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AC700 Series Intelligent Mechanical Programmable Controller

User Guide

Industrial Automation | Intelligent Elevator | New Energy Vehicle | Industrial Robot | Rail Transit

Data code PS00004465A06

Preface

Introduction

The AC700 series intelligent mechanical programmable controller offers abundant network interfaces capable of meeting various project expansion requirements. It delivers robust motion control performance and can be used in various industries, such as packaging, printing, die cutting, mobile phone manufacturing, silicon wafer manufacturing, logistics, and pharmacy.

This guide describes the installation, wiring, operation instructions, maintenance, and troubleshooting of the controller.

Standards Compliance

The following table lists the certifications, directives, and standards that the product may comply with. For details about the acquired certificates, see the certification marks on the product nameplate.

Certification	Directive		Standard
CE Certification	EMC Directive	2014/30/EU	**24 VDC products:** EN 61131-2 **220 VAC products:** EN 61131-2 EN 61000-3-2 EN 61000-3-3
	LVD Directive	2014/35/EU	EN 61010-1 EN 61010-2-201
	RoHS Directive	2011/65/EU amended by (EU)2015/863	EN IEC 63000
UL/cUL Certification	-		UL 61010-1 UL 61010-2-201 CAN/CSA-C22.2 No. 61010-1 CSA C22.2 NO. 61010-2-201
KCC Certification	-		-
EAC Certification	-		-
UKCA Certification	Safety Regulations	Electrical Equipment (Safety) Regulations 2016	EN 61010-1 EN 61010-2-201
	EMC Regulations	Electromagnectic Compatibility Regulations 2016	**24 VDC products:** EN 61131-2 **220 VAC products:** EN 61131-2 EN 61000-3-2 EN 61000-3-3
	RoHS Regulations	Directive (RoHS) Regulations 2012	EN IEC 63000

More Data

Name	Code	Description
Medium-sized PLC Programming Software User Guide	19010334	Introduces the basic functions, quick start, network configuration, and programming basics of the PLC software.
Medium-Sized PLC Programming Guide (Motion Control)	19010539	Introduces the composition of PLC motion control system, motion control program mechanism, detailed explanation of MC instructions, simulation and debugging related operations.
Medium-Sized PLC Instruction Guide	19011700	Introduces the basic instructions.
AC700 Series Intelligent Mechanical Programmable Controller User Guide	PS00004465	Introduces the installation, wiring, operation instructions, maintenance, and troubleshooting of the controller.

Revision History

Date	Version	Revision
February 2025	A06	Made minor corrections.
July 2024	A05	Made minor corrections.
March 2024	A04	Updated the note in *"5.2 Power-Off" on page 39*.
January 2024	A03	• Added the note for network interface communication in *"4.4.1 Network Interface Specifications" on page 29*. • Updated the wiring diagram of the external circuit in *"4.3.3 Wiring of User Terminals" on page 26*. • Updated CPU error codes in *"8.2 Controller Related Error Codes" on page 51*. • Updated *"8.3 EtherCAT Related Error Codes" on page 53*.
August 2023	A02	Updated the following sections: Cable Selection, Nameplate and Model, Power-on, Power-off, Programming and Debugging, and Appendix. Made minor corrections.
December 2022	A01	Added solutions for error codes. Updated product appearance, nameplate, and description. Added network interface communication specifications.
January 2022	A00	First release

Access to the Guide

This guide is not delivered with the product. You can obtain the PDF version in the following ways

- Do keyword search under Service and Support at *www.inovance.com*.
- Scan the QR code on the product with your smart phone.
- Scan the QR code below to install My Inovance app, where you can search for and download user guides.

Warranty Disclaimer

Inovance provides warranty service within the warranty period (as specified in your order) for any fault or damage that is not caused by improper operation of the user. Maintenance will be charged after the warranty expires.

Within the warranty period, maintenance fee will be charged for the following damage:

- Damage caused by operations not following the instructions in the user guide
- Damage caused by fire, flood, or unusual voltage
- Damage caused by unintended use of the product
- Damage caused by use beyond the specified scope of application of the product
- Damage or secondary damage caused by force majeure (natural disaster, earthquake, and lightning strike)

The maintenance is charged according to the latest Price List of Inovance. If otherwise agreed upon, the terms and conditions in the agreement shall prevail.

For details, see the Product Warranty Card.

Table of Contents

Fundamental Safety Instructions

Safety Precautions

- This chapter provides essential safety instructions for proper use of the equipment. Before operating the equipment, read through the guide and comprehend all the safety instructions. Failure to comply with the safety precautions may result in death, serious injury, or equipment damage.
- "CAUTION", "WARNING", and "DANGER" items in the guide only indicate some of the precautions that need to be followed; they just supplement the safety precautions.
- Use this equipment according to the designated environment requirements. Damage caused by improper use 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

Indicates that failure to comply with the notice will result in death or severe personal injuries.

Indicates that failure to comply with the notice may result in death or severe personal injuries.

Indicates that failure to comply with the notice may result in minor or moderate personal injuries or equipment damage.

General Safety Instructions

- Drawings in the guide are sometimes shown without covers or protective guards. Remember to install the covers or protective guards as specified first, and then perform operations in accordance with the instructions.
- The drawings in the guide are shown for illustration only and may be different from the product you purchased.

Unpacking
 • Do not install the equipment if you find damages, rust, or signs of use on the equipment or accessories upon unpacking. • Do not install the equipment if you find water seepage or missing or damaged components upon unpacking. • Do not install the equipment if you find the packing list does not conform to the equipment you received.

- Check whether the packing is intact and whether there is damage, water seepage, dampness, and deformation before unpacking.
- Unpack the package by following the unpacking sequence. Do not strike the package violently.
- Check whether there is damage, rust, or injuries on the surface of the equipment and equipment accessories before unpacking.
- Check whether the package contents are consistent with the packing list before unpacking.

Storage and Transportation

- Large-scale or heavy equipment must be transported by qualified professionals using specialized hoisting equipment. Failure to comply may result in personal injuries or equipment damage.
- Before hoisting the equipment, ensure the equipment components such as the front cover and terminal blocks are secured firmly with screws. Loosely-connected components may fall off and result in personal injuries or equipment damage.
- Never stand or stay below the equipment when the equipment is being hoisted by the hoisting equipment.
- When hoisting the equipment with a steel rope, ensure the equipment is hoisted at a constant speed without suffering from vibration or shock. Do not turn the equipment over or let the equipment stay hanging in the air. Failure to comply may result in personal injuries or equipment damage.

- Handle the equipment with care during transportation and mind your steps to prevent personal injuries or equipment damage.
- When carrying the equipment with bare hands, hold the equipment casing firmly with care to prevent parts from falling. Failure to comply may result in personal injuries.
- Store and transport the equipment based on the storage and transportation requirements. Failure to comply will result in equipment damage.
- Avoid storing or transporting the equipment in environments with water splash, rain, direct sunlight, strong electric field, strong magnetic field, and strong vibration.
- Avoid storing the equipment for more than three months. Long-term storage requires stricter protection and necessary inspections.
- Pack the equipment strictly before transportation. Use a sealed box for long-distance transportation.
- Never transport the equipment with other equipment or materials that may harm or have negative impacts on this equipment.

Installation

- The equipment must be operated only by professionals with electrical knowledge. Non-professionals are not allowed.

- Thoroughly read the safety precautions and user guide before installation.
- Do not install this equipment in places with strong electric or magnetic fields.
- Before installation, check that the mechanical strength of the installation site can bear the weight of the equipment. Failure to comply will result in mechanical hazards.
- Do not wear loose clothes or accessories during installation. Failure to comply may result in an electric shock.
- When installing the equipment in a closed environment (such as a cabinet or casing), use a cooling device (such as a fan or air conditioner) to cool the environment down to the required temperature. Failure to comply may result in equipment over-temperature or a fire.
- Do not retrofit the equipment.
- Do not fiddle with the bolts used to fix equipment components or the bolts marked in red.
- When the equipment is installed in a cabinet or final assembly, a fireproof enclosure providing both electrical and mechanical protections must be provided. The IP rating must meet IEC standards and local laws and regulations.
- Before installing devices with strong electromagnetic interference, such as a transformer, install a shielding device for the equipment to prevent malfunction.
- Install the equipment onto an incombustible object such as a metal. Keep the equipment away from combustible objects. Failure to comply will result in a fire.

- Cover the top of the equipment with a piece of cloth or paper during installation. This is to prevent unwanted objects such as metal chippings, oil, and water from falling into the equipment and causing faults. After installation, remove the cloth or paper on the top of the equipment to prevent over-temperature caused by poor ventilation due to blocked ventilation holes.
- Resonance may occur when the equipment operating at a constant speed executes variable speed operations. In this case, install the vibration-proof rubber under the motor frame or use the vibration suppression function to reduce resonance.

Wiring

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Before wiring, cut off all the power supplies of the equipment, and wait for at least the time designated on the equipment warning label before further operations because residual voltage still exists after power-off. After waiting for the designated time, measure the DC voltage in the main circuit to ensure the DC voltage is within the safe voltage range. Failure to comply will result in an electric shock.
- Do not perform wiring, remove the equipment cover, or touch the circuit board with power ON. Failure to comply will result in an electric shock.
- Check that the equipment is grounded properly. Failure to comply will result in an electric shock.

- Do not connect the input power supply to the output end of the equipment. Failure to comply will result in equipment damage or even a fire.
- When connecting a drive to the motor, check that the phase sequences of the drive and motor terminals are consistent to prevent reverse motor rotation.
- Cables used for wiring must meet cross sectional area and shielding requirements. The shield of the cable must be reliably grounded at one end.
- Fix the terminal screws with the tightening torque specified in the user guide. Improper tightening torque may overheat or damage the connecting part, resulting in a fire.
- After wiring is done, check that all cables are connected properly and no screws, washers or exposed cables are left inside the equipment. Failure to comply may result in an electric shock or equipment damage.

- During wiring, follow the proper electrostatic discharge (ESD) procedure, and wear an antistatic wrist strap. Failure to comply will damage the equipment or the internal circuits of the equipment.
- Use shielded twisted pairs for the control circuit. Connect the shield to the grounding terminal of the equipment for grounding purpose. Failure to comply will result in equipment malfunction.

Power-on

- Before power-on, check that the equipment is installed properly with reliable wiring and the motor can be restarted.
- Check that the power supply meets equipment requirements before power-on to prevent equipment damage or a fire.
- After power-on, do not open the cabinet door or protective cover of the equipment, touch any terminal, or disassemble any unit or component of the equipment. Failure to comply will result in an electric shock.

- Perform a trial run after wiring and parameter setting to ensure the equipment operates safely. Failure to comply may result in personal injuries or equipment damage.
- Before power-on, check that the rated voltage of the equipment is consistent with that of the power supply. Failure to comply may result in a fire.
- Before power-on, check that no one is near the equipment, motor, or machine. Failure to comply may result in death or personal injuries.

Operation

- The equipment must be operated only by professionals. Failure to comply will result in death or personal injuries.
- Do not touch any connecting terminals or disassemble any unit or component of the equipment during operation. Failure to comply will result in an electric shock.

- Do not touch the equipment casing, fan, or resistor with bare hands to feel the temperature. Failure to comply may result in personal injuries.
- Prevent metal or other objects from falling into the equipment during operation. Failure to comply may result in a fire or equipment damage.

Maintenance

 • Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals. • Do not maintain the equipment with power ON. Failure to comply will result in an electric shock. • Before maintenance, cut off all the power supplies of the equipment and wait for at least the time designated on the equipment warning label. • In case of a permanent magnet motor, do not touch the motor terminals immediately after power-off because the motor terminals will generate induced voltage during rotation even after the equipment power supply is off. Failure to comply will result in an electric shock.
 • Perform routine and periodic inspection and maintenance on the equipment according to maintenance requirements and keep a maintenance record.
Repair
 • Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals. • Do not repair the equipment with power ON. Failure to comply will result in an electric shock. • Before inspection and repair, cut off all the power supplies of the equipment and wait for at least the time designated on the equipment warning label.
 • Require repair services according to the product warranty agreement. • When the fuse is blown or the circuit breaker or earth leakage current breaker (ELCB) trips, wait for at least the time designated on the equipment warning label before power-on or further operations. Failure to comply may result in death, personal injuries or equipment damage. • When the equipment is faulty or damaged, the troubleshooting and repair work must be performed by professionals that follow the repair instructions, with repair records kept properly. • Replace quick-wear parts of the equipment according to the replacement instructions. • Do not use damaged equipment. Failure to comply may result in death, personal injuries, or severe equipment damage. • After the equipment is replaced, check the wiring and set parameters again.
Disposal
 • Dispose of retired equipment in accordance with local regulations and standards. Failure to comply may result in property damage, personal injuries, or even death. • Recycle retired equipment by observing industry waste disposal standards to avoid environmental pollution.

