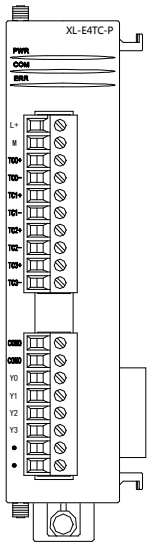
8. Thermocouple temperature control module XL-E4TC-P

8-1. Specifications

XL-E4TC-P can process 4-channel of thermocouple signal and send the data to the PLC.



Features

- thermocouple sensor signal input
- 4 channels input, 4 channels output
- 4 groups PID parameters, auto-tune function
- Built-in cold-terminal compensation circuit
- Resolution is 0.1℃
- As special function module of XL3, up to 10 modules can be connected to PLC (XL5, XL5E PLC can connect 16 modules, XL1 cannot connect extension module)

Specification

Item	Contents
Analog input signal	K, S, E, N, B, T, J type thermocouple
Temperature measurement range	0℃~1000℃
Digital output range	0~10000, 16 bits with sign bit, binary
Control precision	±0.5℃
Resolution	0.1℃
Integrate precision	1% (relative max value)
Conversion speed	80ms per channel
Analog power	DC24V ±10%, 50mA
Install format	Fixed with M3 screws or directly installed on orbit of

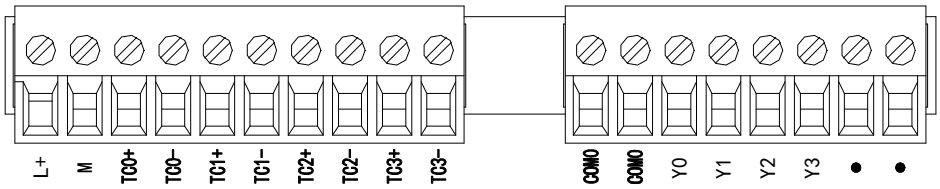
	DIN46277 (Width: 35mm)

Note:

1. If no signal input, the channel data is -1.
2. According to the actual requirement to connect the thermocouple
3. The cover of device which installs thermocouple should be connected to the ground.

8-2. Terminals

Arrangment



Signal

Name		Function
Indicator light	PWR	The indicator lights up when the module has a power supply
	COM	When the module communication port communicates normally, the indicator lights on
	ERR	When there is an error in the module, the indicator is always on or flickering (red) When the ERR lamp is always on, there are serious application errors in the module that can not be used, so the mode of use must be adjusted, and the PLC body is switched to STOP state. When the ERR lamp flickers, there are application errors, abnormal work and abnormal data in the module, but the PLC body is still RUN.
Wiring terminal	L+	External power supply 24V +
	M	External power supply 24V -
	TC0+	0CH thermocouple input +
	TC0-	0CH thermocouple input -
	TC1+	1CH thermocouple input +
	TC1-	1CH thermocouple input -
	TC2+	2CH thermocouple input +

	TC2-	2CH thermocouple input -
	TC3+	3CH thermocouple input +
	TC3-	3CH thermocouple input -
	COM0	PID output common terminal
	Y0~Y3	CH0~CH3 related PID output terminals

Wiring specification

When wiring the module, its wiring head should meet the following requirements:

(1) The stripping length is 9 mm;

(2) Flexible conductors with bare tubular ends are 0.25-1.5 square.

(3) Flexible conductor with tubular pre-insulated end is 0.25-0.5 square.

8-3. I/O address assignment

XL series analog module will not occupy I/O unit, the conversion value will be sent to PLC register. Each channel related PLC register address are shown as below:

