Instruction Manual

SYL-2381-mA PID TEMPERATURE CONTROLLER INSTRUCTION MANUAL

Version 1.4 (Dec, 2024)

⚠ Caution

- This controller is intended to control equipment under normal operating conditions. If failure or malfunction of it could lead to an abnormal operating condition that could cause personal injury or damage to the equipment or other property, other devices (limit or safety controls) or systems (alarm or supervisory) intended to warn of or protect against failure or malfunction of the controller must be incorporated into and maintained as part of the control system.
- Installing the rubber gasket supplied will protect the controller front panel from dust and water splash (IP54 rating). Additional protection is needed for higher IP rating.
- This controller carries a 90-day warranty. This warranty is limited to the controller only.

1. Features

- The PID control with artificial intelligent enhancement for precision temperature control.
- Auto-tuning function can find the best PID parameter automatically.
- ON/OFF control mode for refrigerator, motor and solenoid valve control application.
- Linear output control 0 ~ 20 mA or 4 ~ 20 mA.
- Bumpless transfer between Auto and Manual control mode.
- Optional serial communication port (RS-485/Modbus_RTU).
- The output can be set for linear output controller or relay contactor control by the user.
- Support 10 different types of commonly used temperature sensor inputs.

2. Specifications

Input type	Thermocouple (TC): K, E, S, R, J, T, B, WRe3/25 RTD (Resistance temperature detector): Pt100, Cu50
Input range	See Table 2
Display	Dual lines, four digits, °F or °C
Display resolution	1°C, 1°F; or 0.1°C, 0.1°F with Pt100
Accuracy	± 0.2% or ± 1 unit of full input range
Control mode	PID, manual
Output mode	Relay contact: 3 A at 240 VAC. Linear current output: 0 ~ 20 mA, 4 ~ 20 mA.
Alarm	Process high/low alarm
Power consumption	< 2 Watt
Power supply	85 ~ 260 VAC / 50 ~ 60 Hz or 85 ~ 260 VDC
Communication (optional)	RS-485 (Modbus_RTU)
Operating condition	0 ~ 50°C, ≤ 85% RH
Mounting cutout	45 x 45 mm
Dimension	48 x 48 x 82 mm (1/16 DIN)

3. Front Panel and Operation

Figure 1. Front panel

① AL1: Relay J1 output indicator.
AT: ON for manual mode. Blinking during auto-tuning process.
OUT: main output indicator.
② Up key: value increment / select the next parameter.
③ Down key: value decrement / select previous parameter.
④ Shift key: start auto tuning / shift digit / check output percentage*
⑤ Set key: confirm change / switch between Manual and Auto mode.
⑥ PV window: measured temperature, or, Process Value (PV)
⑦ SV window: set temperature, or, Set Value (SV)

Note *: Press Shift key momentarily to change the SV window from set temperature to real-time output percentage. It will be display as "o XXX". For example, "o 90" means the current output percentage is 90%. Press Shift key again to switch back to set temperature.

4. Terminal Wiring (back view)

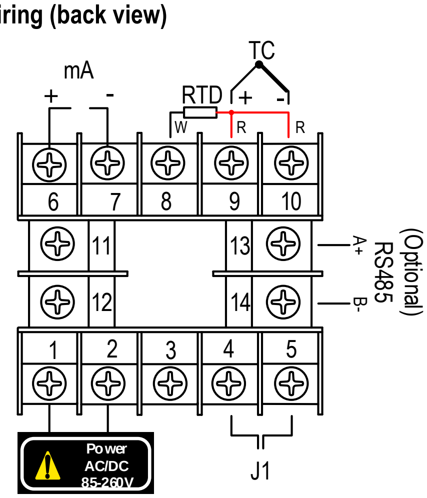

Figure 2. Terminal assignment of SYL-2381-mA.

4.1 Sensor connection

4.1.1 Thermocouple

The thermocouple should be connected to terminals 9 and 10. Make sure that 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.

4.1.2 RTD sensor

For a three-wire RTD with standard DIN color code, the two red wires should be connected to the terminals 9 and 10. The white wire should be connected to terminal 8. For a two-wire RTD, the wires should be connected to terminals 8 and 9. Jump a wire between terminals 9 and 10.

