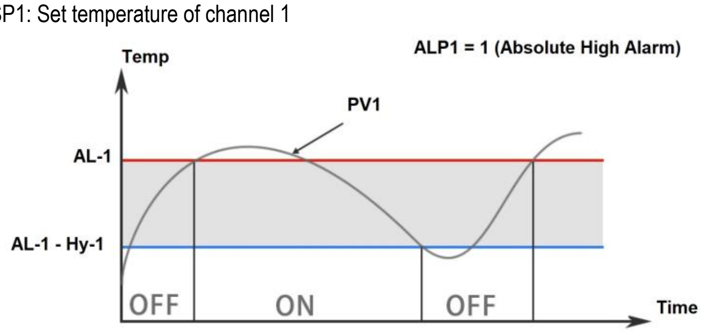

Figure 6. Absolute high alarm example for AL1.

5.1.7 Input offset "SC"

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

5.1.8 Control mode

1) PID control mode
Here are the definition for the PID algorithm used in this controller: proportional, integral, and derivative parameters.

(1) Proportional constant "P"
P is also called the proportional band. Its unit is the temperature range. e.g. P = 20 means the proportional band is 20°C. Assuming the set temperature (SV) = 200. When integral, I, and derivative, d, actions are removed - the controller output power will change from 100% to 0% when temperature increases from 180 to 200°C. The smaller the P value is, the stronger action will be for the same temperature difference between SV and PV.

(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.

(3) Derivative time "D"
Derivative time can be used to minimize the temperature overshoot by responding to its rate of change. The larger the number, the faster the action. Setting d-value too small or too large would decrease system stability, cause oscillation or even non-convergence.

2) On/off control mode
On/off control mode is not as precise as PID control mode. However, 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 the set point, the heater (or cooler) will be turned off. When the temperature drops back to below the hysteresis band (dead band) the heater will be turned 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.

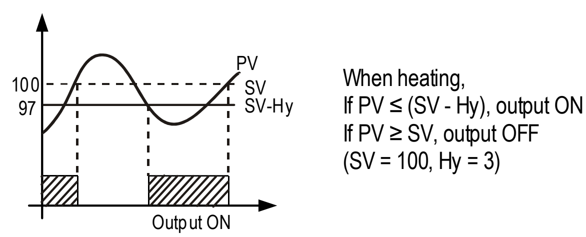

Figure 7. ON/OFF control mode

5.1.9 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.

5.1.10 Initial Power Output Limit "uo"

Parameter "uo" is similar as the proportional constant "P", but it will provide precise adjustment. By default, "uo" is set to 10. Auto-tune will also adjust this parameter.

After the auto-tune, if you still have slightly overshoot, you can decrease "uo" parameter. If you take a long time to heat up your load initially, you can increase "uo" parameter.

5.1.11 Auto-tune "At"

By default settings, this controller is preset for ON/OFF mode for both channels. To use PID mode, the users need to program P, I and D parameters for his setup/application. The easiest way is 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 by the auto-tune.

Before auto-tune, please make sure this controller is wired correctly. Temperature sensor, SSR with heat sink and heater are connected to the controller correctly. Also confirm your hysteresis band Hy is set to a small number such as 0.5. Confirm your set temperature is your most commonly used value. The auto-tune can be started by setting parameter At = ON, then auto-tune will start automatically. When channel 1 is running auto-tune, the top display will flash between "- At -" and the current reading temp. When channel 2 is running auto-tune, the bottom display will flash between "- At -" and the current reading temp.

During auto tuning, the instrument executes on/off control at the current set temperature. After 3 ~ 4 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, D and uo. The whole process may take 20-60 mins, depending on the setup and temperature.

When auto-tune is finished, the display will stop flashing "- At -". Controller will resume the normal temperature control. Generally, you will only need to perform auto tuning once, if you use this controller for the same application and similar set temp. After the auto tuning is finished, controller will set parameter "At" to OFF automatically.

Note 1: To manually stop auto-tuning, please manually set parameter At to OFF.
Note 2: If the controller was powered off during the auto-tune process, once the power is resumed, the auto-tune process will also be resumed.
Note 3: To achieve best result, please run auto-tune for both channels separately.

5.1.12 System Function Selection "op"

Parameter "op" is used to set the controller main output mode for heating or cooling.

Op = 0 (default), reverse action control mode for heating control.
Op = 1, direct action control mode for cooling control.

5.1.13 PV digital filter "PF"

If measurement input fluctuates due to noise, then a digital filter can be used to smooth the input. "PF" may be configured in the range of 0 to 80. Stronger filtering increases the stability of the readout display, but causes more delay in the response to change in temperature. PF = 0 disables the filter. Default PF is set to 20.

5.1.14 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).

6 Wiring Example

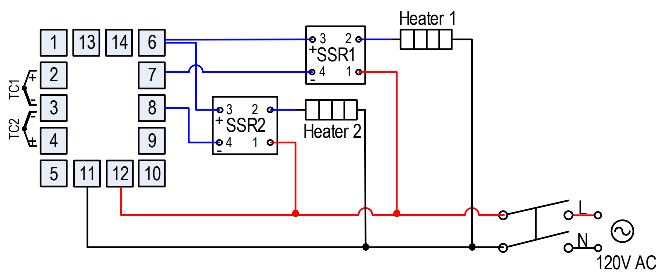

Figure 8. Wiring example with two SSRs & heaters and two type K thermocouples. Heater 1 and heater 2 are for two separate applications.

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