Internal circuit

Signal

AX7 □ Series CPU Module User Manual

Thank you for choosing AX series programmable controller (programmable controller for short).

Based on the Invtmatic Studio platform, the programmable controller fully supports IEC61131-3 programming systems, EtherCAT real-time fieldbus, CANopen fieldbus, and high-speed I/O ports, and provides electronic cam, electronic gear, and interpolation functions.

The manual mainly describes the specifications, features, wiring, and use methods of the CPU 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 http://www.invt.com to download the latest manual version.

1 Safety precautions

1.1 Warning

Symbol	Name	Description	Abbreviation
Danger	Danger	Severe personal injury or even death can result if related requirements are not followed.	A
Warning	Warning	Personal injury or equipment damage can result if related requirements are not followed.	\triangle

1.2 Delivery and installation

- Only trained and qualified professionals are allowed to perform installation, wiring, maintenance, and inspection.
- 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

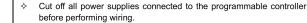


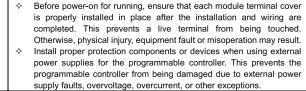
result in equipment damage or electric shock. Only personnel who have received related electrical knowledge and equipment operation training can operate the control cabinet. Do not run the programmable controller if it is damaged or incomplete. Do not contact the programmable controller with damp objects or body

parts. Otherwise, electric shock may result.

1.3 Cable selection

- Only trained and qualified professionals are allowed to perform installation, wiring, maintenance, and inspection
- Fully understand the interface types, specifications, and related requirements before wiring. Otherwise, incorrect wiring will cause abnormal running.





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 programmable controller so that the programmable 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



- programmable controller. Cut off all power supplies connected to the programmable controller before terminal wiring.
- During maintenance and component replacement, take measures to prevent screws, cables and other conductive matters from falling into the internal of the programmable controller.

Only trained and qualified professionals are allowed to perform

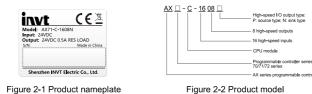
maintenance, inspection, and component replacement for the

1.6 Disposal

\triangle	The programmable controller contains heavy metals. Dispose of a scrap programmable controller as industrial waste.
X	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



2.2 Function overview

As the main control module of the programmable controller, AX7 □-C-1608 □ CPU module (CPU module for short) has the following functions: • Realizes the control, monitoring, data processing, and networking communication for the

- Supports the IL, ST, FBD, LD, CFC, and SFC programming languages compliant with
- IEC61131-3 standards by using Invtmatic Studio platform that INVT has launched for
- Supports 16 local expansion modules (such as the I/O, temperature, and analog modules). Uses EtherCAT or CANopen bus to connect slave modules, each of which supports 16
- expansion modules (such as the I/O, temperature, and analog modules).
- Supports Modbus TCP master/slave protocol.
- Integrates two RS485 interfaces, supporting Modbus RTU master/slave protocol.
- Supports high-speed I/O, 16 high-speed inputs and 8 high-speed outputs.
- Supports EtherCAT fieldbus motion control with synchronization time of 1ms, 2ms, 4ms, or
- Supports pulse-based single- or multi-axis motion control, including 2-4 axis linear interpolation and 2-axis arc interpolation.
- Supports real-time clock.
- Supports power-failure data protection.

2.3 Structural dimensions

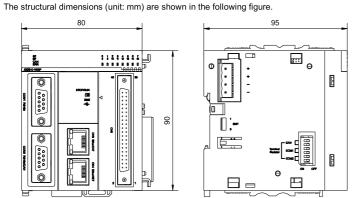


Figure 2-3 AX7 □-C-1608P CPU module dimensions

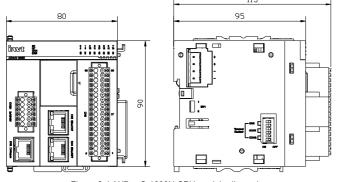


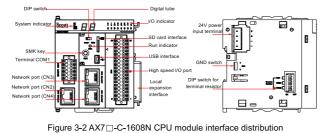
Figure 2-4 AX7 □-C-1608N CPU module dimensions

