

AX-EM-4PTC Temperature Module User Manual

Thanks for choosing AX series programmable controller (programmable controller for short).

AX-EM-4PTC temperature module (temperature module for short) is a 24-bit resolution, 4-channel temperature collection module that works with the main module of the programmable controller. Each channel of the temperature module supports various resistance temperature detectors (RTDs) and thermocouples (TCs).

The manual mainly describes the specifications, features, wiring, and use methods of the temperature module of the programmable controller. To ensure that you use the product safely and properly and bring it into full play, read the manual carefully before the installing. For details about the user program development environments and user program design methods, see *AX Series Programmable Controller Hardware User Manual* and *AX Series Programmable Controller Software User Manual* that we issue.

The manual is subject to change without prior notice. Please visit www.invt.com to download the latest manual version.

1 Safety precautions

1.1 Warning signs

Sign	Name	Description	Abbreviation
	Danger	Serious physical injury or even death may occur if related requirements are not followed.	
	Warning	Physical injury or device damage may occur if related requirements are not followed.	

1.2 Delivery and installation

- Only trained and qualified electricians are allowed to install, wire, maintain, and inspect the programmable controller.
- Do not install the programmable controller on inflammables. In addition, prevent the programmable controller from contacting or adhering to inflammables.
- Install the programmable controller in a lockable control cabinet of at least IP20, which prevents the personnel without electrical equipment related knowledge from touching by mistake, since the mistake may result in device damage or electric shock. Only personnel who have received related electrical knowledge and equipment operation training can operate the control cabinet.
- Do not run the programmable controller if it is damaged or incomplete.
- Do not contact the programmable controller with damp objects or body parts. Otherwise, electric shock may result.

1.3 Wiring

- Only trained and qualified electricians are allowed to install, wire, maintain, and inspect the programmable controller.
- Fully understand the interface types, specifications, and related requirements before wiring. Otherwise, incorrect wiring will cause abnormal running.
- Cut off all power supplies connected to the programmable controller before performing wiring.
- Before power-on for running, ensure that the module terminal cover is properly installed in place after the installation and wiring are completed. This prevents the live terminal from being touched. Otherwise, physical injury, device fault or misoperation may result.
- Install proper protection components or devices when using external power supplies for the programmable controller. This prevents the controller from being damaged due to external power supply faults, overvoltage, overcurrent, or other exceptions.

1.4 Commissioning and running

- Before power-on for running, ensure that the working environment of the programmable controller meets the requirements, the wiring is correct, the input power specifications meet the requirements, and a protection circuit has been designed to protect the controller so that the controller can run safely even if an external device fault occurs.
- For modules or terminals requiring external power supply, configure external safety devices such as fuses or circuit breakers to prevent damage caused due to external power supply or device faults.

1.5 Maintenance and component replacement

- Only trained and qualified electricians are allowed to perform maintenance, inspection, and component replacement for the programmable controller.
- Cut off all power supplies connected to the programmable controller before wiring programmable controller terminals.
- During maintenance and component replacement, take measures to prevent conductive materials such as screws and cables from falling into the internal of the programmable controller.

1.6 Disposal

- The programmable controller contains heavy metals. Dispose of a scrap product as industrial waste.
- Dispose of a scrap product separately at an appropriate collection point but not place it in the normal waste stream.

2 Product introduction

2.1 Model and nameplate

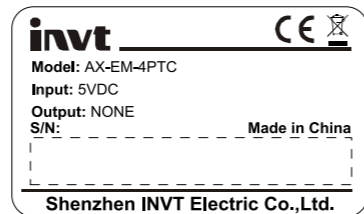


Figure 2.1 Product nameplate

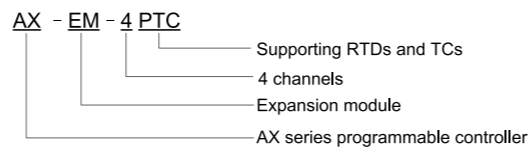


Figure 2.2 Product model

2.2 Function overview

As the expansion module for temperature measuring of the programmable controller, the temperature module supports 4-channel sensor input, and each channel supports RTDs (allowing 2-, 3-, and 4-wire systems) and TCs. When using TCs for measuring, the temperature module supports internal and external cold junction compensation.

