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GL20-4LC-PID Series Thermal Resistor/Thermocouple Temperature Control Module

User Guide

Industrial Automation | Intelligent Elevator | New Energy Vehicle | Industrial Robot | Rail Transit

Data code PS00019555A00

Legal Information

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Due to continuous updates and improvements of products and technologies, the content of this documentation may not fully match the actual products. In the event of any discrepancies, the actual products shall prevail.

The contents are subject to change without notice due to product upgrade.

Waste Disposal

The storage, use, and disposal of this product (including optional accessories) must comply with local laws and regulations.

Qualified Personnel

The product/system described in this documentation may be operated only by personnel qualified for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel can identify the risks of the product/system and prevent possible dangers.

Proper Use of the Product

Proper transportation, storage, assembly, installation, commissioning, operation, and maintenance are required to ensure the safe operation of the product without any problems. The required ambient conditions must be met. All operations must follow the guidelines provided in this documentation.

Preface

Introduction

The GL20-4LC-PID is a 4-channel PID integrated thermal resistor/thermocouple temperature control module. It can be used with GL20 series communication interface modules, such as GL20-RTU-ECT32.

This guide describes the mechanical installation, electrical installation, program commissioning, troubleshooting, and version matching information of the product.

Standards Compliance

The following table lists the certifications, directives, and standards that the product may comply with. For details about the acquired certificates, see the certification marks on the product nameplate.

Certification	Directive		Standard
CE Certification	EMC Directive	2014/30/EU	**24 VDC products:** EN 61131-2 **220 VAC products:** EN 61131-2 EN 61000-3-2 EN 61000-3-3
	LVD Directive	2014/35/EU	EN 61010-1 EN 61010-2-201
	RoHS Directive	2011/65/EU amended by (EU)2015/863	EN IEC 63000
UL/cUL Certification	-		UL 61010-1 UL 61010-2-201 CAN/CSA-C22.2 No. 61010-1 CSA C22.2 NO. 61010-2-201
KCC Certification	-		-
EAC Certification	-		-
UKCA Certification	Safety Regulations	Electrical Equipment (Safety) Regulations 2016	EN 61010-1 EN 61010-2-201
	EMC Regulations	Electromagnectic Compatibility Regulations 2016	**24 VDC products:** EN 61131-2 **220 VAC products:** EN 61131-2 EN 61000-3-2 EN 61000-3-3
	RoHS Regulations	Directive (RoHS) Regulations 2012	EN IEC 63000

More Data

Name	Code	Description
GL20-RTU-ECT32 Series Communication Interface Module User Guide	PS00013434	Introduces the installation, wiring, and other information of the product.
GL20-4LC-PID Series Thermocouple/Thermal Resistor Temperature Control Module User Guide (This guide)	PS00019555	Introduces the mechanical installation, electrical installation, program commissioning, troubleshooting, and version matching information of the product.

Revision History

Date	Version	Revision
September 2025	A00	Initial release.

Access to the Guide

This guide is not delivered with the product. You can obtain the PDF version in the following ways

- Do keyword search under Service and Support at *www.inovance.com*.
- **QR code**: Scan the QR code on the product with your smart phone.
- **My Inovance APP**: Scan the QR code below to install the app, where you can search for and download user guides.

Warranty Dsclaimer

Inovance provides warranty service within the warranty period (as specified in your order) for any fault or damage that is not caused by improper operation of the user. You will be charged for any repair work after the warranty period expires.

Within the warranty period, maintenance fee will be charged for the following damage:

- Damage caused by operations not following the instructions in the user guide
- Damage caused by fire, flood, or unusual voltage
- Damage caused by unintended use of the product
- Damage caused by use beyond the specified scope of application of the product
- Damage or secondary damage caused by force majeure (natural disaster, earthquake, and lightning strike)

The maintenance is charged according to the latest Price List of Inovance. If otherwise agreed upon, the terms and conditions in the agreement shall prevail.

For details, see Product Warranty Card.

1 General Safety Rules

1.1 Fundamental Safety Instructions

Safety Precautions

1. Read and follow the safety instructions when installing, operating, and maintaining the equipment.
2. To ensure your safety and prevent damage to the equipment, follow the marks on the equipment and all the safety instructions in this guide.
3. "CAUTION", "WARNING", and "DANGER" items in this guide do not indicate all safety precautions that need to be followed; instead, they just supplement the safety precautions.
4. Use this equipment according to the designated environment requirements; otherwise, a fault may occur. Malfunction or damage caused by improper use is not covered by warranty.
5. Inovance shall take no responsibility for any personal injury or property damage caused by improper use.

Safety Levels and Definitions

"DANGER" indicates that failure to comply with the notice will result in death or severe personal injuries.

"WARNING" indicates that failure to comply with the notice may result in death or severe personal injuries.

"CAUTION" indicates that failure to comply with the notice may result in minor personal injuries or equipment damage. Keep this user guide properly for future use and deliver it to the end user.

Control System Design
 • Provide a safety circuit outside the PLC so that the control system can still work safely once external power failure or controller fault occurs. • Add an external fuse or circuit breaker to prevent the module from smoking or catching fire due to long-time overcurrent caused by operation above rated current or load short-circuit.
 • An emergency stop circuit, a protection circuit, a forward/reverse operation interlocked circuit, and an upper position limit and lower position limit interlocked circuit must be set in the external circuits of PLC to prevent damage to the equipment. • To ensure safe operation, for the output signals that may cause critical accidents, use external protection circuit and safety mechanism. • Once the CPU of the PLC detects an exception in the system, all outputs may be closed; however, when a fault occurs in the controller circuit, the output may not be under control. Therefore, it is necessary to design an appropriate external control circuit to ensure normal operation. • If the output units such as relays or transistors are damaged, the output may fail to switch between ON and OFF states according to the commands. • The PLC is designed to be used in an indoor electrical environment compliant with overvoltage category II. The power supply must have a system-level surge protector to ensure that overvoltage caused by lightning shock cannot be applied to power supply input terminals, signal input terminals, and control output terminals of the PLC, therefore preventing damage to the product.

Installation

WARNING

- Installation must be carried out by skilled personal who have undergone specialized electrical training and possess comprehensive electrical expertise.
- Disconnect all external power supplies of the system before installing/removing the module. Failure to do so may result in electric shock, module fault, or malfunction.
- Do not use the PLC in environments with dust, greasy smoke, conductive dust, corrosive or combustible gases, exposed to high temperature, condensation, wind & rain, or subject to vibration and shock. Electric shock, fire, and malfunction may also result in damage or deterioration to the product.
- The PLC is open-type equipment that must be installed in a control cabinet with lock (cabinet housing protection > IP20). Only the skilled personnel who have undergone specialized electrical training and possess comprehensive electrical expertise can open the cabinet.

CAUTION

- Prevent metal filings and wire ends from dropping into ventilation holes of the PLC during installation. Failure to comply may result in fire, fault, and malfunction.
- Ensure there are no unwanted matters on ventilation surface. Failure to comply may result in poor ventilation, which may cause fire, fault, or malfunction.
- Ensure the module is connected to the respective connector securely and hook the module firmly. Improper installation may result in malfunction, fault, or fall-off.
- Ensure natural ventilation for the equipment.

Wiring

DANGER

- Wiring must be carried out by skilled personnel who have undergone specialized electrical training and possess comprehensive electrical expertise.
- Disconnect all external power supplies of the system before wiring. Failure to comply may result in electric shock, module fault, or malfunction.
- After wiring, install the terminal cover attached to the product before power-on or operation. Failure to comply may result in electric shock.
- Insulate the cable terminals properly to ensure the insulation distance between cables will not be shortened after cables are connected to the terminal block. Failure to comply may result in electric shock or damage to the product.

CAUTION

- To avoid electric shock, cut off the power supply before connecting the equipment to the power supply.
- The input power supply of this product must be 24 VDC. Power supplies outside ±20% of 24 VDC can cause severe damage to the product. Therefore, check whether the DC power supply provided by the switching-mode power supply is stable at a regular interval.

Operation and maintenance
 • Operation and maintenance must be carried out by skilled personnel who have undergone specialized electrical training and possess comprehensive electrical expertise. • Do not touch the terminals while the power is on. Failure to comply may result in electric shock or malfunction. • Disconnect all external power supplies of the system before cleaning the module or re-tightening screws on the terminal block or the connector. Failure to comply may result in electric shock. • Disconnect all external power supplies of the system before assembling/disassembling the module or connecting/removing the communication cables. Failure to comply may result in electric shock or malfunction.
Safety Recommendations • In the position where the operator directly touches the machinery part, for example, where a machinery tool is loaded/unloaded, or where a machine runs automatically, the on-site manual operating devices and any other alternative means must be carefully arranged and designed so that they are independent of the PLC and can start or terminate the automatic running of the system. • If modification on the program is needed during system operation, use the lock function or other protective measures. Ensure that only authorized personnel can make the necessary modifications.

Disposal
 • Treat the scrapped product as industrial waste. Dispose of the battery according to local laws and regulations. • Recycle retired equipment by observing industry waste disposal standards to avoid environmental pollution.

1.2 Industrial Information Security

The product provides interfaces to connect to the network and transmit data through the network interfaces. In order to protect factories, systems, machines and networks from network attacks and ensure their safe operation, implement appropriate industrial information security protection mechanisms.

The customer is responsible for providing and continuously ensuring a secure connection between the product and the network to prevent unauthorized access to its factories, systems, machines and networks. The system can only be connected to the corporate network or the Internet if it is connected securely and appropriate security measures are in place (for example, using anti-virus software and a firewall).

Inovance continuously develops and improves products and solutions to improve safety. It is strongly recommended that you update the product promptly and always use the latest version.

Tampering with software (such as viruses, Trojans, and Worms) can lead to unsafe drive state, which can put the device in an unsafe operation state. This may result in death, serious injury, and property damage. Observe the following strictly.

- Always use the latest software version. If the product version is no longer supported or the latest version of the program is not applied, customers are at increased risk of cyber-attacks.
- Take proper protection measures (including but not limited to deploying anti-virus software, firewall, WAF, IPS/IDS, situational awareness system, ID verification, and data encryption) to prevent files in the mobile storage device from being damaged by malware and protect products, networks, systems, and interfaces from unauthorized access, disturbance, intrusion, data disclosure, or information theft.
- Check all safety-related interfaces and settings after commissioning.

2 Product Information

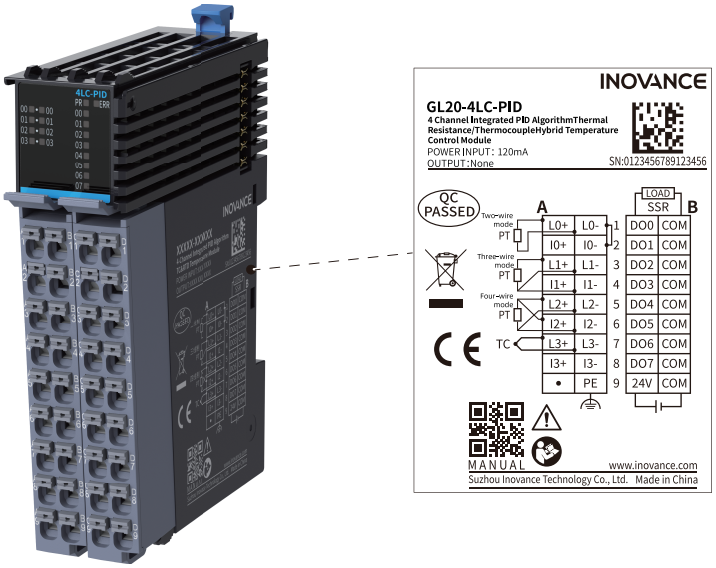
2.1 Model and Nameplate

Model

GL ① 20 ② -4 ③ LC ④ -PID ⑤

① **Product Information** GL: Inovance general local module	③ **Number of Input Channels** 4: 4 input channels	⑤ **Auxiliary Type** PID: PID algorithm (with 8 output channels)
② **Series Number** 20: 20 series module	④ **Module Type** LC: Thermocouple/ Thermal resistor temperature control module	-

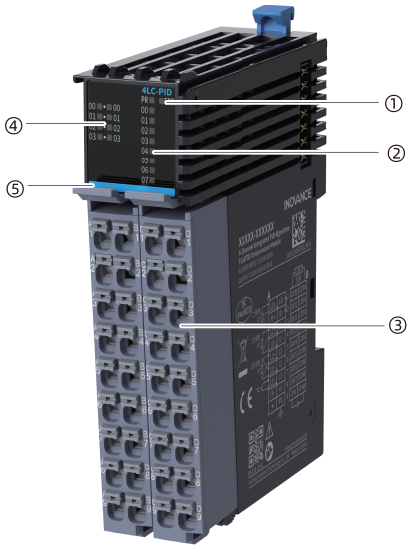
Nameplate



The data for ordering the product is shown in the following table.

Model	Description	Material Code	Applicable Model
GL20-4LC-PID	GL20 series 4-channel PID integrated thermocouple/thermal resistor temperature control module	01441271	Applicable to GL20 series communication interface modules, such as GL20-RTU-ECT32

2.2 Components



No.	Component	Description			
①	Signal indicators	PR (POWER +RUN)	Power/Run indicator	Yellow-green	• Steady ON: The module is running normally. • Flashing quickly: The module is addressed successfully. • Flashing slowly: The module is powered on but not addressed. • OFF: The module is not powered on or is faulty.
		ERR	Fault indicator	Red	ON when the module is faulty. For details, see *"Troubleshooting" on page 43*
②	I/O signal indicator	00 to 07	I/O signal indicator	Yellow-green	• Solid ON: The output is active. • OFF: No output.
③	I/O terminals	For details, see *"4.2 Terminal Definition" on page 18*			
④	Channel indicator	00 to 03	Channel enabling indicator	Green	• Solid ON: The module is operating normally. • OFF: The module is disabled.
		00 to 03	Channel fault indicator	Red	• Solid ON: The channel is faulty. • OFF: The module is disabled.
⑤	Color identification		Red: Digital output		Orange: Analog output
			Gray: Digital input		Green: Analog input
			White: Communica-tion		Blue: Other modules

Note

- Flashing quickly: The indicator is ON for 200ms and OFF for 200ms.
- Flashing slowly: The indicator is ON for 200ms and OFF for 1s.

2.3 Technical Specifications

General specifications

Item	Specification
IP rating	IP20
Dimensions (W x H x D)	24 mm x 100 mm x 75 mm
Weight	About 119 g

Power supply specifications

Item	Specification
Rated voltage of bus input power supply	5 VDC (4.75 VDC to 5.25 VDC)
Rated current of bus input power supply	90 mA (typical value@5 V)
Rated voltage of terminal input power supply	24 VDC (20.4 VDC to 28.8 VDC)
Rated terminal input current	120 mA (typical@24 V)
Rated voltage of terminal output power supply	-
Rated current of terminal output power supply	-
Hot swap	Not supported
Anti-reverse connection for 24 V input	Supported

Input specifications

Item	Specification
Number of input channels	4
Digital resolution	24-bit resolution
Display sensitivity	0.1, 0.01, or 0.001 (depending on the number of decimal places). The unit is ℃ or ℉.
Input terminal	Supports thermocouple (TC) inputs and thermal resistor (PT) inputs
Input type	• Thermocouple input: B, E, N, J, K (default), R, S, T, C, ±100 mV. • Thermal resistor input: PT100 (default), PT500, PT1000, Cu100, NTC10K (optional, NTC type sensor), and KTY84. The resistance signal range is 1 kΩ to 4 kΩ. The thermal resistor connection supports two-wire, three-wire (default), and four-wire modes.
Compensation method	Supports internal and external cold junction compensation. To apply the external cold junction compensation, the 2nd channel of the module shall adopt the PT100 three-wire connection. • External cold junctions: For normal wiring, the value of the external cold junction is displayed. For abnormal wiring (including two-wire connection), the maximum value of 3276.7 is displayed. When overlimit/sensor disconnection/overflow detection is enabled, the corresponding fault code will be reported. • Internal cold junctions: No difference with other channels
Accuracy (at normal temperature: 25°C)	(±0.1%)[1](±100mV full scale) + cold junction compensation error [2]

Item	Specification
Accuracy (at operating temperature: -20°C to +55°C)	(±0.3%)[1](±100mV full scale) + cold junction compensation error [2]
Isolation	Isolated between I/O terminals and power supply, as well as between channels and MCU. Not isolated between channels.
Input indicator	/
Input derating	/
Overflow and open circuit detection	Supported
Power consumption	< 0.9 W
Anti-interference capacity [3]	For default parameter settings, the anti-interference capacity is 50 dB in differential mode and 120 dB in common mode.