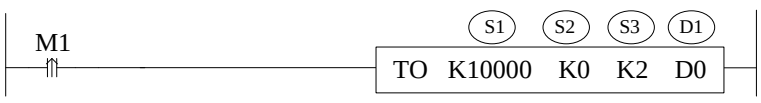
Parameters	Notes				
	Channel	Ch0	Ch1	Ch2	Ch3
Display temperature Unit: 0.1 ℃	Module 1	ID10000	ID10001	ID10002	ID10003
	Module 2	ID10100	ID10101	ID10102	ID10103
	……	ID10×00	ID10×01	ID10×02	ID10×03
	Module 16	ID11500	ID11501	ID11502	ID11503
PID output (return to the X input of PLC)	Module 1	X10000	X10001	X10002	X10003
	Module 2	X10100	X10101	X10102	X10103
	……	X10×00	X10×01	X10×02	X10×03
	Module 16	X11700	X11701	X11702	X11703
	When module duty cycle output, X point should be monitored, but Y point should not be monitored, because Y point is the PID enabler.				
Connection state of thermocouple(0 is connection, 1 is disconnection)	Module 1	X10010	X10011	X10012	X10013
	Module 2	X10110	X10111	X10112	X10113
	……	X10×10	X10×11	X10×12	X10×13
	Module 16	X11710	X11711	X11712	X11713
PID auto-tune error signal bit(0 is normal, 1 is error)	Module 1	X10020	X10021	X10022	X10023
	Module 2	X10120	X10121	X10122	X10123
	……	X10×20	X10×21	X10×22	X10×23
	Module 16	X11720	X11721	X11722	X11723
Channel enable	Module 1	Y10000	Y10001	Y10002	Y10003

signal	Module 2	Y10100	Y10101	Y10102	Y10103
	·····	Y10×00	Y10×01	Y10×02	Y10×03
	Module 16	Y11700	Y11701	Y11702	Y11703
Auto-tune PID control bit	Auto-tune triggered signal, start to auto-tune mode when set to 1 After auto-tune, PID parameters and temperature control period value are refreshed, the bit value is cleared to be 0. The user can read the bit to know the state. 1 means auto-tune is ongoing. 0 means auto-tune has finished.				
PID output value (operation result)	Digital quantity output range is 0~4095. When the PID output is analog quantity (such as steam valve open degree or silicon-controlled conduction angle), the value can be transmitted to the analog quantity output module in order to realize the control demand.				
PID parameters (P, I, D)	The best PID parameters got from the PID auto-tune. If the current PID parameters cannot meet the control requirements, users can set the experience PID parameters to make the module work according to the user setting value.				
PID calculation range (Diff) Unit: 0.1℃	This function can set the temperature range of the PID operation, such as setting the relevant parameter Tdiff, the target temperature is Target, then the operation range of the PID is Target-Tdiff < T < Target + Tdiff, when T < Target-Tdiff, the output is the largest, when T > Target + Tdiff, the output is 0.				
Temperature difference value δ Unit: 0.1℃	The actual temperature display = (sampling temperature value + temperature deviation value δ)/10. When the user thinks the measured temperature is different from the actual temperature, this value can be modified to correct the temperature.				
Set temperature Unit: 0.1℃	The target temperature of the control system. Range from 0~1000℃, precision degree is 0.1℃.				
Temperature control period Unit: 0.1s	The adjusting range of temperature control period is 0.1s~200s, and the minimum precision range is 0.1s. For example, when writing 5, the actual temperature control period is 0.5s.				
Adjusting environment temperature Unit: 0.1℃	If the actual temperature deviates from the module acquisition temperature, the known temperature can be written into the corresponding register. After writing, the module calculates the difference between the acquisition temperature and the actual temperature according to the value, and saves it. Calculate temperature deviation value δ = actual input temperature-sampling temperature. (Note: Do not write this value at will, otherwise it will cause display temperature error)				
auto-tune output range	The input of auto-tuning, the unit is % and input 100 is expressed as full scale output (if no output is found during use, the value can be read to see if it is 0).				

Note: Start signal (Y): When Y is 0, turn off the PID control and turn on the PID control when Y is 1.

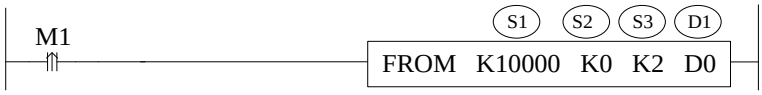
From/To instruction

Parameter write insruction TO



Function: write the PLC register data to module address, the operate unit is word.
Operand:
S1: target module number, range: 10000~10015. Operand: K, TD, CD, D, HD, FD
S2: first address of module. Operand: K, TD, CD, D, HD, FD
S3: write in register numbers. Operand: K, TD, CD, D, HD, FD
D1: first address of PLC. Operand: TD, CD, D, HD, FD

Parameter read instruction FROM



Function: read the module data to the PLC regsiter, the operate unit is word.
S1: target module number, range: 10000~10015. Operand: K, TD, CD, D, HD, FD
S2: first address of module. Operand: K, TD, CD, D, HD, FD
S3: read register numbers. Operand: K, TD, CD, D, HD, FD
D1: first address of PLC. Operand: TD, CD, D, HD, FD

Note: FROM and TO only can be programmed in the sequence block, one program only supports 8 sequence blocks.