3 Interface

3.1 Interface description

Figure 3-1 and Figure 3-2 show the CPU module interface distribution. For each interface, a respective silk screen description is provided nearby, which facilitates wiring, operation, and

Figure 3-1 AX7 □-C-1608P CPU module interface distribution



Interface		Function				
DIP sv	vitch	RUN/STOP DIP switch.				
System indicator		SF: System fault indicator. BF: Bus fault indicator. CAN: CAN bus fault indicator. ERR: Module fault indicator.				
SMK	key	SMK smart key.				
	COM1 (DB9) female	One RS485 interface, supporting Modbus RTU master/slave protocol.				
AX7□-C-1608P	COM2 (DB9) female	One RS485 interface, and the other CAN interface The RS485 interface supports Modbus RTU master/slave protocol and the other CAN interface supports CANopen master/slave protocol.				
AX7□-C-1608N	COM1&COM2 (Push-in terminal)	Two RS485 interfaces, supporting Modbus RTU master/slave protocol.				
	CN2 (RJ45)	CAN interface, supporting CANopen master/slave protocol.				
CN3 (F	RJ45)	EtherCAT interface				
CN4 (F	RJ45)	Modbus TCP protocol Standard Ethernet functions User program download and debug (only with IPv4)				
Digital	tube	Displays alarms and replies to SMK key pressing.				
I/O indi		Indicates whether the signals of 16 inputs and 8 outputs are valid.				
SD card in	nterface	Used to store user programs and data.				
Run ind	icator	Indicates whether the CPU module is running.				
USB inte	erface	Used to download and debug programs.				
High-spe	ed I/O	16 high-speed inputs and 8 high-speed outputs.				
Local expansi	on interface	Supports the expansion of 16 I/O modules, disallowing hot swapping.				
24V power interface		DC 24V voltage input				
Grounding switch		Connection switch between the system internal digital ground and housing ground. It is disconnected by default (SW1 is set to 0). It is used only in special scenarios where the system internal digital ground is taken as the reference plane. Exercise caution before operating it. Otherwise, system stability is impacted.				
DIP switch of terminal resistor		ON indicates terminal resistor connection (it is OFF by default). COM1 corresponds to RS485-1, COM2 corresponds to RS485-2, and CAN correspond to CAN.				

The SMK key is mainly used to reset the CPU module IP address (rP), and clear application programs (cA). The default CPU module address is 192.168.1.10. If you want to restore the default address from a modified IP address, you can restore the default address through the SMK key. The method is as follows:

- 1. Set the CPU module to the STOP state. Press the SMK key. When the digital tube displays "rP", press and hold the SMK key. Then the digital tube displays "rP" and turns off alternately, indicating IP address reset is being performed. The reset operation succeeds when the digital tube is steady off. If you release the SMK key at this time, the digital tube displays "rP". Press and hold the SMK key until the tube displays "00" (rP \rightarrow cA \rightarrow rU \rightarrow rP).
- 2. If you release the SMK key during the process in which the digital tube displays "rP" and turns off alternately, the IP address reset operation is canceled, and the digital tube displays "rP".

To clear a program from the CPU module, do as follows:

Press the SMK key. When the digital tube displays "cA", press and hold the SMK key. Then the digital tube displays "rP" and turns off alternately, indicating the program is being cleared. When the digital tube is steady off, restart the CPU module. The program is cleared successfully.

3.1.3 Digital tube description

- If programs have no fault after download, the digital tube of the CPU module displays "00"
- If a program has a fault, the digital tube displays the fault information in blinking way.

 For example, if only fault 19 occurs, the digital tube displays "19" and turns off alternately. If fault 19 and fault 29 occur simultaneously, the digital tube displays "19", turns off, displays "29", and turns off alternately. If more faults occur simultaneously, the display way is similar.

3.2 Terminal definition

3.2.1 AX7 □-C-1608P COM1/COM2 communication terminal definition

For AX7 -C-1608P CPU module, COM1 is the RS485 communication terminal and COM2 is the RS485/CAN communication terminal, both of which use a DB9 connector for data transmission. The interfaces and pins are described in the following.