Note

- [1]: Indicates ADC sampling accuracy, which needs to be determined based on sensor type and thermocouple detection temperature range. For details, see *"8.1 Appendix 1: Accuracy Calculation" on page 45*.
- [2]: The cold junction compensation error needs to be determined based on the compensation type, installation direction, adjacent module type and operating temperature range. For details, see *"8.1 Appendix 1: Accuracy Calculation" on page 45*.
- [3]: The anti-interference capacity is strongly associated with sampling cycle and filter time.The anti-interference capacity is only about 25 dB when the filter time is set to 0, and sampling cycle to 100ms.The sensor must be equipped with shielded cables for use by the customer.

Output specifications

Item	Specification
Output type	Source mode (PNP)
Number of output channels	8
Output voltage	24 VDC (20.4 VDC to 28.8 VDC)
Output load	21 mA/channel; 84 mA/module
Hardware response time upon ON/OFF	100μs
Isolation	No isolation among interface channels; no isolation between the power supply and interface; isolation applied between the interface and the bus.
Leakage current upon OFF	100 μA
Overcurrent protection	Supported
PWM output	Supported

PID specifications

Item	Specification
PID control mode	• 0: PID negative action (unipolar heating) • 1: PID positive action (unipolar cooling) • 2: PID bipolarity controlled by cooling coefficient • 3: PID bipolarity controlled independently
Auto-tuning coefficient range	0 to 100 with the default of 50
PID output limit	Upper and lower limits of heating and cooling output: -100% to +100%
Temperature control mode	Unipolar PID controlled by heating and bipolar PID controlled by heating/cooling

Item	Specification
PID output type	Bit 3 to Bit 4: Output type • 0: PWM output • 2: Percentage output Bit 5 to Bit 6: Cooling output type • 0: PWM output • 2: Percentage output
Analog output	Supported. The upper and lower limits of the analog output are configurable.
Output data range (MV)	• Heating and cooling range: -105% to +105% • Heating range: -5% to +105%
PID incomplete differential function	Supported
PID dead zone control function	In dead zones of PID control, no PID adjustment is performed. The SP (temperature set point) range is 0℃ (default) to 100℃.
PID output compensation function	Supports heating and cooling output offset compensation functions. Final output = PID output + Output offset compensation (range: -100% to +100%, with the default of 0).
PID disconnection hold function	Supported • For sensor disconnection: Options include outputting last value and outputting preset value. • For communication disconnection: Options include continuing PID operation and outputting preset value.

Software specifications

Item	Specification
Input PDO data volume	Max. 112 bytes
Output PDO data volume	Max. 112 bytes
Diagnostic report configuration	Supported
Diagnostic detection enable configuration	Supported
Filter time	0s to 16s (configurable through software, default is 5s)
Overflow and underflow detection	Supported
Overflow detection configuration	Supported
Independent channel configuration	Supported
Temperature offset configuration	Supported
Temperature configuration range	-204.8 to +204.7
Sampling cycle	Thermocouple: 50ms, 250ms, 500ms, 1000ms Thermal resistor: 250ms, 500ms, 1000ms
Warm-up time	45 min
Sampling refresh	Refresh according to the sampling cycle
Stop mode	Output based on the maximum value with no further refresh
Open circuit or overflow/underflow detection	Output based on the maximum value with no further refresh
Channel diagnosis	Upper limit exceeded alarm, lower limit exceeded alarm, open circuit alarm, and overflow/underflow alarm
Software diagnosis	Not supported
Configuration diagnosis	Configuration fault identification, channel parameter configuration fault

2.4 Environmental Specifications

Item	Specification
Installation/Operating environment	Free from conductive dust, conductive fibers, explosive dust, flammable gases, water mist/greasy dirt, corrosive dusts/gases, strong vibration, and repetitive shock
Max. altitude	≤ 2000 m
Pollution degree	2
Immunity	2 kV on power supply cable (compliant with IEC 61000-4-4)
Overvoltage category	I
EMC immunity level	Zone B, IEC61131-2
ESD protection level	Contact discharge +/-6 kV, air discharge +/-8 kV
Vibration resistance	• Application scenario: Tested according to IEC60068-2-6; 3.5 mm amplitude at 5 Hz to 8.4 Hz; 1 g acceleration at 8.4 Hz to 200 Hz; in ten cycles/axes • Transportation scenario: Tested according to IEC60068-2-64, 0.01 g^2/Hz power spectral density at 5 Hz to 100 Hz; 0.001 g^2/Hz power spectral density at 200 Hz; 1.14 g Grms
Shock resistance	Application/Transportation scenario: Tested according to IEC60068-2-27; 15 g peak gravitational acceleration; 11ms pulse width; 18 times in X/Y/Z-axis directions
Operating temperature/ humidity	• Temperature: -20°C to +55°C • Humidity: < 95% RH (30°C), without condensation
Storage temperature/ humidity	• Temperature: -20°C to +60°C • Humidity: < 95% RH (30°C), without condensation
Transportation temperature/humidity	• Temperature: -40°C to +70°C • Humidity: < 95% RH (40°C), without condensation

3 Mechanical Installation

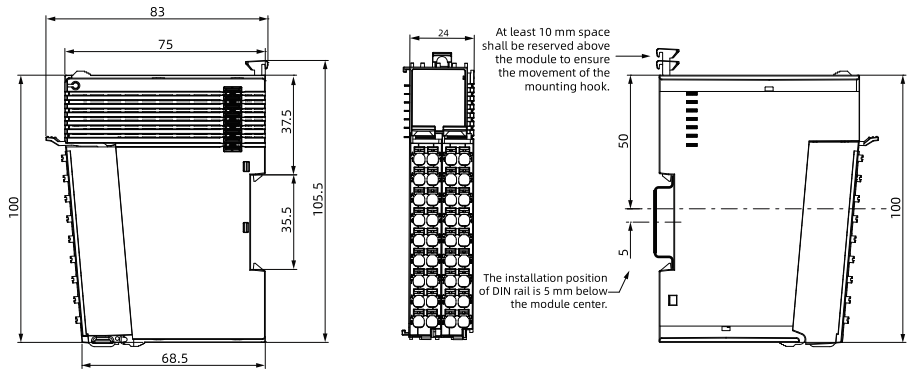
3.1 Installation Precautions

- Make sure the module is powered off before installing or removing.
- Do not hot swap the modules. Otherwise, the modules may be damaged by overcurrent or overvoltage, and the communication interface module or PLC may be subject to restart, user data loss or corruption.
- Do not drop or shock the housing or terminals of the module to avoid damage.

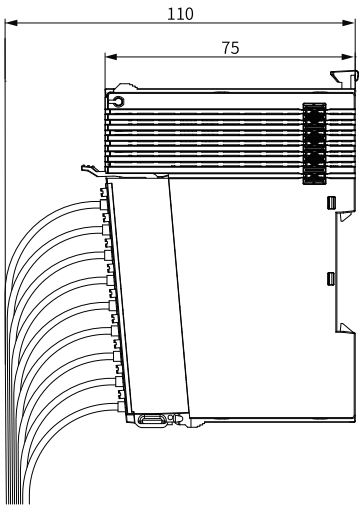
3.2 Installation Dimensions

Module

The installation dimensions (in mm) are shown in the figure below.



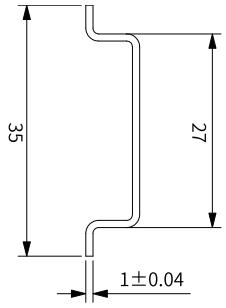
Cable



3.3 Installation Method

Installing modules side by side

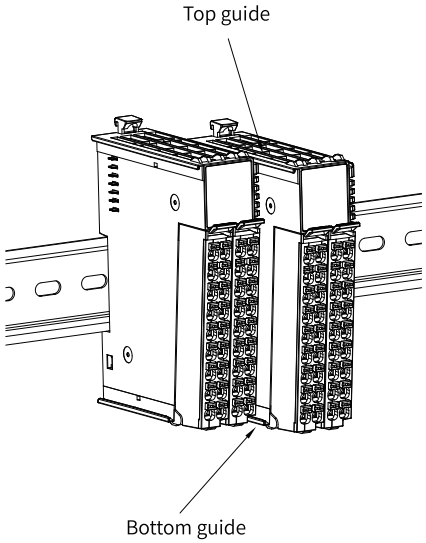
The module is mounted onto a DIN rail according to IEC 60715 (width: 35 mm, thickness: 1 mm). The dimensions (in mm) are shown below.



Caution

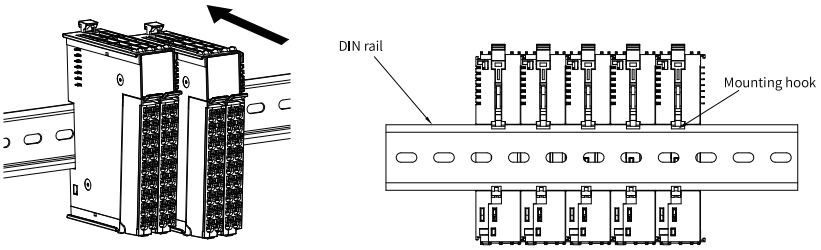
When installed on a DIN rail other than the recommended one (especially the one whose thickness is not 1.0 mm), the module will not fit in place as the mounting hook does not work.

Install modules side by side by sliding them along the top and bottom guide rails of adjacent modules.

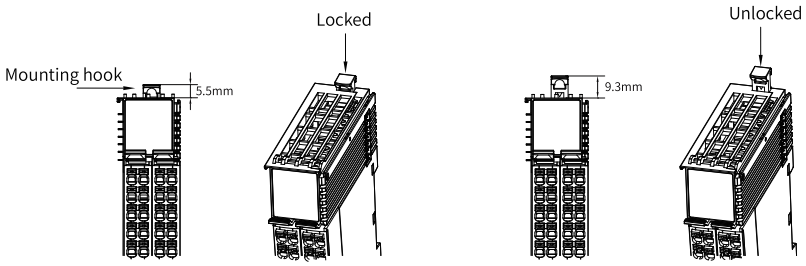


Installing modules onto DIN Rail

1. Align the module with the DIN rail and push it in the direction indicated by the arrow until you hear a click, as shown below.



2. Make sure the DIN rail mounting hook of the module is locked. The locked and unlocked states of the mounting hook are shown below.



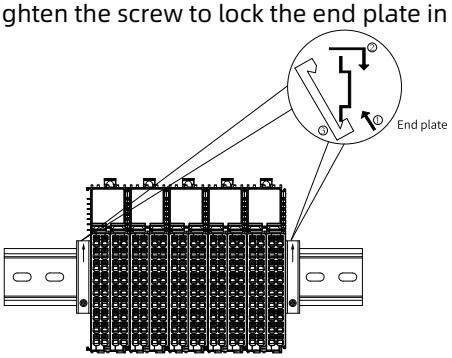
- If the mounting hook is pressed down, it is locked.
- If the mounting hook is lifted up, it is unlocked.

To lock the module to the DIN rail, press down the mounting hook.

Caution

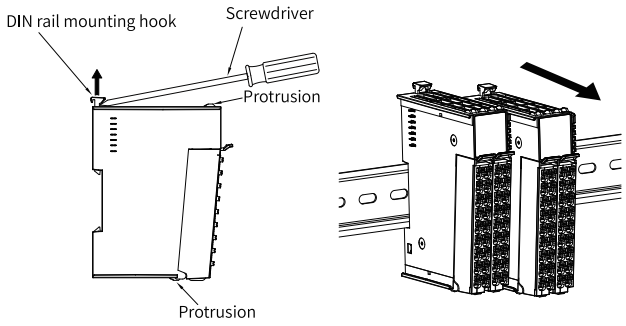
When the module is not installed on the rail, keep the mounting hook in the locked state. Keeping the mounting hook unlocked for a prolonged time may cause the hook to fail.

3. Install a DIN rail end plate on both sides of the PLC or expansion module. To install the end plate, hook the bottom of it to the bottom of the DIN rail, rotate the end plate to hook the top of it to the top of the DIN rail, and then tighten the screw to lock the end plate in place, as shown below.



Removing modules

Pry the DIN rail mounting hook upwards with a tool such as slotted screwdriver, hold the protrusions and pull the module out straight forward, and then press down the top of the DIN rail mounting hook.


DIN rail mounting hook
Screwdriver
Protrusion
Protrusion

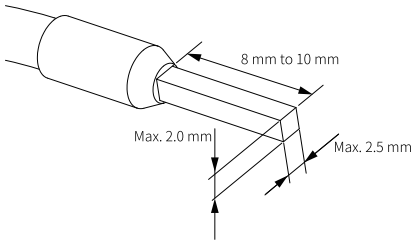
4 Electrical Installation

4.1 Cable Selection

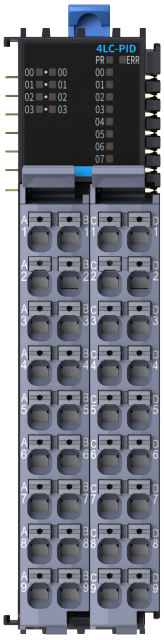
The cable lug and cable diameter included in the following table are only for reference.

Material Name	Applicable Cable Diameter		KST		Suzhou Yuanli	
	mm^2	AWG	Model	Crimping Tool	Model	Crimping Tool
Tubular lug	0.3	22	E0308	KST2000L	0308	YAC-5
	0.5	20	E0508		0508	
	0.75	18	E7508		7508	
	1.0	18	E1008		1008	
	1.5	16	E1508		1508	

To use other types of tubular lugs, crimp the lug to the cables according to the shape and dimension requirements shown below.



4.2 Terminal Definition



Left Signal Description (1st Column from Left)	Left Signal (1st Column from Left)	Left Terminal (1st Column from Left)	Left Terminal (2nd Column from Left)	Left Signal (2nd Column from Left)	Left Signal Description (2nd Column from Left)
• TC input (+) for channel 0 • Two-wire PT input A for channel 0 • Three-wire PT input A for channel 0 • Four-wire PT input A for channel 0	L0+	A1	B1	L0-	• TC input (-) for channel 0 • Two-wire PT input B for channel 0 • Three-wire PT input B for channel 0 • Four-wire PT input B for channel 0
Four-wire PT input A for channel 0	I0+	A2	B2	I0-	• Three-wire PT input B for channel 0 • Four-wire PT input B for channel 0
• TC input (+) for channel 1 • Two-wire PT input A for channel 1 • Three-wire PT input A for channel 1 • Four-wire PT input A for channel 1	L1+	A3	B3	L1-	• TC input (-) for channel 1 • Two-wire PT input B for channel 1 • Three-wire PT input B for channel 1 • Four-wire PT input B for channel 1
Four-wire PT input A for channel 1	I1+	A4	B4	I1-	• Three-wire PT input B for channel 1 • Four-wire PT input B for channel 1
• TC input (+) for channel 2 • Two-wire PT input A for channel 2 • Three-wire PT input A for channel 2 • Four-wire PT input A for channel 2	L2+	A5	B5	L2-	• TC input (-) for channel 2 • Two-wire PT input B for channel 2 • Three-wire PT input B for channel 2 • Four-wire PT input B for channel 2
Four-wire PT input A for channel 2	I2+	A6	B6	I2-	• Three-wire PT input B for channel 2 • Four-wire PT input B for channel 2
• TC input (+) for channel 3 • Two-wire PT input A for channel 3 • Three-wire PT input A for channel 3 • Four-wire PT input A for channel 3	L3+	A7	B7	L3-	• TC input (-) for channel 3 • Two-wire PT input B for channel 3 • Three-wire PT input B for channel 3 • Four-wire PT input B for channel 3
Four-wire PT input A for channel 3	I3+	A8	B8	I3-	• Three-wire PT input B for channel 3 • Four-wire PT input B for channel 3
Empty terminal (unconnected)	•	A9	B9	PE	PE grounding

Right Indicator (1st Column from Right)	Left Signal (1st Column from Left)	Right Signal (1st Column from Right)	Right Terminal (1st Column from Right)	Right Terminal (2nd Column from Right)	Right Signal (2nd Column from Right)	Right Signal Description (2nd Column from Right)
00	Digital output for channel 0	DO0	C1	D1	COM	Grounding terminal of the 24 VDC power supply
01	Digital output for channel 1	DO1	C2	D2	COM	Grounding terminal of the 24 VDC power supply
02	Digital output for channel 2	DO2	C3	D3	COM	Grounding terminal of the 24 VDC power supply
03	Digital output for channel 3	DO3	C4	D4	COM	Grounding terminal of the 24 VDC power supply
04	Digital output for channel 4	DO4	C5	D5	COM	Grounding terminal of the 24 VDC power supply
04	Digital output for channel 5	DO5	C6	D6	COM	Grounding terminal of the 24 VDC power supply
06	Digital output for channel 6	DO6	C7	D7	COM	Grounding terminal of the 24 VDC power supply
07	Digital output for channel 7	DO7	C8	D8	COM	Grounding terminal of the 24 VDC power supply
/	24 V power supply voltage	24V	C9	D9	COM	Grounding terminal of the 24 VDC power supply

The following table shows the relationship between temperature input channels and digital outputs.

