



User Guide

GR10-8TCE



19011146A02

Temperature Detection Module

1. Overview

Thank you for purchasing the GR10-8TCE temperature detection module developed and manufactured independently by Inovance. The product, which supports EtherCAT communication and various types of thermocouple temperature acquisition with resolution up to 24 bits, can be used with the main module of AM600 series medium-sized PLCs.

This guide describes the specifications, characteristics and using methods of the product. Please read this guide carefully before using to ensure safe usage. Visit our website (www.inovance.com) for the latest version of the guide.

2. Safety Information and Precautions

Safety Precautions

- Before installing, using, and maintaining this product, read the safety information and precautions thoroughly, and comply with them during operations.
- To ensure the safety of humans and products, follow the signs on the product and all the safety instructions in this user guide.
- The "CAUTION," "WARNING," and "DANGER" signs are only supplements to the safety instructions.
- Use this product according to the designated environment requirements. Damage caused by improper usage is not covered by warranty.
- Inovance shall take no responsibility for any personal injuries or property damage caused by improper usage.

Safety Levels and Definitions

- **WARNING** Indicates that failure to comply with the notice may result in severe personal injuries or even death.
- **CAUTION** indicates that failure to comply with the notice may result in minor or moderate personal injury or damage to the equipment.

Please keep this guide well so that it can be read when necessary and forward this guide to the end user.

During control system design

**WARNING**

- Provide a safety circuit outside the PLC so that the control system can still work safely once external power failure or PLC fault occurs.
- Add a fuse or circuit breaker because the module may smoke or catch fire due to long-time overcurrent caused by operation above rated current or load short-circuit.

During control system design

**CAUTION**

- locked circuit, and a upper position limit and lower position limit interlocked circuit must be set in the external circuits of PLC to prevent damage to the machine.
- To ensure safe operation, for the output signals that may cause critical accidents, please design external protection circuit and safety mechanism;
- Once PLC CPU detects abnormality 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 PLC's 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 indoor electrical environment (overvoltage category II). The power supply must have a system-level lightning protection device, assuring that overvoltage due to lightning shock can't be applied to the PLC's power supply input terminals, signal input terminals and output terminals and so forth, so as to avoid damage to the equipment.

During installation

**WARNING**

- Installation must be carried out by the specialists who have received the necessary electrical training and understood enough electrical knowledge.
- Disconnect all external power supplies of the system before removing/ installing the module. Failure to do so may result in electric shock, module fault or malfunction.
- Do not use the PLC where there are dust, oil smoke, conductive dust, corrosive or combustible gases, or exposed to high temperature, condensation, wind & rain, or subject to vibration and impact. 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 personnel who have received the necessary electrical training and understood enough electrical knowledge 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 foreign matters on ventilation surface. Failure to comply may result in poor ventilation, which may cause fire, fault and 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.

During wiring

**WARNING**

- Wiring must be carried out by personnel who have received the necessary electrical training and understood enough electrical knowledge.
- Disconnect all external power supplies of the system before wiring. Failure to comply may result in electric shock, module fault or malfunction.
- Install the terminal cover attached to the product before power-on or operation after wiring is completed. Failure to comply may result in electric shock
- Perform good insulation on terminals so that insulation distance between cables will not reduce after cables are connected to terminals. Failure to comply may result in electric shock or damage to the equipment.

**CAUTION**

- Prevent dropping metal filings and wire ends drop into ventilation holes of the PLC at wiring. Failure to comply may result in fire, fault and malfunction.
- The external wiring specification and installation method must comply with local regulations. For details, see the wiring section in this guide.
- To ensure safety of equipment and operator, use cables with sufficient diameter and connect the cables to ground reliably.
- Ensure that all cables are connected to the correct interface. Failure to comply may result in module and external equipment fault.
- Tighten bolts on the terminal block in the specified torque range. If the terminal is not tight, short-circuit, fire or malfunction may be caused. If the terminal is too tight, fall-off, short-circuit, fire or malfunction may be caused.
- If the connector is used to connect with external equipment, perform correct crimping or welding with the tool specified by manufacturer. If connection is in poor contact, short-circuit, fire or malfunction may be caused.
- A label on the top of the module is to prevent foreign matters entering the module. Do not remove the label during wiring. Remember to remove it before system operation, facilitating ventilation.
- Do not bundle control wires, communication wires and power cables together. They must be run with distance of more than 100 mm. Otherwise, noise may result in malfunction.
- Select shielded cable for high-frequency signal input/output in applications with serious interference so as to enhance system anti-interference ability.

