AX-EM-4DA Analog Output Module User Manual

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

AX-EM-4DA analog output module (AO module for short) is a 16-bit resolution, 4-channel analog output module that works with the main module of the programmable controller. Each channel of the AO module supports voltage and current output.

The manual mainly describes the specifications, features, wiring, and use methods of the module. 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 perform installation, wiring, maintenance, and inspection for AX series programmable controller.
- ✧ Do not install AX series programmable controller on inflammables. In addition, prevent AX series programmable controller from contacting or adhering to inflammables.
- ✧ Install AX series 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 AX series programmable controller if it is damaged or incomplete.
- ✧ Do not contact AX series programmable controller with damp objects or body parts. Otherwise, electric shock may result.

1.3 Wiring

- ✧ Only trained and qualified electricians are allowed to perform installation, wiring, maintenance, and inspection for AX series 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 AX series 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 for external power supply input to AX series programmable controller. This prevents the controller from being damaged due to external power supply faults, overvoltage, overcurrent, or other exceptions.

1.4 Commission and running

- ✧ Before power-on for running, ensure that the working environment of AX series programmable controller meets the requirements, the wiring is correct, the input power specifications meet the requirements, and the respective 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 avoid damage caused due to external power supply or device fault.

1.5 Maintenance and component replacement

- ✧ Only trained and qualified electricians are allowed to perform maintenance, inspection, and component replacement for AX series programmable controller.
- ✧ Cut off all power supplies connected to AX series programmable controller before wiring AX series 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 AX series programmable controller.

1.6 Disposal

- ✧ AX series 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

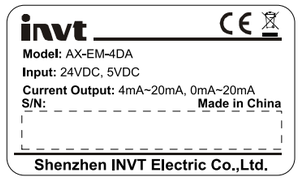


Figure 2.1 Product nameplate

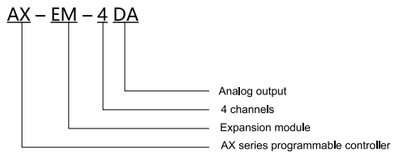


Figure 2.2 Product model

2.2 Product function

As an expansion module of the programmable controller, the AO module supports 4 channels of voltage and current output. The voltage output ranges are bipolar ±5V and ±10V and unipolar +5V and +10V, and the range of the load that can be driven is 1kΩ–1MΩ. The output range of current output mode is 4mA–20mA and 0mA–20mA, and the range of the load that can be driven is 0–1kΩ.

2.3 Structural dimensions

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

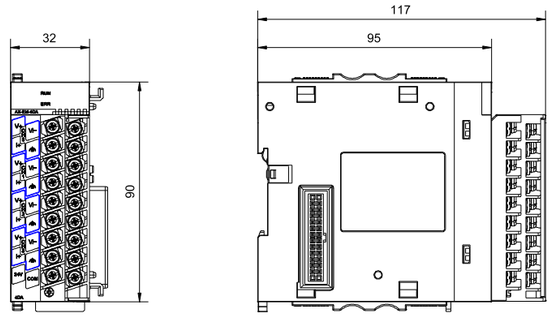


Figure 2.3 Mounting dimensions

3 Interfaces

3.1 Interface appearance

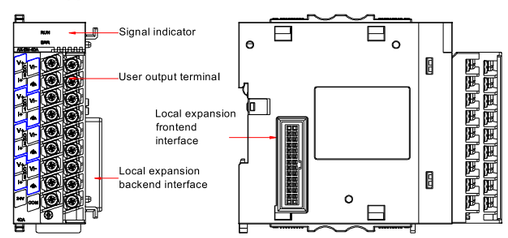


Figure 3.1 Interface distribution

Interface	Function
Signal indicator	RUN indicator: it is on when the operation is normal and off when the operation is faulty. ERR indicator: it is off when the operation is normal and on when the operation is faulty.
User output terminal	4 outputs (support voltage/current output)
Local expansion frontend interface	Connects to the frontend module, disallowing hot swapping