For PT100 sensor, set Input Sensor Type, **Inty**, to “P100” (1 degree resolution) or “P10.0” (0.1 degree resolution).

4.2 Power to the controller

The power cables should be connected to terminals 1 and 2. Polarity does not matter. It can be powered by 85 - 260 V AC or DC 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 2 and neutral to 1. Since the controller is in a plastic shell, ground wire is unnecessary.

4.3 Output connection

Three control output options are offered by this controller: (1) Linear current output provides 0 ~ 20 mA or 4 ~ 20mA current output. (2) J1 relay output can be used to turn on a contactor or a solenoid valve. It can also drive a small heater directly if the heater draws less 3 Ampere.

4.3.1 Drive the load through linear current output (mA)

Connect terminal 7 to the negative input and terminal 6 to the positive input of the loads which takes linear input (like linear controlled valve). Set the Control Output Mode (**outy**) to 1, 2, or 5 depending on the control mode to be used. Then set the Main Output Mode (**Coty**) to “0-20” or “4-20”. See Figure 12 for an example. Please note that the SSR output is not available on this model.

4.3.2 Drive the load through J1 relay

Assuming the controller is powered by a 120 V AC source and the contactor has a 120 V AC coil, jump a wire between terminal 2 and 4. Connect terminal 5 to one lead of the coil and terminal 1 to the other lead of the coil. Set the system Control Output Mode (**outy**) to 3 or 4 depending on the control mode to be used. Please see Figure 10 for an example.

4.4 Note for first time users

For first time users with no prior experience with PID controllers, the following notes may prevent you from making a few common mistakes.

4.4.1 Power to the heater does not flow through terminal 4 and 5 of the controller. The controller consumes less than 2 watts of power. It only provides a control signal to the relay. Therefore, 20 gauge wires are sufficient for providing power to terminal 1 and 2. Thicker wires may be more difficult to install.

4.4.2 The J1 relay is “dry single pole switch”. It does not provide power by itself. Figure 11 shows how the J1 relay is wired to pass the 120 V AC power to drive an external contactor which requires 120 V AC for its coil. If the coil of the contactor requires a different voltage than the power supplied to the controller, an additional power source will be needed (Please see Figure 11 for an example).

5. Parameter Settings

For safety reasons, control parameters are divided into three groups with different pass codes. You should only give the code to those who have the responsibility and knowledge of how to properly change it. Code 0089 contains parameters for system configuration that may need to be changed during the initial set up. Code 0036 contains parameters for tuning the control performance. Code 0001 is for changing set temperature and alarm settings.

5.1 System configuration parameters (accessed by code 0089)

The system configuration parameters are listed in Table 1. To change the parameters, press SET key briefly, enter the code “0089” and press SET key again. The procedures to change system parameters are shown in the flow chart in Figure 3.

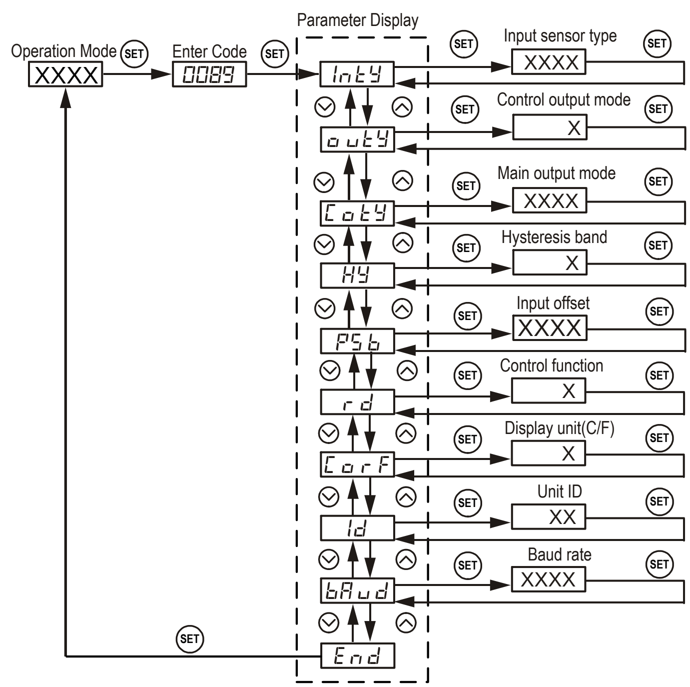

Figure 3. System parameters setup flow chart.