Temperature Input Channel	Digital Output Indicator	Digital Output Signal
Channel 0 (CH0)	00, 01	DO0, DO1
Channel 1 (CH1)	02, 03	DO2, DO3
Channel 2 (CH2)	04, 05	DO4, DO5
Channel 3 (CH3)	06, 07	DO6, DO7

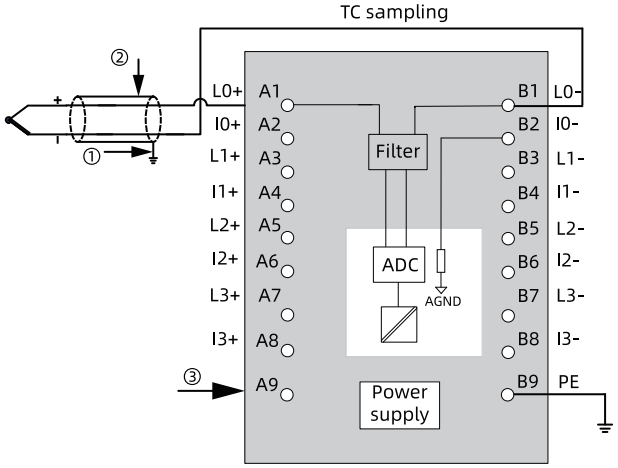
4.3 Terminal Wiring

Wiring precautions

- Do not bundle the expansion cable together with power cables (with high voltage and large current) that produce strong interference signals; otherwise, the expansion cable may be influenced by noise, surge, or induction. Separate it from other cables and avoid cabling in parallel.
- Use recommended cables and adapter boards for connection. It is recommended that shielded cables be used as expansion cables to enhance anti-interference capacity.
- Apply single-point grounding for the shielding of shielded cable and solder sealed cable.

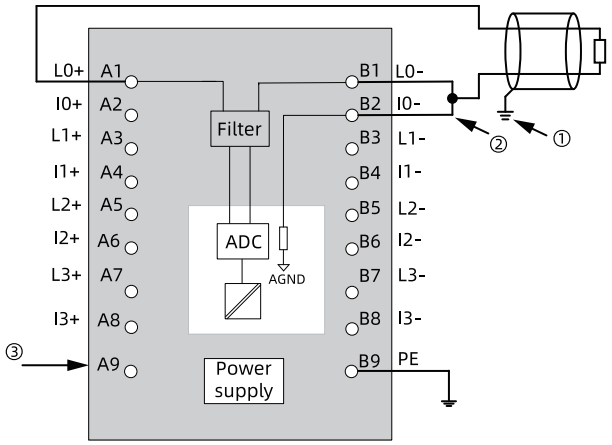
Circuit block diagram and wiring diagram

- Input wiring diagram
  - TC wiring diagram



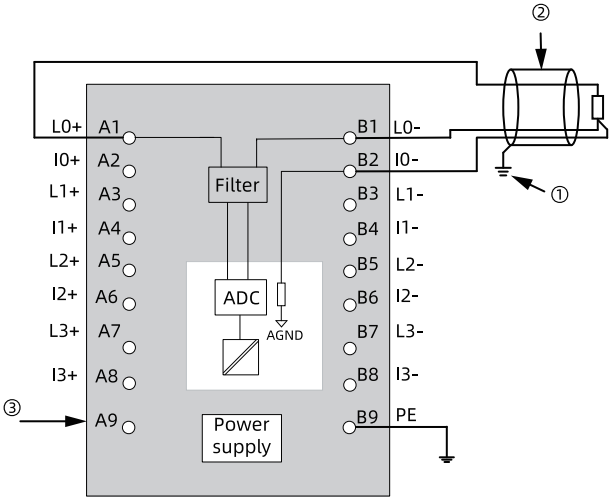
Name	Description
①	Use shielded compensating cables and connect the shield to PE. It is recommended to connect the PE terminal of the module to the external PE.
②	Compensating cables are required to extend thermocouples; otherwise, temperature measurements may be abnormal.
③	4-channel TC wiring: The wiring methods for A3&B3, A5&B5, A7&B7 are the same as those for A1 and B1. A9 is an empty terminal with no electrical connections.

  - PT wiring diagram
    - Two-wire mode



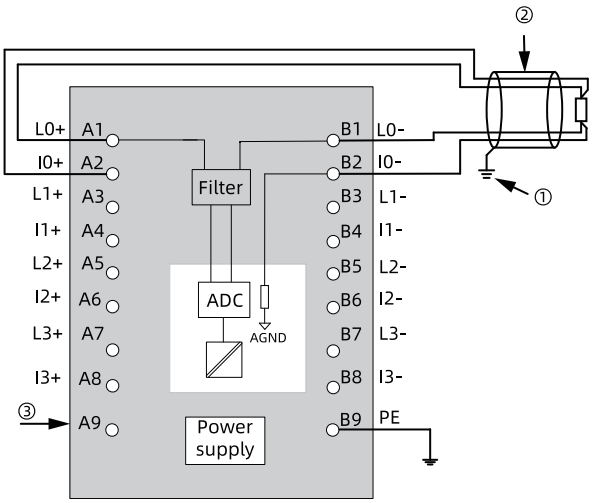
Name	Description
①	Use shielded compensating cables and connect the shield to PE. It is recommended to connect the PE terminal of the module to the external PE.
②	If two-wire connection is used, short the L0- and I0- channels together. In this case, the resistance on the cable will affect the measurement.
③	4-channel RTD connection in two-wire mode: The wiring methods for A3&B3&B4, A5&B5&B6, A7&B7&B8 are the same as those for A1&B1&B2. A9 is an empty terminal with no electrical connections.

- Three-wire mode



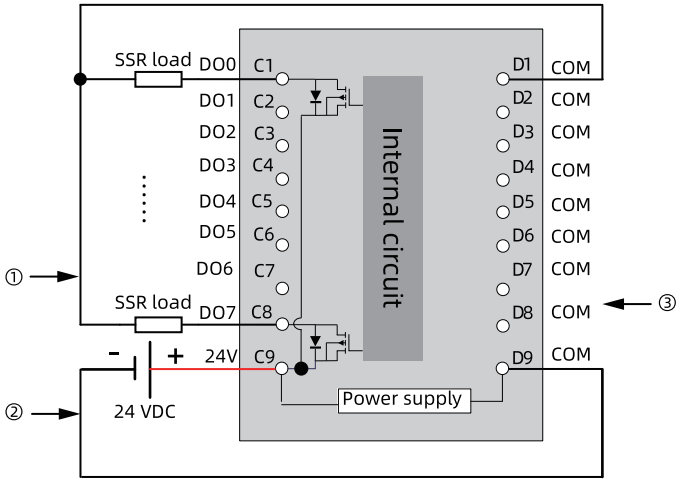
Name	Description
①	Use shielded compensating cables and connect the shield to PE. It is recommended to connect the PE terminal of the module to the external PE.
②	Use a cable having three low-resistance wires that have no difference in resistance.
③	4-channel RTD connection in three-wire mode: The wiring methods for A3&B3&B4, A5&B5&B6, A7&B7&B8 are the same as those for A1&B1&B2. A9 is an empty terminal with no electrical connections.

- Four-wire mode



Name	Description
①	Use shielded compensating cables and connect the shield to PE. It is recommended to connect the PE terminal of the module to the external PE.
②	Use a cable having three low-resistance wires that have no difference in resistance.
③	4-channel RTD connection in four-wire mode: The wiring methods for A3&A4&B3&B4, A5&A6&B5&B6, A7&A8&B7&B8 are the same as those for A1&A2&B1&B2. A9 is an empty terminal with no electrical connections.

- Output wiring diagram



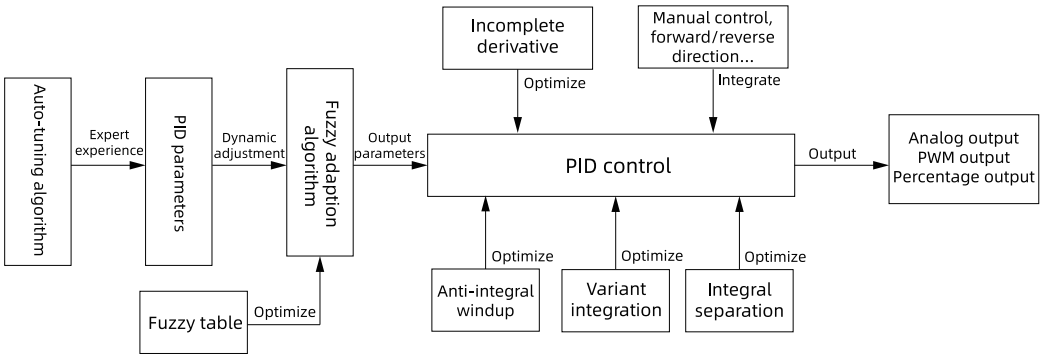
Name	Description
①	C1 to C8 are output terminals for wiring. C9 to D9 are power supply terminals.
②	Wiring of power supply (C9 to D9)
③	All COM terminals are internally connected. A COM terminal can be connected to multiple SSR loads.

5 PID Temperature Control Function

5.1 Introduction

The PID temperature control function is based on the auto-tuning fuzzy adaption bipolar PID control algorithm. It is applicable to both unipolar and bipolar control applications.

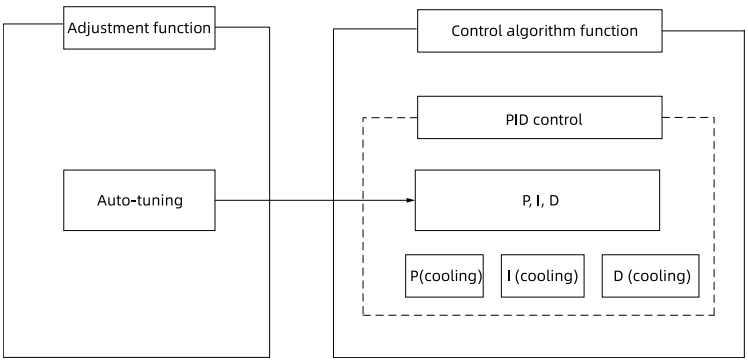
The PID temperature control algorithm mainly consists of three functions: auto-tuning, fuzzy adaption, and PID control. The auto-tuning function uses relay feedback algorithms. The fuzzy adaption algorithms, based on auto-tuning PID parameters, modify PID parameters in real time according to deviation and deviation change rate. The PID control function uses a positional PID algorithm to calculate the percentage output, which integrates variable integral, anti-integral windup, integral separation, incomplete derivation, and manual control. For complex control systems, auto-tuning can be completed by simply enabling the PID auto-tuning function.



5.2 Auto-Tuning Function

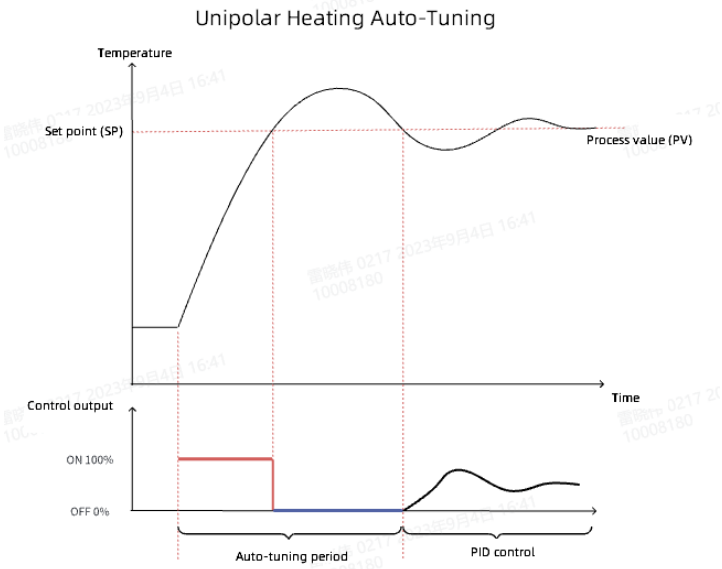
Introduction

Auto-tuning adjustment function: The temperature control unit of the module automatically calculates the PID parameters (including proportional, integral, and derivative) and determines the set point to adjust the temperature. This function enables fast, stable, and precise temperature control, boosts commissioning efficiency, and simplifies the complicated manual commissioning workflow. The module features the temperature control function by heating and cooling. The corresponding function blocks are shown below.

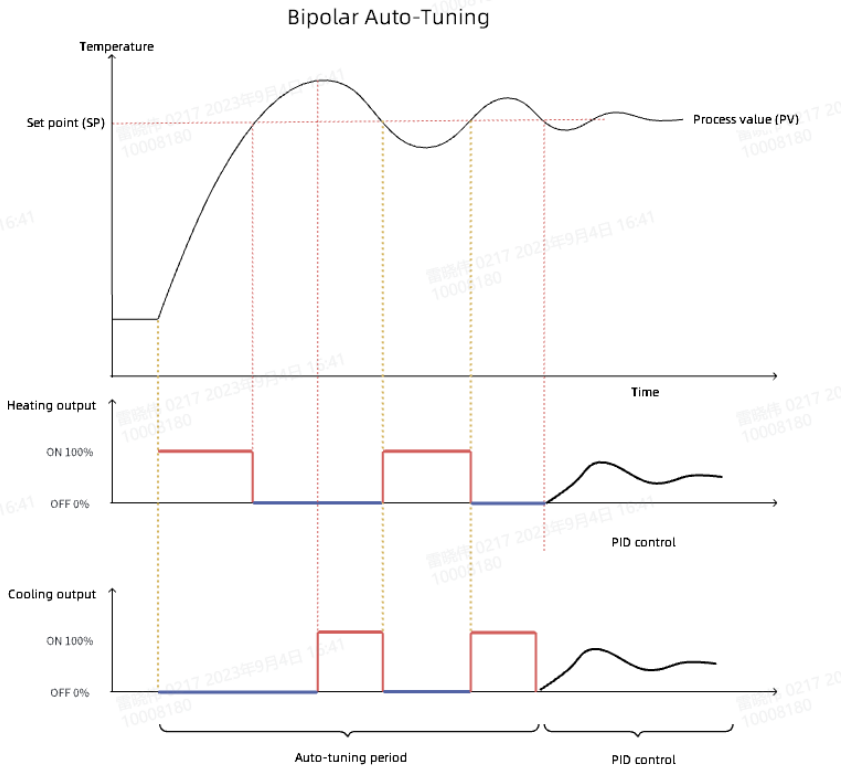


The auto-tuning function can be divided into unipolar heating auto-tuning and bipolar auto-tuning.

The following figure illustrates the unipolar heating auto-tuning process, with a waveform near the set point.



The following figure illustrates the bipolar auto-tuning process, with 2 waveforms near the set point. After auto-tuning, manually set the StartAT parameter to False.



Calculation of the initial auto-tuning PID value

The initial value of PID is obtained through the relay feedback auto-tuning algorithm, combined with expert experience.

Based on the relay feedback method of the Z-N formula, the calculation of the initial auto-tuning PID value is shown below.

$$\begin{cases} A = \dfrac{y_{max} - y_{min}}{2} \\ T_u = 2(t_2 - t_1) \end{cases}$$

$$\begin{cases} K_u = \dfrac{4d}{\pi A} \\ T_u = \dfrac{2\pi}{\omega} \end{cases}$$

"d" represents the relay characteristic amplitude; "A" represents the amplitude generated by the system; "T_u" represents the critical oscillation cycle; "y_{max}" and "y_{min}" represent the peak and valley values respectively; "t2" and "t1" represent the time of the peak and valley respectively.

The critical proportional band method is used to calculate the controller parameters during the relay-type auto-tuning process, as shown below.

$K_p0 = 0.6K_u$

$T_i = 0.5T_u$

$T_d = 0.125Tu$

"K_p" represents the proportional gain; "T_i" represents the integral time constant; "T_d" represents the derivative time constant.

The following formulas are derived from $K_i0 = K_p0 \div T_i$, and $K_d0 = K_p0 \times T_d$.

$$\begin{cases} K_p0 = 0.6K_u \\ K_i0 = \dfrac{0.3K_u}{T_u} \\ K_d0 = 0.75K_uT_u \end{cases}$$

According to the above formulas, K_p0, K_i0, and K_d0 can be calculated.

Function description

Enable the appropriate auto-tuning type based on the application scenario. Install sensors and other execution units in accordance with electrical requirements. The parameter settings and descriptions are as shown in the following table.