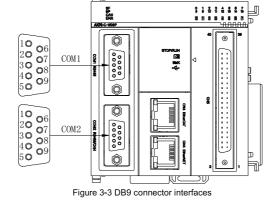


Table 3-1 COM1/COM2 DB9 connector pins						
Interface	Distribution	Pin	Definition	Function		
		1	1	/		
		2	1	/		
	(10)	3	1	1		
COM1	10 06 20 06	4	RS485A	RS485 differential signal +		
(RS485)	30 07 40 08 50 09	5	RS485B	RS485 differential signal -		
(K3465)		6	1	1		
		7	1	/		
		8	1	/		
		9	GND_RS485	RS485 power ground		
	10 06 20 07 30 08 40 09	1	1	/		
		2	CAN_L	CAN differential signal -		
		3	1	/		
COMO		4	RS485A	RS485 differential signal +		
COM2 (RS485/CAN)		5	RS485B	RS485 differential signal -		
		6	GND_CAN	CAN power ground		
		7	CAN_H	CAN differential signal +		
		8	1	1		
		9	GND_RS485	RS485 power ground		

3.2.2 AX7□-C-1608P high-speed I/O terminal definition

 $AX7 \square -C-1608P$ CPU module has 16 high-speed inputs and 8 high-speed outputs. The interfaces and pins are described in the following.

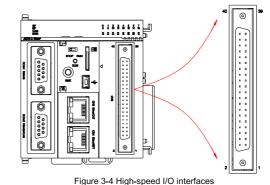


Table 3-2 High-speed I/O pins

Signal

+ HSD 24V input 40 00 HSD 24V input 3.9K

		+	HSD 24V Input		ا مما	HSD 24V Input	3.9K
		24VDC	(IN0-24V)	40	39	(IN1-24V)	~~~
	' \		HSD differential input	38	37	HSD differential input	680 Ω
	'	>	(IN0-DIFF) HSD input common	-00	0,	(IN1-DIFF) HSD input common	⋠
	1, 0		terminal	36	35	terminal	
		1 \	(IN0-COM)	Н		(IN1-COM)	
		+	HSD 24V input	34	33	HSD 24V input	3.9K
	'	24VDC	(IN2-24V)	Н	-	(IN3-24V)	680 Ω
			HSD differential input	32	31	HSD differential input	I—
		>	(IN2-DIFF) HSD input common	Н	-	(IN3-DIFF) HSD input common	∮ ∤ [≭]
	1 4	`	terminal (IN2-COM)	30	29	terminal (IN3-COM)	
		1+	HSD 24V input	Н		HSD 24V input	3.9K
	_~~	24VDC	(IN4-24V)	28	27	(IN5-24V)	-×××
	1 1 .	Z4VDC	HSD differential input			HSD differential input	680 Ω
	``<		(IN4-DIFF)	26	25	(IN5-DIFF)	w-
Input	1 - 6	^	HSD input common	П		HSD input common	I † † ⁷ □√,
		`	terminal (IN4-COM)	24	23	terminal (IN5-COM)	
		_	Input common terminal			Input common terminal	
	24V	ot 기·	SS1	22	21	SS2	
		45	0			0	
		ر''	Standard input (IN6)		19	Standard input (IN7)	▎⋰▏ [▐] ▞▀ [▗] ▁
			(IIVO)	\vdash		(IN7)	4.2K
			Standard input	18	17	Standard input	₽
	'		(IN8)			(IN9)	4.2K
			Standard input	16	15	Standard input	***
		•	(IN10)	16	15	(IN11)	
		_	Standard input			Standard input	
		•	(IN12)	14	13	(IN13)	
			0			0	4.2K
	L		Standard input (IN14)	12	11	Standard input (IN15)	
-		•	(11414)	Н	-	(11415)	4.2K
			Output	10	9	Output	Opto-iso
		Load Load	(OUT0)		Ŭ	(OUT1)	
			Output			Output	Opto-iso
		-WV	(OUT2)	8	7	(OUT3)	
		2000	` '	Н	\vdash		<u> </u>
Output			Output	6	5	Output	Opto-iso
		Load	(OUT4)	Щ	ш	(OUT5)	
			Output	l . l	١. ا	Output	Opto-iso
		-WV Load	(OUT6)	4	3	(OUT7)	
		24VDC	Common output	Н		Common output	1
			terminal	2	1	terminal	
	Fuse	-1 +	(COM1)	ı		(COM2)	