Related address definition:
The address of the read/write parameters:

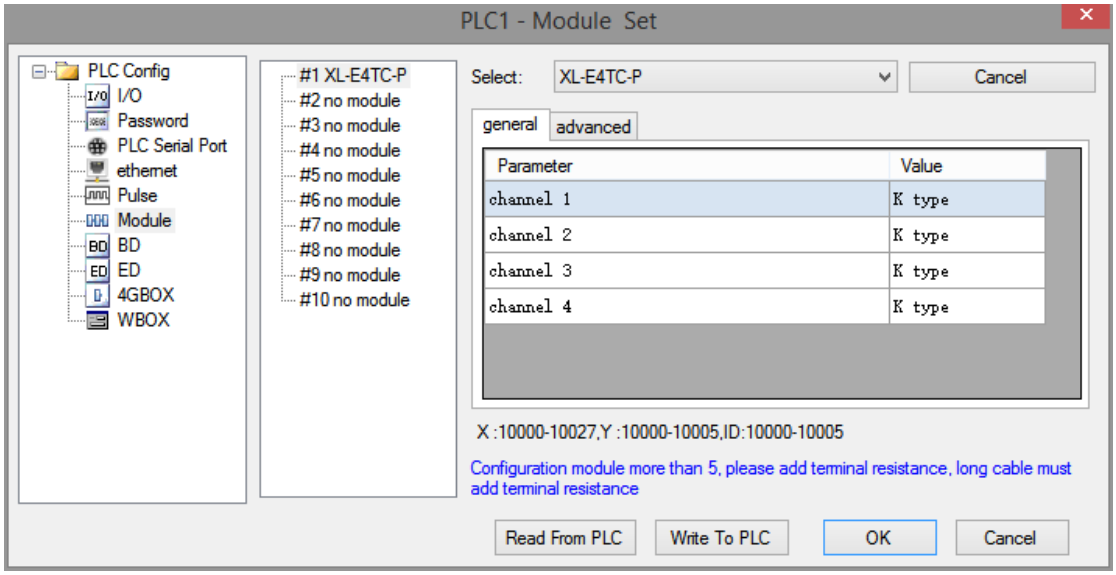
Related parameters	Note				Read
Channel	CH0	CH1	CH2	CH3	/write
Auto-tune bit	K0	K0	K0	K0	R/W
PID output	K1	K2	K3	K4	R
Target temperature	K5	K6	K7	K8	R/W
Kp	K9	K13	K17	K21	R/W
Ki	K10	K14	K18	K22	R/W
Kd	K11	K15	K19	K23	R/W
Diff	K12	K16	K20	K24	R/W
Control period	K25	K26	K27	K28	R/W
Output range	K29	K30	K31	K32	R/W
Temperature difference	K33	K34	K35	K36	R/W
Temperature correction	K37	K38	K39	K40	W

Besides, the module can save the setting temperature, PID parameters, temperature difference value, temperature control period, auto-tune output range, etc. The parameters will be saved after auto-tune or user modification, and be operated after re-power on.

8-4. Working mode

Set via software

Please use XDPPro software V3.5.1 and up to set the module.
Open the software, click configure/expansion module setting, then select the module type in the following window:



Set the thermocoupler of each channel, click write to PLC and ok. Then download user program and run, the settings will be effective.
Note: The first-order low-pass filtering method weighted this sampling value and the output value of the last filtering to get the effective filtering value; the filter coefficient is set by the user to 0-254, the smaller the value, the more stable the data, but it may lead to data lag; therefore, when set to 1, the filtering effect is strongest and the data is the most stable; when set to 254, the filtering effect is the weakest; default is 0 (no filtering).