Sequence	Parameter	Name	Description	Default Value
1	ControlMode +ErrorAction +OutType +OutTypeCool	Auto-tuning type	Options include unipolar heating auto-tuning and bipolar auto-tuning. • Bit 0 to Bit 1: Control mode • 0: PID negative action (unipolar heating) • 2: PID bipolarity controlled by cooling coefficient • 3: PID bipolarity controlled independently	0
2	ATNum	Number of auto-tuning waveforms	• Selects at least one waveform for unipolar heating auto-tuning. • Selects at least 2 waveforms for bipolar auto-tuning.	2

Sequence	Parameter	Name	Description	Default Value
3	SampleMode +SenserType +ChannelEnable	Sensor type	Bit 2 to Bit 6: Sensor type Thermal resistor: The default is PT100. • 0: PT100 • 1: PT500 • 2: PT1000 • 3: Cu100 • 4: KTY84 • 5: Resistance value (1 kΩ to 4 kΩ) Default is K type. • 0: K • 1: J • 2: E • 3: B • 4: N • 5: R • 6: S • 7: T • 8: C • 9: ±100 mV	K type
4	SampleTime/ Unit/Float/ CoolJunction	Sampling cycle	Bit 0 to Bit 2: Sampling cycle • 0: 50ms • 1: 250ms • 2: 500ms • 3: 1000ms	2
5	ControlMode +ErrorAction +OutType +OutTypeCool	Action upon an alarm	Bit 2: Action upon an alarm • 0: Keep the current value • 1: Output the predefined value	1
6	ControlMode +ErrorAction +OutType +OutTypeCool	Output type	Bit 3 to Bit 4: Output type • 0: PWM output • 2: Percentage output Bit 5 to Bit 6: Cooling output type • 0: PWM output • 2: Percentage output	00
7	TempCommand	PID enabling	Bit 0: Enable temperature control 0: Disabled 1: Enabled	0
8	TempCommand	Auto-tuning enabling	Bit 2: Enable auto-tuning mode (StartAT) 0: Disabled 1: Enabled	0

Sequence	Parameter	Name	Description	Default Value
9	Set Point	Target temperature	Sets this parameter to the common operating temperature.	-
10	Output State	Temperature control state	Indicates the auto-tuning state of temperature control. Bit 3 to Bit 4: Auto-tuning state (ATState) 0: Not tuned 1: Tuning 2: Tuned	0

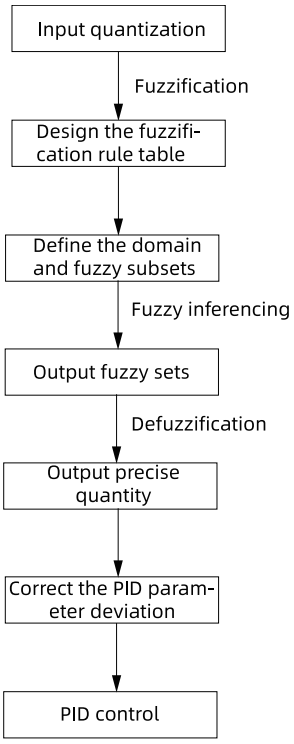
Caution

- The auto-tuning PID parameter is used to adjust the target temperature. If there is a large deviation between the target temperature and the temperature during auto-tuning, the adjustment speed and accuracy may not meet expectations, and auto-tuning must be performed again.
- During the auto-tuning process, parameter configurations cannot be modified; otherwise, unreasonable parameters may be obtained.
- After the auto-tuning, the auto-tuned parameters are recorded, written, and saved to the PID-related parameters of RPDO.
- For detailed auto-tuning parameter settings, see *"8.2 Appendix 2: Object Dictionary Definition" on page 47*.

5.3 Fuzzy Adaption Function

The fuzzy adaption function is based on is an algorithm based on intelligent reasoning, capable of handling complex, variable, and uncertain control environments. It addresses control problems in complex nonlinear systems where characteristics vary with time or operating conditions – problems that traditional PID controllers, and even those with auto-tuning function, cannot handle effectively.

A fuzzy adaption controller comprises three functional modules: fuzzification, fuzzy inferencing, and defuzzification. It also includes a knowledge base, which consists of a database and a rule base. The fuzzy adaption function is enabled by setting the Bit 0 in "OtherParameter" to correct the PID parameter offset.



Note

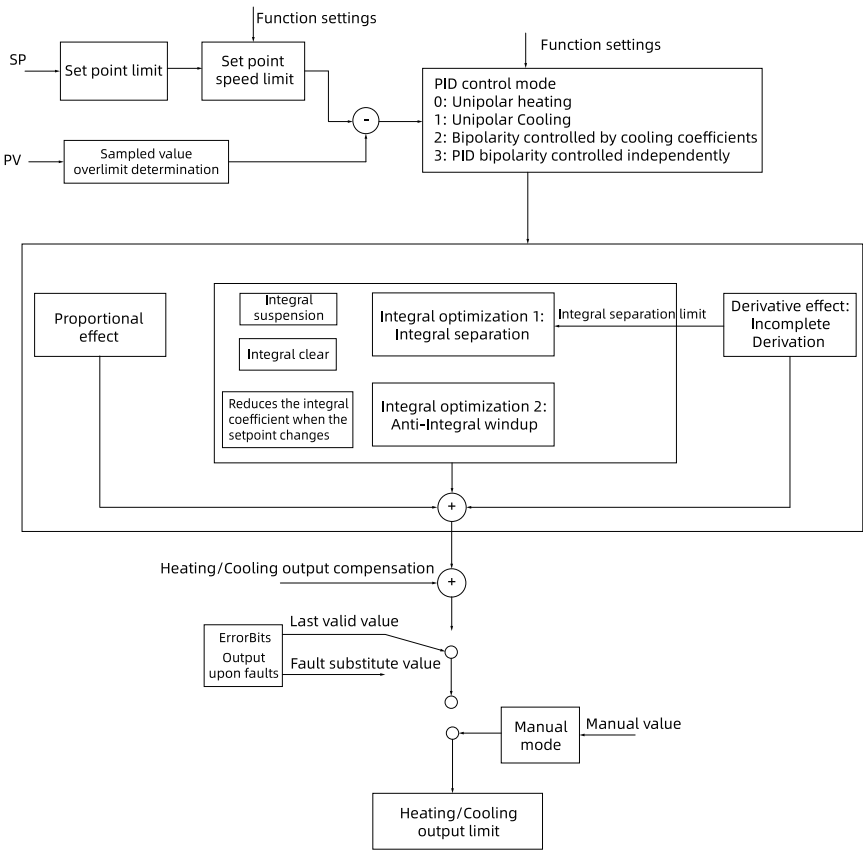
The fuzzy adaption function is enabled by setting the Bit 0 in "OtherParameter".

5.4 PID Control Function

Introduction

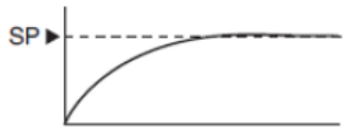
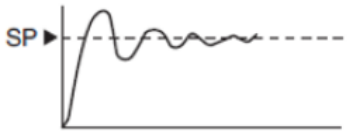
The PID control function supports both manual and automatic modes, and features parameter auto-tuning. It is applicable to heating, cooling, and heating/cooling scenarios, with two separate outputs for heating and cooling.

As shown in the figure below, select the PID control mode and set the target temperature (SP) according to actual application scenarios and requirements. Connect the actual sensor to sample the temperature as PV and output the heating/cooling amplitude using the PID algorithm of the module.

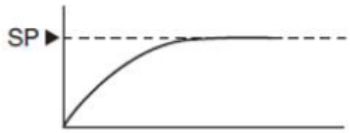
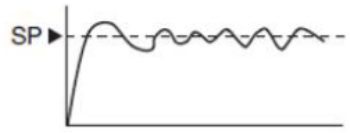


Function description

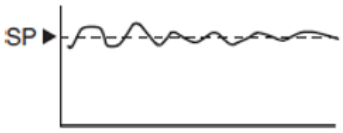
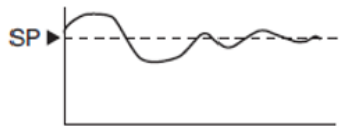
- PID parameters
  For PID control, set the proportional band (K_p), integral time (T_i), and derivative time (T_d) based on actual needs.
  - The larger the K_p, the stronger the proportional effect, which only focuses on the deviation.

Modification	Curve	Description
When K_p decreases		The curve increases gradually and takes longer to stabilize, but overshoot can be avoided.
When K_p increases		Overshoots and fluctuations occur, but the curve quickly reaches the set point and remains stable.

  - The larger the T_i, the weaker the integral effect, which only focuses on the deviation.

Modification	Curve	Description
When T_i increases		The time to reach the set point increases. The stabilization time is longer, but fluctuations, overshoots, and undershoots are reduced.
When T_i decreases		Overshoots and undershoots occur. Fluctuations occur. The curve reaches the set point quickly.

- The larger the T_d, the stronger the derivative effect. The derivative process only focuses on the deviation changes (when the set point is constant, it only focuses on PV changes), and the derivative action occurs only when PV changes.

Modification	Curve	Description
When T_d increases		The overshoot/undershoot magnitudes and the stabilization time are reduced. Minor fluctuations occur when the system's state changes.
When T_d decreases		The overshoot/undershoot magnitudes are relatively large and it takes longer to return to the set point.

- Parameter setting
  Enable the PID control algorithm. Install sensors and other execution units in accordance with electrical requirements. The parameter settings and descriptions are as shown in the following table.

No.	Parameter	Name	Description	Default Value
1	SampleTime/Unit/ Float/CoolJunction	Sampling cycle	Bit 0 to Bit 2: Sampling cycle • 0: 50ms • 1: 250ms • 2: 500ms • 3: 1000ms	2
2	SampleMode + SenserType + ChannelEnable	Sensor type and sampling mode	Bit 0 to Bit 1: Sampling mode Three-wire mode (default) • 0: Thermal resistor in two-wire mode • 1: Thermal resistor in three-wire mode • 2: Thermal resistor in four-wire mode • 3: Thermocouple Bit 2 to Bit 6: Sensor type Thermal resistor: The default is PT100. • 0: PT100 • 1: PT500 • 2: PT1000 • 3: Cu100 • 4: KTY84 • 5: Resistance value (1 kΩ to 4 kΩ) Default is K type. • 0: K • 1: J • 2: E • 3: B • 4: N • 5: R • 6: S • 7: T • 8: C • 9: ±100 mV	1, 2, 9
2	ControlMode +ErrorAction+OutType +OutTypeCool	PID control mode	Bit 0 to Bit 1: Control mode • 0: PID negative action (unipolar heating) • 1: PID positive action (unipolar cooling) • 2: PID bipolarity controlled by cooling coefficient • 3: PID bipolarity controlled independently	0
3	ControlMode +ErrorAction+OutType +OutTypeCool	Action upon an alarm	Bit 2: Action upon an alarm • 0: Keep the current value • 1: Output the predefined value	1

No.	Parameter	Name	Description	Default Value
4	ControlMode +ErrorAction+OutType +OutTypeCool	Output type	Bit 3 to Bit 4: Output type • 0: PWM output • 2: Percentage output Bit 5 to Bit 6: Cooling output type • 0: PWM output • 2: Percentage output	00
5	OtherParameter	Configuration parameters (optional)	• Bit 0: Fuzzy adaptation • Bit 1: Integral suspension (IntegralSuspend) • Bit 2: Integral separation control (IntegralDivision) • Bit 3: Integral clear (IntegralClear) • Bit 4 to Bit 7: Reserved	0
6	TempCommand	PID enabling	Bit 0: Enable temperature control • 0: Disabled • 1: Enabled	0
7	TempCommand	Manual enabling	Check whether the wiring is correct during commissioning. Bit 1: Enable manual mode (ManualEnable) • 0: Disabled • 1: Enabled	0
8	Set Point	Target temperature	Sets this parameter to the common operating temperature.	-

Note

For PID-related parameter settings, see *"8.2 Appendix 2: Object Dictionary Definition" on page 47*

6 Program Commissioning

The is an example where AM600 series PLC is used with the GL20-4LC-PID module and heating/cooling devices.

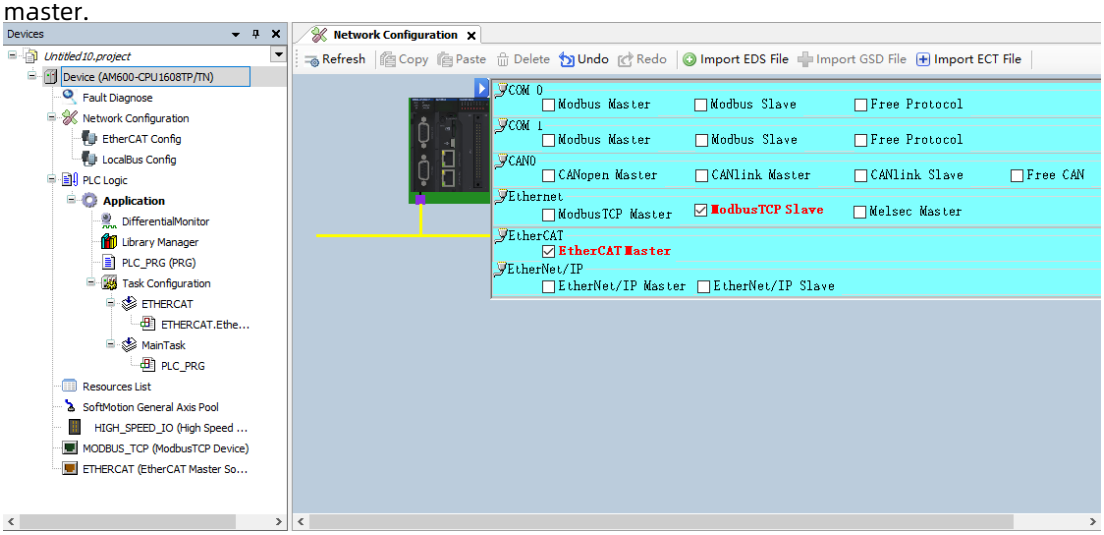
Prerequisites

- The installation and wiring of the required hardware are completed.
- All products are powered on.
- The PC equipped with the InoProShop programming software is connected to the network port of the AM600 PLC.
- The firmware is upgraded and the XML device file is imported.

Procedure

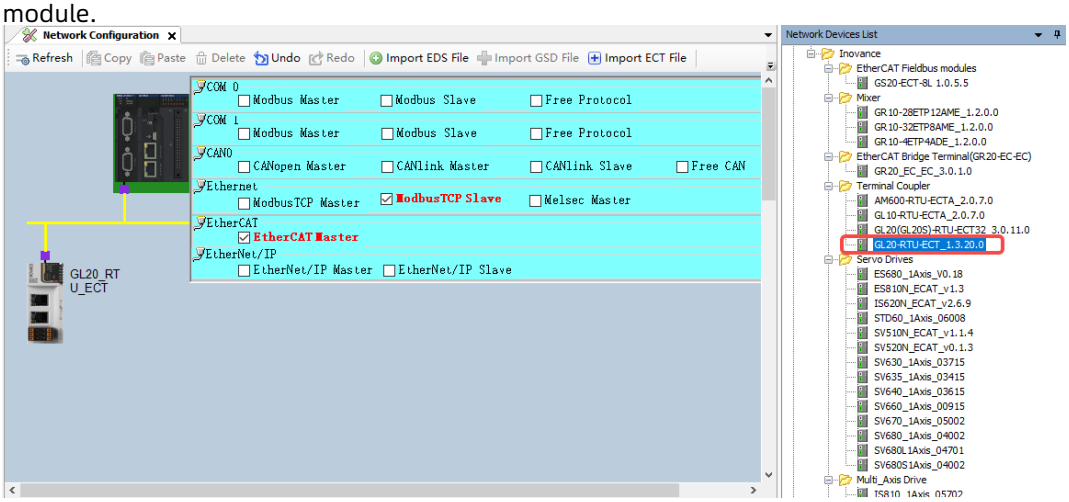
1. Add the GL20-RTU-ECT32 communication interface module.

   a. In the left **Devices** pane, double-click **Network Configuration** and click the AM600 figure in the upper left corner of the interface. Check the "EtherCAT Master" to enable the PLC as an EtherCAT master.

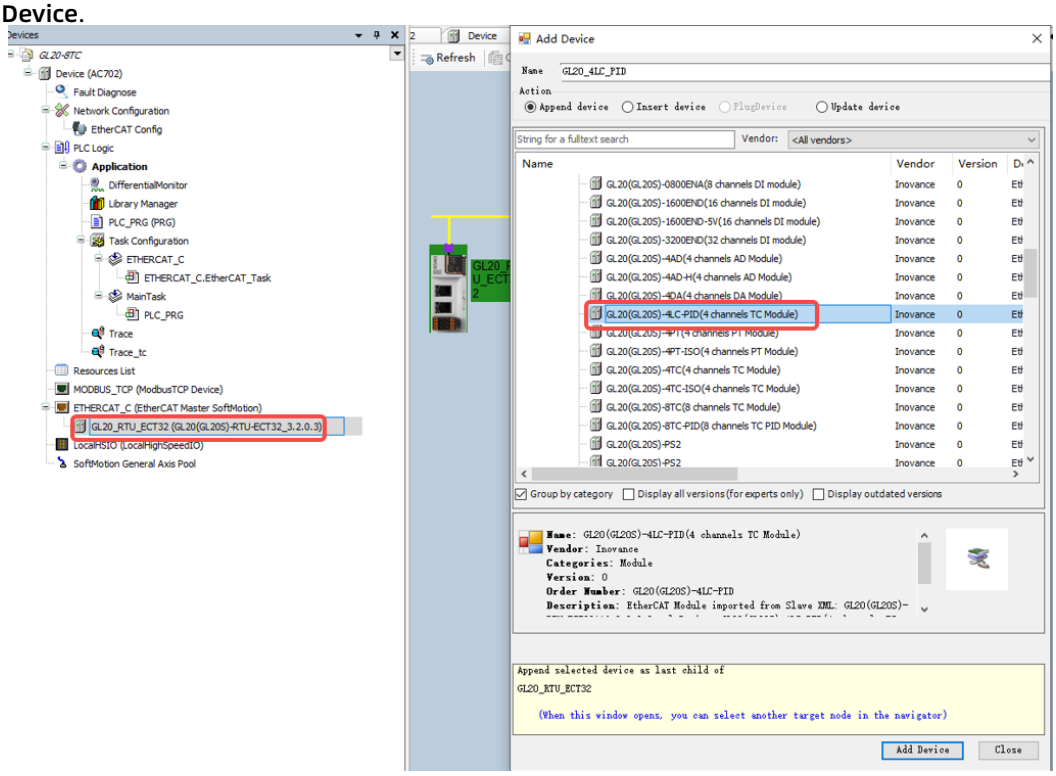


   b. Add the GL20-RTU-ECT32 communication interface module.

