AX-EM-4AD Analog Input Module User Manual

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

AX-EM-4AD analog input module (AI module for short) is a 24-bit resolution, 4-channel analog input module that works with the main module of the programmable controller. Each channel of the AI module supports voltage and current input.

The manual mainly describes the specifications, features, wiring, and use methods of the AI module of AX series programmable controller. To ensure that you use the product safety 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	Danger	Serious physical injury or even death may occur if related requirements are not followed.	
Warning	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

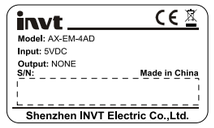


Figure 2.1 Product nameplate

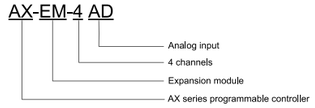


Figure 2.2 Product model

2.2 Function overview

The AI module is an expansion module of the programmable controller main module and belongs to special function modules.

The AI module has 4 analog signal input channels, with 24-bit resolutions. At input terminals, you can perform current or voltage input, and select different current ranges, including -20mA–+20mA, 0mA–20mA, and 4mA–20mA, or voltage ranges, including 0V–5V, 0V–10V, -5V–+5V, and -10V–+10V, with the measuring result accurate to 0.001.

2.3 Structural dimensions

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

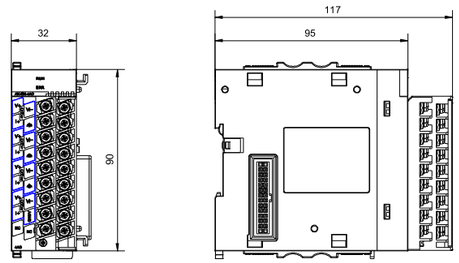


Figure 2.3 Structural dimensions

3 Interfaces

3.1 Interface distribution

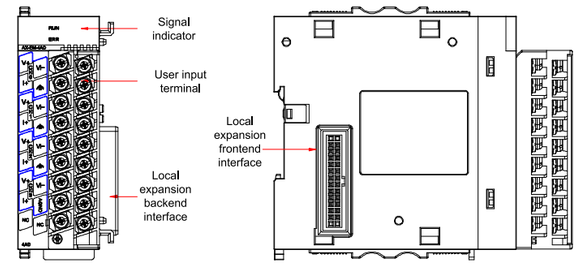


Figure 3.1 Interface distribution

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 output terminal	4 inputs
Local expansion frontend interface	Connects to frontend modules. Disallows hot swapping.
Local expansion backend interface	Connects to backend modules. Disallows hot swapping.

3.2 Terminals

Terminal No.	Channel	Terminal symbol	Type	Function
1	CH0	V+	Input	Voltage input of channel 0
2		VI-	Input	Voltage/current input of channel 0
3		I+	Input	Current input of channel 0
4		⏚	/	Shield ground (internally connected to the housing ground)
5	CH1	V+	Input	Voltage input of channel 1
6		VI-	Input	Voltage/current input of channel 1
7		I+	Input	Current input of channel 1
8		⏚	/	Shield ground (internally connected to the housing ground)
9	CH2	V+	Input	Voltage input of channel 2
10		VI-	Input	Voltage/current input of channel 2
11		I+	Input	Current input of channel 2

Terminal No.	Channel	Terminal symbol	Type	Function
12		⏚	/	Shield ground (internally connected to the housing ground)
13	CH3	V+	Input	Voltage input of channel 3
14		VI-	Input	Voltage/current input of channel 3
15		I+	Input	Current input of channel 3
16		AGND	Analog signal ground	Analog signal ground
17		NC	/	No connection
18		NC	/	No connection

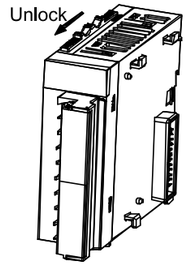
4 Installation and wiring

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

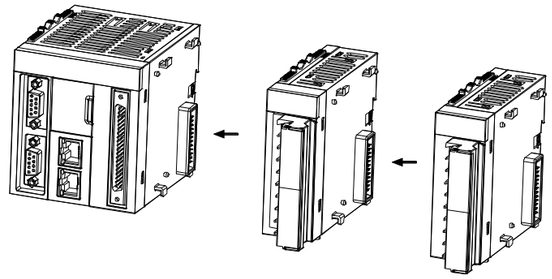
The modules are connected by using the module-provided connection interfaces and snap-fits.