Interface	Function
Local expansion backend interface	Connects to the backend module, disallowing hot swapping

3.2 Terminal definition

Terminal No.	Channel	Terminal symbol	Type	Function
1	CH0	V+	Output	Channel 0 voltage output
2		VI-	Output	Channel 0 voltage/current output
3		I+	Output	Channel 0 current output
4		⏚	/	Shield ground
5	CH1	V+	Output	Channel 1 voltage output
6		VI-	Output	Channel 1 voltage/current output
7		I+	Output	Channel 1 current output
8		⏚	/	Shield ground
9	CH2	V+	Output	Channel 2 voltage output
10		VI-	Output	Channel 2 voltage/current output
11		I+	Output	Channel 2 current output
12		⏚	/	Shield ground
13	CH3	V+	Output	Channel 3 voltage output
14		VI-	Output	Channel 3 voltage/current output
15		I+	Output	Channel 3 current output
16		⏚	/	Shield ground
17	/	24V	Power supply	24V power supply
18		COM	Power ground	Power ground

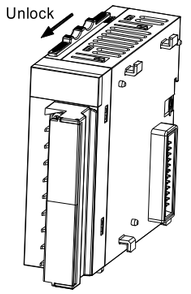
4 Installation and wiring

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

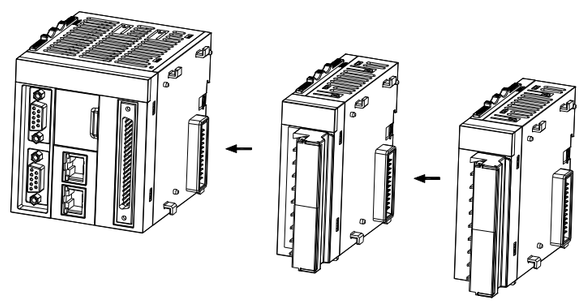
The modules are connected by using the module-provided connection interfaces and snap-fits.

4.1 Installation procedure

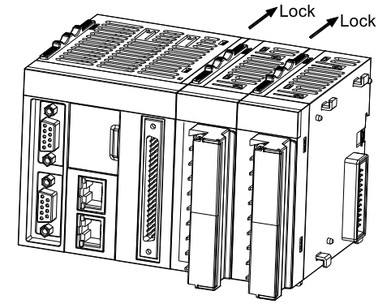
Step 1 Slide the snap-fit on the AO module in the direction shown in the following figure.



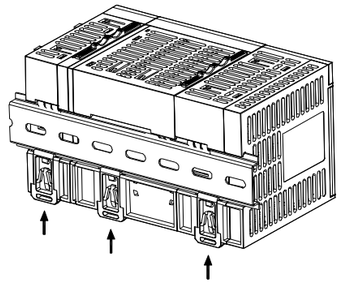
Step 2 Align the AO module with the CPU module connector for interlocking.



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 instruction

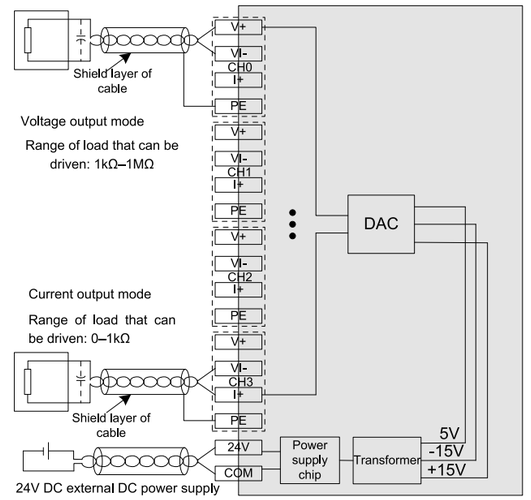


Figure 4.1 Wiring diagram of user terminals

Notes:

- Adopt two-core shielded twisted pairs as the power cable.
- If there is noise or ripple in the external wiring, you can connect a capacitance of 0.1mF to 0.47mF and withstanding voltage of 25V between the V+/I terminal and the VI- terminal.
- The AO 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 output cable of the module together with AC cable, main circuit cable, or high voltage cable. Otherwise, the binding can increase the impact of noise, surge and induction. When using shielded cables, use single-point grounding for the shield layer.