(1) Press SET key to enter setting mode;
(2) Press >, V, or ∧ key to adjust parameters;
(3) Press SET key to confirm;
(4) Press V or ∧ key to select the new parameter and repeat step 2 and 3.
(5) Go to “End”, press SET key to exit parameter setting mode.

Table 1. System configuration parameters.

Code		Description	Setting Range	Initial	Note
IntY	Inty	Input Sensor Type	See Table 2	K	1
outY	outy	Control Output Mode	1, 2, 3, 4, 5, 6	1	2
CotY	coty	Main Output Mode	0 - 20 mA, 4 - 20 mA, SSR (does not apply to this model)	0 - 20 mA	3
HY	Hy	Hysteresis Band	0 ~ 9999	3	4
PSb	PSb	Input Offset	-100 ~ 100 (deg.)	0	5
rd	rd	Control Direction	0: heating; 1: cooling	0	
CorF	CorF	Display Unit	C, F	F	
Id	Id	Unit ID	1 ~ 64	5	6
bAud	bAud	Baud Rate	1200, 2400, 4800, 9600	9600	6
End	End	Exit			

Note 1. The controller is preset for K type thermocouple input. If any other type of sensor is used, the **Inty** value needs to be changed to the corresponding symbol as shown in Table 2.

Table 2. Temperature sensor code.

Symbol		Description	Working Temperature Range
t	T	TC, Type T	-200 ~ 400°C; -320 ~ 752°F
r	R	TC, Type R	-50 ~ 1600°C; -58 ~ 2900°F
J	J	TC, Type J	-200 ~ 1200°C; -320 ~ 2200°F
WrE	WRe	TC, WRe 3/25	0 ~ 2300°C; 32 ~ 4200°F
b	B	TC, Type B	350 ~ 1800°C; 660 ~ 3300°F
S	S	TC, Type S	-50 ~ 1600°C; -58 ~ 2900°F
K	K	TC, Type K	-200 ~ 1300°C; -320 ~ 2400°F
E	E	TC, Type E	-200 ~ 900°C; -320 ~ 1650°F
P100	P100	RTD, Pt100	-200 ~ 600°C; -320 ~ 1100°F
P10.0	P10.0	RTD, Pt100	-99.9 ~ 600.0°C; -99.9 ~ 999.9°F
Cu50	Cu50	RTD, Cu50	-50.0 ~ 150.0°C; -60 ~ 300°F

Note 2. The setting of **outy** determines the control output mode. When it is set to:
1 - J1 relay works as absolute alarm output; mA port as PID control output;
2 - J1 relay works as derivation alarm output; mA port as PID control output;
3 - J1 relay works as PID control output; mA port disabled;
4 - J1 relay works as on/off control output; mA port disabled;
5 - J1 relay works as absolute alarm output; mA port disabled.

Note 3. The setting of **Coty** determines the main output modes on the mA port. When it is set to:
"0-20" - Main output is set to 0 - 20 mA linear current output mode.
"4-20" - Main output is set to 4 - 20 mA linear current output mode.
"SSR" - Not available on SYL-2381-mA.

Note 4. Hysteresis Band **Hy** (also called dead band, or differential) is used in on/off control mode. Its unit is in degrees (°C or °F). When the controller works in on/off control mode for heating, the output will be off when PV > SV and on again when PV < (SV - Hy). When the controller works in on/off control model for cooling, the output will be off when PV < SV and on again when PV > (SV + Hy).

Note 5. Input offset **PSb** is used to set an input offset to compensate the error produced by the sensor. For example, if the meter displays 3ºC when probe is in ice/water mixture, setting **PSb** = -3, will make the controller display 0ºC. To set a negative value, use Shift (>) key to go to the very left digit, then press Down key (V) until the first digit change to "-".

Note 6. Parameter **ID** and **bAud** are used for RS485 communication. For details, please check the supplementary manual.

5.2 PID parameters (accessed by code 0036)

The PID control parameters are listed in Table 3. To change the parameters, press SET key, enter code "0036", and press SET key again. The operation to change these parameters is similar to what is shown in the flow chart in Figure 3.