Safety label

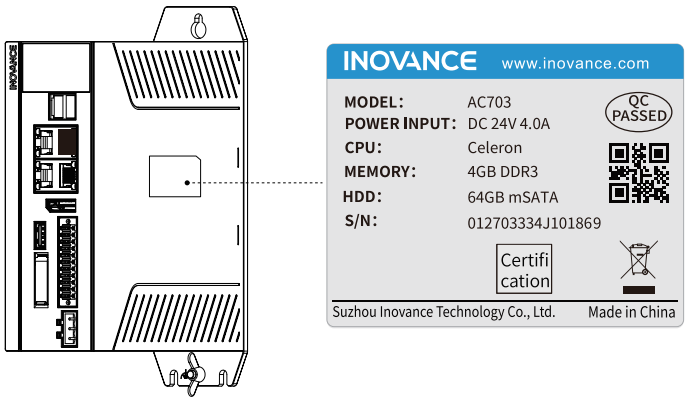
For safe equipment operation and maintenance, comply with the safety labels on the equipment. Do not damage or remove the safety labels. See the following table for descriptions of the safety labels.

Safety Label	Description
	• Read through the safety instructions before operating the equipment. Failure to comply may result in death, personal injuries, or equipment damage. • Do not touch the terminals or remove the cover with power ON or within 10 min after power-off. Failure to comply will result in an electric shock.

1 Product Information

1.1 Nameplate and Model

Nameplate



Model

A ① C ② 7 ③ 03 ④ - W ⑤

① **Product name** A: Controller	③ **Series number (1st digit)** 7: Series 7	⑤ **Operating system** W: Windows system Blank: Linux system (such as AC703)
② **Product structure** C: Booksize	④ **Hardware configuration** 03: Two-digit number, defined according to functions and performance	

1.2 Components

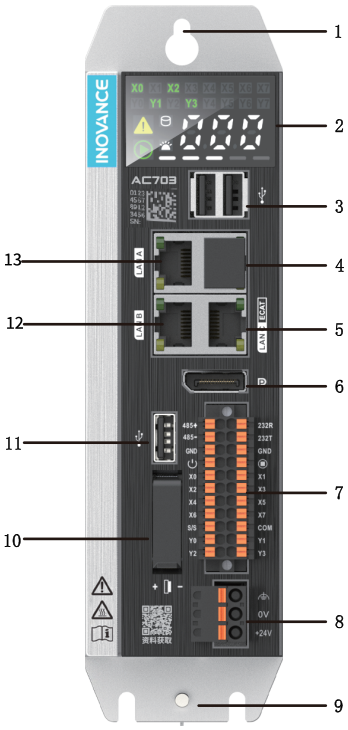
1.2.1 Appearance

The AC700 series includes the following controllers and accessories:

Controller	Accessory	Model	Code
Booksize controller	Celeron processor; 4 GB memory; 64 GB hard disk; three USB 2.0 interfaces; three network interfaces; DP interface; Display; 16 axes	AC702	01440300
Booksize controller	Celeron processor; 4 GB memory; 64 GB hard disk; three USB 2.0 interfaces; three network interfaces; DP interface; Display; 32 axes	AC703	01440354
Booksize controller	Celeron processor; 4 GB memory; 64 GB hard disk; three USB 2.0 interfaces; four network interfaces; DP interface; Display; 32 axes	AC712	01440335

1.2.2 Interfaces

The following figure shows the external interfaces of the AC700 series booksize controller:



No.	Interface	Description
1	Rear earhook	Standard component
2	Display	For specific functions and operations, see *"5.3 Display" on page 40*.
3/11	USB interface	Three USB 2.0 interfaces
4	LAN interface	Not supported
5	LAN C interface	EtherCAT communication interface
6	DP interface	DisplayPort interface
7	I/O communication interface	Eight DI terminals, four DO terminals, and RS485/RS232 communication terminals. For details, see *"4.3.4 RS485 Bus Wiring Instructions" on page 27*, *"4.3.5 RS232 Bus Wiring Instructions" on page 29*, and *"4.3.1 Interface Definition" on page 23*.
8	Power supply interface	24 V power supply input
9	Grounding terminal	Controller grounding
10	Battery cover	Open the battery cover to replace the battery.
12	LAN B interface	Ethernet interface
13	LAN A interface	Ethernet interface

2 Product Specifications

2.1 General Specifications

The AC700 series includes two controller models: AC702 and AC703. The following table provides basic specifications of the two models:

Item	AC702	AC703
Power supply	24 VDC (-15% to +20%)	
CPU model	Celeron, 2GHz	
Memory	4 GB	
Memory type	DDR3 SO-DIMM	
Hard drive capacity	64 GB	
Hard drive type	mSATA SSD	
SPI FLASH	64 Mbit	
Programming mode	IEC 61131-3 programming language (LD, ST, SFC, CFC)	
Program execution mode	Compiling execution	
Number of EtherCAT axes	16	32
User program storage	128 MB	
User data storage	128 MB	
EtherCAT communication	1 channel (that supports up to 128 slaves)	
Modbus TCP communication	2 channels (each supports up to 63 slaves)	
Modbus (serial port) communication	2 channels (each supports up to 31 slaves)	
EtherNet/IP	1 channel Maximum number of clients connected: 64 Maximum number of servers connected: 32	
Retentive space upon power failure	5 MB	
Dimensions (W x H x D)	55 mm x 160 mm x 151 mm	
Weight	About 1.3 kg	
Heat dissipation	Natural cooling	
EMC specifications	EN61131-2 Zone B/EN61000-6-2/EN61000-6-4	

2.2 Environmental Specifications

	Parameter Type		Operating Specification	Transportation Specification	Storage Specification
Environmental parameters (IEC60721-3)	Class		IE33	IE22	IE12
	Temperature		-5°C to +55°C	-40°C to +70°C	-25°C to +70°C
	Humidity		10% RH to 95% RH, without condensation		
	Vibration	Frequency	5 Hz to 150 Hz	2M2	1M2
		Displacement	3.5 mm (direct installation) (<8.4 Hz)		
		Acceleration rate	1 g (direct installation) (>8.4 Hz)		
		Direction	3-axial directions		
	Shock (collision)		15 g, 11 ms, half sine wave, 3-axial directions		
	Altitude/Air pressure		0 m to 2000 m	0 m to 3000 m (> 70 kPa)	

3 Installation

3.1 Installation Requirements

3.1.1 Installation Precautions

- Before installation, ensure that the controller is powered off.
- To avoid damage to the controller, do not drop or strike on the controller enclosure, terminal block, or connector.
- Do not disassemble the controller; otherwise the controller may be damaged.
- To avoid damage to the terminal and controller, do not overtighten the fasteners.
- The left panel of the controller is an aluminum plate for heat dissipation. Exercise caution to avoid burns.

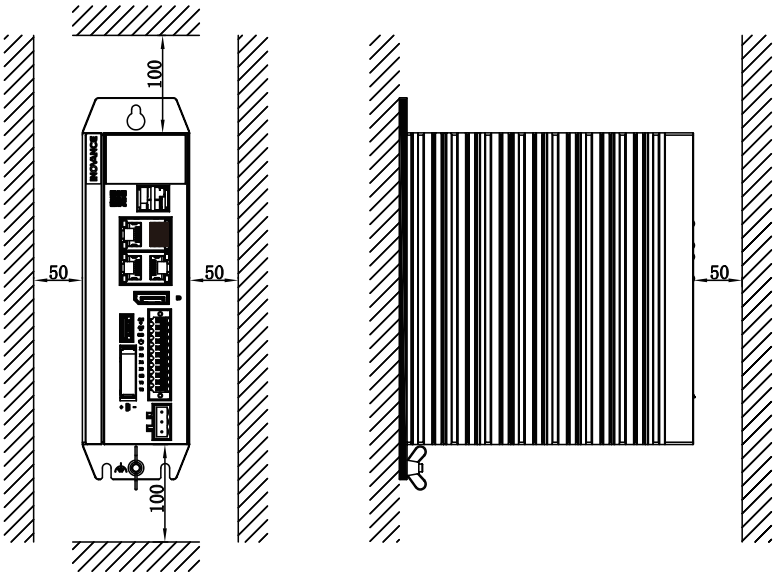
3.1.2 Installation Environment

When installing the controller, take the operability, maintainability, and environmental adaptation into account. Do not install the controller in a location with:

- An ambient temperature exceeding the range of -5°C to +55°C
- An ambient humidity exceeding the range of 10% to 95% RH
- Drastic temperature changes and condensation
- Corrosive or flammable gas
- Conductive powders (such as dust and iron powder), oil mist, salt, or organic solvents
- Direct sunlight
- Strong electric or magnetic fields
- Vibration or shocks

3.1.3 Installation Space

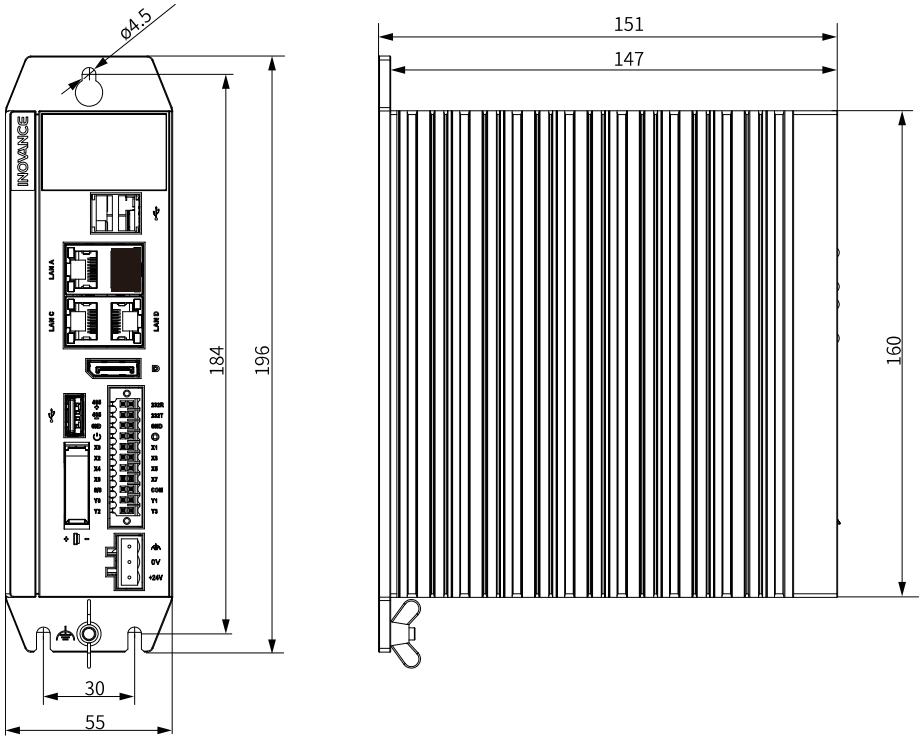
To facilitate ventilation and module replacement, reserve enough space around the product, as shown in the figure below (in mm).