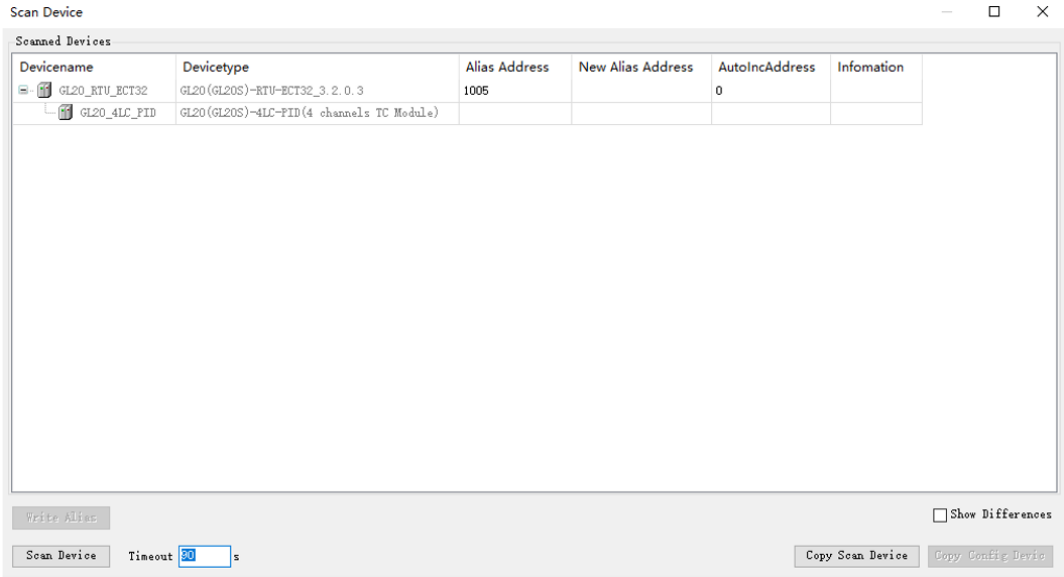
   - Method 1: In the right **Network Devices List**, double-click "GL20-RTU-ECT32" to add the module.



- Method 2: In the left **Devices** pane, right-click **ETHERCAT(EtherCAT Master SoftMotion)** and select **Add Device**. Select "GL20_RTU_ECT32_*X.X.X.X*" in the pop-up dialog box and click **Add Device**.



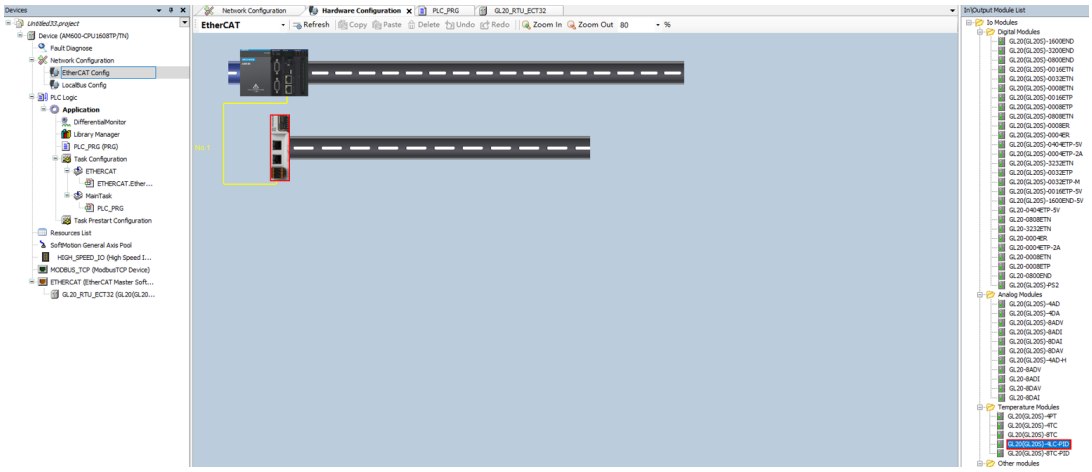
- Method 3: In the left **Devices** pane, right-click **ETHERCAT(EtherCAT Master SoftMotion)** and select **Scan For Devices**. Click **Scan Devices**, select the "GL20-RTU-ECT32" module, and click **Copy Scan Device**.



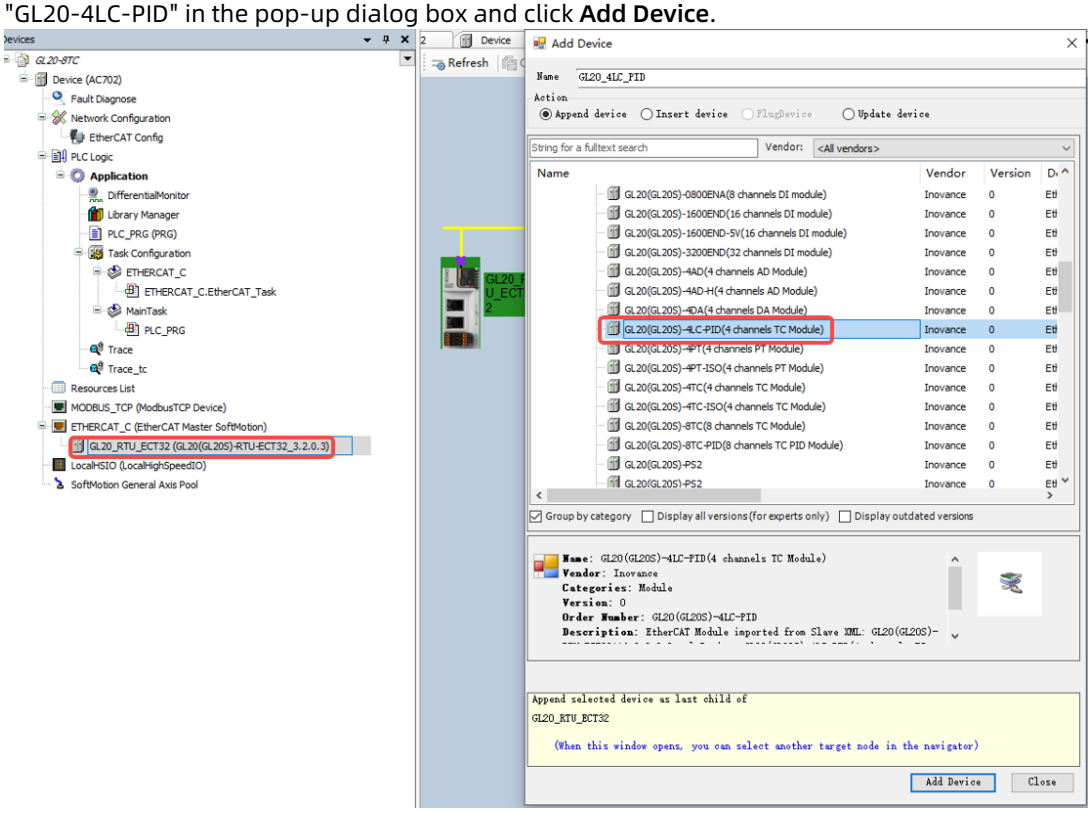
2. Add the GL20-4LC-PID module.

   There are three ways to add the GL20-4LC-PID module.

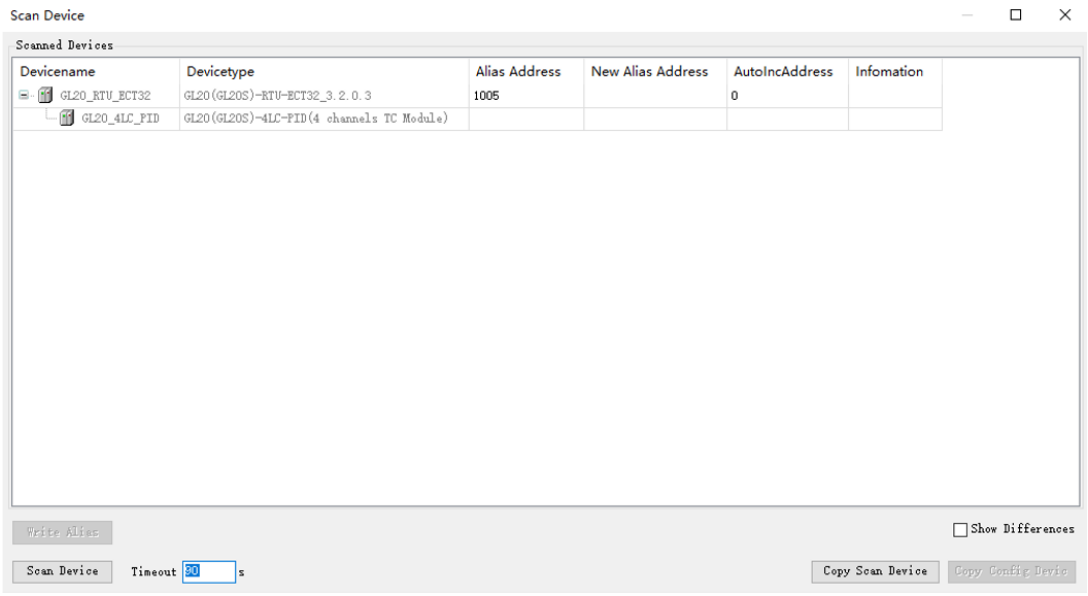
- Method 1: Open the **Hardware Configuration** pane by double-clicking **EtherCAT Config** in the left **Devices** pane, or double-clicking the GL20-RTU-ECT32 figure in the **Network Configuration** pane. In the right **In\Output Module List**, double-click "GL20-4LC-PID" or drag and place it after the GL20-RTU-ECT32 module.



- Method 2: In the left **Devices** pane, right click **GL20_RTU_ECT32** and select **Add Device**. Select "GL20-4LC-PID" in the pop-up dialog box and click **Add Device**.



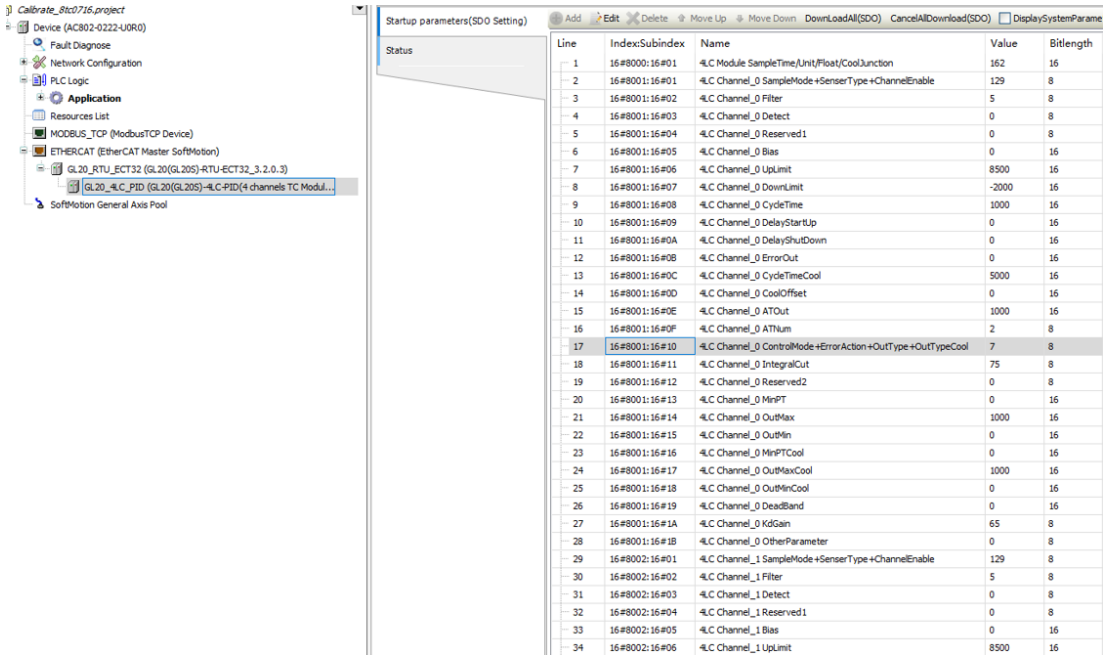
- Method 3: In the left "Devices" pane, right-click "ETHERCAT(EtherCAT Master SoftMotion)" and select "Scan For Devices". Click "Scan Devices", select the GL20-4LC-PID module, and click "Copy Scan Device".



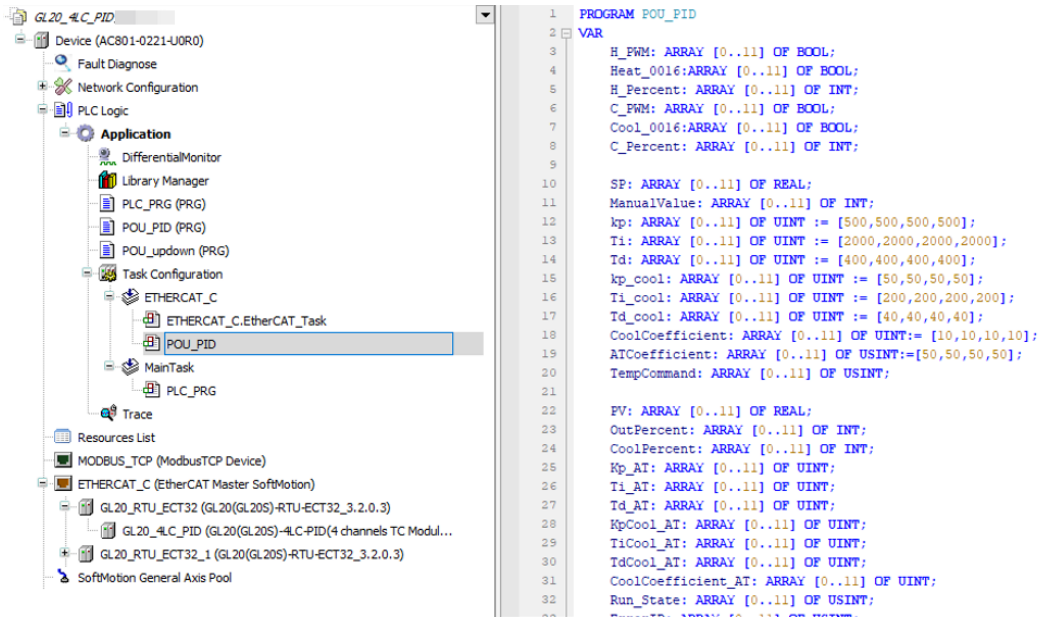
3. Create new variables.

a. Set the PID control mode (ControlMode), fault alarm action (ErrorAction), and output type (OutType) according to the actual requirements. For detailed parameter description, see *"8.2 Appendix 2: Object Dictionary Definition" on page 47*.

Double-click **GL20-4LC-PID** in the left **Devices** pane. In the **Startup parameters (SDO Setting)** interface, set the value of "4LC-PIDChannel_0 ControlMode_EroorAction" to 7.



b. Double-click **POU_PID** to set the RPDO parameters, TPDO parameters, and PWM output parameters



1). Set the RPDO parameters as follows.

```
// RPDO settings
SP: ARRAY [0..11] OF REAL;
ManualValue: ARRAY [0..11] OF INT;
kp: ARRAY [0..11] OF UINT := [500,500,500,500];
Ti: ARRAY [0..11] OF UINT := [2000,2000,2000,2000];
Td: ARRAY [0..11] OF UINT := [400,400,400,400];
kp_cool: ARRAY [0..11] OF UINT := [50,50,50,50];
Ti_cool: ARRAY [0..11] OF UINT := [200,200,200,200];
Td_cool: ARRAY [0..11] OF UINT := [40,40,40,40];
CoolCoefficient: ARRAY [0..11] OF UINT:= [10,10,10,10];
ATCoefficient: ARRAY [0..11] OF USINT:=[50,50,50,50];
TempCommand: ARRAY [0..11] OF USINT;
```

2). Set the TPDO parameters as follows.