The values of the **P**, **I**, and **D** parameters are critical for good response time, accuracy, and stability of the system. Using the Auto-tune function to automatically determine these parameters is recommended for the first-time users. If the auto-tuning result is not satisfactory, you can manually fine-tune the PID constants for improved performance.

Table 3. PID parameters.

Symbol		Description	Setting Range	Initial	Note
P	P	Proportional Constant	0.1 ~ 9999.9	5.0	7
I	I	Integral Time	2 ~ 1999 (sec)	100	8
d	d	Derivative Time	0 ~ 399 (sec)	20	9
End	End	Exit			

Note 7. Proportional Constant (**P**): Also called Proportional Band. Its unit is degree. If **CorF** is set to °F, the unit of P is 1°F. If **CorF** is set to °C, the unit of P is 1°C. Assuming the set temperature **SV** is set to 200°F, Proportional Constant **P** is set to 5.0. When integral (**I**) and derivative (**d**) actions are both removed, i.e., **I** = 0 and **d** = 0, the controller's output should change from 100% to 0% as the temperature increases from 195°F to 200°F. The smaller the **P** value, the stronger the action will be for the same amount of temperature difference between **SV** and **PV**.

Note 8. Integral Time (**I**): Brings the system up to the set value (**SV**) by adding to the output that is proportional to how far the process value (**PV**) is from the set value (**SV**) and how long it has been there. When **I** is set to a smaller value, the response speed is faster but the system is less stable. When **I** is set to a larger value, the respond speed is slower, but the system is more stable.

Note 9. Derivative Time (**d**): Responds to the rate of process temperature (PV) change, so that the controller can compensate in advance before the difference between **SV** and **PV** (|**SV** - **PV**|) gets too big. A larger **d** value increases its action. Setting **d** value too small or too large would decrease the stability of the system, cause oscillation, or even make the system non-convergent.

5.3 Control parameters

The control parameters are listed in Table 4. To change the parameters, press they SET key, enter code "0038", then press the SET key again. The procedures to change control parameters are similar to what is shown in Figure 3.

Table 4. Control parameters.

Symbol		Description	Setting Range	Initial	Note
bb	bb	Proportional Band Range Limit	1 ~ 1999	300	10
SouF	SouF	Damp Constant	0.1 ~ 1.0	0.2	11
ot	ot	Control Cycle	1 ~ 500 (sec)	2	12
FILt	FILt	Digital Filter Strength	0 ~ 3	0	13
End	End	Exit			

Note 10. Proportional Band Range Limit (**bb**): This parameter sets a temperature range in which the Proportional Constant (**P**) functions. If the absolute value of the difference between **PV** and **SV** is greater than **bb**, the proportional output will always be 100%. If a user wish to use parameter **bb** to fine tune the performance of the controller, the value of **bb** should be smaller than the value of **P**. By default, **bb** is set to 300 degrees.

Note 11. Damp Constant (**SouF**): This constant can help the PID controller further improve its control quality. It uses the artificial intelligence to dampen the temperature overshot. When **SouF** is set to a small value, the system may overshoot; when **SouF** is set to a high value, the system will be over-damped.

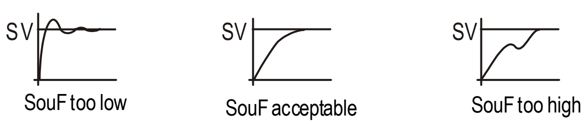

Figure 4. Using damp constant to adjust the control results.

Note 12. Control Cycle (**ot**): It is a time period setting (unit in seconds) that decide how often does the controller calculates and changes its output. A smaller **ot** can result in a better control precision. However, when using the relay output or control an external relay/contactor, set **ot** to a small value will operate the relay frequently and shorten the its life. When **Outy** is set to 1 or 2, set **ot** to 1 ~ 3 seconds; when **Outy** is set to 3, set ot to 20 ~ 40 seconds; when Outy is set to 4 or 5, **ot** setting is ignored. Generally speaking, set **ot** to small value for a fast response system, set ot to larger value for a slow response system.

Note 13. Digital Filter (**Filt**): **Filt** = 0 (default), filter disabled; **Filt** = 1, weak filtering effect; **Filt** = 3, strongest filtering effect. Stronger filtering increases the stability of the readout display, but causes more delay in the response to changes in temperature.