3.2 Installation Instructions

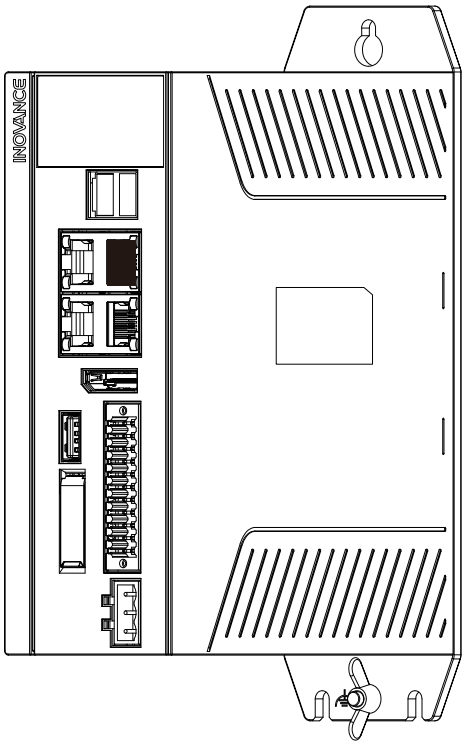
3.2.1 Installation Dimensions

The installation dimensions (in mm) are shown in the figure below.



3.2.2 Installation Method

Install the AC700 series booksize controller through the rear earhook, as shown below. Secure the controller with three screws at a torque of 1.2 N·m.



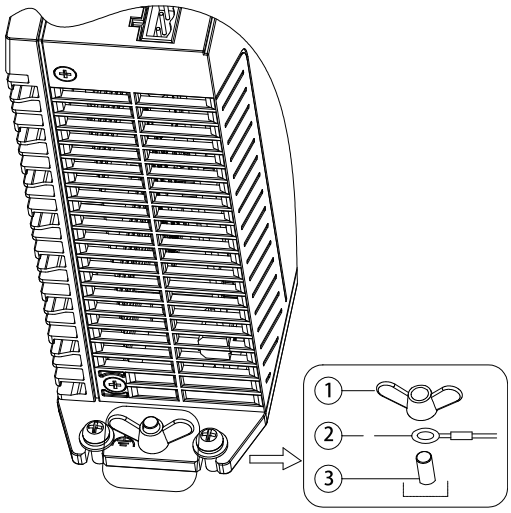
4 Wiring

4.1 Wiring Recommendations

4.1.1 Grounding Requirements

A grounding point ( ) is set on the power terminal of the controller and the rear earhook each. Choose one of the grounding points as needed. Use a grounding wire that is as thick and short (less than 30 cm) as possible to ground the controller. The grounding point on the rear earhook is recommended.

Use a wing nut for grounding, with a tightening torque of 0.55 N.m to 0.8 N.m, as shown below:

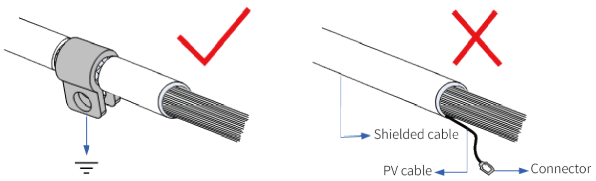


① - Wing nut; ② - Grounding cable; ③ - Grounding screw

Grounding of shielded cables

Use shielded cables for communication signals. Ground the shielded cable as close to the controller as possible so that the cable is not interfered by electromagnetic induction. The exposed shielded cable must be in large-area contact with the grounding point to ensure good contact.

Do not solder a PVC wire to the shielded cable for grounding because this will increase the high frequency impedance and attenuate the shielding effect. The shielded cable must be grounded at both ends, as shown below.

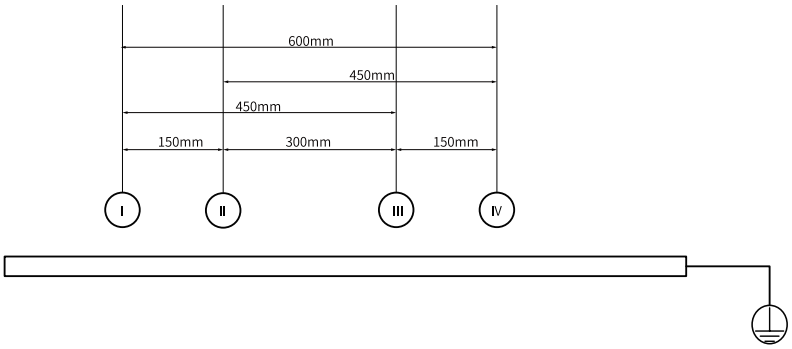


4.1.2 Cabling Requirements

Low-voltage cables (< 1 kV) are generally divided into four types. Only cables of the same type can be bundled together. Cables of different types must be separated without intersection or overlap. If intersection cannot be avoided, route cables in a right-angle crossover manner.

No.	Type	Application
1	I	Ethernet interface and EtherCAT interface
2	II	Low-speed digital communication signals (such as RS232 and RS485) and DI/DO signals
3	III	Low-voltage AC power distribution cables or DC power cables (such as 24 VDC cable of a switch-mode power supply)
4	IV	Input and output cables, welding machine cables, and power converter cables

Keep a proper distance between different types of cables. For cables shorter than 30 m, the minimum distance allowed is shown below.



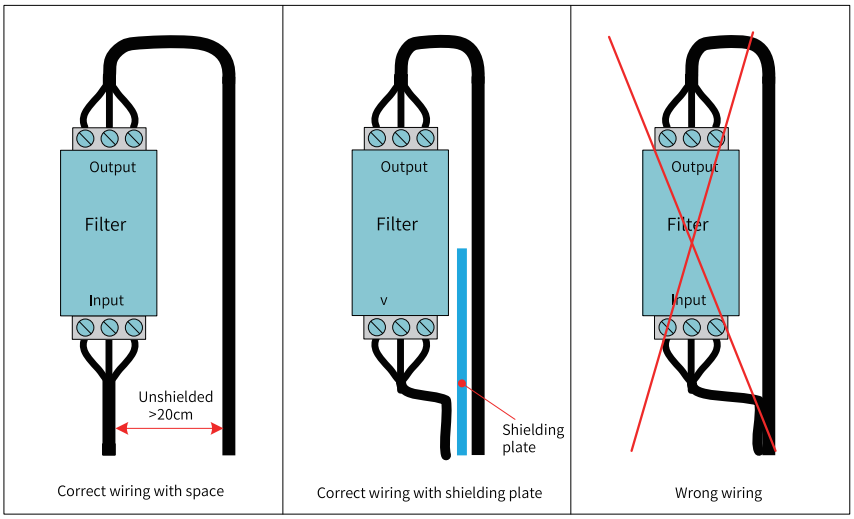
Note

- If two cables run parallel for an extended length, increase the distance between the two cables accordingly.
- You can also install spliced shielding plates between different types of cables. To reduce cross interference, route all cables as closely as possible to the grounded structural components of the cabinet, such as the cabinet's mounting plate or rack components.

4.1.3 Installing the Filter

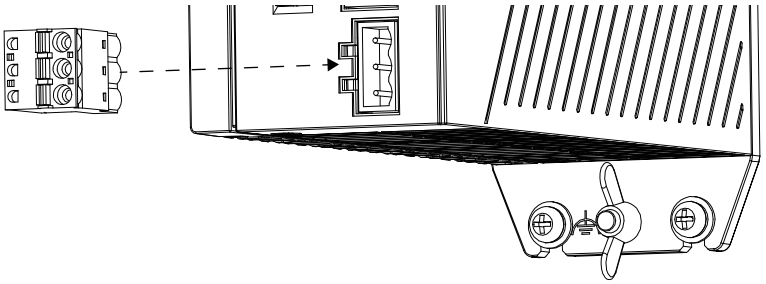
If the controller is subject to a strong interference source (such as an AC drive), it is recommended to add a noise filter to suppress the interference.

Install the filter as close as possible to the power supply of the controller. Fix the filter to the conductive backplane through screws. Protect the area around the screws with paint and ensure reliable grounding. The outgoing and incoming cables of the filter should be routed separately to avoid noise coupling on the cables.

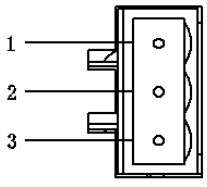


4.2 Wiring of Power Input Terminal

The power input terminal contains three pluggable pins spaced at 5.08 mm. To facilitate on-site wiring, replacement and maintenance, use springs to crimp wires onto the terminal. The following figure shows how to insert the power cable connector into the power input terminal:



Definition of power input pins

Terminal	No.	Name	Type	Function
	1	⏚	Grounding	Enclosure protective earth
	2	0V	Input	Negative DC input
	3	+24V	Input	Positive DC input

Specifications of input power supply

No.	Item	Specification
1	Input voltage	24 VDC (-15% to +20%)
2	Input current	4 A
3	Power failure threshold	18 V
4	Hold-up time upon power failure	150 ms
5	Anti-reverse connection	Supported
6	Short circuit protection	Supported

Note

The power input must be equipped with a fuse.

Power supply cable preparation

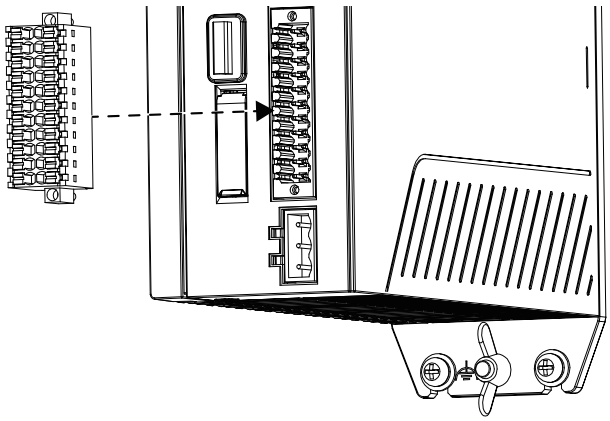
The power supply input cable uses a pin terminal. For preparation instructions, see *"4.7.2 Cable Preparation" on page 36*.

4.3 Wiring of I/O Communication Interface

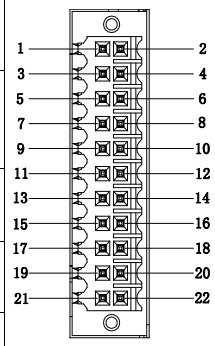
4.3.1 Interface Definition

Introduction to I/O communication interface

The I/O communication interface adopts a 22-pin (dual-row 11-pin) terminal with a 3.5 mm pitch, which includes DI/DO signals, RS-232 signals, RS-485 signals, power-on signals, and PLC program run/stop control signals. The wiring terminal adopts screw-fixed pluggable terminals, utilizing spring-type and crimping connection methods for convenient on-site installation and wiring, replacement and maintenance. The following figure shows how to insert the I/O connector into the I/O communication interface:



Definition of I/O communication interface

Type	Function	Terminal	No.	I/O Communication Interface	No.	Type	Function	No.
RS485	RS485+	485+	1		2	232R	RS232 reception	RS232
	RS485-	485-	3		4	232T	RS232 transmis-sion	
	Serial port ground	GND	5		6	GND	Serial port ground	
DI	Power-on signal		7		8		RUN/STOP	DI
DI	High-speed input 0	X0	9		10	X1	High-speed input 1	DI
DI	High-speed input 2	X2	11		12	X3	High-speed input 3	DI
DI	High-speed input 4	X4	13		14	X5	High-speed input 5	DI
DI	High-speed input 6	X6	15		16	X7	High-speed input 7	DI
DI	Input common terminal	S/S	17		18	COM	Output common terminal	DO
DO	High-speed output 0	Y0	19		20	Y1	High-speed output 1	DO
DO	High-speed output 2	Y2	21		22	Y3	High-speed output 3	DO

Note

- Power-on signal: When the controller is powered on, energize the input circuit for 5 s to shut it down. When it is powered off, energize the input circuit for 1 s to start it up.
- RUN/STOP signal: Continuously energizing the input circuit will repeatedly trigger the product to switch on and off.
- When the PLC crashes, you can forcibly stop and restart the PLC program through the RUN/STOP interface.
- When the startup icon on the display turns off, it indicates that the PLC is forcibly stopped.