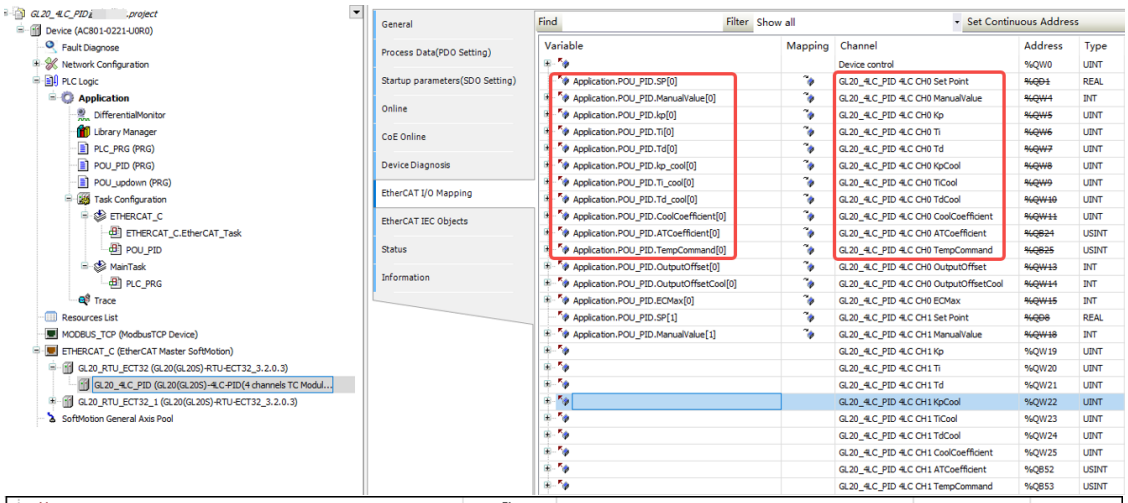
```
// TPDO settings
PV: ARRAY [0..11] OF REAL;
OutPercent: ARRAY [0..11] OF INT;
CoolPercent: ARRAY [0..11] OF INT;
Kp_AT: ARRAY [0..11] OF UINT;
Ti_AT: ARRAY [0..11] OF UINT;
Td_AT: ARRAY [0..11] OF UINT;
KpCool_AT: ARRAY [0..11] OF UINT;
TiCool_AT: ARRAY [0..11] OF UINT;
TdCool_AT: ARRAY [0..11] OF UINT;
CoolCoefficient_AT: ARRAY [0..11] OF UINT;
Run_State: ARRAY [0..11] OF USINT;
ErrorID: ARRAY [0..11] OF USINT;
Output_State: ARRAY [0..11] OF USINT;
```

3). Set the parameters related to PWM output for monitoring, as shown below.

```
39    // Related to PWM output
40    H_PWM: ARRAY [0..11] OF BOOL;
41    C_PWM: ARRAY [0..11] OF BOOL;
```

4. Map the PDO data.

In the left **Devices** pane, double-click **GL20-RTU-ECT32** and select **EtherCAT I/O Mapping**.



Application.POU_PID.PV[0]		GL20_4LC_PID CH0 Temperature	%ID3	REAL
Application.POU_PID.OutPercent[0]		GL20_4LC_PID CH0 OutPercent	%IW8	INT
Application.POU_PID.CoolPercent[0]		GL20_4LC_PID CH0 CoolPercent	%IW9	INT
Application.POU_PID.Kp_AT[0]		GL20_4LC_PID CH0 Kp_AT	%IW10	UINT
Application.POU_PID.Ti_AT[0]		GL20_4LC_PID CH0 Ti_AT	%IW11	UINT
Application.POU_PID.Td_AT[0]		GL20_4LC_PID CH0 Td_AT	%IW12	UINT
Application.POU_PID.KpCool_AT[0]		GL20_4LC_PID CH0 KpCool_AT	%IW13	UINT
Application.POU_PID.TiCool_AT[0]		GL20_4LC_PID CH0 TiCool_AT	%IW14	UINT
Application.POU_PID.TdCool_AT[0]		GL20_4LC_PID CH0 TdCool_AT	%IW15	UINT
Application.POU_PID.CoolCoefficient_AT[0]		GL20_4LC_PID CH0 CoolCoefficient_AT	%IW16	UINT
Application.POU_PID.Run_State[0]		GL20_4LC_PID CH0 Run State	%IB34	USINT
Application.POU_PID.ErrorID[0]		GL20_4LC_PID CH0 ErrorID	%IB35	USINT
Application.POU_PID.Output_State[0]		GL20_4LC_PID CH0 Output State	%IB36	USINT
Application.POU_PID.H_PWM[0]		Bit0	%IX36.0	BOOL
Application.POU_PID.C_PWM[0]		Bit1	%IX36.1	BOOL

5. Check, compile, log in, download, and run the program.

   a. Click  on the toolbar at the top of the interface to check whether the program is correct.

   b. Click  on the toolbar to compile all the code into PLC executable code.

   c. Click  on the toolbar, and follow the interface prompts to log in to the PLC and download the program.

   d. Click  on the toolbar to execute the program.

6. Perform the heating function.

   a. Set the target temperature to 40°C, as shown below.

		Device control	%QW0	UINT	0
Application.POU_PID.SP[0]		GL20_4LC_PID 4LC CH0 Set Point	%QD1	REAL	40
Application.POU_PID.ManualValue[0]		GL20_4LC_PID 4LC CH0 ManualValue	%QW4	INT	0
Application.POU_PID.kp[0]		GL20_4LC_PID 4LC CH0 Kp	%QW5	UINT	500
Application.POU_PID.Ti[0]		GL20_4LC_PID 4LC CH0 Ti	%QW6	UINT	2000
Application.POU_PID.Td[0]		GL20_4LC_PID 4LC CH0 Td	%QW7	UINT	400
Application.POU_PID.kp_cool[0]		GL20_4LC_PID 4LC CH0 KpCool	%QW8	UINT	50
Application.POU_PID.Ti_cool[0]		GL20_4LC_PID 4LC CH0 TiCool	%QW9	UINT	200
Application.POU_PID.Td_cool[0]		GL20_4LC_PID 4LC CH0 TdCool	%QW10	UINT	40
Application.POU_PID.CoolCoefficient[0]		GL20_4LC_PID 4LC CH0 CoolCoefficient	%QW11	UINT	10
Application.POU_PID.ATCoefficient[0]		GL20_4LC_PID 4LC CH0 ATCoefficient	%QB24	USINT	50
Application.POU_PID.TempCommand[0]		GL20_4LC_PID 4LC CH0 TempCommand	%QB25	USINT	1
		Bit0	%QX25.0	BOOL	TRUE
		Bit1	%QX25.1	BOOL	FALSE
		Bit2	%QX25.2	BOOL	FALSE
		Bit3	%QX25.3	BOOL	FALSE
		Bit4	%QX25.4	BOOL	FALSE
		Bit5	%QX25.5	BOOL	FALSE
		Bit6	%QX25.6	BOOL	FALSE
		Bit7	%QX25.7	BOOL	FALSE

b. Enable the PID function, as shown below.

		Fault ID	%IW1	UINT	0
		ErrorSolt1	%ID1	UDINT	0
		ErrorSolt2	%ID2	UDINT	0
Application.POU_PID.PV[0]		GL20_4LC_PID CH0 Temperature	%ID3	REAL	26.7
Application.POU_PID.OutPercent[0]		GL20_4LC_PID CH0 OutPercent	%IW8	INT	1000
Application.POU_PID.CoolPercent[0]		GL20_4LC_PID CH0 CoolPercent	%IW9	INT	0
Application.POU_PID.Kp_AT[0]		GL20_4LC_PID CH0 Kp_AT	%IW10	UINT	500
Application.POU_PID.Ti_AT[0]		GL20_4LC_PID CH0 Ti_AT	%IW11	UINT	2000
Application.POU_PID.Td_AT[0]		GL20_4LC_PID CH0 Td_AT	%IW12	UINT	400
Application.POU_PID.KpCool_AT[0]		GL20_4LC_PID CH0 KpCool_AT	%IW13	UINT	50
Application.POU_PID.TiCool_AT[0]		GL20_4LC_PID CH0 TiCool_AT	%IW14	UINT	2000
Application.POU_PID.TdCool_AT[0]		GL20_4LC_PID CH0 TdCool_AT	%IW15	UINT	400
Application.POU_PID.CoolCoefficient_AT[0]		GL20_4LC_PID CH0 CoolCoefficient_AT	%IW16	UINT	100
Application.POU_PID.Run_State[0]		GL20_4LC_PID CH0 Run State	%IB34	USINT	2
Application.POU_PID.ErrorID[0]		GL20_4LC_PID CH0 ErrorID	%IB35	USINT	0
Application.POU_PID.Output_State[0]		GL20_4LC_PID CH0 Output State	%IB36	USINT	1
Application.POU_PID.H_PWM[0]		Bit0	%IX36.0	BOOL	TRUE
Application.POU_PID.C_PWM[0]		Bit1	%IX36.1	BOOL	FALSE
		Bit2	%IX36.2	BOOL	FALSE
		Bit3	%IX36.3	BOOL	FALSE
		Bit4	%IX36.4	BOOL	FALSE
		Bit5	%IX36.5	BOOL	FALSE
		Bit6	%IX36.6	BOOL	FALSE
		Bit7	%IX36.7	BOOL	FALSE

7. Perform the cooling function.

The measured temperature is 33.2℃. To perform the cooling function, set the target temperature to 20℃ and set the Bit 1 of parameter "Output_State" to TRUE, as shown below.

		GL20_4LC_PID 4LC CH3 OutputOffsetCool	%QW56	INT	0
		GL20_4LC_PID 4LC CH3 ECMax	%QW57	INT	0
Application.POU_updown.LBbus_1		LBus status	~~%IW0~~	UINT	8
		Fault ID	%IW1	UINT	0
		ErrorSolt1	%ID1	UDINT	0
		ErrorSolt2	%ID2	UDINT	0
Application.POU_PID.PV[0]		GL20_4LC_PID CH0 Temperature	~~%ID3~~	REAL	33.2
Application.POU_PID.OutPercent[0]		GL20_4LC_PID CH0 OutPercent	~~%IW8~~	INT	0
Application.POU_PID.CoolPercent[0]		GL20_4LC_PID CH0 CoolPercent	~~%IW9~~	INT	851
Application.POU_PID.Kp_AT[0]		GL20_4LC_PID CH0 Kp_AT	~~%IW10~~	UINT	500
Application.POU_PID.Ti_AT[0]		GL20_4LC_PID CH0 Ti_AT	~~%IW11~~	UINT	2000
Application.POU_PID.Td_AT[0]		GL20_4LC_PID CH0 Td_AT	~~%IW12~~	UINT	400
Application.POU_PID.KpCool_AT[0]		GL20_4LC_PID CH0 KpCool_AT	~~%IW13~~	UINT	50
Application.POU_PID.TiCool_AT[0]		GL20_4LC_PID CH0 TiCool_AT	~~%IW14~~	UINT	2000
Application.POU_PID.TdCool_AT[0]		GL20_4LC_PID CH0 TdCool_AT	~~%IW15~~	UINT	400
Application.POU_PID.CoolCoefficient_AT[0]		GL20_4LC_PID CH0 CoolCoefficient_AT	~~%IW16~~	UINT	100
Application.POU_PID.Run_State[0]		GL20_4LC_PID CH0 Run State	~~%IB34~~	USINT	2
Application.POU_PID.ErrorID[0]		GL20_4LC_PID CH0 ErrorID	~~%IB35~~	USINT	0
Application.POU_PID.Output_State[0]		GL20_4LC_PID CH0 Output State	~~%IB36~~	USINT	2
Application.POU_PID.H_PWM[0]		Bit0	~~%IX36.0~~	BOOL	FALSE
Application.POU_PID.C_PWM[0]		Bit1	~~%IX36.1~~	BOOL	TRUE
		Bit2	~~%IX36.2~~	BOOL	FALSE
		Device control	%QW0	UINT	0
Application.POU_PID.SP[0]		GL20_4LC_PID 4LC CH0 Set Point	~~%QD1~~	REAL	20
Application.POU_PID.ManualValue[0]		GL20_4LC_PID 4LC CH0 ManualValue	~~%QW4~~	INT	0
Application.POU_PID.kp[0]		GL20_4LC_PID 4LC CH0 Kp	~~%QW5~~	UINT	500
Application.POU_PID.Ti[0]		GL20_4LC_PID 4LC CH0 Ti	~~%QW6~~	UINT	2000
Application.POU_PID.Td[0]		GL20_4LC_PID 4LC CH0 Td	~~%QW7~~	UINT	400
Application.POU_PID.kp_cool[0]		GL20_4LC_PID 4LC CH0 KpCool	~~%QW8~~	UINT	50
Application.POU_PID.Ti_cool[0]		GL20_4LC_PID 4LC CH0 TiCool	~~%QW9~~	UINT	200
Application.POU_PID.Td_cool[0]		GL20_4LC_PID 4LC CH0 TdCool	~~%QW10~~	UINT	40
Application.POU_PID.CoolCoefficient[0]		GL20_4LC_PID 4LC CH0 CoolCoefficient	~~%QW11~~	UINT	10
Application.POU_PID.ATCoefficient[0]		GL20_4LC_PID 4LC CH0 ATCoefficient	~~%QB24~~	USINT	50
Application.POU_PID.TempCommand[0]		GL20_4LC_PID 4LC CH0 TempCommand	~~%QB25~~	USINT	1
		Bit0	~~%QX25.0~~	BOOL	TRUE
		Bit1	~~%QX25.1~~	BOOL	FALSE

Note

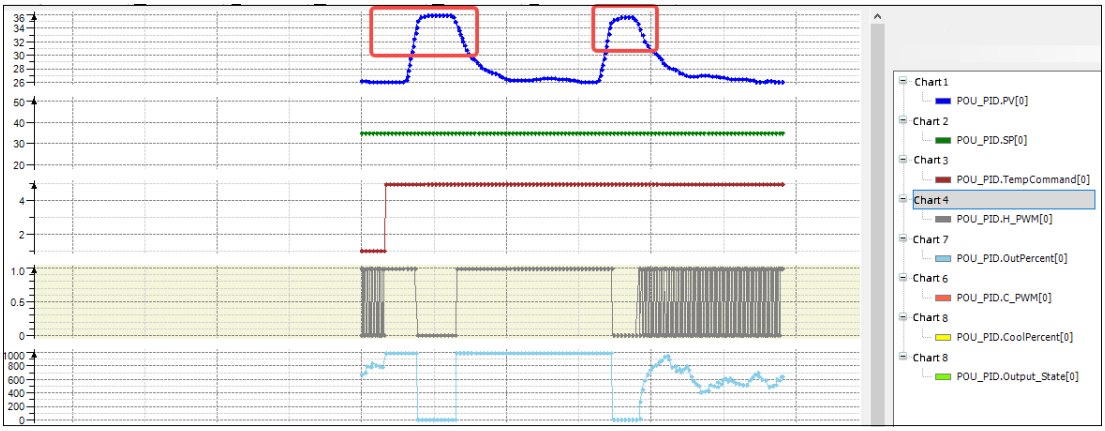
For details on the heating and cooling functions, see *"5.4 PID Control Function" on page 29*. For detailed heating and cooling parameter settings, see *"8.2 Appendix 2: Object Dictionary Definition" on page 47*.

8. Set the auto-tuning PID parameter "TempCommand".

a. Set the target temperature to 35°C and set Bit 0 of parameter "TempCommand" to TRUE to enable the PID function.

		Device control	%QW0	UINT	0
Application.POU_PID.SP[0]		GL20_4LC_PID 4LC CH0 Set Point	~~%QD1~~	REAL	35
Application.POU_PID.ManualValue[0]		GL20_4LC_PID 4LC CH0 ManualValue	~~%QW4~~	INT	0
Application.POU_PID.kp[0]		GL20_4LC_PID 4LC CH0 Kp	~~%QW5~~	UINT	500
Application.POU_PID.Ti[0]		GL20_4LC_PID 4LC CH0 Ti	~~%QW6~~	UINT	2000
Application.POU_PID.Td[0]		GL20_4LC_PID 4LC CH0 Td	~~%QW7~~	UINT	400
Application.POU_PID.kp_cool[0]		GL20_4LC_PID 4LC CH0 KpCool	~~%QW8~~	UINT	50
Application.POU_PID.Ti_cool[0]		GL20_4LC_PID 4LC CH0 TiCool	~~%QW9~~	UINT	200
Application.POU_PID.Td_cool[0]		GL20_4LC_PID 4LC CH0 TdCool	~~%QW10~~	UINT	40
Application.POU_PID.CoolCoefficient[0]		GL20_4LC_PID 4LC CH0 CoolCoefficient	~~%QW11~~	UINT	10
Application.POU_PID.ATCoefficient[0]		GL20_4LC_PID 4LC CH0 ATCoefficient	~~%QB24~~	USINT	50
Application.POU_PID.TempCommand[0]		GL20_4LC_PID 4LC CH0 TempCommand	~~%QB25~~	USINT	5
		Bit0	~~%QX25.0~~	BOOL	TRUE
		Bit1	~~%QX25.1~~	BOOL	FALSE
		Bit2	~~%QX25.2~~	BOOL	TRUE
		Bit3	~~%QX25.3~~	BOOL	FALSE

b. Enable the auto-tuning function. By default, there are 2 auto-tuning waveforms, as shown below.



c. Customize the settings as needed, write the auto-tuned parameters to the RPDO parameters and save them, as shown below.