3.2.3 AX7 □ -C-1608N COM1/CN2 communication terminal definition For AX7 -C-1608N CPU module, COM1 is the two-channel RS485 communication terminal,

using a 12-pin push-in connector for data transmission. CN2 is the CAN communication terminal, using the RJ45 connector for data transmission. The interfaces and pins are described in the following.

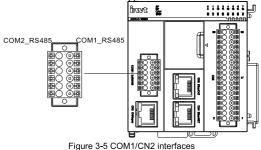


Table 3-3 COM1/ CN2 connector pins

Push-in terminal functions of COM1

	Definition	Function	Pin	
		Α	RS485 differential signal +	12
	COM4 DC405	В	RS485 differential signal -	10
11 BO OB 12	COM1_RS485	GND	RS485_1 chip power ground	8
		PE	Shield ground	6
9 日〇 〇日 10 7 日〇 〇日 8 5 日〇 〇日 6 3 日〇 〇日 4	6 4	Α	RS485 differential signal +	11
1 60 08 2		В	RS485 differential signal -	9
		GND	RS485_2 chip power ground	7
		PE	Shield ground	5
	Note: Pins 1-4 ar	e not used.		
	Pin fu	nctions of (CN2	
	Definition		Function	Pin
		GND	CAN power ground	1
PIN1	CANopen	CAN_L	CAN differential signal -	7
PIN8		CAN_H	CAN differential signal +	8
	Note: Pins 2-6 ar	e not used.	·	

3.2.4 AX7 □ -C-1608N high-speed I/O terminal definition

AX7 -C-1608N CPU module has 16 high-speed inputs and 8 high-speed outputs. The following figure shows the terminal distribution and the following table lists the pins.

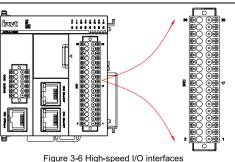
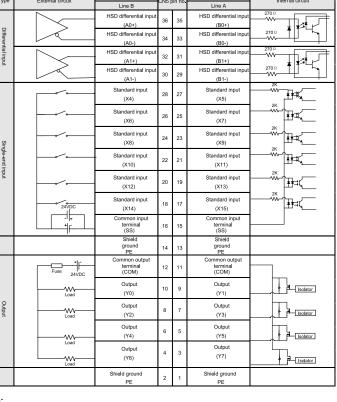


Table 3-4 High-speed I/O pins



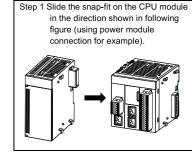
● All 16 input channels of AX7 □-C-1608P CPU module allow high-speed input, but the first 6

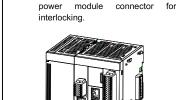
- channels support 24V single-end or differential input, and the last 10 channels support 24V ● All 16 input channels of AX7 □-C-1608N CPU module allow high-speed input, but the first 4
- channels support differential input, and the last 12 channels support 24V single-end input.
- Each I/O point is isolated from the internal circuit.
- The total length of high-speed I/O port connection cable cannot exceed 3 meters. Do not bend the cables when fastening the cables.
- During cable routing, separate the connection cables from high-power cables that cause strong interference but not bind the connection cables with the latter together. In addition, avoid long-distance parallel routing.

3.3 Module installation

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

The modules are connected by using the module-provided connection interfaces and snap-fits. The mounting procedure is as follows:





Step 2 Align the CPU module with the

Step 3 Slide the snap-fit on the CPU module

3.4 Cable connection and specifications

the two modules

3.4.1 EtherCAT bus connection

Item

Communication protocol

Min. synchronization interva

Supported service

Physical layer

Duplex mode

Topology structure

Transmission medium

Transmission distance

Number of slave nodes

EtherCAT frame length

Process data

the cables meet the following requirements:

circuit, opened circuit, dislocation or poor contact.

bulletin TSB, and EIA/TIA SB40-A&TSB36.