4.3.2 Interface Specifications

High-speed digital input specifications (pins 9/10/11/12/13/14/15/16)

Item	Specification
Number of channels	8
Input type	DC digital input
Input mode	Sink/Source mode
Maximum input frequency	200 kHz
Frequency detection error	±1 pulse

Item	Specification
Input impedance	4.3 kΩ
Input voltage/Current rating	Detection voltage: 24 V (max. 30 V. When all inputs are ON, the input voltage cannot exceed 26.4 V) ON: Voltage ⩾ 15 V; input current > 5 mA OFF: Voltage ⩽ 5 V; input current < 1.5 mA

High-speed digital output specifications (pins 19/20/21/22)

Item		Specification
Number of channels		4
Output type		Digital output/transistor output
Output mode		Sink mode
Maximum output frequency		200 kHz (requiring an external equivalent load of more than 12 mA)
Control circuit voltage		5 VDC to 24 VDC
Minimum load		5 mA
Maximum output current	Resistive load	0.1 A/channel; 0.5 A/module
	Inductive load	7.2 W/24 VDC
	Lamp load	0.9 W/24 VDC
Maximum voltage drop upon ON		0.2 V (typical value)
Leakage current upon OFF		< 0.1 mA
ON response time		1 μs
OFF response time		1 μs
Isolation mode		Isolated
Short circuit-proof output		Supported

RS485 communication specifications

Item	Specification
Number of channels	1
Communication rate (bps)	4800, 9600, 19200, 38400, 57600, 115200
Maximum number of stations	31
Supported protocol	Modbus and free protocols
Isolation mode	Isolated

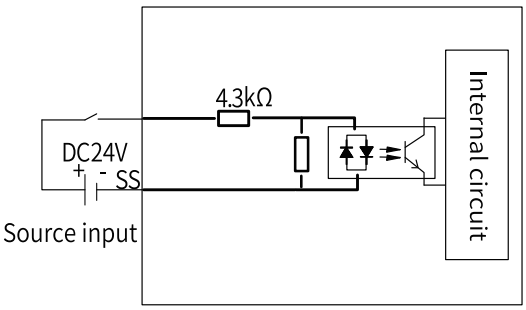
RS232 communication specifications

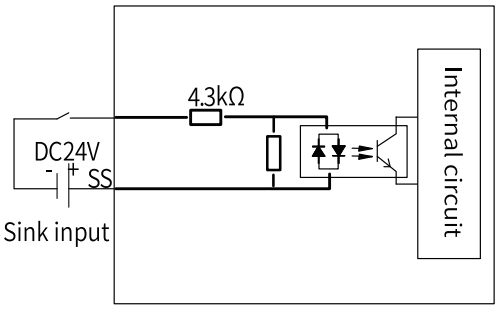
Item	Specification
Number of channels	1
Communication rate (bps)	4800, 9600, 19200, 38400, 57600, 115200
Supported protocol	Modbus and free protocols
Isolation mode	Isolated

4.3.3 Wiring of User Terminals

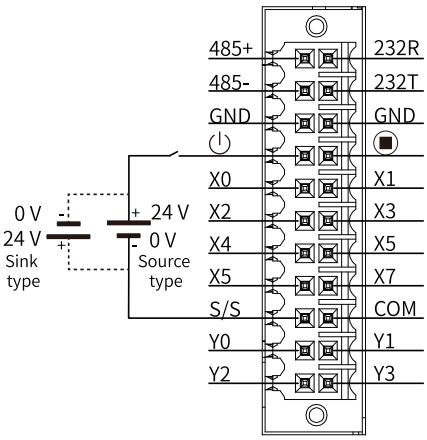
Wiring of power-on signal terminal and run/stop signal terminal

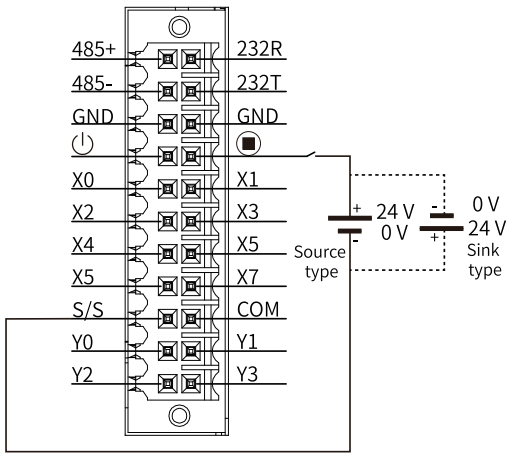
Internal structure





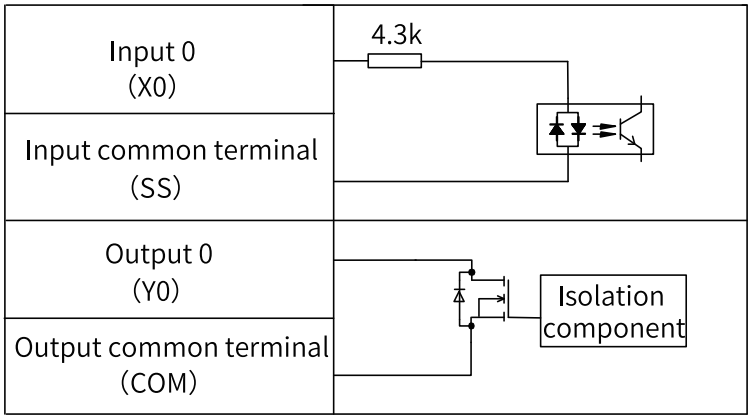
Wiring of the external circuit



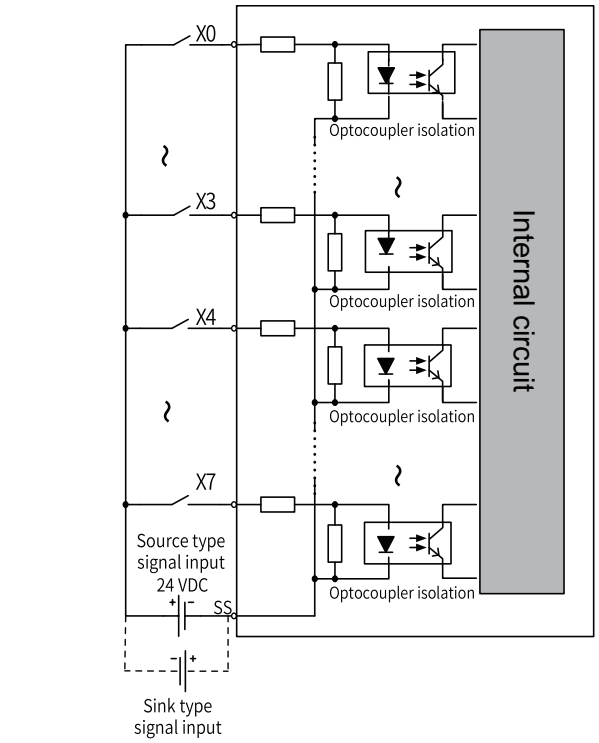


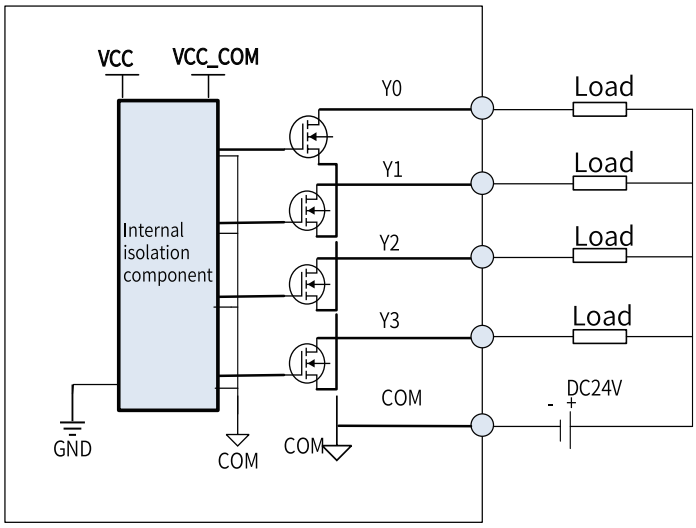
Wiring of 8 high-speed DI and 4 high-speed DO terminals

Internal structure



Wiring of the external circuit





4.3.4 RS485 Bus Wiring Instructions

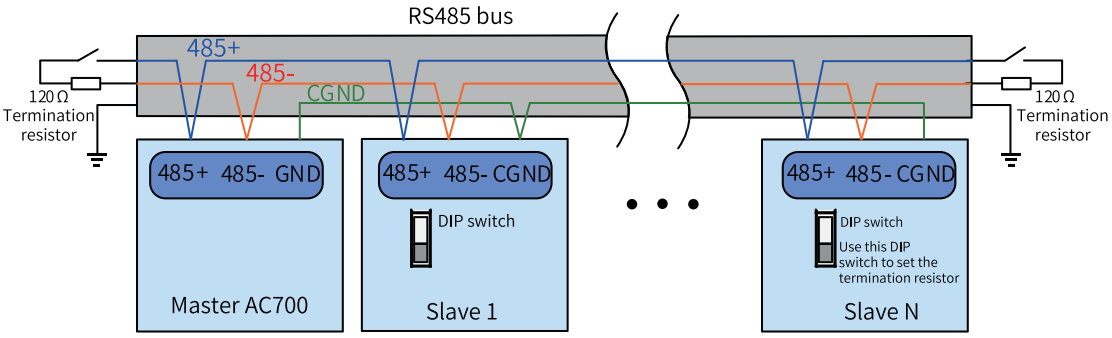
Danger

- Do not bundle the extension cable together with power cables (high voltage, large current) which produce strong interference signals. Separate it from other cables and avoid cabling in parallel.
- Select recommended cables and pinboards for connection. It is recommended that shielded cables be used as extension cables to enhance capacity of resisting interference.

- **RS485 topology**

  The figure below shows the RS485 bus topology. It is recommended to use a shielded twisted pair cable as the RS485 bus. The RS485+ and RS485— terminals are connected by a twisted pair cable.

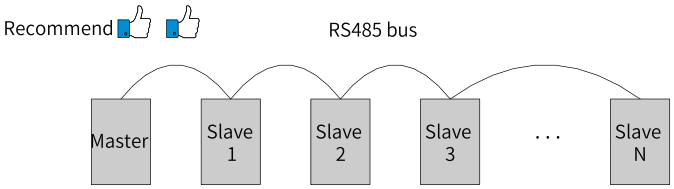
Connect a 120 Ω termination resistor to both ends of the bus to prevent signal reflection. Connect the signal reference grounds of all nodes together. Up to 128 nodes can be connected and the distance between branches must be less than 3 m.



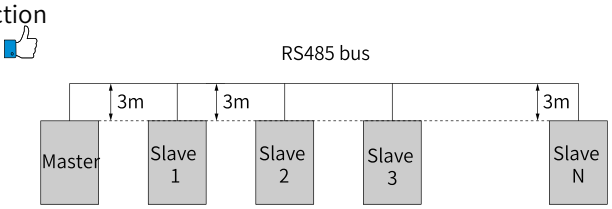
- **Multi-node topology**

  To connect a large number of nodes, use the daisy chain topology for the RS485 bus. If a branch cable is needed, keep its length shorter than 3 m and as short as possible. Star connection is strictly prohibited. The following figures show the common bus topology:

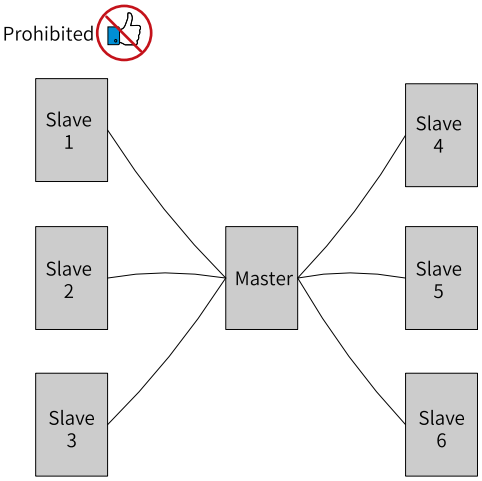
  - Daisy chain connection



  - Branch cable connection



  - Star connection (prohibited)

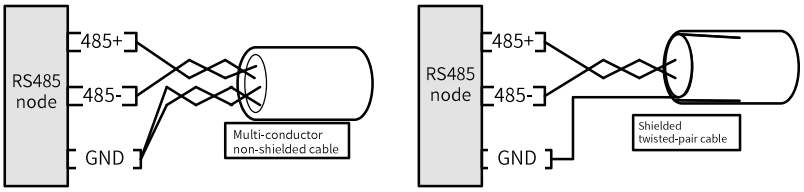


Note

It is recommended that the distance between the bus and the node do not exceed 3 m.