During maintenance & inspection

**WARNING**

- Maintenance & inspection must be carried out by personnel who have the necessary electrical training and experience.
- 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 screws of the connector. Failure to comply may result in electric shock.
- Disconnect all external power supplies of the system before removing the module or connecting/removing the communication wirings. Failure to comply may result in electric shock or malfunction.

**CAUTION**

- Get with the guide and ensure safety before online modification, forcible output, and RUN/STOP operation.
- Disconnect the power supply before installing/removing the extension card.

At disposal

**CAUTION**

- Treat scrapped module as industrial waste. Dispose the battery according to local laws and regulations.

3. Product Information

Model and Nameplate

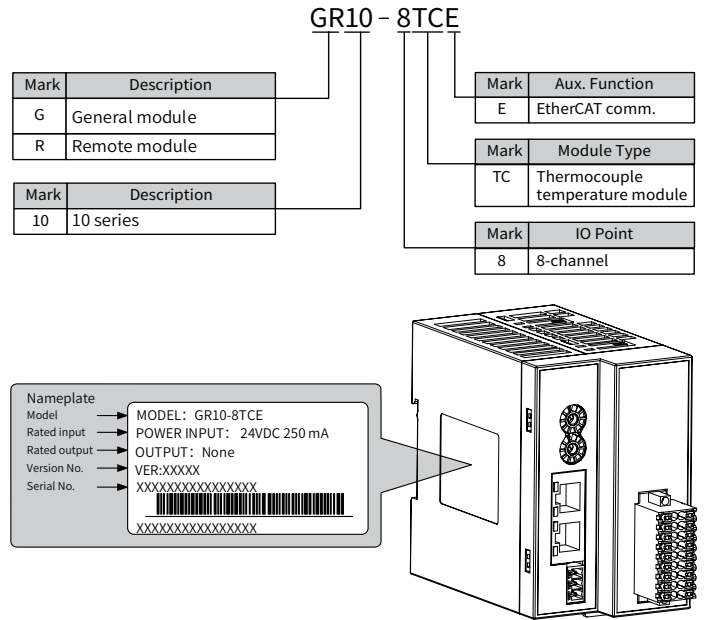
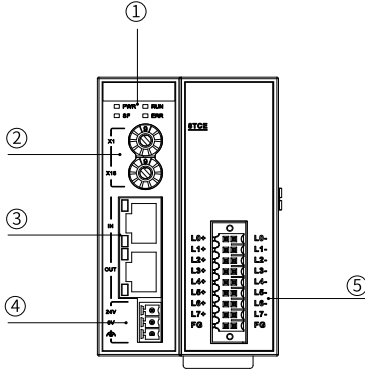


Figure 1 Description of model and nameplate

Model	Classification	Description	Applicable Model
GR10-8TCE	EtherCAT communication temperature detection module	8-channel thermocouple temperature acquisition, supports multiple thermocouple types.	AM600 series

External Interface



No.	Interface Name	Function			
①	Signal indicators	PWR	Power indicator	Green	ON when power supply is switched on.
		RUN	Running status indicator	Green	ON when the module is in normal operation
		SF	Fault indicator	Red	Is ON when the module is faulty
		ERR	State machine error indicator	Red	Is ON when an error occurs in the state machine
②	Address DIP switch	Slave address setting switch: ADDR1/ ADDR0: address DIP switch, address is set in hexadecimal, slave decimal address = ADDR1*16+ADDR0*1 1-255			
③	EtherCAT communication port	X1 IN: EtherCAT input X2 OUT: EtherCAT output for connecting back-end EtherCAT slaves			
④	24 V power input terminal	For module power supply input			
⑤	Terminal	8-channel thermocouple input, see "Electrical Design Reference" for details.			