3.4.2 CANopen cable connection

uses single-point grounding.

Networking

Cable selection

EtherCAT bus specifications

in the direction shown in the

following figure to connect and lock

Step 4 As for standard DIN rail installation.

snap-fit clicks into place.

Description

EtherCA7

COE (PDO/SDO)

1ms/4 axes (Typical value)

DC for sync/DC unused

Full duplex

Network cable (see the section "Cable selection")

Serial connection

Less than 100m between two nodes

Up to 125

44 bytes-1498 bytes

The CPU module can implement EtherCAT bus communication through the CN3 port, INVT

standard cables are recommended. If you make the communication cables by yourself, ensure

Figure 3-7 User-made network cable requirements

• The communication cables you use must pass the conductivity test 100%, without short

• To ensure communication quality, the EtherCAT communication cable length cannot exceed

• You are recommend to make the communication cables by using the shielded twisted pair

The CAN bus connection topology structure is shown in the following figure. It is recommended

that the shielded twisted pair be used for CAN bus connection. Each end of the CAN bus connects to a 120Ω terminal resistor to prevent signal reflection. In most cases, the shield layer

Figure 3-8 CAN bus connection

● For AX7 -C-1608P CPU module, the same terminal is used for both CANopen

● For AX7 □-C-1608N CPU module, the RJ45 terminal is used for CANopen communication

INVT standard cables are recommended. If you make the communication cables by yourself,

make the cables according to the pin description and ensure the manufacturing process and

• To enhance cable anti-interference capability, you are recommended to use aluminum foil

shielding and aluminum-magnesium braid shielding techniques when making the cables.

• For AX7 □-C-1608P CPU module, the ports COM1 and COM2 uses the DB9 connector for

data transmission. The pins in the DB9 connector have been described earlier.

for data transmission. The pins in the RJ45 connector have been described earlier

The pins in the DB9 connector have been described earlier.

technical parameters meet communication requirements.

3.4.3 RS485 serial communication connection

Use the twisted-pair winding technique for differential cables.

The CPU module supports 2 channels of RS485 communication.

communication and RS485 communication, using a DB9 connector for data transmission.

.....N.....

cables of category 5e, compliant with EIA/TIA568A, EN50173, ISO/IEC11801, EIA/TIA

Up to 1486 bytes contained in a single frame

hook the respective module into the

standard installation rail until the

- To enhance cable anti-interference capability, you are recommended to use shielding and aluminum-magnesium braid shielding techniques when making t
- Use the twisted-pair winding technique for differential cables.

3.4.4 Ethernet connection

The Ethernet port of the CPU module is CN4, which can connect to another device such as a computer or HMI device by using a network cable in the point-to-point mode.

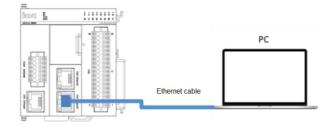
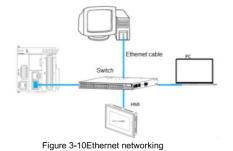


Figure 3-9 Ethernet connection

You can also connect the Ethernet port to a hub or switch by using a network cable, implementing multi-point connection.



Cable selection

To improve communication reliability, use shielded twisted-pair cables of category 5 or higher as Ethernet cables. INVT standard cables are recommended.

4 Use instructions

Interruption mode

4.1 Technical parameters

Item		Description				
Input voltage			24\	/DC		
Power consumption			< 1	5W		
Power-failure protection time	30	0ms (no prote	ction within	20 secon	ds after po	wer-on)
Backup battery of the real-time clock			Supp	orted		
Backplane bus power supply			5V/2	2.5A		
Programming method	IEC 61131-3 programming languages (LD, FBD, IL, ST, SFC, and CFC)					
Program execution method		Local online				
User program storage space	10MB					
Flash memory space for power failure protection	512KB					
SD card specifications	32G MicroSD					
	Element Name	0	Storage characteristics			
	Element	Name	Count	Default	Writable	Description
Soft elements and characteristics	I	Input relay	64KWord	Not save	No	X: 1 bit B: 8 bits
Grial actoristics	Q	Output relay	64KWord	Not save	No	W: 16 bits
	М	Auxiliary output	256KWord	Save	Yes	D: 32 bits L: 64 bits
Program retention method upon power failure	Retention by the internal flash					

The high-speed DI signal of the CPU module can be set as

interruption input, allowing up to eight points of input, and the

rising edge and falling edge interruption modes can be set.