- **Terminal wiring**
  The AC700 series controller provides three terminals (RS485+, RS485-, and GND) for RS485 communication. Ensure that the RS485 bus contains three cables and the terminals are connected correctly. For shielded cables, the shielding layer must be connected to the GND terminal, rather than controller enclosure, ground terminals, or any other location.

  Due to cable attenuation, use AWG26 or thicker cables for connection longer than 3 m. Twisted pair cables are always recommended for connecting RS485+ and RS485- terminals.



  - **Multi-conductor non-shielded cable**: A data transmission cable with weak anti-interference capability, mainly used in situations with low transmission quality requirements. Use one twisted pair to connect to RS485+ and RS485- terminals and twist other wires together to connect to the GND terminal.
  - **Shielded twisted-pair cable**: A cable with a shielding layer between the twisted pair and the outer insulation covering. It is mainly used in situations with strong interference, severe electromagnetic radiation, and high transmission quality requirements. Use the twisted pair to connect to RS485+ and RS485- terminals and use the shielding layer to connect to the GND terminal. The shielding layer can only be connected to GND, not to the ground.

4.3.5 RS232 Bus Wiring Instructions

When you use an RS232 to RS485 converter, it is recommended to use an external power supply for the converter. If the external power supply is unavailable, the baud rate should not exceed 9.6 kbps.

4.4 Wiring of Network Interface

4.4.1 Network Interface Specifications

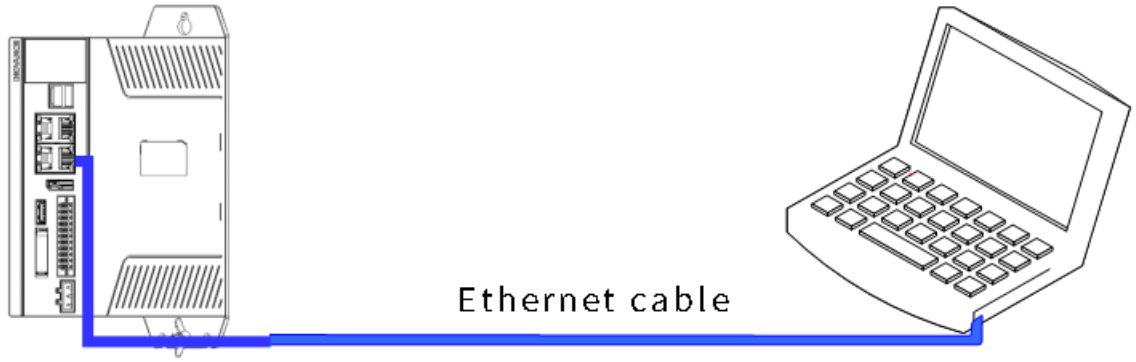
The AC700 series controller provides three network interfaces, which are described as follows:

Model	No.	Network Interface	Function
AC702	1	LAN A	Programming interface (used for downloading and monitoring) and communication interface (for Modbus TCP, EtherNet/IP, and OPC UA protocols)
	2	LAN B	Communication interface for Modbus TCP, EtherNet/IP, and OPC UA protocols
	3	LAN C	EtherCAT master interface
AC703	1	LAN A	Programming interface (used for downloading and monitoring) and communication interface (for Modbus TCP, EtherNet/IP, and OPC UA protocols)
	2	LAN B	Communication interface for Modbus TCP, EtherNet/IP, and OPC UA protocols
	3	LAN C	EtherCAT master interface

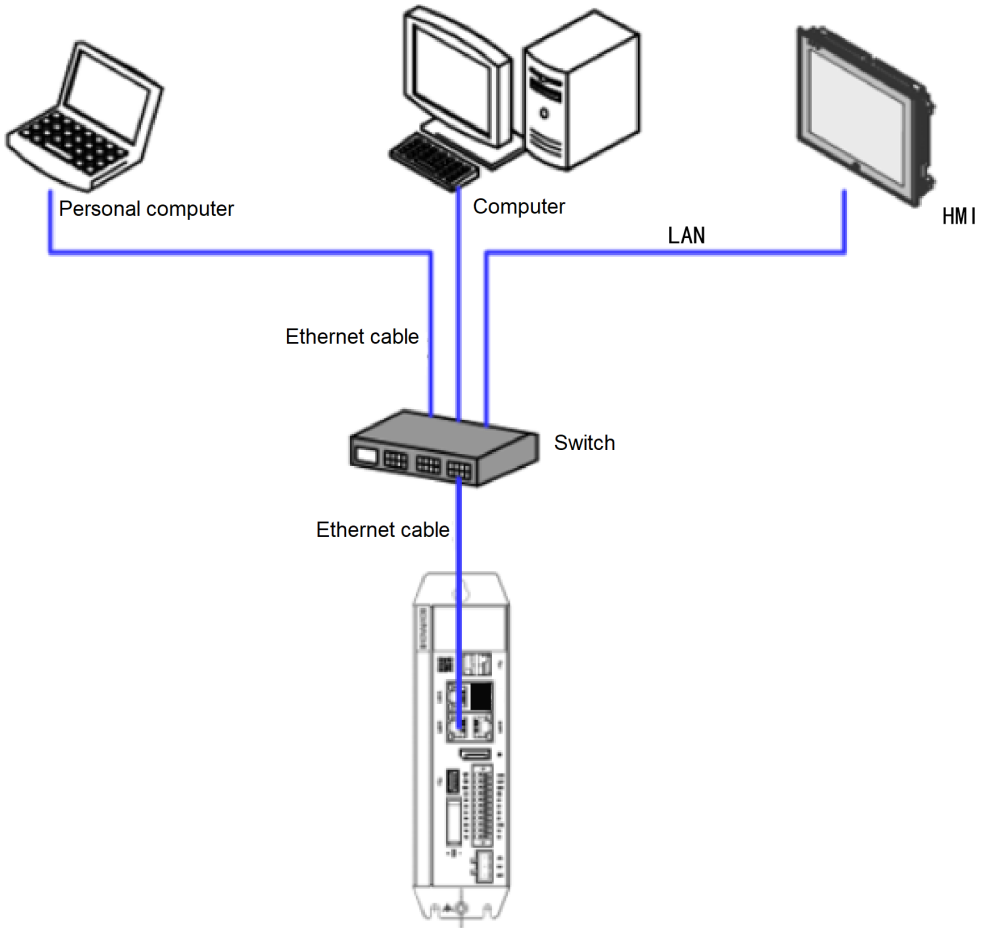
Note The IP addresses of LAN A and LAN B ports must not be within the same subnet.

4.4.2 Ethernet Connection

The controller can be connected point-to-point with a computer, HMI, and other devices through the Ethernet port, as shown below.



The controller can also be connected to a hub or switch through the Ethernet cable, enabling multi-point connection with other network devices.



4.4.3 EtherNet Wiring Instructions

EtherNet specifications

- Supports 2x standard Ethernet interfaces.
- Supported protocols: Modbus TCP, EtherNet/IP, and OPC UA.

The Modbus TCP communication specifications are as follows:

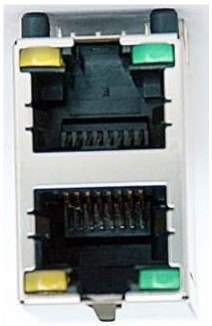
Item	Specification
Station No.	1 to 247
Communication rate	10M/100M/1000M adaptive
Data length	8 bits
Parity bit	None/Odd parity/Even parity
Stop bit	1 bit/2 bits
Maximum number of stations	64
Special functions	Diagnostic function

The OPC UA communication specifications are as follows:

Item	Specification
Security policy	-
User authentication	Anonymous

Item	Specification
Server interface	4840
Session timeout (s)	5 to 600,000
Sampling interval (ms)	100, 300, 500, 1000, 2500, 5000
Publish interval (ms)	200 to 20,000,000
Maximum number of sessions	50
Maximum number of subscriptions per server	200
Maximum number of monitored nodes per server	20,000
Maximum number of subscriptions per session	50
Maximum number of monitored nodes per subscription	10,000
Maximum number of nodes for single-frame read/write	1000

Definition of network interface indicators

Indicator	Function	Color	Status	Description
	A: Link/Act	Yellow		OFF: Disconnected
				Blinking: Connected with data sending/ receiving
				ON: Connected
	B: Speed	Green		OFF: Disconnected or connected at 10 Mbps
				ON: Connected at 100/1000 Mbps

4.4.4 EtherCAT Wiring Instructions

EtherCAT specifications

Item	Specification
Number of channels	1
Communication protocol	EtherCAT protocol
Supported services	FoE, EOE, CoE (PDO, SDO)
Minimum synchronization period of the 8 axes with cam (32 axes without cam)	1 ms (typical value)
Maximum number of axes	32
Synchronization mode	Distributed Clock (DC) synchronization for servo, input and output synchronization for I/O
Physical layer	100BASE-TX
Baud rate	100 Mbps (100Base-TX)
Duplex mode	Full duplex
Topology	Line topology
Transmission medium	Network cable, see cable specifications in the following section

Item	Specification
Transmission distance	Less than 100 m between two nodes
Number of slaves	128 slaves per EtherCAT bus
EtherCAT frame length	44 bytes to 1498 bytes
Process data	Maximum 1,486 bytes per Ethernet frame
Update time	The update time is specified only in the EtherCAT bus design. For specific update time, see the manual or specifications of the slave module.
Ring network	Not supported in the current version
Automatic scanning	Supported

Network interface indicators

See details in *" Definition of network interface indicators" on page 32*.

4.4.5 Communication Cable Wiring Instructions

Connection of RJ45 network cable

Connection: Insert the cable into the RJ45 port of the communication module until you hear a click sound.

Removal: Press down the clip of the RJ45 cable and pull it out along the direction parallel with the module.

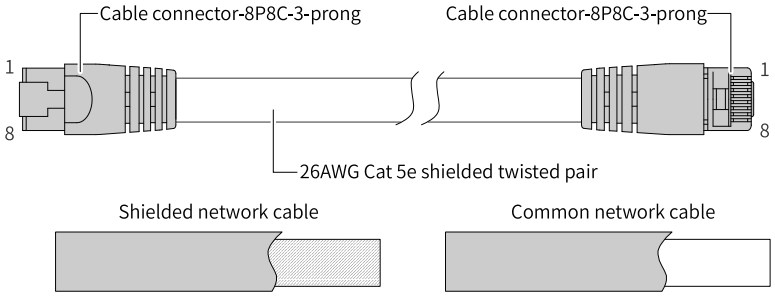
Note

Fix the cable near the product before EtherCAT communication to prevent the cable from being affected by other tension and ensure communication stability.

Cable specifications

Use shielded cables of Cat 5e and above for EtherCAT communication, as required below:

1. Cable requirements



2. Length requirements

   According to FastEthernet, when an EtherCAT bus is used, the length of the cable between devices cannot exceed 100 m. Otherwise, the signal will be attenuated, affecting communication.

3. Technical requirements

   100% continuity test without short circuit, open circuit, misalignment, or poor contact.

Use a shielded cable as the EtherCAT bus for network data transmission, with the following recommended specifications:

Item	Specification
Cable type	Flexible crossover cable, S-FTP, Cat 5e
Standard compliance	EIA/TIA568A, EN50173, ISO/IEC11801 EIA/TI Abulletin TSB, EIA/TIA SB40-A&TSB36
Cross sectional area	AWG26
Conductor type	Twisted pair
Number of pairs	4

4. Signal pin assignment

Pin	Signal (Ethernet 1000 Mbps)	Signal Direction	Description
1	TD+	Output	Data transmission +
2	TD-	Output	Data transmission -
3	RD+	Input	Data reception +
4	-(DC+*)	-(bidirectional)	Unused (data C+)
5	-(DC-)	-(bidirectional)	Unused (data C+)
6	RD-	Input	Data reception -
7	-(DD+)	-(bidirectional)	Unused (data D+)
8	-(DD-)	-(bidirectional)	Unused (data D-)

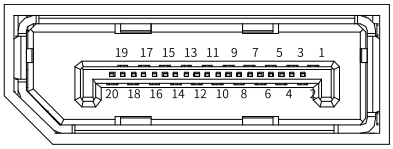
The definition of pins 4, 5, 7, and 8 under 1000 Mbps baud rate differs from that under 100 Mbps.