General Specifications

Item	Specifications
Power supply specifications	24 VDC (20.4 VDC to 28.8 VDC) (–15% to +20%)
Communication protocol	EtherCAT industrial real-time bus protocol
Max. communication speed	100 Mbps
Network port/network cable	Standard network port with Cat 5e network cables, cable length not exceeding 100 meters
Station number range	1 to 255 if set by a DIP switch, or automatically allocated by a network bus

The specific performance indicators are as follows:

Item	Specifications
Communication protocol	EtherCAT protocol
Service supported	CoE (PDO, SDO)
Min. synchronization period of the 6-axis cam	1250 us (TYP)
Synchronization mode	Input and output synchronization or DC-distributed clock
Physical layer	100BASE-TX
Baud rate	100 Mbit/s (100Base-TX)
Duplex mode	Full duplex
Topological structure	Linear topological structure
Transmission medium	Network cables, see "Electrical Design Reference"
Transmission distance	Less than 100 m between two nodes
EtherCAT frame length	44–1,498 bytes
Process data	Max. 1486 bytes per frame
Synchronization jitter of two slave stations	< 1us
Update time	About 30 us for 1,000 digital inputs and outputs About 100 us for 32 servo axes

Environmental Specifications

Item	Specifications				
Ambient temperature	During operation: -5-55°C, during storage: -25-75°C				
Relative humidity	During operation: 5-95%RH (no condensation)				
Vibration	Item	Frequency (Hz)	Acceleration (m/s ²)	Single amplitude (mm)	X, Y and Z 10 times each, for a total of 80 minutes
	Installation with DIN guide rails	10 to 57	--	0.035	
		57 to 150	4.9	--	
	Direct installation	10 to 57	--	--	
		57 to 150	9.8	0.075	
Working Environment	No corrosive and flammable gas and no excessive conductive dust				
Operating height	Below 2000 m				

Input specification

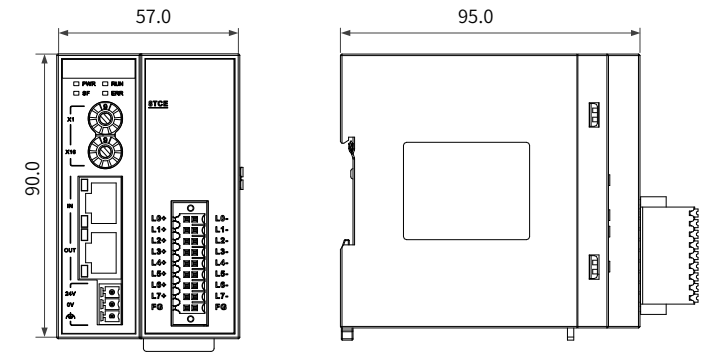
Item	Specifications
Input channels	8
Input connection method	Leaf spring terminal
Sensor type	Thermocouple: B, E, J, K, N, R, S, T
Display mode	Celsius (°C), Fahrenheit (°F)
Wiring method of thermocouple	two-wire
Cold junction compensation method of thermocouple	Internal/external cold junction compensation;
Resolution	24 bits
Sensitivity	0.1°C to 0.1°F
Sampling cycle	250 ms, 500 ms, 1000 ms/8 channels (configurable through software)
filter time	0–100s (configurable through software)
Accuracy (normal temperature: 25°C)	Full scale [Note] (±0.1%) +1°C
Accuracy (ambient temperature: 0–55°C)	Full scale [Note] (±0.3%) +1°C
Diagnosis and protection	Over-limit and disconnection diagnosis.
Isolation mode	I/O terminals isolated from power supply; Channels are isolated with each other.
Program upgrade	Firmware upgrade through EOE and FOE-based EtherCAT communication