4.1.3 High-speed I/O specifications

INVT standard cables are recommended. If you make the communication cables by yourself, make the cables according to the pin description and ensure the manufacturing process and technical parameters meet communication requirements.

aluminum foil	R
the cables.	0

2.5V<|V_{IN+} - V_{IN-}|<6V voltage Rated input 6 8mA 5.7mA (Typical value) (at 24V DC) current Less than 2mA ON current OFF current Less than 1mA 540Ω Input resistance 2.2kΩ

High-speed differential input

Max. counting 800K Pulses/s (2PH fourfold frequency), 200kHz (single channel of input) speed 2PH input duty 40%: 60% ratio One common terminal is used. Common terminal

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High-speed single-end input

24VDC (-15% - +20%, pulsating

High-speed output specifications

INVI 深圳市英原腭电气股份有限公司 SHENZHEN INVIT ELECTRIC CO., LTD.

Item

Signal name

Rated input

High-speed input specifications

Item	Specifications			
Signal name	Output (Y0–Y7)			
Output polarity	AX7 □-C-1608P: Source type output (active high) AX7 □-C-1608N: Sink type output (active low)			
Control circuit voltage	DC 5V-24V			
Rated load current	100mA/point, 1A/COM			
Max. voltage drop at ON	0.2V (Typical value)			
Leakage current at OFF	Less than 0.1mA			
Output frequency	200kHz (The output of 200kHz requires the externally connected equivalent load must be greater than 12mA.)			
Common terminal	Every eight points use one common terminal.			

- The high-speed I/O ports have restrictions on the allowed frequency. If the input or output frequency exceeds the allowed value, control and identification may be abnormal. Arrange the I/O ports properly.
- The high-speed differential input interface does not accept the differential pressure input level of greater than 7V. Otherwise, the input circuit may be damaged.

4.2 Programming software introduction and download

Programming software introduction

INVTMATIC Studio is programmable controller programming software that INVT develops. It provides an open and fully integrated programming development environment with advanced technology and powerful functions for project development that is based on programming languages compliant with IEC 61131-3. It is widely used in energy, transportation, municipal metallurgy, chemical, pharmaceutical, food, textile, packaging, printing, rubber and plastics, machine tools and similar industries.

Running environment and download

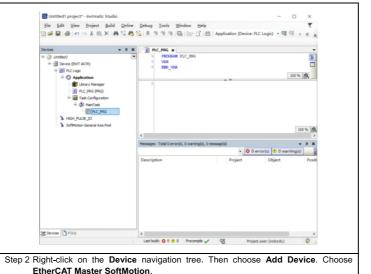
You can install Invtmatic Studio on a desktop or portable computer, of which the operating system is at least Windows 7, memory space is at least 2GB, free hardware space is at least 10GB, and the CPU main frequency is higher than 2GHz. Then you can connect your computer to the CPU module of the programmable controller through a network cable and edit the user programs through the Invtmatic Studio software so that you can download and debug user

5 Programming instance

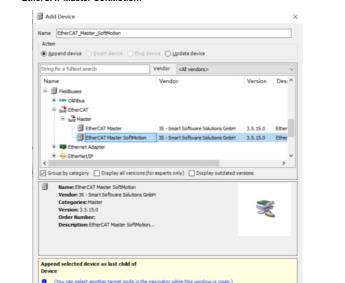
The following describe how to perform programming by using an example (AX72-C-1608N).