4.5 Display Port

The controller provides a standard display port (DP). The specifications of this port are as follows:

Item	Specification
Signal type	Digital DP
Maximum resolution	1920 x 1200 @60 Hz
Hot swap	Supported

Pins of the DP port are defined as follows:

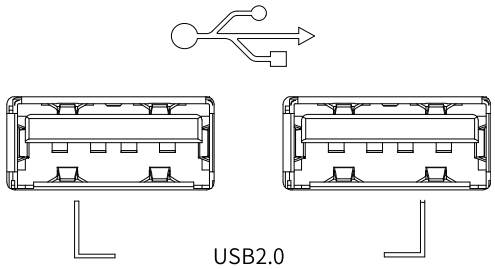


No.	Description	Function
1	ML_Lane 0(p)	Lane 0 of the main link: Differential signal
2	GND	-
3	ML_Lane 0(n)	Lane 0 of the main link: Differential signal
4	ML_Lane 1(p)	Lane 1 of the main link: Differential signal
5	GND	-
6	ML_Lane 1(n)	Lane 1 of the main link: Differential signal
7	ML_Lane 2(p)	Lane 2 of the main link: Differential signal
8	GND	-

No.	Description	Function
9	ML_Lane 2(n)	Lane 2 of the main link: Differential signal
10	ML_Lane 3(p)	Lane 3 of the main link: Differential signal
11	GND	-
12	ML_Lane 3(n)	Lane 3 of the main link: Differential signal
13	GND	-
14	GND	-
15	AUX_CH(p)	Auxiliary channel: Differential signal
16	GND	-
17	AUX_CH(n)	Auxiliary channel: Differential signal
18	Hot Plug	Hot swap detection
19	DP_PWR Return	DP power return signal
20	DP_PWR	Power supply: +3.3 V

4.6 USB Interface

The controller provides three USB 2.0 interfaces, as shown below:



USB interface specifications:

Item	Specification
Maximum communication rate	480 Mbps
Maximum output current at 5 V	500 mA
Maximum communication distance	5 m
Isolation	Not isolated

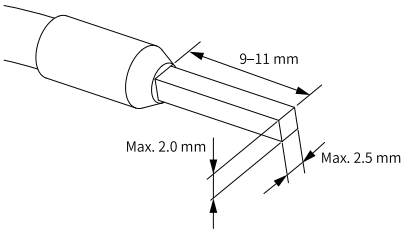
4.7 Cable Selection and Preparation

4.7.1 Cable Selection

- Power cable
  The cable lugs and diameters in the following table are only for reference.

Material Name	Applicable Cable Diameter		KST		Suzhou Yuanli	
	mm^2	AWG	Model	Crimping tool	Model	Crimping Tool
Tubular lug	0.3	22	E0308	KST2000L	0308	YAC-5
	0.5	20	E0508		0508	
	0.75	18	E7508		7508	
	1.0	18	E1008		1008	
	1.5	16	E1508		1508	

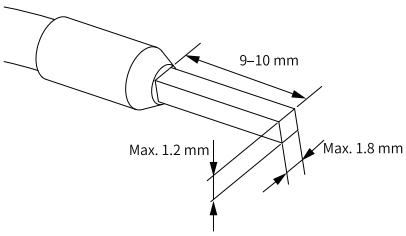
To use other types of tubular lugs, crimp the lug to the cables according to the shape and dimension requirements shown below.



- Communication cable
  The cable lugs and diameters in the following table are only for reference.

Material Name	Applicable Cable Diameter		KST		Suzhou Yuanli	
	mm^2	AWG	Model	Crimping Tool	Model	Crimping Tool
Tubular lug	0.3	22	E0308	KST2000L	0308	YAC-5
	0.5	20	E0508		0508	

To use other types of tubular lugs, crimp the lug to the cables according to the shape and dimension requirements shown below.

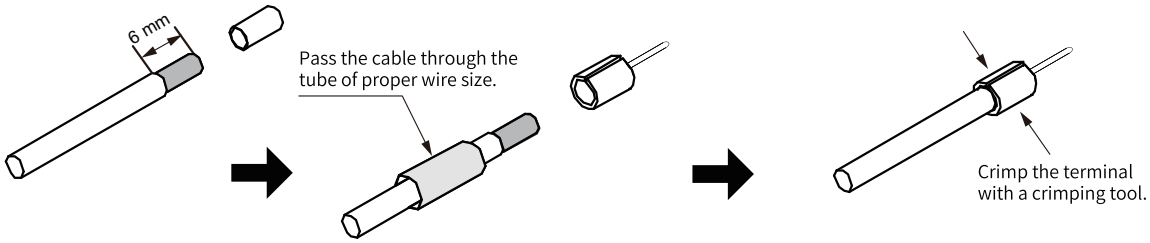


4.7.2 Cable Preparation

Cable with pin type lug

Preparation procedure:

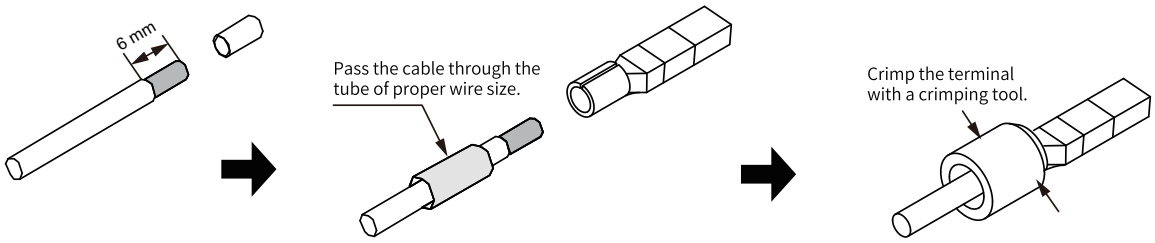
1. Strip the insulation layer to expose 6 mm of the conductor.
2. Pass the cable through the tube of proper wire size.
3. Insert the exposed conductor into the hole of the cable lug and then crimp it with a crimping tool recommended by the lug manufacturer.
4. Use a heat-shrinkable tube (Φ3) of 20 mm long to wrap the copper tube of the cable lug and then perform thermal shrinkage.
5. Insert the cable lug into the terminal block.



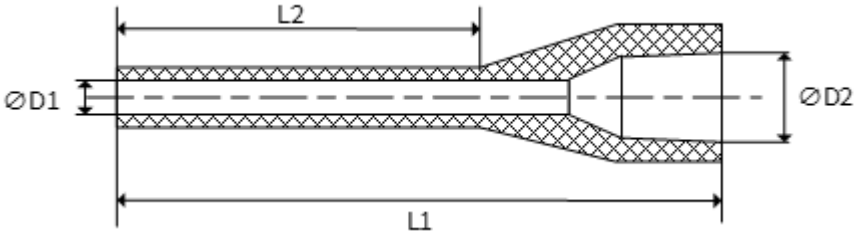
Cable with tubular lug

Preparation procedure:

1. Strip the insulation layer to expose 6 mm of the conductor.
2. Pass the cable through the tube of proper wire size.
3. Insert the exposed conductor into the hole of the cable lug and then crimp it with a crimping tool recommended by the lug manufacturer.
4. Insert the cable lug into the terminal block and fix it with a screwdriver. The maximum tightening torque is 0.45 N.m.



For the 2*6-pin dual-row connector used for I/O and communication, the requirements are as follows:



Category	Terminal Head Size	Length of Metal Part (L2)	Length of Stripped Part
Tubular head with sheath (max. conductor OD: 2.6 mm)	1.00 mm^2 [H1.0/18D]	12 mm	15 mm
	0.75 mm^2 [H0.75/18D]	12 mm	14 mm
	0.50 mm^2 [H0.5/16D]	10 mm	12 mm
	0.34 mm^2 [H0.34/12D]	8 mm	10 mm
	0.25 mm^2 [H0.25/12D]	8 mm	10 mm
	0.14 mm^2 [H0.14/12D]	8 mm	10 mm
Naked head	1.50 mm^2 [H1.5/10D]	10 mm	10 mm

Category	Terminal Head Size	Length of Metal Part (L2)	Length of Stripped Part
Tubular head with sheath (crimping two wires)	2 x 0.20 mm^2 [H0.5/16D]	10 mm	12 mm
	2 x 0.34 mm^2 [H0.5/16D]	12 mm	15 mm

5 Operation Instructions

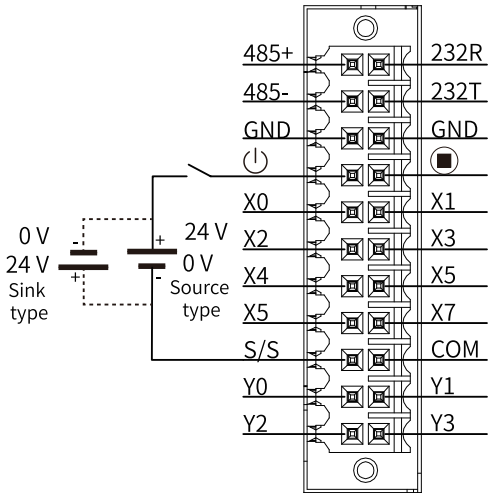
5.1 Power-On

Prerequisite: The controller has been powered off.

Procedure

The controller can be powered on in two ways:

- If the 24 V input power terminal is not connected, connect the 24 V power input.
- If the 24 V input power terminal is connected and the ON/OFF terminal is wired as shown below, power on the ON/OFF signal circuit for 1 second.



Warning

- Do not touch the terminals during power on. Failure to comply may result in electric shock.
- Do not disassemble this product, especially during power on or shortly after power off. Failure to comply may result in short circuits and other faults. In addition, sharp components and high temperatures inside the product may cause physical injury.
- Do not keep powering on the remote ON/OFF signal circuit. The input signal will repeatedly trigger the product to switch on and off.

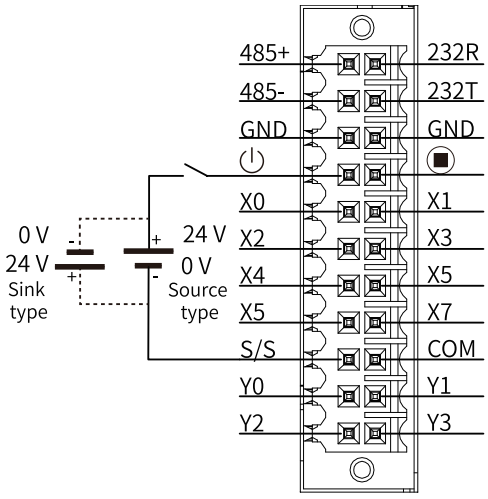
5.2 Power-Off

Prerequisite: The controller has been powered on.

Procedure

The controller can be powered off in three ways:

- Directly disconnect the 24 V input power.
- Enter the command "shutdown" on the Linux command line.
- If the ON/OFF terminal is wired as shown below, the controller can be powered off by powering on the ON/OFF signal circuit for 5 seconds.

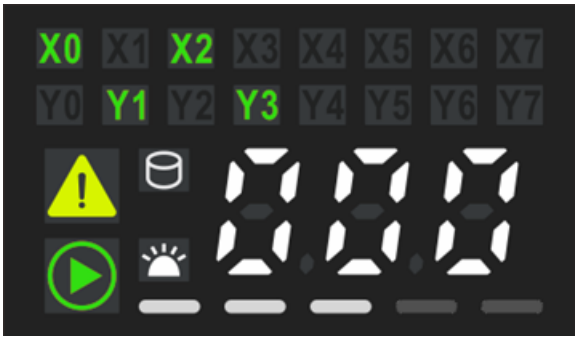


Caution

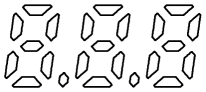
The product does not support rapid power-on and power-off. After power-off, ensure at least a 5-second interval before power-on. Failure to comply may result in unsuccessful power-on. In this case, power off and restart the product again.

5.3 Display

The display is shown below.



The following table describes the function of each display part.

Part	Function	Remark
	DI/DO status	ON: Green OFF: Not displayed
	Error code	White: The error code is displayed in white.
	SSD indicator	The indicator blinks when data is being read or written.
	Operation warning	Steady on (in yellow): Operation warning for user program or system.