5.3 Set value setting and alarm setting (accessed by code 0001)

The set value and alarm parameters are listed in Table 5. To change the parameters, press SET key, enter code "0001", and press SET key again. The procedures to change control parameters are similar to what is shown in Figure 3.

Table 5. Set temperature and alarm parameters.

Symbol		Description	Initial Setting	Note
Su	SV	Target temperature (Set Value)	800	12
AH1	AH1	J1 pull-in temperature	900	13
AL1	AL1	J1 drop-out temperature	800	13
End	END	Exit		

Note 12. There are two ways to set the target temperature:

a. In the normal operation mode, press ∧ or V key to directly increase or decrease the SV. Then wait about 4 seconds to allow the controller save the new SV.

b. Press SET key once, enter code 0001, the press SET key again to confirm. Then the display will flash **SV** (Su) in the top display. Press the SET key again to show the current SV setting in the bottom display. Now use >, ∧ ,and V key to enter the new SV and press the SET key to save the value. Press V key to put END on the top display, then press SET key to exit; or you can wait about 30 seconds then the controller will return to normal operation mode.

Note 13. Alarm setting (**AH1** and **AL1**). The J1 relay can be set to works as absolute temperature alarm (when **outy** = 1 or 5), or as temperature deviation alarm (when **outy** = 2).

1) Absolute alarm (outy = 1 or 5)

When J1 works as an absolute temperature alarm, the **AH1** is the alarm-on temperature, **AL1** is the alarm-off temperature. When **AH1** > **AL1**, J1 works as an absolute high temperature alarm: when PV is higher than AH1, J1 relay pulls in; when PV is lower than AL1, J1 relay drops out. The diagram is shown in Figure 5 to illustrate how it works. When **AH1** < **AL1**, J1 works as an absolute low temperature alarm. A diagram is shown in Figure 6 to illustrate how it works. When **AH1** = **AL1**, the alarm is disabled.

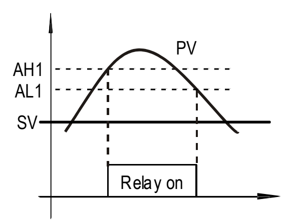

Figure 5. Absolute high alarm

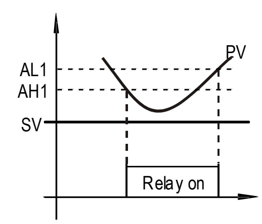

Figure 6. Absolute low alarm

2) Deviation alarm (outy = 2)

When J1 is set as a deviation alarm, it will be activated if **PV** deviates too far away from the set value (**SV**). **AH1** defines the deviation high alarm, **AL1** defines the deviation low alarm. For the deviation high alarm, when **PV** is higher than (**SV** + **AH1**) relay J1 will pull in, when PV drops below (**SV** + **AH1** -**Hy**) relay J1 will drop out; for the deviation low alarm, when PV is lower than (**SV** - **AL1**) relay J1 will pull in, when PV is higher than (**SV** - **AL1** + **Hy**) relay J1 will drop out. To deactivated the deviation high alarm, set **AH1** = 0; to deactivated the deviation low alarm, set **AL1** = 0.

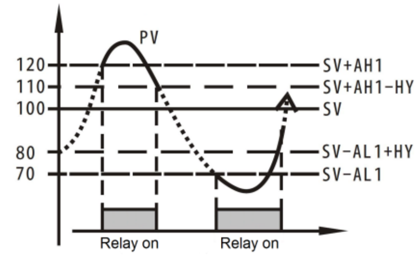

Figure.7 J1 relay works as derivation alarms
(SV = 100, AH1 = 20, AL1 = 30, Hy = 10).

6. Auto-tuning

The Auto-tuning function (also called self-tuning) can automatically optimize the PID parameters for the system. The auto-tuning function will provide "ON/OFF mode" (see 6.3 below for details) to heat up the system until it passes the set point, then let it cool down. It will repeat this about three times. Based on the response time of the system, the built-in artificial intelligence program will calculate and set the PID parameters for the controller. If your system has a very slow response, the auto-tuning could take a long time.

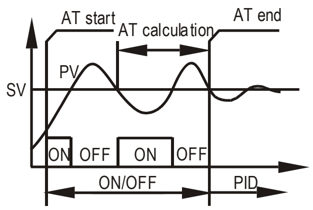

Figure 8. Auto-tuning.