Set via Flash register

The expansion module 0CH~3CH channel can set the type of thermocouple, and it can be set through the special FLASH data register FD inside the PLC. As follows:

Module ID	SFD address	Module ID	SFD address
#1	SFD350~SFD359	#9	SFD430~SFD439
#2	SFD360~SFD369	#10	SFD440~SFD449
#3	SFD370~SFD379	#11	SFD450~SFD459
#4	SFD380~SFD389	#12	SFD460~SFD469
#5	SFD390~SFD399	#13	SFD470~SFD479

#6	SFD400~SFD409	#14	SFD480~SFD489
#7	SFD410~SFD419	#15	SFD490~SFD499
#8	SFD420~SFD429	#16	SFD500~SFD509

SFD bit definition

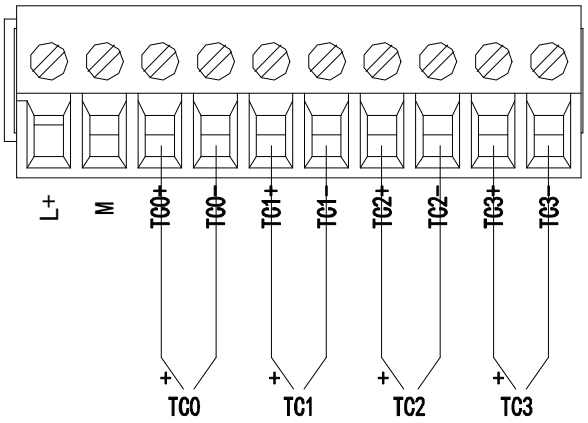
Take module 1 as an example to explain the setting method:

	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Note
Byte0	TC1 channel				TC0 channel				To set the thermocouple type of each channel, each channel occupies 4 bits.
	K：0000 S：0001 E：0010 N：0011 J：0100 T：0101 R：0110 B：0111				K：0000 S：0001 E：0010 N：0011 J：0100 T：0101 R：0110 B：0111				
Byte1	TC3 channel				TC2 channel				
	K：0000 S：0001 E：0010 N：0011 J：0100 T：0101 R：0110 B：0111				K：0000 S：0001 E：0010 N：0011 J：0100 T：0101 R：0110 B：0111				
Byte2~Byte19	Reserved								

8-5. External connection

For thermocouple connection, When connect to＋24V power, please use the 24V power supply of PLC to avoid interference.

Input wiring



Output circuit

- Output terminal

  For transistor output terminals, please use DC5V~30V power supply.

- Circuit insulation

  PLC internal circuit and output transistor is optical insulation with optical coupling device. Each public module is separate.

- Response time

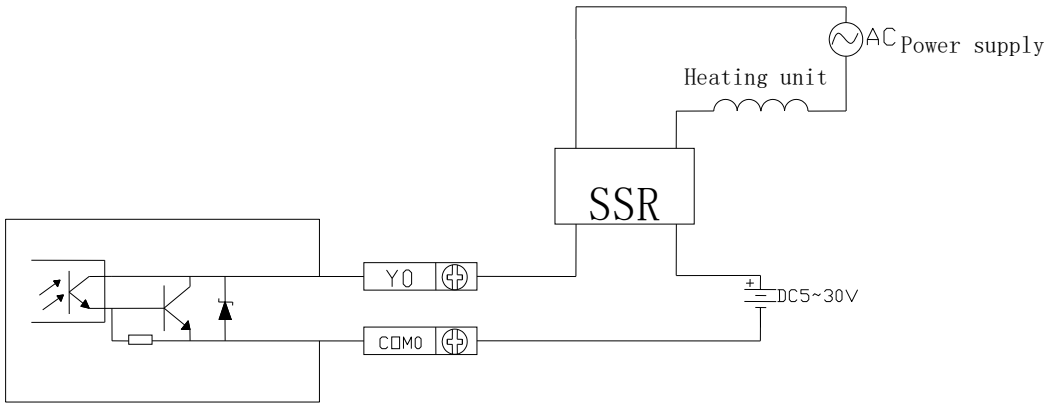
  The time is less than 0.2ms from PLC driving (or cut) optical coupling circuit to transistor ON/OFF.

- Output circuit

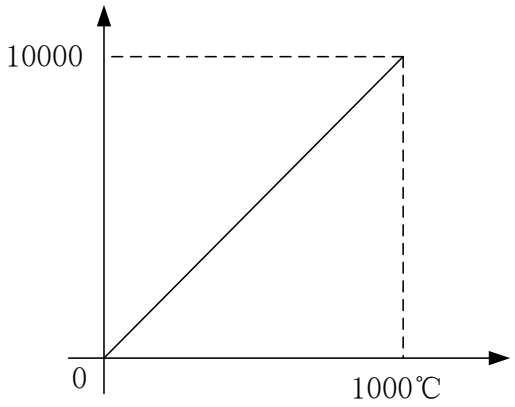
  Each point current is 0.15A to avoid over-heating.