Thermocouple Detection Range and Accuracy

Item	Sensor	Detection Range (°C)	Detection Range (°F)	Accuracy
Thermocouple Type	B	250°C to 1800°C	482°F to 3272°F	±3.5°C @ T < 300°C
				±2°C@T = 300°C–800°C
				±3.5°C@ T > 800°C
	E	-270°C to 1000°C	-454°F to 1832°F	±2.5°C @ T < -200°C
				±1°C@ T = -200°C–500°C
				0.2%displayed value@ T > 500°C
	N	-200°C to 1300°C	-328°F to 2372°F	±1°C@ T = -200°C–500°C
				0.2%disp@ T > 500°C
				±2.5°C @ T < -100°C
	J	-210°C to 1200°C	-346°F to 2192°F	±1°C@ T = -100°C–500°C
				0.2%disp@ T > 500°C
				±3.5°C @ T < -200°C
Thermocouple Type	K	-270°C to 1372°C	-454°F to 2502°F	±1°C@ T = -200°C–500°C
				0.2%displayed value@T > 500°C
				±2.5°C @ T < 0°C
	R	-50°C to 1768°C	-58°F to 3214°F	±1°C@ T = -200°C–500°C
				0.2%disp@ T > 500°C
				±2.5°C @ T < 0°C
	S	-50°C to 1768°C	-58°F to 3214°F	±1°C@ T = -200°C–500°C
				0.2%disp@ T > 500°C
				±2°C @ T < -200°C
	T	-270°C to 400°C	-454°F to 752°F	±2°C @ T < -200°C
				±1°C@ T = -200°C–400°C

4. Mechanical Design Reference

Installation Dimensions (unit: mm)



5. Electrical Design Reference

Selection Guidelines of Communication Cables

Specification	Supplier
0.2 m–10 m	Inovance
More than 10 m	Haituo

Basic information about EtherCAT communication cables of Inovance

Cable models are as follows:

Mark	Series	S6-L-T04-3.0
S6	S6 series	
Mark	Significance	
L	Line	
Mark	Significance	
T	Comm. cable	

Cable length (unit: m)			
Mark	Length	Mark	Length
0.2	0.2m	2.0	2.0m
0.3	0.3m	3.0	3.0m
0.5	0.5m	5.0	5.0m
1.0	1.0m	10.0	10.0m

Mark	Significance
04	EtherCAT multi-comm. cable

Cable Ordering information

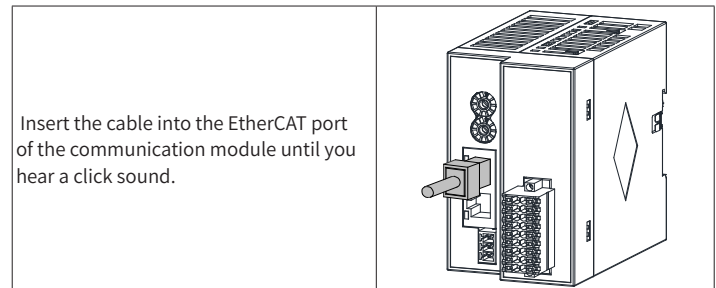
Material Code	Model	Length (m)
15040261	S6-L-T04-0.3	0.3
15040262	S6-L-T04-3.0	3.0
15041960	S6-L-T04-0.2	0.2
15041961	S6-L-T04-0.5	0.5
15041962	S6-L-T04-1.0	1.0
15041963	S6-L-T04-2.0	2.0
15041964	S6-L-T04-5.0	5.0
15041965	S6-L-T04-10.0	10.0

Features

Item	Detailed Description
UL certification	Comply with UL certification
CAT.5E cable	CAT.5E cable
Double shield	Braided shield (coverage 85%), aluminum foil shield (coverage 100%)