6.1 To start auto-tuning, press and hold > key about 3 seconds until the "AT" indicator starts to blink, which indicates auto-tuning is in progress. When "AT" stops blinking, the auto-tuning is finished. Now, the newly calculated PID parameters are set to be used for the system. Please note that auto-tuning is only for PID control mode (when "outy" is set at 1, 2 or 3).

6.2 To stop the Auto-tuning, press and hold > key about 3 seconds until "AT" indicator stops blinking. In this case, no new PID parameters are calculated. The control will resume PID control with previous PID parameters.

6.3 In SYL-2381-mA. auto-tune can be used for J1 relay as main output modes (OUTY = 3 or 4) and linear output as main output modes (OUTY = 1 or 2). When you run auto-tune with linear output heating modes (OUTY = 1 or 2, RD = 0), the linear output will be either 100% (when your PV is below your SV) or 0% (when your PV is over your SV).

7. On/off control mode

In on/off control mode, the controller works like a mechanical thermostat. It simply turns on or off the output when PV is below or above the SV. On/off control is not as precise as PID control mode. However, this control mode is suitable for inductive loads such as motors, compressors, or solenoid valves that do not like pulsed power.

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 (**Hy**) the heater will be turned on again. Please see the Note 4 in 5.1 for details.

On this controller, only J1 relay can be used for on/off control. To use the on/off mode, set **outy** = 4. Then set **Hy** to a desired value based on the requirements of the control precision. Smaller **Hy** values result in tighter temperature control, but also cause the on/off action to occur more frequently. In the PID parameters menu (code 0036), only **ot** and **FILt** settings will apply to on/off control mode. Settings for other parameters **P**, **I**, **D**, and **SouF** have no effect on/off control.

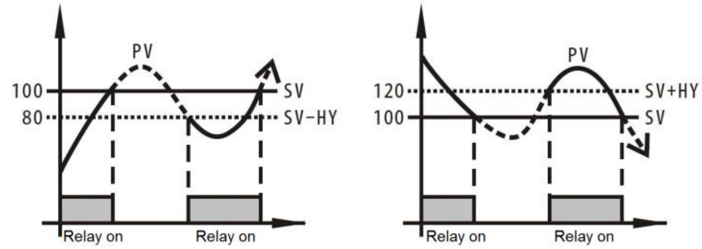

Figure 9. On/off control mode for heating (left) and cooling (right), in both situations SV = 100 and Hy = 20.

8. Manual mode

Manual mode allows the user to manually adjust the output as a percentage of the total output power. It is like a stove dial. The output is independent of the temperature sensor reading. The manual control mode can only be switched from PID control mode, not from on/off control mode. To switch from the PID mode to manual mode, press and hold the SET key 4 seconds till the "AT" indicator turns on. In manual mode, the SV window will show the percentage of the power output. The very left digit in the SV window should show letter M (ñ). To switch from manual mode to PID mode, press and hold SET key 4 seconds till the "AT" indicator turns off. This controller offers "bumpless" switch from PID mode to manual mode. For example, if the controller is sending 75% of power in PID mode, when user switch to manual mode the controller will show "ñ 75" in the bottom display, the output will stay at 75% till the user changes the output percentage.

9. Serial communication

RS485 serial communication is an optional feature available on SYL-2381-mA-S. It complies with the widely-accepted MODBUS_RTU protocol. Please refer to the supplementary manual for details.

10. Application Examples

10.1 A furnace needs to be controlled at 1200°F. The power source is 120 V AC. The heating element is 1800 W at 120 V. It is switched on/off by a contactor. The coil voltage of the contactor is 120 V AC. The temperature sensor is a type K thermocouple.

a. Wiring diagram.