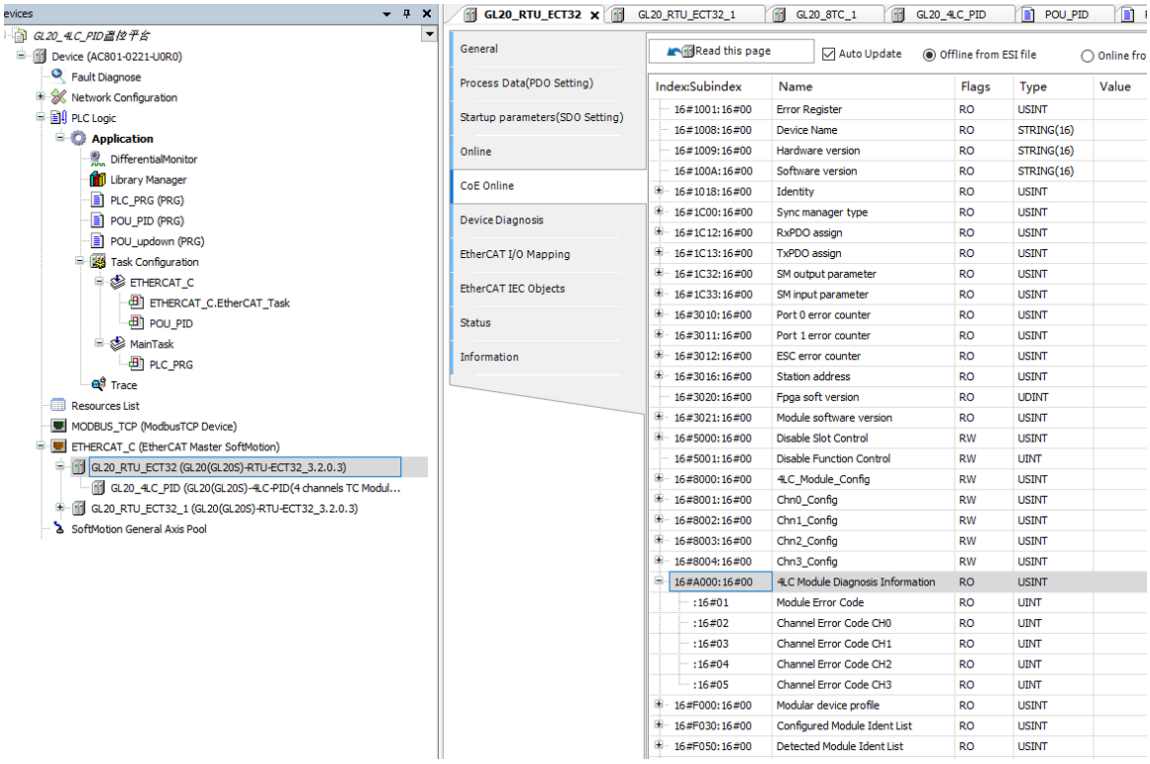
		Fault ID	%IW1	UINT	0
		ErrorSolt1	%ID1	UDINT	0
		ErrorSolt2	%ID2	UDINT	0
Application.POU_PID.PV[0]		GL20_4LC_PID CH0 Temperature	~~%ID3~~	REAL	26.9
Application.POU_PID.OutPercent[0]		GL20_4LC_PID CH0 OutPercent	~~%IW8~~	INT	574
Application.POU_PID.CoolPercent[0]		GL20_4LC_PID CH0 CoolPercent	~~%IW9~~	INT	0
Application.POU_PID.Kp_AT[0]		GL20_4LC_PID CH0 Kp_AT	~~%IW10~~	UINT	1000
Application.POU_PID.Ti_AT[0]		GL20_4LC_PID CH0 Ti_AT	~~%IW11~~	UINT	390
Application.POU_PID.Td_AT[0]		GL20_4LC_PID CH0 Td_AT	~~%IW12~~	UINT	78
Application.POU_PID.KpCool_AT[0]		GL20_4LC_PID CH0 KpCool_AT	~~%IW13~~	UINT	38
Application.POU_PID.TiCool_AT[0]		GL20_4LC_PID CH0 TiCool_AT	~~%IW14~~	UINT	3120
Application.POU_PID.TdCool_AT[0]		GL20_4LC_PID CH0 TdCool_AT	~~%IW15~~	UINT	312
Application.POU_PID.CoolCoefficient_AT[0]		GL20_4LC_PID CH0 CoolCoefficient_AT	~~%IW16~~	UINT	3
Application.POU_PID.Run_State[0]		GL20_4LC_PID CH0 Run State	~~%IB34~~	USINT	2
Application.POU_PID.ErrorID[0]		GL20_4LC_PID CH0 ErrorID	~~%IB35~~	USINT	0
Application.POU_PID.Output_State[0]		GL20_4LC_PID CH0 Output State	~~%IB36~~	USINT	17
Application.POU_PID.H_PWM[0]		Bit0	~~%IX36.0~~	BOOL	TRUE
Application.POU_PID.C_PWM[0]		Bit1	~~%IX36.1~~	BOOL	FALSE
		Bit2	~~%IX36.2~~	BOOL	FALSE
		Bit3	~~%IX36.3~~	BOOL	FALSE
		Bit4	~~%IX36.4~~	BOOL	TRUE
		Bit5	~~%IX36.5~~	BOOL	FALSE
		Bit6	~~%IX36.6~~	BOOL	FALSE
		Bit7	~~%IX36.7~~	BOOL	FALSE

Note

For details on the auto-tuning function, see *"5.2 Auto-Tuning Function" on page 24*. For detailed auto-tuning parameter settings, see *"8.2 Appendix 2: Object Dictionary Definition" on page 47*.

7 Troubleshooting

When the ERR indicator is ON, it indicates that the module is faulty. The module reports a fault code, which can be obtained through the diagnostic data object dictionary value in the **CoE Online** interface, as shown below.



For the module in slot n (n = 0 to 31), the object dictionary definition for index 0xA000+0x40*n is shown in the table below.

Index	0xA000+0x40*n: 4LC -PID Diag data				
Subindex	Name	Data Type	Access Type	Mapping	Default Value
0	Subindex 000	USINT	RO	NO	9
1	Module Error Code	UINT	RO	NO	0x0000
2	Channel Error Code CH0	UINT	RO	NO	0x0000
3	Channel Error Code CH1	UINT	RO	NO	0x0000
4	Channel Error Code CH2	UINT	RO	NO	0x0000
5	Channel Error Code CH3	UINT	RO	NO	0x0000

Note

The thermocouple input supports fault detection for the module and channels.

The fault codes of the module are defined as follows:

Fault Code	Description	Solution
0x5003	Module 24 V power supply failure	Check the external power supply wiring and the power supply voltage.

The channel fault codes are defined as follows:

Fault Code	Description	Solution
0x6001	Channel open-circuited	Check the wiring of the sensor.
0x6002	Channel short-circuited	/
0x6003	Channel data exceeds the upper limit.	Check whether the sensors, wiring, or configured limit ranges are appropriate.
0x6004	Channel data exceeds the lower limit.	Check whether the sensors, wiring, or configured limit ranges are appropriate.
0X6005	Overflow	Check whether the selected sensor range is exceeded.
0X6006	Underflow	Check whether the selected sensor range is undershot.
0x6035	DO0 overload	-
0x6036	DO1 overload	-

8 Appendix

8.1 Appendix 1: Accuracy Calculation

Within the operating temperature range, when the temperature change rate is less than 0.3℃/min. The accuracy of this product is shown below.

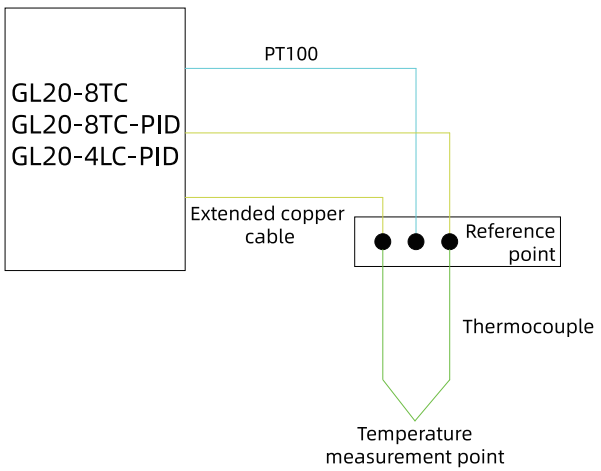
- Internal cold junction measurement accuracy = ADC sampling accuracy + Internal cold junction compensation error (irrelevant to the installation method)
  - It is recommended to install the module horizontally in upright position (refer to *"3.3 Installation Method" on page 15*) and use it adjacent to temperature modules within the operating temperature range. In this case, the cold junction compensation error is within ±3℃.
  - It is not recommended to use the module adjacent to modules that consume more than 3.5 W power, such as the GL20-3232ETN module.

  The following table shows the internal cold junction compensation error.

Installation Direction	Adjacent Module Type	Cold Junction Compensation Error (-20℃ to 0℃)	Cold Junction Compensation Error (0℃ to 55℃)
Horizontal, upright	Temperature module	±3℃	±1.75℃
	Non-temperature module	±6.5℃	±4.5℃
Non-horizontal, upright	Temperature module	±5.5℃	±4℃
	Non-temperature module	±5.5℃	±4.5℃

  The module is equipped with four built-in temperature sensors for internal cold junction compensation.

- External cold junction measurement accuracy = ADC sampling accuracy + External cold junction compensation error (±1℃) + Sensor error (irrelevant to the installation method)
  The external cold junction measurement principle is shown below. The module requires a 45-minute warm-up after power-on before measurement.



The following table shows the thermocouple detection range and ADC sampling accuracy.

Sensor Type	Detection Range	ADC Sampling Accuracy
B	200.0℃ to 1800.0℃, 392.0℉ to 3272.0℉	≥ ±5℃@200℃ ≤ T ≤ 400℃ < ±5℃@400℃ ≤ T ≤ 750℃ < ±3℃@750℃ ≤ T ≤ 1200℃ < ±3.5℃@1200℃ ≤ T ≤ 1800℃
E	-270.0℃ to +1000.0℃, -454.0℉ to +1832.0℉	≥ ±1℃@-270℃ ≤ T ≤ -200℃ < ±1℃@-200℃ ≤ T ≤ 400℃ < ±1.5℃@400℃ ≤ T ≤ 1000℃
N	-200.0℃ to +1300.0℃, -328.0℉ to +2372.0℉	< ±2℃@-200℃ ≤ T ≤ -150℃ < ±1.5℃@-150℃ ≤ T ≤ 750℃ < ±0.2% of displayed value @750℃ ≤ T ≤ 1300℃
J	-210.0℃ to +1200.0℃, -346.0℉ to +2192.0℉	≥ ±1℃@-210℃ ≤ T ≤ -100℃ < ±1℃@-100℃ ≤ T ≤ 500℃ < ±0.2% of displayed value @500℃ ≤ T ≤ 1200℃
K	-270.0℃ to +1370.0℃, -454.0℉ to +2498.0℉	≥ ±1.5℃@-270℃ ≤ T ≤ -200℃ < ±1.5℃@-200℃ ≤ T ≤ -100℃ < ±1℃@-100℃ ≤ T ≤ 500℃ < ±0.2% of displayed value @500℃ ≤ T ≤ 1300℃ ≥ ±2.6℃@1300℃ ≤ T ≤ 1370℃
R	-50.0℃ to +1765.0℃, -58.0℉ to +3209.0℉	≥ ±4℃@-50℃ ≤ T ≤ 0℃ < ±4℃@0℃ ≤ T ≤ 250℃ < ±2℃@250℃ ≤ T ≤ 500℃ < ±3.5℃@500℃ ≤ T ≤ 1700℃ ≥ ±3.5℃@1700℃ ≤ T ≤ 1765℃
S	-50.0℃ to +1765.0℃, -58.0℉ to +3209.0℉	≥ ±4℃@-50℃ ≤ T ≤ 0℃ < ±4℃@0℃ ≤ T ≤ 250℃ < ±2℃@250℃ ≤ T ≤ 500℃ < ±3.5℃@500℃ ≤ T ≤ 1700℃ ≥ ±3.5℃@1700℃ ≤ T ≤ 1768℃
T	-270.0℃ to +400.0℃, -454.0℉ to +752.0℉	≥ ±1℃@-270℃ ≤ T ≤ -200℃ < ±1℃@-200℃ ≤ T ≤ 400℃
C	0℃ to 2300℃, 32℉ to +3276.7℉	≤ ±3℃@0℃ ≤ T < 300℃ ≤ ±4℃@300℃ ≤ T < 700℃ ≤ ±5.75℃@700℃ ≤ T < 2300℃
Pt100	-200.0℃ to +850.0℃ -328.0℉ to +1562.0℉	±1℃@ T < 300℃ ±2℃@ 300℃ ≤ T ≤ 700℃ ±2.5℃@ T > 700℃
Pt500	-200.0℃ to +850.0℃ -328.0℉ to +1562.0℉	±1℃@ T < 300℃ ±2℃@300℃ ≤ T ≤ 700℃ ±2.5℃@ T > 700℃
Pt1000	-200.0℃ to +850.0℃ -328.0℉ to +1562.0℉	±1℃@ T < 300℃ ±2℃@300℃ ≤ T ≤ 700℃ ±2.5℃@ T > 700℃

Sensor Type	Detection Range	ADC Sampling Accuracy
Cu100	-50.0℃ to +150.0℃ -58.0℉ to +302.0℉	±1℃@-50℃ ≤ T ≤ 150℃
KTY84	0.0℃ to 200.0℃ 32.0℉ to 392.0℉	±1.5℃@ 0℃ ≤ T ≤ 200℃

8.2 Appendix 2: Object Dictionary Definition

Introduction

The GL20-4LC-PID module can be used for temperature acquisition from thermal resistors and thermocouple sensors. It is equipped with 4 channels for simultaneous temperature acquisition. The configuration of each channel is independent from each other. The module also supports PID adjustment and can control the heating or cooling of external devices based on the collected temperature.

- Name: GL20-4LC-PID Module
- Module category: Temperature Measure
- Module identification code: 0x10F41052

Input data

For the module in slot n (n = 0 to 62) and channel m (m = 0 to 3), the object dictionary definition for index 0x7000+0x40*n+m is shown in the table below.

There are 28 bytes of input data for a channel.

Index	0x7000+0x40*n+m:				
Subindex	Name	Data Type/Length	Data Type	Access Type	Mapping
0	Subindex 000	4	USINT	RO	NO
1	4LC CHm Set Point	4	REAL	RW	YES
2	4LC CHm Manual Value	2	REAL	RW	YES
3	4LC CHm Kp	2	INT	RW	YES
4	4LC CHm Ti	2	INT	RW	YES
5	4LC CHm Td	2	UINT	RW	YES
6	4LC CHm KpCool	2	USINT	RW	YES
7	4LC CHm TiCool	2	UINT	RW	YES
8	4LC CHm TdCool	2	UINT	RW	YES
9	4LC CHm CoolCoefficient	2	UINT	RW	YES
10	4LC CHm ATCoefficient	1	USINT	RO	YES
11	4LC CHm TempCommand	1	USINT	RO	YES
12	4LC CHm OutputOffset	2	INT	RW	YES
13	4LC CHm OutputOffsetCool	2	INT	RW	YES
14	4LC CHm ECMax	2	UINT(INT)	RW	YES

The parameters for channel configuration are shown in the following table.