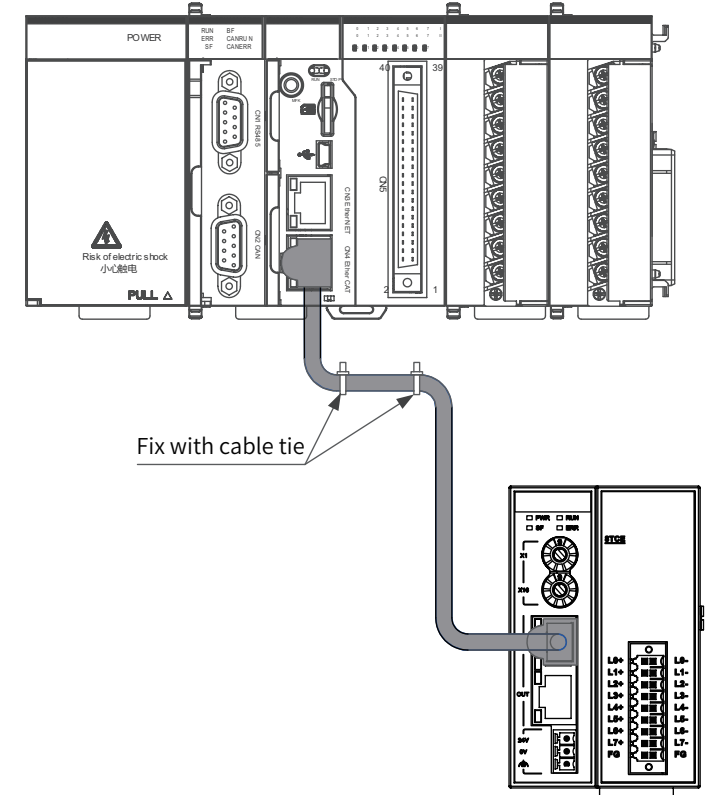
Communication Wiring

1) EtherCAT connection



2) Requirements for securing communication cable

To avoid the influence on the communication cable due to other stresses and ensure the stability of communication, secure the cable near the equipment before EtherCAT communication, as shown in the following figure:



3) Fault Indication and troubleshooting for EtherCAT remote communication expansion module

EtherCAT slave station:

LED indicator	Meaning	Solution
RUN	OFF	Check configuration and parameter assignment; Check the communication address Check that the length and other specifications of the network cable are as specified.
	Blinking	EtherCAT slave is in a state other than OP Check the slave configuration to for any missing, faulty or unconfigured module.
ERR	Blinking	No data exchange between EtherCAT master and slave Check that the cable connector is inserted correctly; Check that the network cable is intact; Re-power on.
SF	Steady ON	Input channel is faulty Check if an overtemperature fault has occurred in the input channel.

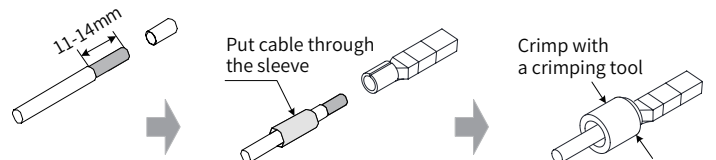
Cable Selection

Cable Name	Model	Applicable Cable Diameter		Manufacturer Name	Crimping Tool
		Chinese Standard/MM	AWG		
Tubular lug	GTVE07512	0.75	21	Suzhou Yuanli	YAC-5

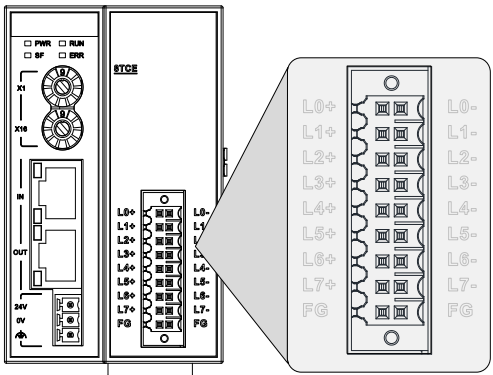
Cable preparing procedures:

Remove the insulation of the cable so that a length of 11–14 mm of the conductor is exposed, and put the cable through a cable marking sleeve.

Insert the exposed end into the hole of the cable lug, and then crimp it with recommended crimping tool.