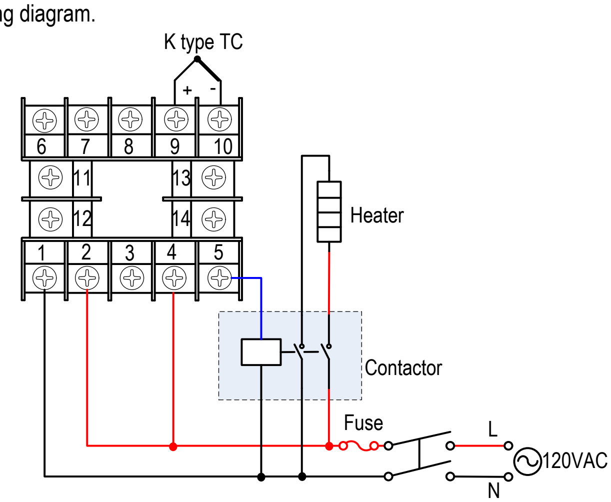

Figure 10. A typical wiring set up for powder coating oven and kiln. This diagram also applies to 240 V AC power system if both the heater and the coil voltage of the contactor are 240 V AC.

b. Parameter settings. These are the parameters that need to be changed from the initial value: **outy** = 3 for PID mode with J1 relay output; **ot** = 20 to avoid switching the contactor too often; for target temperature set **SV** = 1200°F.

10.2 A 24 V AC solenoid valve is controlled by J1 relay in on/off mode. The valve should be on till the temperature reaches 200°F; once the temperature is above 200°F, it should be shut off. When the temperature drops below 195°F, it should be turned on again. The power source is 120 V AC. The temperature sensor is a type K thermocouple.

a. Wiring diagram.

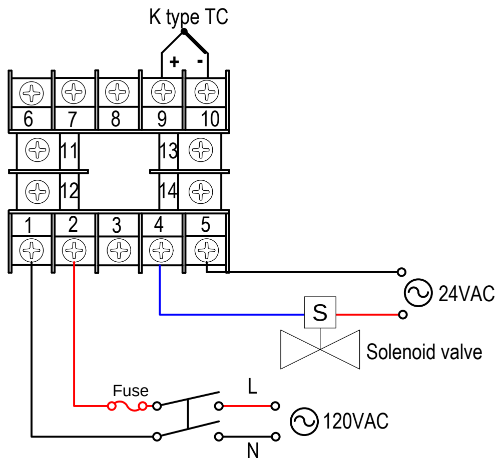

Figure 11. A typical wiring set up for a 24 V AC gas valve, hot water valve, or a contactor with 24 V AC coil voltage

b. Parameter settings. These are the parameters that need to be changed from the initial values: **outy** = 4 for using J1 relay in on/off mode; **Hy** = 5; **SV** = 200°F. Note: if this is to control a contactor with 24 V coil, PID mode can be used. Then the setting should be the same as example 10.1 except the SV value.

10.3 Drive a proportional control valve directly in cooling mode.

In a cooling system where the controller is connected to a linear control valve to control the flow of the coolant. The target temperature is SV = 50°F. An PT100 RTD sensor is used to measure the temperature. A 120 V buzzer is connected to the J1 relay which works as an absolute high temperature alarm, which should be triggered at 54°F.

a. Wiring diagram

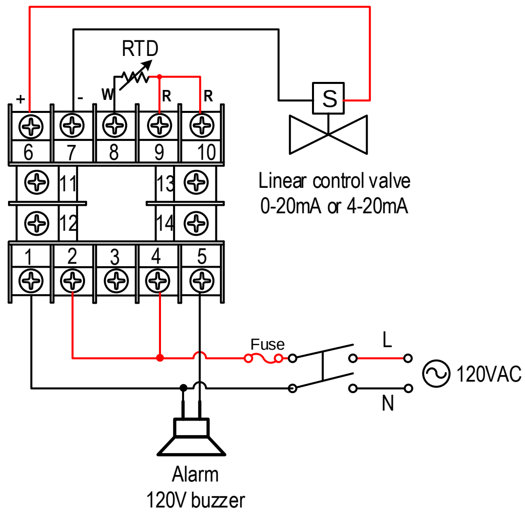

Figure 12a. A wiring example for controlling a proportional valve (0-20mA or 4-20mA).