5 Technical parameters

5.1 Power supply

Item	Specification
External power supply	24V DC (-15%–+20%)
Internal 5V power consumption	100mA (typical value)

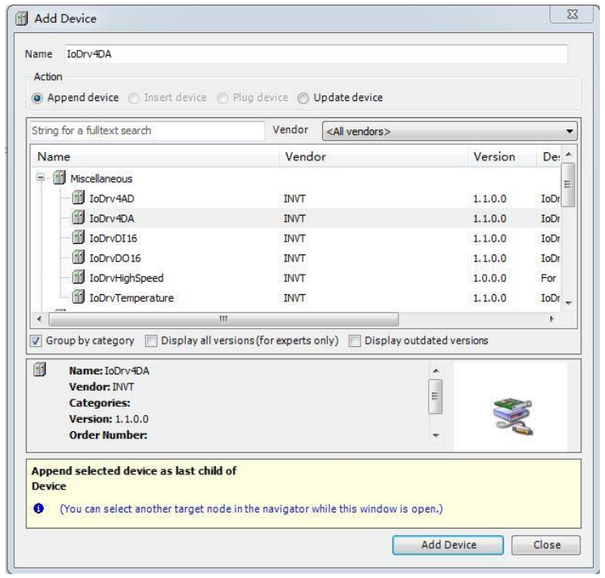
5.2 Performance parameters

Item	Specification
Voltage output range	Bipolarity ±5V, ±10V, unipolarity +5V, +10V
Current output range	4mA–20mA, 0mA–20mA
Voltage output load	1kΩ–1MΩ
Current output load	0Ω–1kΩ
Precision (room temperature 25℃)	Voltage ±0.1%, current ±0.1% (full scale)
Resolution	16 bits
Conversion time	1ms/channel
Output short circuit protection	Enable
System program upgrade mode	Serial upgrade
Isolation method	Output terminals isolated from the power supply terminals, and no isolation between channels

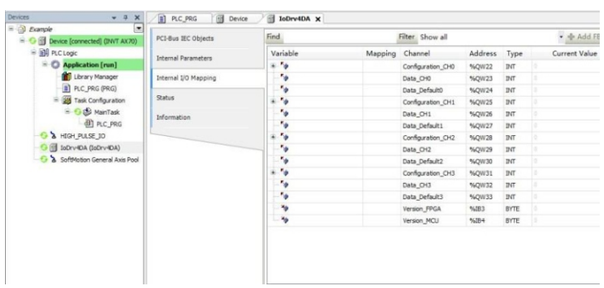
6 Application instance

For instance, channel 0 of the AO module outputs voltage of 10V. The AX70-C-1608P module is used as the main control module, and the high-speed I/O interface board is connected to the AO module (only one).

Step 1 Create a new project on the CODESYS upper PC, add the corresponding CPU device, and add the device description file (IoDrv4DA) corresponding to the AO module in the project, as shown in the following figure.



Step 2 Double-click IoDrv4DA in the Device bar, you can see the configuration variables of the parameters related to each channel on the Internal I/O Mapping interface, and you can configure it as needed. Note that in CODESYS upper PC, the number and order of the added I/O expansion modules must be consistent with the actual configuration of the hardware. In this application, the CODESYS upper PC interface is shown in the following figure:



The variables of channel 0 are described as follows.