- Open circuit leak current

  Below 0.1mA.



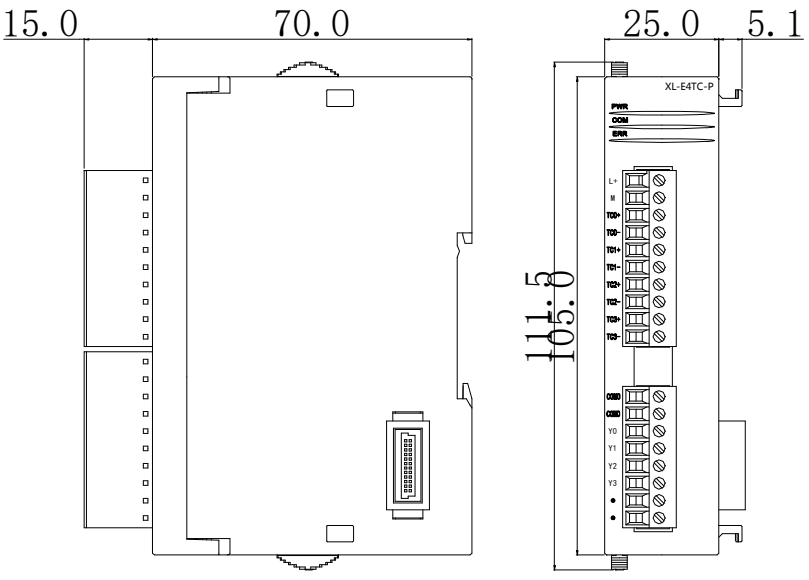
Thermocouple input characteristic curve



8-6. Dimension

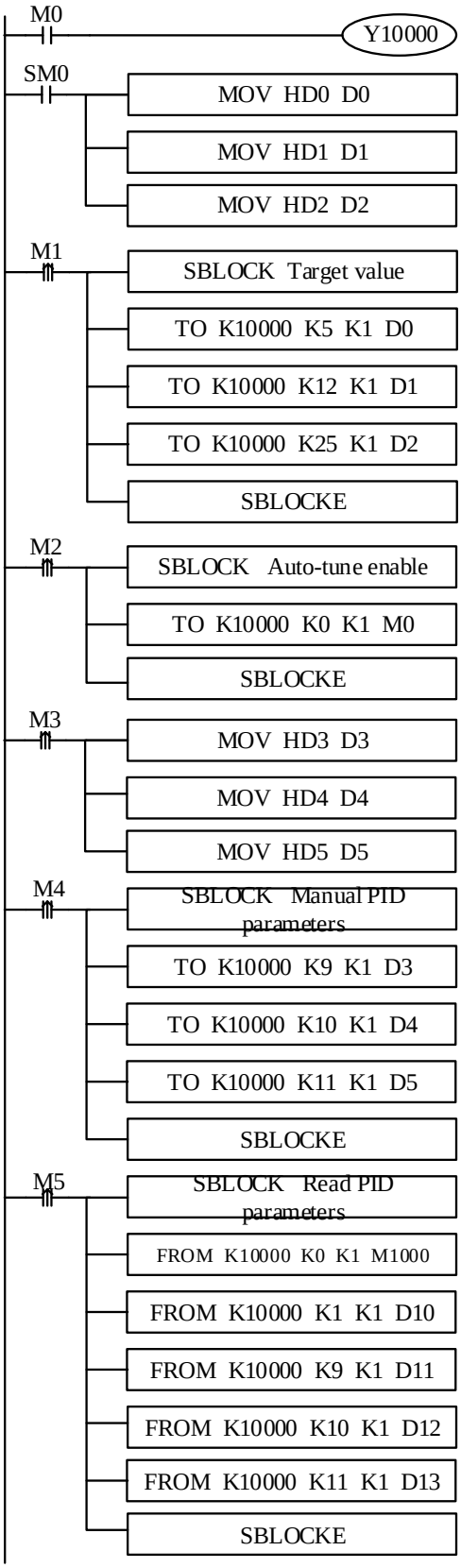
The outline and dimension:

(unit: mm)



8-7. Programming example

Example: Do PID control for CH0 of module 1.



// open PID enable bit

// set target value

// set operation range

// set control period

// write in the target value, operation range, control period

// start the auto-tune function

// set P value

// set I value

// set D value

// do manual PID control, write in PID parameters

// read the auto-tune bit, PID parameters, PID output value