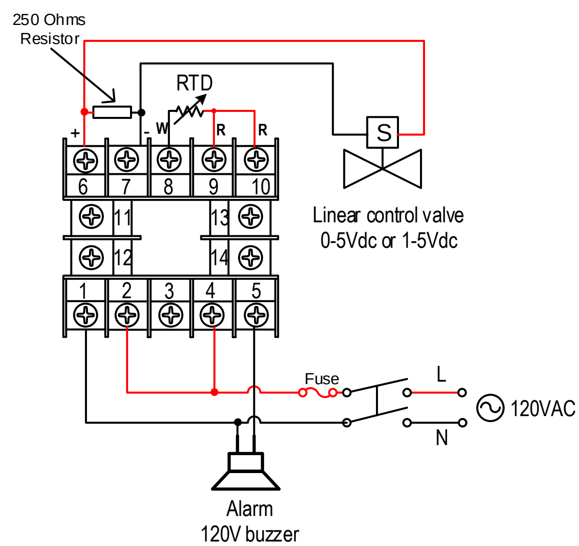

Figure 12b. A wiring example for controlling a proportional valve (0-5Vdc or 1-5Vdc). One 250 Ohms resistor is required (not included).

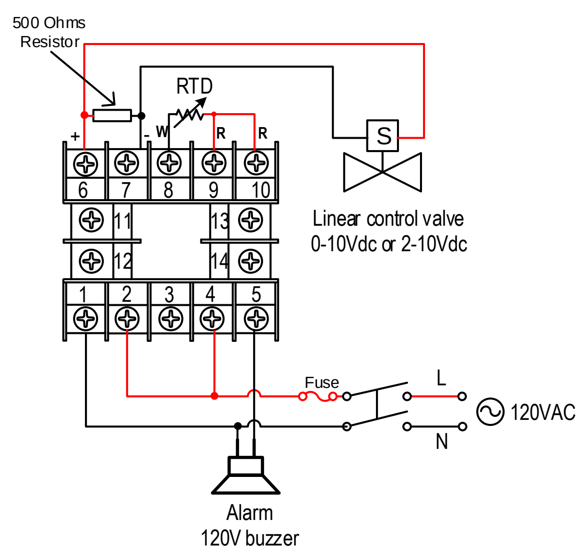

Figure 12c. A wiring example for controlling a proportional valve (0-10Vdc or 2-10Vdc). One 500 Ohms resistor is required (not included).

b. Parameter settings. Set **inty** = P100, **outy** = 1, **coty** = 0-20 mA or 4-20 mA depending on your valve, **rd** = 1 (cooling mode), **SV** = 50°F, **AH1** = 54°F, and **ot** = 2 for fast response. Adjust **Hy** (hysteresis band) accordingly. If the input of your valve is 0-20 mA, 0-5 Vdc or 0-10 Vdc, please set **coty = 0 - 20 mA**. If the input of your valve is 4-20 mA, 1-5 Vdc or 2-10 Vdc, please set **coty = 4 - 20 mA**.

11. Error Message and Trouble Shooting

11.1 Display EEEE

This is an input error message. The possible reasons are, the sensor is not connected correctly; the input setting is wrong type; or the sensor is defective. If this happens when using thermocouple sensor, you can short terminal 9 and 10 with a copper wire or paper clip. If then the display shows ambient temperature, the thermocouple is probably defective. If this happens when using the RTD sensor, check the input sensor type (**Inty**) setting first because most controllers are shipped with input sensor type set for type K thermocouple. Then check the wiring. The two red wires should be on terminal 9 and 10. The clear wire should be on terminal 8.

11.2 No output

When **outy** is set to 1 or 2, the control output is sent to the mA port (pin 6 and 7). The control output is synchronized with the OUT indicator. The flashing frequency of the OUT light is an indication of how much mA current is being sent out. When **outy** is set to 3 or 4, the control output is sent through J1 relay. The J1 relay action is synchronized with the AL1 indicator. When AL1 is on, J1 relay should pull in; when AL1 is off, J1 relay should drop out. If the control signal and the indicator are synchronized, please check whether the external device is working properly.

11.3 Poor accuracy

Please make sure calibration is done by immersing the probe in liquid. Comparing the probe reading with a reference probe in air is not recommended because the response time of probes can vary a lot. Different probes are designed for different applications, and they can be quite different in their thermal mass, which will affect their response time a lot. Some of our sensors have response time more than 10 minutes in the air. When the calibration is done correctly in liquid and the error is 5°F or larger, the most common problem for a thermocouple probe is improper connection between the thermocouple and the controller. A thermocouple needs to be connected directly to the controller unless thermocouple connector and thermocouple extension wire are used. A copper connector, copper wire, or thermocouple extension wire with wrong polarity connected on the thermocouple will cause the reading drift more than 5°F.

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