Parameter			Value	Valid bit	Variable name
Configuration items of channel 0	Channel enabling	Enable	1	[0]	CN_Enable
		Disable	0		
	Disconnection detection	Reserved		[1]	CN_Diagnosis
	Conversion	0V~5V	000	[4: 2]	Conversion_Mode_Bi

Parameter			Value	Valid bit	Variable name
	mode	0V~10V	001		t0 Conversion_Mode_Bi t1 Conversion_Mode_Bi t2
		-5V~5V	010		
		-10V~10V	011		
		4mA~20mA	100		
		0mA~20mA	101		
	Output state after stopping	Output zeroing	00	[6: 5]	Output_State_Bit0 Output_State_Bit1
		Output retention	01		
		Preset output value	10		
	Reserved			[15: 7]	Reserved
ASCII code value of channel 0	Data			[15: 0]	Data_CH0
Preset output value of channel 0	Preset output value			[15: 0]	Data_Default0

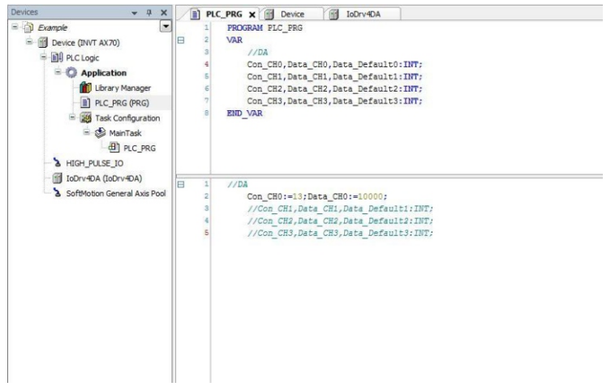
The relationship between mapping and actual analog input values is shown as follows.

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

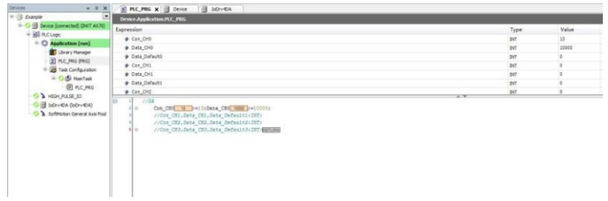
The AO module fault codes are listed in the following table.

Fault code	Fault type	Solution
16#b0	The current output of channel 0 is disconnected.	Check whether the current channel is disconnected. If yes, restore the connection.
16#b1	The voltage output of channel 0 is short circuited.	Check whether the voltage channel is disconnected. If yes, restore the connection.
16#b2	The current output of channel 1 is disconnected.	Check whether the current channel is disconnected. If yes, restore the connection.
16#b3	The voltage output of channel 1 is short circuited.	Check whether the voltage channel is disconnected. If yes, restore the connection.
16#b4	The current output of channel 2 is disconnected.	Check whether the current channel is disconnected. If yes, restore the connection.
16#b5	The voltage output of channel 2 is short circuited.	Check whether the voltage channel is disconnected. If yes, restore the connection.
16#b6	The current output of channel 3 is disconnected.	Check whether the current channel is disconnected. If yes, restore the connection.
16#b7	The voltage output of channel 3 is short circuited.	Check whether the voltage channel is disconnected. If yes, restore the connection.
16#b8	The 24V power board of the output module is powered off.	Check whether the 24 power supply is proper and whether reverse wiring happens.

Step 3 Perform programming by using ST programming language, map the variables defined in the program to the variables relating to channel 0 of the AX-EM-4DA module, and complete the variable mapping. Configure the Configuration_CH0 variable of channel 0, based on the description of each variable of channel 0, use channel 0, select the voltage range -10V–10V, and 13 (0000000000001101) is assigned. The digital value corresponding to -10V–10V is -10000–10000, so 10000 is assigned to Data_CH0. After the hardware device is powered on, log in to the device, and run the program as shown in the following figure. Measured by relevant instruments, channel 0 outputs +10V voltage, as shown in the following figure.



Step 4 After the program is compiled successfully, log in to the device, and run the program.



7 Pre-startup check and preventive maintenance

7.1 Pre-startup check

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

- The module output cables meet requirements.
- The expansion interfaces at all 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, 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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