2.3 Structural dimensions

The structural dimensions (unit: mm) of the temperature module are shown in the following figure.

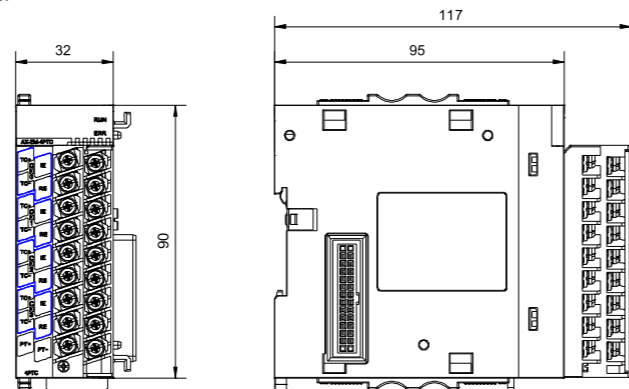


Figure 2.3 Structural dimensions

3 Interfaces

3.1 Interface distribution

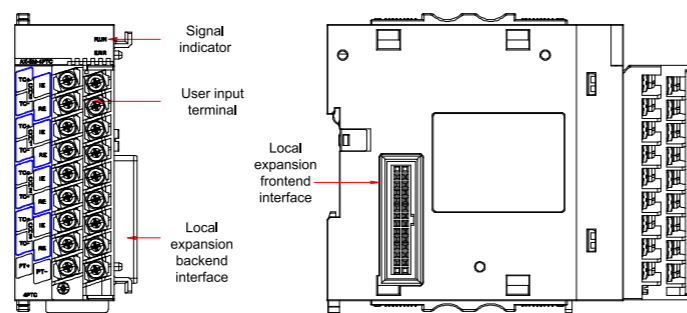


Figure 3.1 Interface distribution

Interface	Function
Signal indicator	RUN: running status indicator. It is on when the running is normal, and it is off when the running is abnormal. ERR: error status indicator. It is on when the running is abnormal, and it is off when the running is normal.
User input terminal	4 inputs
Local expansion backend interface	Connects to backend modules. Disallows hot swapping.
Local expansion frontend interface	Connects to frontend modules. Disallows hot swapping.

3.2 Terminals

Terminal No.	Channel	Terminal symbol	Type	Function
1	CH0	TC+	Input	Input of RTD/TC channel 0
2		IE	Output	Exciting current output of RTD measuring channel 0
3		TC-	Input	Input of RTD/TC channel 0

Terminal No.	Channel	Terminal symbol	Type	Function
4		RE	Input	Exciting current return terminal of RTD measuring channel 0
5	CH1	TC+	Input	Input of RTD/TC channel 1
6		IE	Output	Exciting current output of RTD measuring channel 1
7		TC-	Input	Input of RTD/TC channel 1
8		RE	Input	Exciting current return terminal of RTD measuring channel 1
9	CH2	TC+	Input	Input of RTD/TC channel 2
10		IE	Output	Exciting current output of RTD measuring channel 2
11		TC-	Input	Input of RTD/TC channel 2
12		RE	Input	Exciting current return terminal of RTD measuring channel 2
13	CH3	TC+	Input	Input of RTD/TC channel 3
14		IE	Output	Exciting current output of RTD measuring channel 3
15		TC-	Input	Input of RTD/TC channel 3
16		RE	Input	Exciting current return terminal of RTD measuring channel 3
17	/	PT+	Input	External cold junction compensation terminal
18	/	PT-	Input	External cold junction compensation terminal

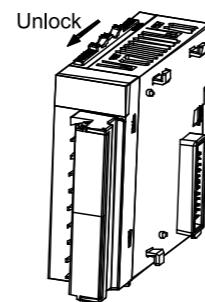
4 Installation and wiring

Using modular design, the programmable controller is easy to install and maintain. As for the temperature module, the main connection objects are the CPU module, EtherCAT module, and expansion modules.