4.1 Installation procedure

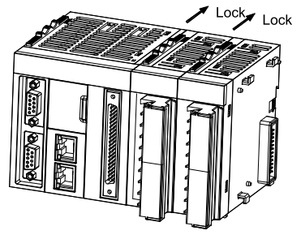
Step 1 Slide the snap-fit on the AI module in the direction shown in following figure.



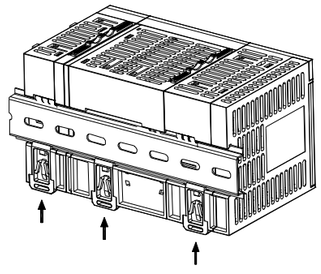
Step 2 Align with the connector on the CPU module for interlocking.



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.

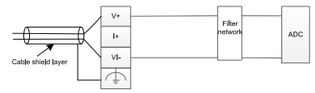


Figure 4.1 Wiring for voltage input

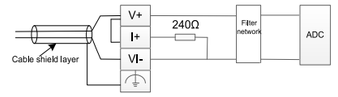


Figure 4.2 Wiring for current input

Note:

- For voltage input, use V+ and VI- for input, as shown in figure 4.1, and ensure the voltage input is within the range.
- For current input, connect V+ to I+ in short circuit mode, as shown in figure 4.2, and ensure the current input is within the range.
- The AI module needs to be installed on a properly-grounded metal bracket, and the metal dome at the module bottom is in good contact with the bracket.
- Do not bind the analog input 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	138mA (typical value)

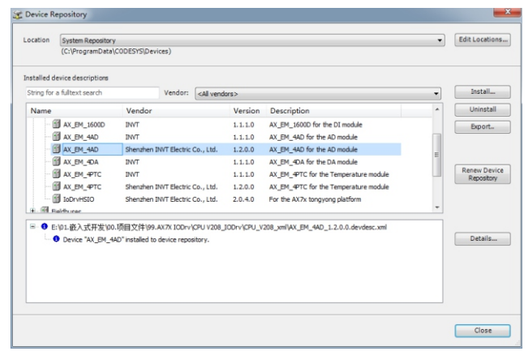
5.2 Performance parameters

Parameter	Specifications
Input channels	4
Voltage input impedance	2.4MΩ
Current sampling impedance	240Ω
Voltage input range	Unipolar: 0V–5V，0V–10V; Bipolar: -5V–+5V，-10V–+10V
Current input range	-20mA–+20mA，0mA–20mA，4mA–20mA
Resolution	24 bits
Accuracy (at normal temperature 25°C)	Voltage: ±0.1%; Current: ±0.1% (full measuring range)
Limiting voltage	±12V
Limiting current	±24mA
Max. common-mode voltage between channels	30VDC
Insulation mode	I/O terminals insulated from the power supply; No insulation between channels
System program upgrade method	Using the serial port

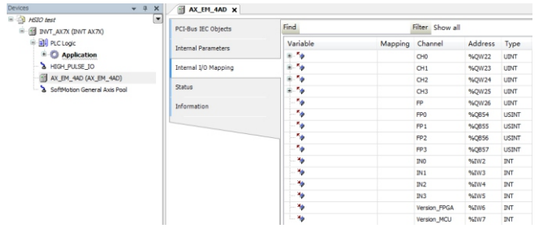
6 Application instance

The following assumes that channel 0 of the AI module collects voltage samples and assigns the sampling values to the corresponding variables; AX70-C-1608P is the main module of the programmable controller, and the high-speed I/O interface board connects to the AI module (only one).

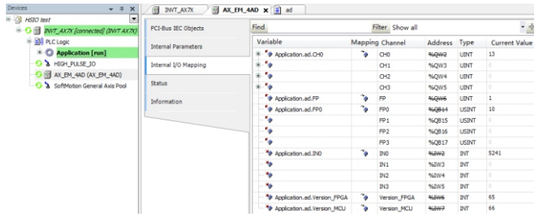
Step 1 Start CODESYS, choose **File** > **New Project** to create a new project. Install the device description file (AX_EM_4AD_1.x.x.x.devdesc.xml) corresponding to the AX-EM-4AD module in the project, as shown in the following figure.



Step 2 Right click on the CPU module to add a device and select the AX-EM-4AD device. Double click AX_EM_4AD in the **Devices** bar after installation. Set parameters on the **Internal I/O Mapping** interface. Note that the quantity and sequence of the I/O expansion modules added in the CODESYS interface must be the same as the actual hardware configuration. See the following figure.