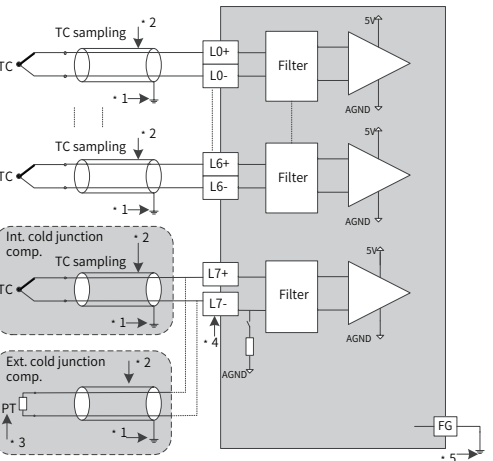
Terminal Layout



Terminal Definition

SN	Network Name	Type	Function	Remarks
1	L0+	Input	Channel 0 thermocouple	The L7 sampling channel is used for compatibility with both normal thermocouple sampling and external cold junction compensation. If the cold junction of the thermocouple is distant from the module and temperature difference is large, and high temperature accuracy is required, the channel can be used for external cold junction compensation and connected to Pt100 thermal resistance compensation. In this case, only CH0-CH6 of the module are used for TC sampling.
2	L0-	Input	Channel 0 thermocouple	
3	L1+	Input	Channel 1 thermocouple	
4	L1-	Input	Channel 1 thermocouple	
5	L2+	Input	Channel 2 thermocouple	
6	L2-	Input	Channel 2 thermocouple	
7	L3+	Input	Channel 3 thermocouple	
8	L3-	Input	Channel 3 thermocouple	
9	L4+	Input	Channel 4 thermocouple	
10	L4-	Input	Channel 4 thermocouple	
11	L5+	Input	Channel 5 thermocouple	
12	L5-	Input	Channel 5 thermocouple	
13	L6+	Input	Channel 6 thermocouple	
14	L6-	Input	Channel 6 thermocouple	
15	L7+	Input	Channel 7 thermocouple/ external cold junction compensation	High-precision mode for external cold junction compensation
16	L7-	Input	Channel 7 thermocouple/ external cold junction compensation	
17	FG	Housing GND	Grounding	--
18	FG	Housing GND	Grounding	--

Wiring Diagram



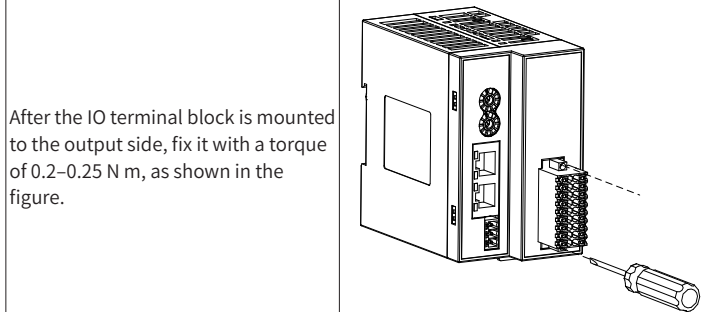
- 1 If the cable is shielded, ensure that it can be well grounded. The cable length should not be more than 10 m.
- 2 If there is a gap between the cold junction compensation and the end of the thermocouple, and a compensation wire is not used, the measured temperature value will be abnormal.

*3 A thermistor can be used for cold junction compensation of channel 7. In this case, the thermistor must be PT100, and the software needs to enable the channel.

*4 When internal cold junction compensation is used for the module, channel L7 can be used for normal thermocouple sampling. The wiring is the same as channels L0–L6 as shown in the figure. When external cold junction compensation is used, a PT100 thermistor needs to be connected to channel L7 as shown in the figure.

*5 The module should be mounted on a well-grounded metal bracket, and ensure that the metal shrapnel at the bottom of the module is in good contact with the bracket.

Wiring precautions



Do not bundle the cable together with AC cable, main lines, high voltage cable and so forth; otherwise, it may result in an increased noise, surge and induction.

Apply single-point grounding for the shielding of shielded cable and solder sealed cable.

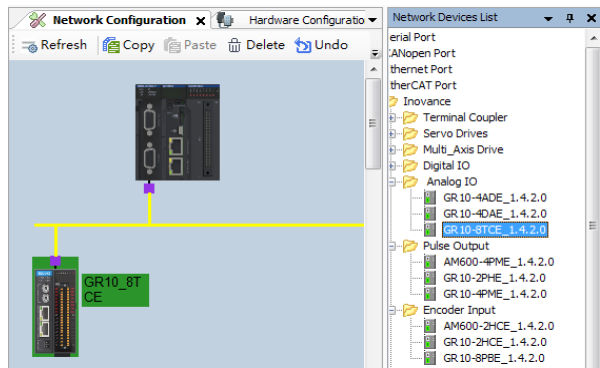
Tubed and solderless crimp terminal cannot be used with terminal block. Using marking sleeve or insulation sleeve to cover the cable connector part of the crimp terminals is recommended.

Do not bundle the terminal connection cables together with power cables (high voltage, large current) which produce strong interference signals. Separate it from other cables and avoid cabling in parallel. Use recommended cables and adapter boards. It is recommended to use shielded cables as terminal cables for increased anti-interference ability.