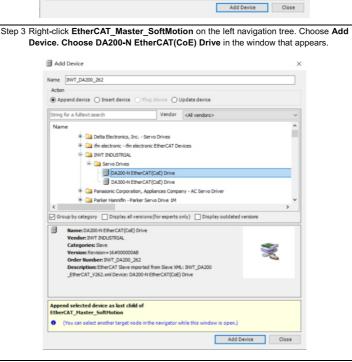
First of all, connect all the hardware modules of the programmable controller, including connecting the power supply to the CPU module, connecting the CPU module to the computer where Invtmatic Studio has been installed and to the required expansion module, and connecting the EtherCAT bus to the motor drive. Start Invtmatic Studio to create a project and perform programming configuration.

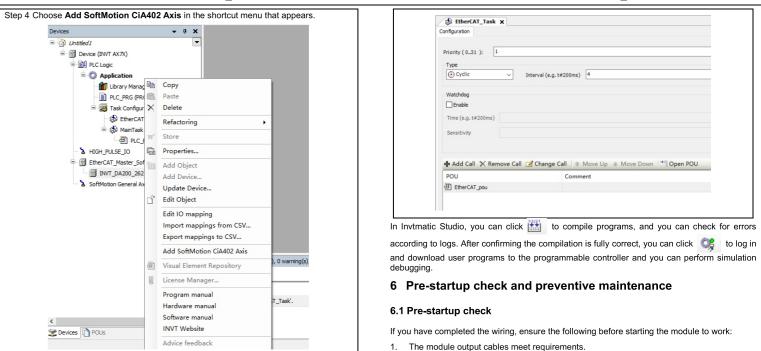
The procedure is as follows: Step 1 Choose File > New Project, select the standard project type, and set the project saving location and name. Click OK. Then select the INVT AX7X device and Structured Text (ST) programming language in the standard project configuration window that appears. The CODESYS configuration and programming interface appears. Standard Project You are about to create a new standard project. This wizard will create the following objects within this project: One programmable device as specified below A program PLC_PRG in the language specified below A cyclic task which calls PLC_PRG A reference to the newest version of the Standard library currently installed. <u>D</u>evice INVT AX7X (Shenzhen INVT Electric Co., Ltd.) PLC_PRG in Structured Text (ST) Continuous Function Chart (CFC) - page-oriented Function Block Diagram (FBD)



AX7 ☐ Series CPU Module User Manual

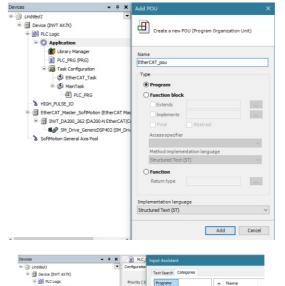






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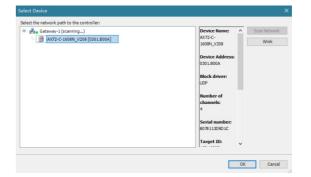
POU. Double-click the automatically generated EtherCAT_Task to invoke. Choose the created EtherCAT_pou. Write the application program based on the application 6.2 Preventive maintenance



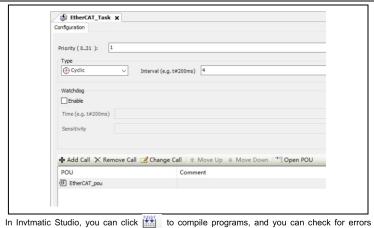
Step 5 Right-click Application on the left navigation tree and choose to add an EtherCA

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Step 6 Double-click the Device navigation tree, click Scan Network, choose AX72-C-1608N shown in the following figure, and click Wink. Then click OK when the CPU system indicator blinks.



Step 7 Double-click EtherCAT_Task under Task Configuration in the left pane. Set task priorities and execution intervals based on task real-time requirements.



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6 Pre-startup check and preventive maintenance

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

- 2. The expansion interfaces at any levels are reliably connected.
- 3. The application programs use the correct operation methods and parameter settings.

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Perform preventive maintenance as follows:

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

7 Further information

Please feel free to contact us for further information. Please provide the product model and serial number when making an inquiry.

To obtain related product or service information, you can:

- Contact INVT local office.
- Visit <u>www.invt.com</u>.
- Scan the following QR code.



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