Part	Function	Remark
	Error indicator (ERR)	Steady on (in red): Error alarm for user program or system.
	Running status indicator (RUN)	Blinking: The device is being identified. Steady on (in green): The user program is running.
	System identification indicator	Blinking: The PLC is identified.
	CPU usage	0 < CPU usage ⩽ 10: One LED indicator is on. 10 < CPU usage ⩽ 30: Two LED indicators are on. 30 < CPU usage ⩽ 60: Three LED indicators are on. 60 < CPU usage ⩽ 90: Four LED indicators are on. CPU usage > 90: Five LED indicators are on.

6 Programming and Debugging

For the programming and debugging process, see *Medium-Sized PLC Programming Software User Guide*, *Medium-Sized PLC Programming Guide (Motion Control)*, and *Medium-Sized PLC Programming Instructions*.

7 Maintenance and Troubleshooting

7.1 Periodical Maintenance and Inspection

Periodical inspection is required because the parts of the controller may deteriorate due to environmental conditions. The recommended interval is 6 to 12 months, which can be shortened according to the environmental conditions. If any item fails the inspection, take the corresponding solution.

No.	Item	Description	Criteria	Solution
1	Power supply	Measure the voltage through the power terminal block to see if the voltage variation is within the allowable range.	24 VDC (-15% to +20%)	Measure the voltage between terminals using a multimeter and keep the voltage variation within the allowable range.
2	Ambient environment	Ambient temperature (when the controller is located in a cabinet, the temperature in the cabinet is the ambient temperature).	-5°C to +55°C	Measure the ambient temperature using a thermometer and keep the ambient temperature within the range of -5°C to +55°C.
		Ambient humidity (when the controller is located in a cabinet, the humidity in the cabinet is the ambient humidity).	10% RH to 90% RH, without condensation	Measure the ambient humidity using a hygrometer and keep the ambient humidity within the range of 10% to 90% RH. If the temperature changes drastically, make sure there is no condensation.
		Direct sunlight	Not allowed	Provide a shelter.
		Dust, dirt, salt, and iron filings	Not allowed	Remove them and provide a shelter.
		Droplets of water, oil, and chemicals	Not allowed	Remove them and provide a shelter.
		Corrosive gas or flammable gas	Not allowed	Use an odor or gas sensor for detection.
		Vibration or shock to the controller	The vibration or shock to the controller should be within the specified resistance range.	Use cushioning materials for vibration and shock resistance.
		Interference sources	Not allowed	Keep the controller away from interference sources or take shielding measures.

No.	Item	Description	Criteria	Solution
3	Installation and wiring	Check whether the cable connectors are fully inserted and locked.	Avoid loose connection.	Fully insert the connector and lock it with screws.
		Check whether the external wiring screws are securely fastened.	Avoid loose connection.	Use a Phillips screwdriver to tighten the screws.
		Check whether the external wiring terminals are properly distanced.	Ensure a proper distance between terminals.	Check the distance visually and correct any improper distance.
		Check for broken external cables.	Avoid broken external cables.	Check cables visually and replace broken cables (if any).
4	Real-time clock battery (button battery)	Check whether the battery has exceeded the validity period or service life.	No alarm for low battery voltage is displayed on the controller.	The validity period of the battery at 25°C is 5 years. The service life of the battery is generally 0.75 to 5 years, depending on the model and ambient temperature. If the service life expires, replace the battery whether it can run normally or not. For the replacement method, see section *"7.2 Battery Installation and Removal" on page 44*.

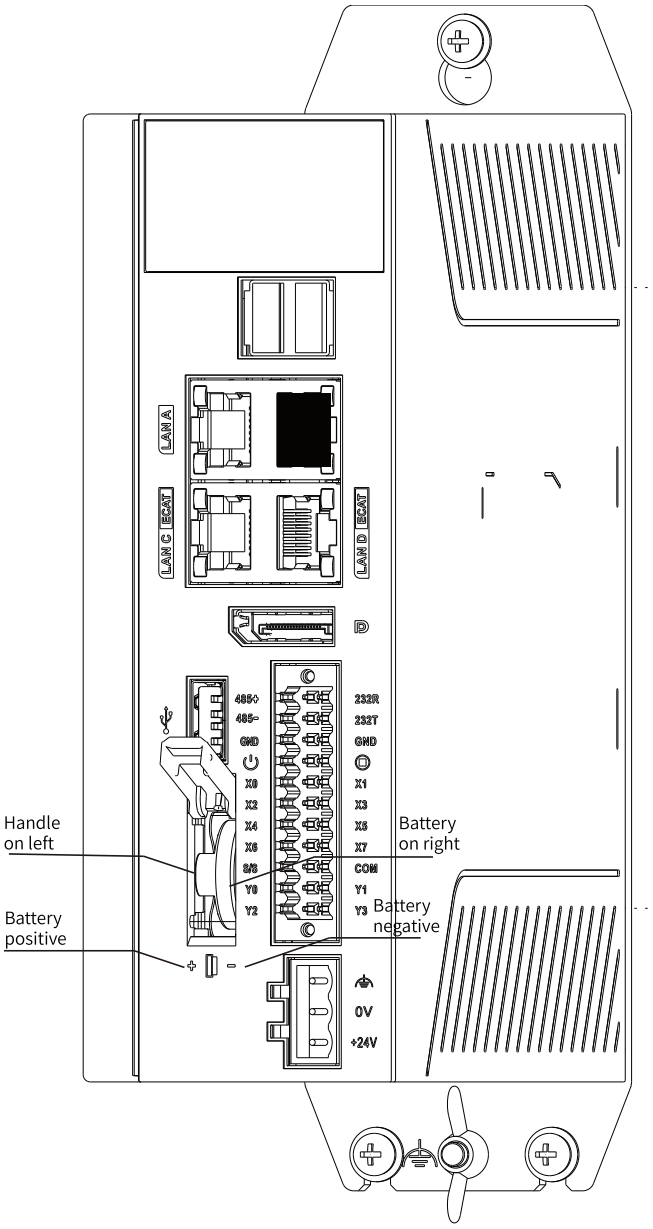
7.2 Battery Installation and Removal

Precautions

- Before installing or removing the battery, power off the controller.
- When installing the battery, check the label at the bottom of the battery to identify the positive and negative poles. Make sure the battery is located on the right of the battery handle to facilitate the next removal.
- After replacing the battery, you need to manually start the controller.
- After replacing the battery, power on the controller and check if the controller reports a battery error. If such an error is reported, check whether the battery is installed correctly.
- If the controller is powered on without reporting any error, recalibrate the system clock.
- Do not replace the battery in environments with potential explosion hazards such as gas, vapor, dust, or fibers.
- Dispose of the removed battery properly to avoid environmental pollution and physical injury.

Procedure

1. Open the battery cover clockwise.
2. Slowly pull out the battery handle in the direction perpendicular to the controller.



Caution

Do not pull the pull tab forcibly to prevent it from breakage.

3. Insert the new battery into the slot, flip the handle, and close the battery cover.

7.3 Maintenance of the Battery

Purpose of the battery

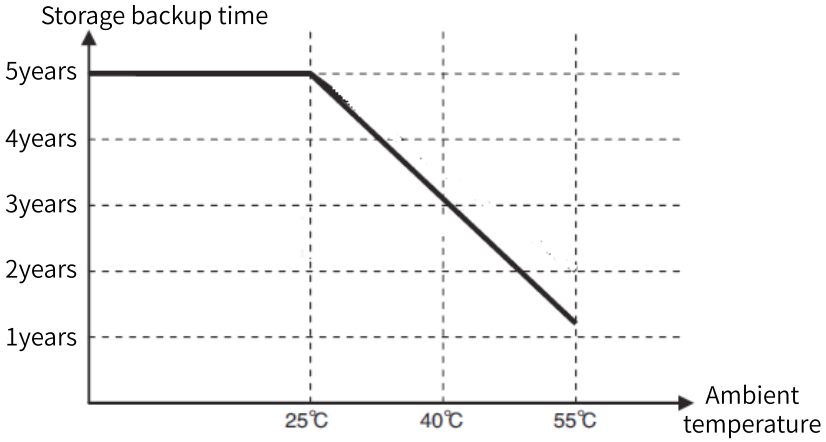
A battery is required for the RTC timing of the clock in the controller and for keeping the CMOS data when the power is off. If the battery is not installed or the battery is depleted, the clock will stop timing, and the BIOS CMOS data will be lost when the power is off.

Battery life and replacement interval

The actual life of the battery is related to the application scenario of the controller. The curve below shows the longest life and is for reference only.

When the controller prompts that the battery is abnormal, replace the battery in time to ensure that the clock function of the controller is normal.

When a time deviation is found, check the battery voltage and replace the battery in time.



* The storage backup time in the figure is for reference.

7.4 Upgrade Using the USB Flash Disk

PLC firmware upgrade

Procedure:

1. Obtain the PLC firmware upgrade package from Inovance.
2. Copy this package to the root directory of the USB flash disk, insert the USB flash disk to the USB interface of the PLC, and wait for the automatic upgrade.

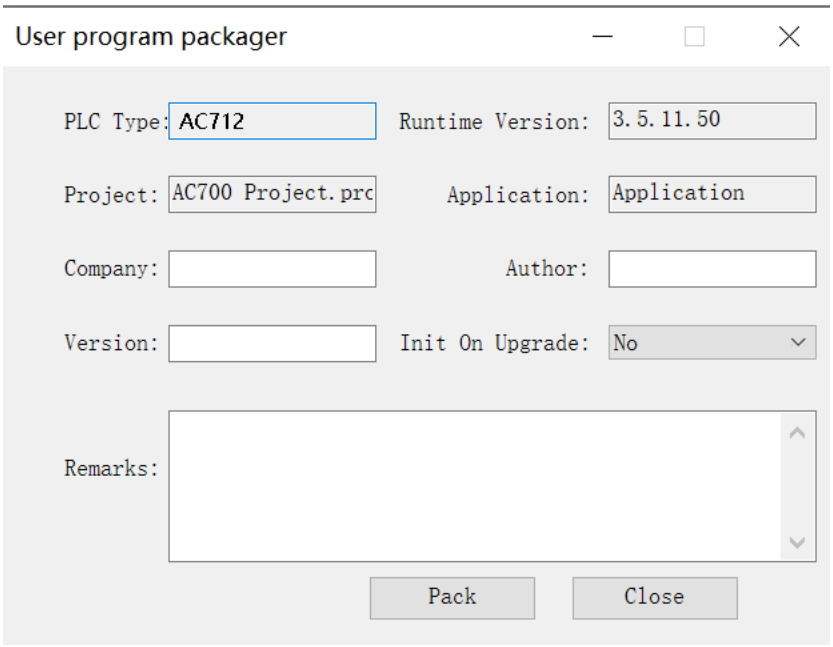
Note

- Do not modify the name of the PLC firmware upgrade package.
- Place the PLC firmware upgrade package only under the root directory of the USB flash disk.
- Before the upgrade is completed, do not remove the USB flash disk. Remove the disk only after the automatic restart following the upgrade.
- If you remove the USB flash disk before countdown, the upgrade will not start. The firmware upgrade starts after countdown. Removing the disk at this time will bring uncertainty to the upgrade result.
- Do not power off the controller during the firmware upgrade.

User program upgrade

Procedure:

1. Choose Compile > Pack User Program to generate a user program package.



PLC Type: Retain the default value.

Runtime Version: Retain the default value.

Application: Retain the default value.

Init On Upgrade: "Yes" indicates the data saved upon power failure will be initialized after upgrade; "No" indicates an upgrade without initialization.

2. Place the user program package under the root directory of the USB flash disk, insert the USB flash disk to the USB interface of the PLC, and wait for the automatic upgrade.

Note

- Place the user program package only under the root directory of the USB flash disk.
- Before the upgrade is completed, do not remove the USB flash disk.
- Do not power off the controller during the user program upgrade.

7.5 USB Flash Disk Operation

Note

The PLC needs to be in normal operation to complete the following operations.