Parameter	Description	Value Range	Default Value	Unit
Set Point	Set point value (SP)	Value range	-	0.1℃
ManualValue	Manual output percentage	• Unipolar: 0 to 1000 • Bipolar: -1000 to +1000	0	0.10%
Kp	Proportional coefficient	1 to 10000	500	0.1
Ti	Integral time	0 to 65535	2000	0.1s
Td	Differential time	0 to 65535	400	0.1s
KpCool	Proportional coefficient	1 to 10000	50	0.1
TiCool	Integral time	0 to 65535	200	0.1s
TdCool	Differential time	0 to 65535	40	0.1s
CoolCoefficient	Cooling coefficient	1 to 1000	1	0.1
ATCoefficient	Auto-tuning coefficient	0 to 100	50	0.01
TempCommand	Bit 0: Enable temperature control • 0: Disabled • 1: Enabled Bit 1: Enable manual mode (ManualEnable) • 0: Disabled • 1: Enabled Bit 2: Enable auto-tuning mode (StartAT) • 0: Disabled • 1: Enabled	• 0: Disabled • 1: Enabled	0	
OutputOffset	Compensation value of the output offset Final output = PID output + Output offset compensation	-1000 to +1000	0	0.1%
OutputOffsetCool	Compensation value of the cooling output offset Final output = PID output + Output offset compensation	-1000 to +1000	0	0.1%
ECMax	Maximum heating speed per second	≥ 0	10	0.1

Output data

For the module in slot n (n = 0 to 62) and channel m (m = 0 to 3), the object dictionary definition for index 0x6000+0x40*n+m is shown in the table below.

Index	0x6000+0x40*n+m:				
Subindex	Name	Data Type/Length	Data Type	Access Type	Mapping
0	Subindex 000	4	USINT	RO	NO
1	Temperature	4	REAL	RW	YES
2	OutPercent (HeatPercent)	2	INT	RW	YES
3	CoolPercent	2	INT	RW	YES
4	Kp_AT	2	UINT	RW	YES
5	Ti_AT	2	UINT	RW	YES

Index	0x6000+0x40*n+m:				
Subindex	Name	Data Type/Length	Data Type	Access Type	Mapping
6	Td_AT	2	UINT	RW	YES
7	KpCool_AT	2	UINT	RW	YES
8	TiCool_AT	2	UINT	RW	YES
9	TdCool_AT	2	UINT	RW	YES
10	CoolCoefficient_AT	2	UINT	RO	YES
11	Run State	1	USINT	RO	YES
12	ErrorID	1	USINT	RW	YES
13	Output State	1	USINT	RW	YES
14	Reserved	1	USINT	RW	YES
15	ECMaxOut_AT	2	UINT	RW	YES

The parameters for channel configuration are shown in the following table.

Parameter	Description	Value Range	Default Value	Unit
Temperature	Temperature	-	-	-
OutPercent (HeatPercent)	Output percentage of unipolar control	-1000 to +1000	-	0.1%
CoolPercent	Cooling output percentage of bipolar controls	-1000 to +1000	-	0.1%
Kp_AT	Proportional coefficient in auto-tuning mode	1 to 10000	0	0.1
Ti_AT	Integral time in auto-tuning mode	0 to 65535	0	0.1s
Td_AT	Differential time in auto-tuning mode	0 to 65535	0	0.1s
KpCool_AT	Proportional coefficient in auto-tuning mode	1 to 10000	0	0.1
TiCool_AT	Integral time in auto-tuning mode	0 to 65535	0	0.1s
TdCool_AT	Differential time in auto-tuning mode	0 to 65535	0	0.1s
CoolCoefficient_AT	Cooling coefficient in auto-tuning mode	0 to 1000	10	0.01
Run State	Running state	• 0: Not activated • 1: Manual • 2: Automatic • 3: Reserved • 4: Tuned • 5: Output the last valid value upon a fault • 6: Output the predefined substitute value upon a fault	-	-
ErrorID	Fault code For details, see *"8.3 Appendix 3: PID Fault Code" on page 55*	-	-	-

Parameter	Description	Value Range	Default Value	Unit
Output State (of temperature control)	• Bit 0: HeatPWM (unipolar mode output) • Bit 1: Cooling PWM output (CoolPWM), only applicable in bipolar control modes 2, 3, and 6 • Bit 2: Enable auto-tuning mode (StartAT) • Bit 3: Auto-tuning state ATState • Bit 4: Auto-tuning state ATState • Bit 5: Overload of heating output • Bit 6: Overload of cooling output • Bit 7: Reserved Note: This bit is used for output for unipolar heating/ cooling control mode.	For unipolar control mode, Bit 0 • 1: ON • 0: OFF For bipolar control mode, Bit 0: Heating output • 1: Heating • 0: No heating Bit 1: Cooling output • 1: Cooling • 0: No cooling Bit 2: Enabling • 0: Disabled • 1: Enabled Bit 3 to Bit 4 • 0: Not tuned • 1: Tuning • 2: Tuned	-	-
Reserved	Reserved	-	-	-
ECMaxOut_AT	Maximum heating speed per second in auto-tuning mode	≥ 0	0	0.1℃

Configuration data

For the module in slot n (n = 0 to 31), the object dictionary definition for index 0x8000+0x40*n is shown in the table below.

There are 2 bytes of configuration data of the module.

Index	0x8000+0x40*n: SampleTime/Unit/Float/CoolJunction					
Subindex	Name	Data Type/ Length	Data Type	Access Type	Mapping	Default Value
0	Subindex 000	-	USINT	RO	NO	1
1	4LC SampleTime/ Unit/Float/ CoolJunction	2	USINT	RW	NO	162

The parameters for channel configuration are shown in the following table.

Parameter	Description	Value Range	Default Value	Unit
SampleTime/Unit/ Float/CoolJunction	Sampling cycle + Temperature unit + Decimal place + Cold junction compensation	Bit 0 to Bit 2: Sampling cycle • 0: 50ms • 1: 250ms • 2: 500ms • 3: 1000ms Bit 3 to Bit 4: Temperature unit • 0: Celsius degree • 1: Fahrenheit degree Bit 5 to Bit 6: Decimal places • 1: One decimal place • 2: Two decimal places • 3: Three decimal places Bit 7: Cold junction compensation of thermocouple • 0: External cold junction compensation • 1: Internal cold junction compensation	162	-

For the module in slot n (n = 0 to 62), the object dictionary definition for index 0x8001+0x40*n is shown in the table below.

There are 44 bytes of SDO configuration data.

Subindex	Name	Data Type/ Length	Data Type	Access Type	Mapping
0	Subindex 000	1	UINT	RO	NO
1	4LC CHm SampleMode +SenserType+ ChannelEnable	1	USINT	RW	NO
2	4LC CHm Filter	1	USINT	RW	NO
3	4LC CHm Detect	2	USINT	RW	NO
4	4LC CHm Reserved1	2	USINT	RW	NO
5	4LC CHm Bias	2	INT	RW	NO
6	4LC CHm UpLimit	2	INT	RW	NO
7	4LC CHm DownLimit	2	INT	RW	NO
8	4LC CHm CycleTime	2	UINT	RW	NO
9	4LC CHm DelayStartUp	2	UINT	RW	NO
10	4LC CHm DelayShutDown	2	UINT	RW	NO
11	4LC CHm ErrorOut	2	INT	RW	NO
12	4LC CHm CycleTimeCool	2	UINT	RW	NO
13	4LC CHm CoolOffset	2	INT	RW	NO
14	4LC CHm ATOut	2	UINT	RW	NO
15	4LC CHm ATNum	1	USINT	RW	NO
16	4LC CHm ControlMode +ErrorAction+OutType +OutTypeCool	1	USINT	RW	NO
17	4LC CHm IntegralCut	1	USINT	RW	NO
18	4LC CHm Reserved2	1	USINT	RW	NO
19	4LC CHm MinPT	2	UINT	RW	NO

Subindex	Name	Data Type/ Length	Data Type	Access Type	Mapping
20	4LC CHm OutMax	2	INT	RW	NO
21	4LC CHm OutMin	2	INT	RW	NO
22	4LC CHm MinPTCool	2	UINT	RW	NO
23	4LC CHm OutMaxCool	2	INT	RW	NO
24	4LC CHm OutMinCool	2	INT	RW	NO
25	4LC CHm DeadBand	2	INT	RW	NO
26	4LC CHm KdGain	1	USINT	RW	NO
27	4LC CHm OtherParameter	1	USINT	RW	NO

The parameters for channel configuration are shown in the following table.

Parameter	Description	Value Range	Default Value	Unit
SampleMode + SenserType + ChannelEnable	Sampling mode + Sensor type + Channel enabling	Bit 0 to Bit 1: Sampling mode Three-wire mode (default) • 0: Thermal resistor in two-wire mode • 1: Thermal resistor in three-wire mode • 2: Thermal resistor in four-wire mode • 3: Thermocouple Three-wire mode (default) Bit 2 to Bit 6: Sensor type Thermal resistor: The default is PT100. • 0: PT100 • 1: PT500 • 2: PT1000 • 3: Cu100 • 4: KTY84 • 5: Resistance value (1 kΩ to 4 kΩ) Thermocouple: The default is K type. • 0: K • 1: J • 2: E • 3: B • 4: N • 5: R • 6: S • 7: T • 8: C • 9: ±100 mV Bit 7: Channel enabling • 0: Disabled • 1: Enabled	129	-
Filter	Channel filter parameter	0s to 16s, with the default of 5s	5	-

Parameter	Description	Value Range	Default Value	Unit
Detect	Temperature detection and diagnostic parameters	Bit 0: Temperature offset • 0: Disabled • 1: Enabled (normal) Bit 1: Wire disconnection detection • 0: Disabled • 1: Enabled Bit 2: Overlimit detection • 0: Disabled • 1: Enabled Bit 3: Overflow/underflow detection • 0: Disabled • 1: Enabled Bit 4: Action upon a fault • 0: Keep the current value • 1: Output the predefined value Bit 5 to Bit 6: Reserved Bit 7: Flag bit for tooling test, which is set to 0	0	-
Reserved1	Reserved	-	0	-
Bias	Channel temperature offset parameter	-204.8 to +204.7, with the default of 0	0	-
UpLimit	Upper limit of channel temperature	The range of "UpLimit" equals to the temperature setting range of the current mode, with the default being the maximum value of the temperature setting range in the current mode.	8500	-
DownLimit	Lower limit of channel temperature	The range of "DownLimit" equals to the temperature setting range of the current mode, with the default being the minimum value of the temperature setting range in the current mode.	-2000	-
CycleTime	Output cycle	1 to 65535	1000	ms
DelayStartUp	PID starts after the set delay time, which is used for staggered startup when the device is equipped with multiple temperature control channels.	0 to 65535	0	ms
DelayShutDown	PID is closed after the set delay time.	0 to 65535	0	ms
ErrorOut	Outputs a predefined percentage value in case of an alarm	-1000 to +1000	0	0.10%
CycleTimeCool	Cooling output cycle	1 to 65535	5000	ms
CoolOffset	Cooling offset. Cooling setpoint = SP+ OffsetCool	-1000 to +1000	0	℃
ATOut	Auto-tuning output	0 to 1000	1000	0.10%
ATNum	Number of auto-tuning waveforms	0 to 20	2	-

Parameter	Description	Value Range	Default Value	Unit
ControlMode +ErrorAction +OutType +OutTypeCool	Control mode + Fault action + Output type + Cooling output type	Bit 0 to Bit 1: Control mode • 0: PID negative action (unipolar heating) • 1: PID positive action (unipolar cooling) • 2: PID bipolarity controlled by cooling coefficient • 3: PID bipolarity controlled independently Bit 2: Action upon a fault • 0: Keep the current value • 1: Output the predefined value Bit 3 to Bit 4: Output type • 0: PWM output • 2: Percentage output Bit 5 to Bit 6: Cooling output type • 0: PWM output • 2: Percentage output Bit 7: Reserved	4	-
IntegralCut	Reduces the integral coefficient when the setpoint changes	0 to 100	75	0.01
Reserved2	Reserved	-	-	-
MinPT	Minimum ON/OFF time of PWM	0 to 1000	0	ms
OutMax	Maximum output percentage	-1000 to +1000	1000	0.1%
OutMin	Minimum output percentage	-1000 to +1000	0	0.1%
MinPTCool	Minimum ON/OFF time for cooling PWM	0 to 10000	0	ms
OutMaxCool	Maximum cooling output percentage (applicable to bipolar mode)	-1000 to +1000	1000	0.1%
OutMinCool	Minimum cooling output percentage (applicable to bipolar mode)	-1000 to +1000	0	0.1%
DeadBand	Deviation dead zone limit	0 to 1000	0	0.1℃

Parameter	Description	Value Range	Default Value	Unit
KdGain	Indicates the incomplete derivative coefficient (0.0 to 1.0). The larger the KdGain, the smoother the derivative effect. When KdGain = 1, there is no derivative effect. When KdGain = 0, the incomplete derivation is disabled.	0 to 100	65	0.01
OtherParameter	Other configuration parameters	• Bit 0: Fuzzy adaptation • Bit 1: Integral suspension (IntegralSuspend) • Bit 2: Integral separation control (IntegralDivision) • Bit 3: Integral clear (IntegralClear) • Bit 4 to Bit 7: Reserved	0	-

8.3 Appendix 3: PID Fault Code

Group	No.	Fault Code	Description
No fault	0	NO_ERROR :=0	No fault
Input interface parameters	1	KP_ERROR	Kp configuration fault
	4	KPCOOL_ERROR	Cooling Kp configuration fault
	7	COOL_COEFFICIENT_ERROR	Cooling coefficient configuration fault
	9	CYCLE_TIME_ERROR	General configuration fault of the output cycle
	12	MANUAL_VALUE_ERROR	General configuration fault of the manual output value
	13	ATCOEFFICIENT_ERROR	General configuration fault of the auto-tuning coefficient
Heating output configuration	25	OUT_TYPE_ERROR	Configuration fault of the heating output type
	26	OUT_MIN_ERROR	Configuration fault of the minimum heating output percentage
	27	OUT_MAX_ERROR	Configuration fault of the maximum heating output percentage
	28	AO_MIN_ERROR	Configuration fault of the minimum heating analog output
	29	AO_MAX_ERROR	Configuration fault of the maximum heating analog output
	30	OUTPUT_OFFSET_ERROR	Configuration fault of the heating output compensation value

Group	No.	Fault Code	Description
Cooling output configuration	31	COOL_OUT_TYPE_ERROR	Configuration fault of the cooling output type
	32	COOL_OUT_MIN_ERROR	Configuration fault of the minimum cooling output percentage
	33	COOL_OUT_MAX_ERROR	Configuration fault of the maximum cooling output percentage
	36	COOL_OUTPUT_OFFSET_ ERROR	Configuration fault of the cooling output compensation value
Advanced configuration	37	ECMAX_ERROR	Advanced configuration fault of the maximum heating speed
	38	KD_GAIN_ERROR	Advanced configuration fault of the incomplete derivative coefficient
	39	INTEGRAL_MAX_ERROR	Advanced configuration fault of the maximum integral value
	40	INTEGRAL_CUT_ERROR	The integral coefficient is reduced when the setpoint changes
Cooling configuration	41	COOL_PID_TYPE_ERROR	Configuration fault of the cooling PID type
	42	SAMPLE_COOL_TIME_ERROR	Configuration fault of the cooling sampling cycle
	43	CYCLE_COOL_TIME_ERROR	Configuration fault of the cooling output cycle
	44	COOL_OFFSET_ERROR	Configuration fault of the cooling set deviation
	45	PV_LOW_LIMIT_ERROR	The PV target temperature is lower than the lower limit alarm. This fault is only related to the configured lower limit.
	46	PV_HIGH_LIMIT_ERROR	The PV target temperature is higher than the upper limit alarm. This fault is only related to the configured upper limit.
Advanced configuration fault	50	DEADBAND_ERROR	The control dead zone is incorrectly configured.
Cooling output configuration fault	51	COOL_MINPT_ERROR	The minimum ON/OFF time for cooling is incorrectly configured.
Output configuration fault	52	OUT_MINPT_ERROR	The minimum ON/OFF time is incorrectly configured.
General configuration fault	57	AT_NUM_ERROR	The number of auto-tuning waveforms exceeds the range of 0 to 20.
	58	AT_OUT_ERROR	The auto-tuning output percentage exceeds the range
Temperature fault	59	TEMP_ERROR	Temperature fault

8.4 Appendix 4: Version Matching Information

The version matching information is shown in the following table.

Product Name	Firmware Version	Device Description File (.xml)	InoProShop Version
This module	Board software: 1.2.3.0 and later Logic software: 4.0.0.0 and later	-	V1.9.1 and later
GL20-RTU-ECT32 series communication interface module	Board software: 3.1.16.0 and later Logic software: 0.1.4.5 and later	3.2.0.3 and later	

Note

You can get the firmware of the module and the firmware of communication interface module from Inovance technical support, and download XML files and InoProShop from *https://www.inovance.com*.

Service and Support

Should you encounter a safety accident during the use or operation of the product, or face challenges in operating and maintaining the equipment, which remain unresolved after the relevant documentation is consulted, we provide multiple channels to ensure prompt resolution:

- Channel #1: Contact service@inovance.com.
- Channel #2: Visit https://www.inovance.com/global to access document downloads, after-sales support, spare parts ordering, repair applications, and authenticity verification services.
- Channel #3: Download My Inovance app (https://zshc-eu.inovance.com/download-pc/) where you can access products info and documentation, and query product parameters.

We are committed to providing you with quick and professional technical support, and we look forward to your satisfaction and trust.

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