Step 3 Use the ST programming language to write a program, and map the variables defined in the program to channel 0 of the AI module. Set CH0 and FP0 variables of channel 0. According to the variable description of channel 0, select the filter sinc3, and set FP to 1 (2#0000 0000 0000 0001). Select the voltage measuring range -10–+10V and set CH0 to 13 (2#0000 0000 0000 1101). Take the average of 10 sampling values for filtering, and set FP0 to 10. After the hardware is turned on, log in, and download the project for running. See the following figure. Input 5.2V voltage to channel 0, you can read 5241 from channel IN0 on the CODESYS interface. According to the mapping table, you can obtain the information that 5.241V is input to channel 0.



Step 4 Read FPGA version 1.01 (65 is converted to octal system) and MCU version 1.02 (66 to is converted to octal system) during running.

Table 6.1 Variables of channel 0

Parameter			Value	Valid bits	Variable name	Variable type
Filter selection	sinc5+sinc1		00	[1:0]	FP	UINT
	sinc5+sinc1+enhance 50/60		01			
	sinc3		10			
	Reserved					
Filtering parameter configuration	FP0			[7:0]	FP0	USINT
Configuration items of channel 0	Channel enabling	Enable	1	[0]	CN_Enable	UINT
		Disable	0			
	Disconnection detection	Enable	1	[1]	BK	
		Disable	0			
	Conversion mode	0V–5V	000	[4:2]	CM_Bit0 CM_Bit1 CM_Bit2	
		0V–10V	001			
		-5V–5V	010			
		-10V–10V	011			
		-20mA–20mA	100			
		0mA–20mA	101			
		4mA–20mA	110			
	Limit exceeding flag	Enable	1	[5]	OVR	
		Disable	0			
	Measuring range detection enabling bit	Enable	1	[6]	ORD	
		Disable	0			
	Reserved			[15:7]	Reserved	
Data item of channel 0	Data			[15:0]	IN0	INT

Table 6.2 Mapping between actual analog input values and rated values

Type	Rated range	Digital
Analog voltage input	-10V – +10V	-10000 – +10000
	0V–10V	0–10000
	-5V – +5V	- 5000 – +5000
	0V–5V	0–5000
Analog current input	-20mA – +20mA	-20000 – +20000
	0mA–20mA	0–20000
	4mA–20mA	4000–20000

Table 6.3 Analog input module fault codes

Fault code	Fault type	Solution
16#A0	Channel 0 disconnected.	Check whether the connection is proper.
16#A1	Channel 0 is out of the range (that is, the voltage is out of the range -25V – +25V, or the current is out of the range -104mA – +104mA).	Check whether the input voltage or current value is out of the range.
16#A2	Channel 0 exceeds the upper limit of the allowed range (that is, the input value is higher than the set upper limit).	Decrease the input voltage or current value, or select a wider range.
16#A3	Channel 0 does not reach the lower limit of the allowed range (that is, the input value is lower than the set lower limit).	Increase the input voltage or current value, or select a wider range.
16#A4	Channel 1 disconnected.	Check whether the connection is proper.
16#A5	Channel 1 is out of the range (that is, the voltage is out of the range -25V – +25V, or the current is out of the range -104mA – +104mA).	Check whether the input voltage or current value is out of the range.
16#A6	Channel 1 exceeds the upper limit of the allowed range (that is, the input value is higher than the set upper limit).	Decrease the input voltage or current value, or select a wider range.
16#A7	Channel 1 does not reach the lower limit of the allowed range (that is, the input value is lower than the set lower limit).	Increase the input voltage or current value, or select a wider range.
16#A8	Channel 2 disconnected.	Check whether the connection is proper.
16#A9	Channel 2 is out of the range (that is, the voltage is out of the range -25V – +25V, or the current is out of the range -104mA – +104mA).	Check whether the input voltage or current value is out of the range.
16#AA	Channel 2 exceeds the upper limit of the allowed range (that is, the input value is higher than the set upper limit).	Decrease the input voltage or current value, or select a wider range.
16#Ab	Channel 2 does not reach the lower limit of the allowed range (that is, the input value is lower than the set lower limit).	Increase the input voltage or current value, or select a wider range.
16#AC	Channel 3 disconnected.	Check whether the connection is proper.
16#Ad	Channel 3 is out of the range (that is, the voltage is out of the range -25V – +25V, or the current is out of the range -104mA – +104mA).	Check whether the input voltage or current value is out of the range.
16#AE	Channel 3 exceeds the upper limit of the allowed range (that is, the input value is higher than the set upper limit).	Decrease the input voltage or current value, or select a wider range.
16#AF	Channel 3 does not reach the lower limit of the allowed range (that is, the input value is lower than the set lower limit).	Increase the input voltage or current value, or select a wider range.

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 input 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.

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202112 (V1.2)