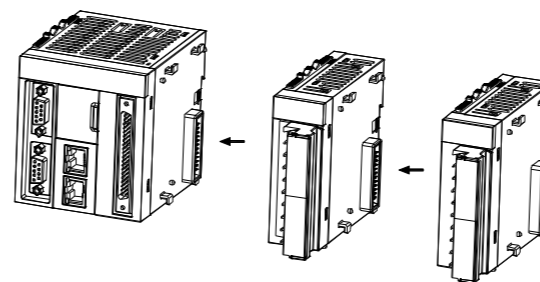
The modules are connected by using the module-provided connection interfaces and snap-fits.

4.1 Installation procedure

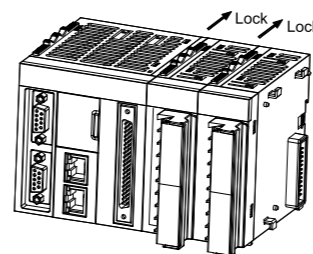
Step 1 Slide the snap-fit on the temperature module in the direction shown in following figure.



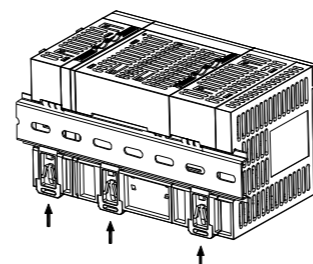
Step 2 Align with the connector on the CPU module for interlocking.



Step 3 Slide the snap-fit in the direction shown in the following figure to connect and lock the two modules.



Step 4 As for standard DIN rail installation, hook the respective module into the standard installation rail until the snap-fit clicks into place.



4.2 Wiring

The user terminal wiring is shown in the following figure.

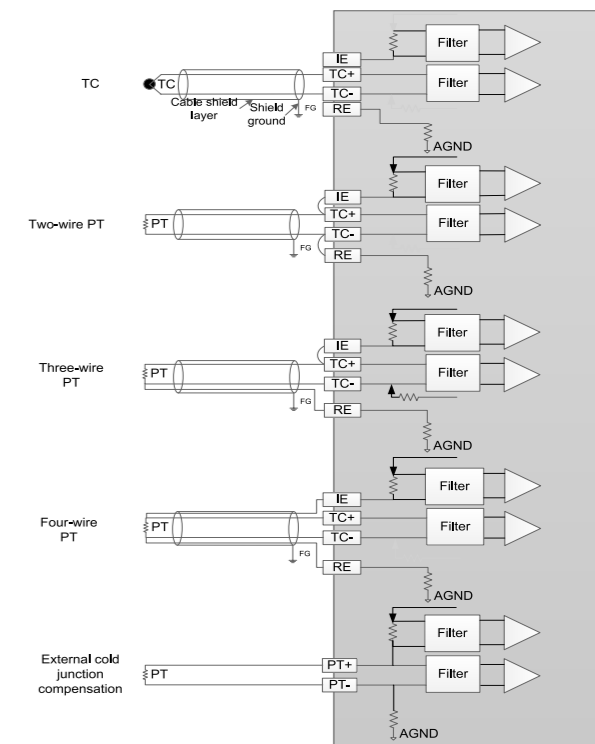


Figure 4.1 Wiring diagram

Note:

- When the PT resistor uses the two-wire system, connect IE to TC+ in short circuit mode and connect TC- to RE also in short circuit mode. In this situation, the cable resistance has an impact on the measuring accuracy.
- When the PT resistor uses the three-wire system, connect IE to TC+ in short circuit mode. In this situation, the cable resistance impact on the measuring accuracy is reduced to the minimum. (You are recommended to use the cable of which the three conductors have the same small resistance. Resistance inconsistency in the three conductors has an impact on the measuring accuracy.)
- When the PT resistor uses the four-wire system, the cable resistance almost has no impact on the measuring accuracy. This is the ideal wiring method.
- If the TC is used as the sensor, when a distance exists between the cold junction compensation and the TC end, the measured temperature is abnormal if no compensation conductor is used.
- If the TC is used as the sensor and internal cold junction compensation is configured, no external cold junction compensation resistor is needed. In this situation, the measuring accuracy may be affected since the module may have thermal accumulation. When multiple modules are connected to form a system, try to place the temperature module at the end of the rail to keep away from the CPU module.
- When the external cold junction compensation resistor is PT1000, shorten the PT resistor lead as much as possible, and place the PT resistor near user terminals.
- The temperature module needs to be installed on a properly-grounded metal bracket, and the metal dome at the module bottom must be in good contact with the bracket.
- Do not bind the sensor cable together with the AC cable, main circuit cable, or high-voltage cable. Otherwise, the binding can increase noise, surge, and induction impact. When using shielded cables, use single-point grounding for the shield layer.

5 Technical parameters

5.1 Power parameters

Parameter	Specifications
Supply voltage	Internal power supply, 5VDC (-10%~10%)
Consumption of internal 5V power supply	150mA (typical value)

5.2 Performance parameters

Table 5.1 Performance parameters

Parameter	Specifications
Input channels	4
Sensor type	RTD types: B, E, J, K, N, R, S, T TC types: PT100, PT500, PT1000, CU100
Display mode	Celsius degree (°C) and Fahrenheit (°F)
Wiring method	TC: Two-wire system RTD: Two-, three-, or four-wire system
TC cold junction compensation method	Internal/external cold junction consumption (software configurable)
Resolution	24 bits

Parameter	Specifications	
Sensitivity	0.1°C, 0.1°F	
Sampling period	250ms/500ms/1000ms/4-channel (software configurable)	
Accuracy (at normal temperature 25°C)	TC: Full range *±0.1%±1°C	RTD: Full range *±0.3%
Accuracy (at ambient temperature 0-50°C)	TC: Full range *±0.3%±1°C	RTD: Full range *±1%
Insulation mode	I/O terminals insulated from the power supply	Channels insulated from each other
System program upgrade method	Using the serial port	

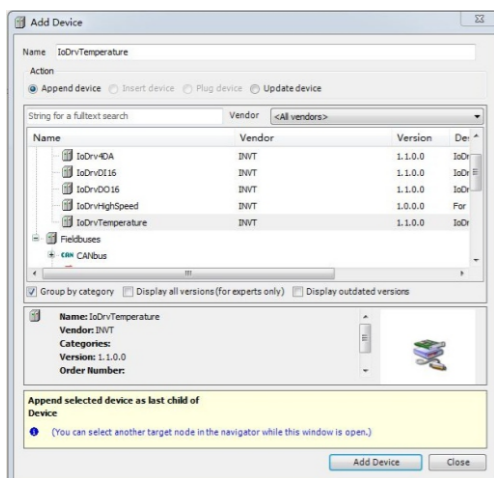
Table 5.2 Sensor types and temperature ranges

Sensor type	Sensor model	Range of measured temperature (°C)	Range of measured temperature (°F)
RTD	PT100	-200.0°C-850°C	-328.0°F-1562.0°F
	PT500	-200.0°C-850°C	-328.0°F-1562.0°F
	PT1000	-200.0°C-850°C	-328.0°F-1562.0°F
	CU100	-50.0°C-150°C	-58.0°F-302.0°F
TC	B	200.0°C-1800°C	392.0°F-3272.0°F
	E	-270.0°C-1000°C	-454.0°F-1832.0°F
	N	-200.0°C-1300°C	-328.0°F-2372.0°F
	J	-210.0°C-1200°C	-346.0°F-2192.0°F
	K	-270.0°C-1370°C	-454.0°F-2498.0°F
	R	-50.0°C-1765°C	-58.0°F-3209.0°F
	S	-50.0°C-1765°C	-58.0°F-3209.0°F
	T	-270.0°C-400°C	-454.0°F-752.0°F