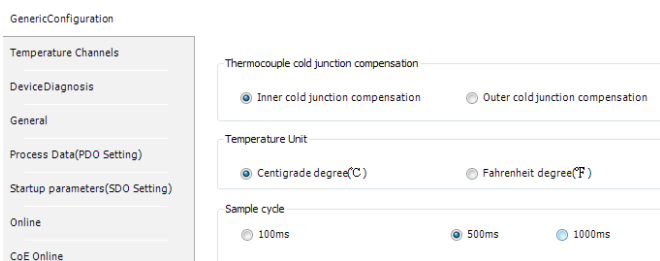
6. Programming Example for GR10-8TCE Module

The following is an example where channel 0 of the GR10-8TCE module is used to sample the K-type thermocouple and the sampled value is assigned to the corresponding variable, and AM600 is used as the main control module:

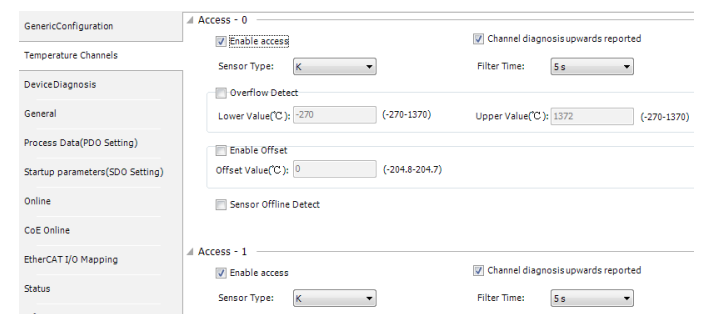
Create a project and perform hardware configuration as follows:



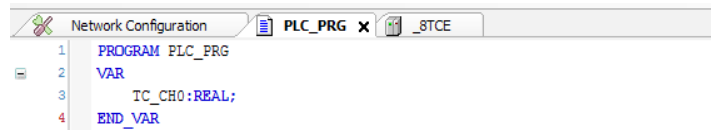
For the 8TCE module, you can select internal or external cold junction compensation in the "General Configuration" Page. When internal cold junction compensation is selected (the default setting), channel 7 performs normal thermocouple sampling; when external cold junction compensation is selected, an external PT100 must be connected to channel 7 for this function, and the other 7 channels can be for normal thermocouple sampling. Functions like diagnosis reporting be configured as needed.



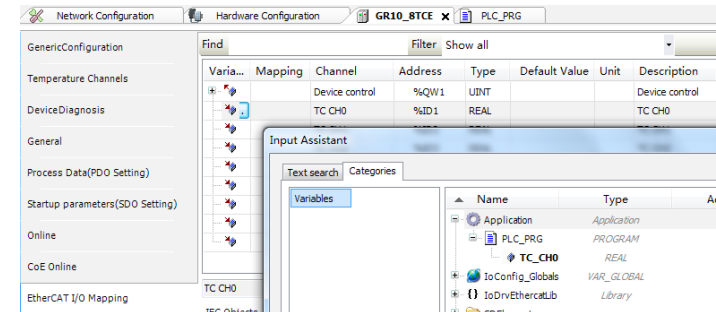
In the "Temperature Channel Configuration" page, enable channel-0 and set the sensor type as K. Other functions can be checked as needed.



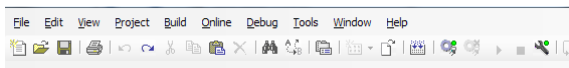
Define a variable TC_CH0 with the ST programming language as shown in the figure below.



Map TC_CH0 to channel 0 of the configured 8TCE module.



After successful compiling, log in and download the project and run it.



INOVANCE Warranty Agreement

- 1) Inovance provides an 18-month free warranty to the equipment itself from the date of manufacturing for the failure or damage under normal use conditions.
- 2) Within the warranty period, maintenance will be charged for the damage caused by the following reasons:
 - a. Improper use or repair/modification without prior permission
 - b. Fire, flood, abnormal voltage, natural disasters and secondary disasters
 - c. Hardware damage caused by dropping or transportation after procurement
 - d. Operations not following the user instructions
 - e. Damage out of the equipment (for example, external device factors)
- 3) The maintenance fee is charged according to the latest Maintenance Price List of Inovance.
- 4) If there is any problem during the service, contact Inovance's agent or Inovance directly.
- 5) Inovance reserves the rights for explanation of this agreement.

Suzhou Inovance Technology Co., Ltd.

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