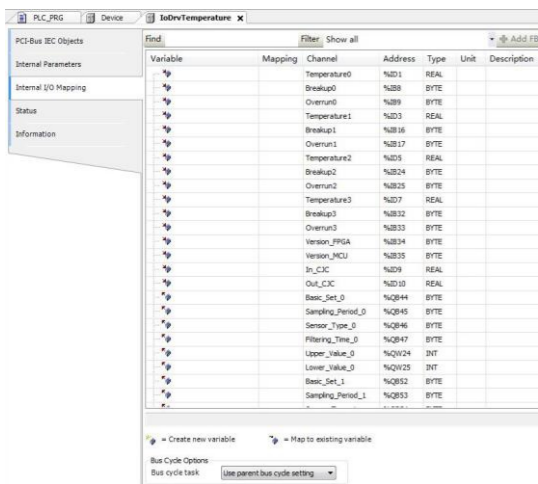
6 Application instance

The following assumes that channel 0 of the temperature module collects samples from the two-wire PT100 RTD and assigns the sampling values to the corresponding variables and AX70-C-1608P is the main module of the programmable controller.

Step 1 Start CODESYS and choose **File > New Project** to create a new project. Right-click **Device** in the left pane, choose **Add Device** in the shortcut menu that appears, and then choose **IoDrvTemperature**. See the following figure.



Step 2 Double-click **IoDrvTemperature**. Set parameters on the **Internal I/O Mapping** interface.



The variables of channel 0 are as follows.

Parameter	Value	Valid bits	Variable
Temperature of channel 0			Temperature0
Disconnection detection result of channel 0	Normal	00	Break_up0
	Disconnected	01	

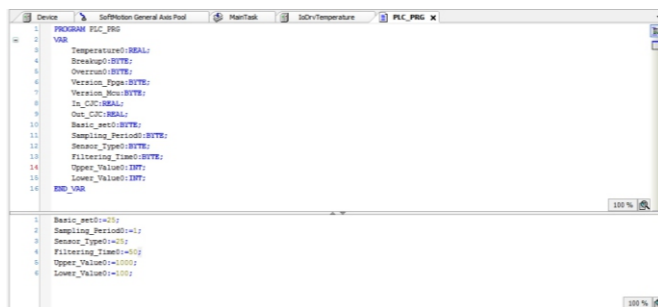
Parameter	Value	Valid bits	Variable	
Limit detection result of channel 0	Normal	00	Overrun0	
	Upper limit exceeded	01		
	Lower limit exceeded	10		
Channel enabling	Enable	1	0	
	Disable	0		
Display mode	°C	0	1	
	°F	1		
Cold junction compensation	Internal	0	2	
	External	1		
Sensor disconnection detection	Enable	1	3	
	Disable	0		
Limit detection	Enable	1	4	
	Disable	0		
Sampling period	250ms	01	0-1	
	500ms	10		
	1000ms	11		
Sensor type	B	000	0-3	
	E	001		
	J	010		
	K	011		
	N	100		
	R	101		
	S	110		
	T	111		
	PT100	1000		
	PT500	1001		
	PT1000	1010		
CU500	1011			
2-wire	00	4-5		
3-wire	01			
4-wire (For RTD)	10			
Filter time	0-100	0-100	0-6	Filtering_time_0
Upper limit	0-1370	0-1370	0-10	Upper_value_0
Lower limit	-270	0-270	0-8	Lower_value_0

The temperature module fault codes are listed in the following table.

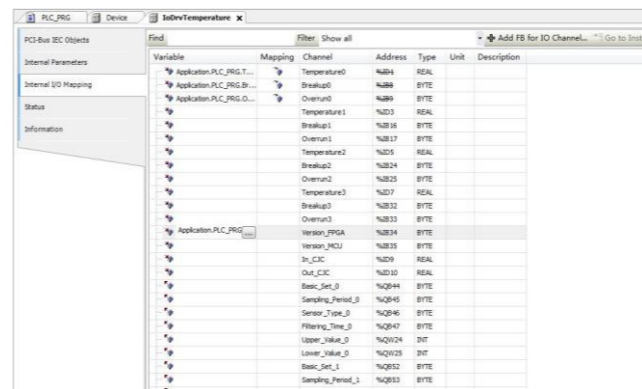
Fault code	Fault type	Solution
16#C0	Channel 0 exceeds the upper limit of the allowed range (that is, the actual temperature value is higher than the set temperature upper limit).	Check whether the set temperature upper limit is higher than the actual temperature value.
16#C1	Channel 0 does not reach the lower limit of the allowed range (that is, the actual temperature value is lower than the set temperature lower limit).	Check whether the set temperature lower limit is lower than the actual temperature value.
16#C2	Channel 1 exceeds the upper limit of the allowed range (that is, the actual temperature value is higher than the set temperature upper limit).	Check whether the set temperature upper limit is higher than the actual temperature value.
16#C3	Channel 1 does not reach the lower limit of the allowed range (that is, the actual temperature value is lower than the set temperature lower limit).	Check whether the set temperature lower limit is lower than the actual temperature value.
16#C4	Channel 2 exceeds the upper limit of the allowed range (that is, the actual temperature value is higher than the set temperature upper limit).	Check whether the set temperature upper limit is higher than the actual temperature value.
16#C5	Channel 2 does not reach the lower limit of the allowed range (that is, the actual temperature value is lower than the set temperature lower limit).	Check whether the set temperature lower limit is lower than the actual temperature value.
16#C6	Channel 3 exceeds the upper limit of the allowed range (that is, the actual temperature value is higher than the set temperature upper limit).	Check whether the set temperature upper limit is higher than the actual temperature value.
16#C7	Channel 3 does not reach the lower limit of the allowed range (that is, the actual temperature value is lower than the set temperature lower limit).	Check whether the set temperature lower limit is lower than the actual temperature value.

Error code	Error type	Solution
	temperature lower limit).	value.
16#C8	Incorrect range setting (that is, the set temperature upper limit is lower than the set temperature lower limit.)	Check whether the set temperature upper limit is higher than the set temperature lower limit.
16#C9	Channel 0 disconnected (reserved)	
16#CA	Channel 1 disconnected (reserved)	
16#CB	Channel 2 disconnected (reserved)	
16#CC	Channel 3 disconnected (reserved)	

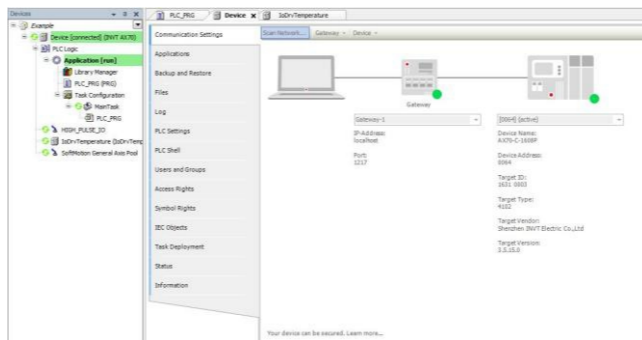
Step 3 Use the ST programming language to write a program, as shown in the following figure. Set variables according to the preceding table.



Step 4 Map the variables defined in the program to the related variables of channel 0 of the temperature module. See the following figure.



Step 5 After the compilation is successful, log in to the programmable controller and download and run the project. See the following figure.



7 Pre-startup check and preventive maintenance

7.1 Pre-startup check

If you have completed the wiring, ensure the following before starting the module to work:

- The module output cables meet requirements.
- The expansion interfaces at any levels are reliably connected.
- The application programs use the correct operation methods and parameter settings.
- The RUN indicator is on.

7.2 Preventive maintenance

Perform preventive maintenance as follows:

- Clean the programmable controller regularly, prevent foreign matters falling into the controller, and ensure good ventilation and heat dissipation conditions for the controller.
- Formulate maintenance instructions and regularly test the controller.
- Regularly check the wiring and terminals to ensure that they are securely fastened.

Customer Service Center, Shenzhen INVT Electric Co., Ltd.

Address: INVT Guangming Technology Building, Songbai Road, Matian, Guangming District, Shenzhen, China

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