Restoring the default IP address

If the IP address of the controller is unknown, restore the default IP address as follows:

1. Format the USB flash disk to FAT32 or NTFS.
2. Create an empty file "network.default" in the root directory of the USB flash disk.
3. Insert the USB flash disk into the controller and wait for the default IP address of the controller to be restored, which takes about 1 to 2 minutes. The default IP address of LAN A port is 192.168.1.88 and that of LAN B port is 192.168.2.88.

4. Use InoProShopTool to scan and modify the IP address by connecting the PC to the LAN A port of the controller.

Obtaining the IP address

If the IP address of the controller is unknown, obtain the IP address as follows:

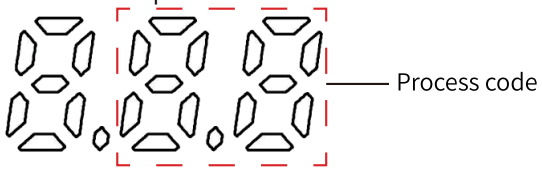
1. Format the USB flash disk to FAT32 or NTFS.
2. Create an empty file "network.info" in the root directory of the USB flash disk.
3. Insert the USB flash disk into the controller and wait for the IP address of the controller to be exported to the file "network.info", which takes about 1 to 2 minutes.

8 Appendix

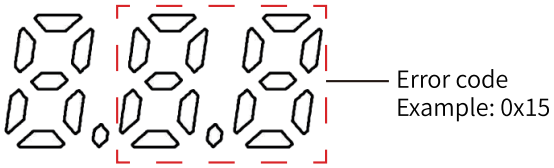
8.1 Process Codes and Error Codes During BIOS Startup

Note: BIOS process coding and error coding are independent of other error coding of the controller.

1. The following figure illustrates a BIOS process code:



2. The following figure illustrates a BIOS error code:



Note

The last two digits on the display screen correspond to the last two digits of the error code. For example, if the last two digits on the display screen are 15, it means that the error code is 0x15.

BIOS Code	Error Message
Process Code	
0x15	Pre-memory North Bridge initialization is started
0x19	Pre-memory South Bridge initialization is started
0x32	CPU post-memory initialization is started
0x3B	Post-Memory South Bridge initialization is started
0x4F	DXE IPL is started
0x60	DXE Core is started
0x61	NVRAM initialization
0x62	Installation of the South Bridge Runtime Services
0x69	North Bridge DXE initialization is started
0x70	South Bridge DXE initialization is started
0x72	South Bridge devices initialization
0x78	ACPI module initialization
0x79	CSM initialization
0x90	Boot Device Selection (BDS) phase is started
0x91	Driver connecting is started
0x92	PCI Bus initialization is started
0x93	PCI Bus Hot Plug Controller Initialization
0x94	PCI Bus Enumeration
0x95	PCI Bus Request Resources
0x96	PCI Bus Assign Resources
0x97	Console Output devices connect
0x98	Console input devices connect
0x99	Super IO Initialization

BIOS Code	Error Message
0x9A	USB initialization is started
0x9C	USB Detect
0x9D	USB Enable
0xA0	IDE initialization is started
0xA2	IDE Detect
0xAD	Ready To Boot event
0xAE	Legacy Boot event
0xB2	Legacy Option ROM Initialization
0xB4	USB hot plug
Error code (When a BIOS error occurs, contact the manufacturer.)	
0x0E	Microcode not found
0x0F	Microcode not loaded
0x50	Memory initialization error. Invalid memory type or incompatible memory speed
0x51	Memory initialization error. SPD reading has failed
0x52	Memory initialization error. Invalid memory size or memory modules do not match
0x2C	PEI_MEMORY_PRESENCE_DETECT Note: If the buzzer beeps consistently during startup, the memory is not installed properly or is not installed. Contact the manufacturer for a solution.
0x54	Unspecified memory initialization error
0x55	Memory not installed
0x56	Invalid CPU type or Speed
0x57	CPU mismatch
0x58	CPU self test failed or possible CPU cache error
0x59	CPU micro-code is not found or micro-code update is failed
0x5A	Internal CPU error
0x5B	reset PPI is not available
0x5C	PEI phase BMC self-test failure
0xAB	Setup Input Wait
0xD0	CPU initialization error
0xD1	North Bridge initialization error
0xD2	South Bridge initialization error
0xD3	Some of the Architectural Protocols are not available
0xD4	PCI resource allocation error. Out of Resources
0xD5	No Space for Legacy Option ROM
0xD6	No Console Output Devices are found
0xD7	No Console Input Devices are found
0xD8	Invalid password
0xD9	Error loading Boot Option (LoadImage returned error)
0xDA	Boot Option is failed (StartImage returned error)
0xDB	Flash update is failed
0xDC	Reset protocol is not available
0xDD	DXE phase BMC self-test failure
0xE8	S3 Resume Failed
0xE9	S3 Resume PPI not Found
0xEA	S3 Resume Boot Script Error
0xEB	S3 OS Wake Error
0xF8	Recovery PPI is not available

BIOS Code	Error Message
0xF9	Recovery capsule is not found
0xFA	Invalid recovery capsule
0xA1	Failed to switch BIOS to OS
0XA2	No BIOS data was received

8.2 Controller Related Error Codes

FPGA error codes

Error Code	Error Message	Solution
dE1	FPGA watchdog timeout	• If you can connect to the PLC by using the "ping+space+controller IP address" command and the version is earlier than 1.10.27.0, it is recommended to upgrade the firmware. • If you cannot, stop running the PLC program through external I/O and download the program again.

Runtime error codes

Runtime error codes for the AC700 series controller are the same as those for the AC800 series controller, indicated by the last two digits.

Error Code	Error Message	Solution
0x70	Modbus RTU0:Slave address setting error	Set a legal slave address.
0x71	Modbus RTU0:Frame length error	Modify the data frame.
0x72	Modbus RTU0:Illegal data address	Set a legal data address.
0x73	Modbus RTU0:CRC check failed	1 Ensure the termination resistor is properly configured. 2 Optimize wiring, such as eliminating potential interference sources.
0x74	Modbus RTU0:Illegal function	Check the slave parameters.
0x75	Modbus RTU0:Communication time out	1 Ensure the slave is working properly. 2 Ensure the connection is normal. 3 Ensure the termination resistor is properly configured. 4 Optimize wiring, such as eliminating potential interference sources.
0x76	Modbus RTU0:Illegal data value	Check the range of data written by slave.
0x77	Modbus RTU0:Buffer overflow	Check the range of data written by slave.
0x78	Modbus RTU0:Server device failure	Check the slave communication device.
0x79	Modbus RTU0:Serial port setting error	Ensure the communication configuration is correct.
0x80	Modbus RTU1:Slave address setting error	Set a legal slave address.
0x81	Modbus RTU1:Frame length error	Modify the data frame.
0x82	Modbus RTU1:Illegal data address	Set a legal data address.

Error Code	Error Message	Solution
0x83	Modbus RTU1:CRC check failed	1 Ensure the termination resistor is properly configured. 2 Optimize wiring, such as eliminating potential interference sources.
0x84	Modbus RTU1:Illegal function	Check the slave parameters.
0x85	Modbus RTU1:Communication time out	1 Ensure the slave is working properly. 2 Ensure the connection is normal. 3 Ensure the termination resistor is properly configured. 4 Optimize wiring, such as eliminating potential interference sources.
0x86	Modbus RTU1:Illegal data value	Check the range of data written by slave.
0x87	Modbus RTU1:Buffer overflow	Reduce communication load.
0x88	Modbus RTU1:Server device failure	Check the slave communication device.
0x89	Modbus RTU1:Serial port setting error	Ensure the communication configuration is correct.
Ethernet (Modbus TCP)		
0x90	Modbus TCP:Slave address setting error	Set a legal slave address.
0x91	Modbus TCP:Frame length error	Modify the data frame.
0x92	Modbus TCP:Illegal data address	Set a legal data address.
0x93	Modbus TCP:CRC check failed	1 Ensure the termination resistor is properly configured. 2 Optimize wiring, such as eliminating potential interference sources.
0x94	Modbus TCP:Illegal function	Check the slave parameters.
0x95	Modbus TCP:Communication time out	1 Ensure the slave is working properly. 2 Ensure the connection is normal. 3 Ensure the termination resistor is properly configured. 4 Optimize wiring, such as eliminating potential interference sources.
0x96	Modbus TCP:Illegal data value	Check the range of data written by slave.
0x97	Modbus TCP:Buffer overflow	Reduce communication load.
0x98	Modbus TCP:Server device failure	Check the slave communication device.
0x9A	Modbus TCP:Destination XX is unreachable	1 Ensure the slave is working properly. 2 Ensure the connection is normal. 3 Ensure the master hardware is working properly. 4 Optimize wiring, such as eliminating potential interference sources.
0x9B	Modbus TCP:Protocol identifier error	Check the protocol identifier.
CPU errors		
0x21	System:Runtime crashed	1 Power on the controller again. 2 Contact the agent or Inovance.
0x22	System:Comm.Timeout between PLC & LCD Panel	1 Power on the controller again. 2 Contact the agent or Inovance.
0x24	Battery voltage is too low or battery is in reverse	Replace the battery or reinstall it properly.

Error Code	Error Message	Solution
0x25	Fan is broken or not installed	Check for fan fault
0x26	The communication between daemon process and application program operation environment times out	1 Correct the application program and restart the PLC. Download and execute the program again. 2 Obtain program run logs through the diagnostic window. 3 Collect log information and analyze it through InoproShopTool.
0x27	Application exception!	Check and update the application program.
0x28	Load bootproject fail!	Check the startup project.
0x2E	ProcessorLoad exception	Check the application task configuration
0x2F	Network open failed	1 Power on the controller again. 2 Contact the agent or Inovance.
Authentication errors		
0x23	Authentication failed, please contact the supplier!	1 Power on the controller again. 2 Contact the agent or Inovance.
Memory errors		
0x31	Memory init fail	Return the device for repair.
Register errors		
0x29	FPGA PCIE offline and online again	1 Record exceptions and provide feedback to Inovance developers. 2 Analyze EMC issues on site.

8.3 EtherCAT Related Error Codes

The EtherCAT error codes are independent and do not conflict with other error codes of the controller. All the EtherCAT error codes start with "E".

Error Code	Error Message	Solution
E01	Master communication error, data loss exceeding 100 consecutive frames.	1 Check if the network cable connection between the master and slave is down. 2 Check that the connection to OUT port of the slave is correct. 3 Check that the network cable is connected properly. 4 Check that the network cable connector is wrapped in metal. 5 Check that the network cable meets the specification requirements for Cat5e cables. 6 Check that the device is properly grounded. 7 On the master, set xRestart to TRUE to restart the bus. 8 Power off and restart the PLC and slave.
E02	Partial slaves are offline and the number of online slaves does not match the configured number.	Check if the slave is powered off and if the network cable is disconnected.
E03	The DC clock is abnormal and the reference clock remains unchanged.	Check if the reference clock slave is disconnected.

Error Code	Error Message	Solution
E04	Failed to open the network card.	1 Check the network interface configuration. 2 Restart the PLC. 3 Replace the PLC.
E05	Failed to open the redundant network card.	1 Check the network interface configuration. 2 Restart the PLC. 3 Replace the PLC.
E06	Failed to open the redundant network card: the redundancy function is incorrectly configured on the same network card.	1 Restart the PLC. 2 Replace the PLC.
E07	Slave initialization error: slave does not exist during startup, or communication cannot be established.	1 Check if the network cable connection between the master and slave is down. 2 Check if the network cable connection between slave stations is disconnected, poorly connected, or experiencing hardware failure. 3 Check if the slaves are interconnected at OUT ports. 4 Use EtherCAT scanning function to locate the faulty slave. 5 Power off and restart all slaves.
E08	Vendor ID mismatch: the configured value does not match the actual one.	1 Use EtherCAT scanning function to compare configuration with scanning results. 2 Power off and restart the slave that the master failed to access.
E09	Product ID mismatch, the configured value does not match the actual one, or the master failed to read the slave's product ID.	1 Use EtherCAT scanning function to compare configuration with scanning results. 2 Power off and restart the slave which the master failed to access.
E0A	Number of slaves mismatch, the configured number of slaves exceeds the actual ones.	Use EtherCAT scanning function to compare configuration with scanning results.
E0B	Failed to download EtherCAT SDO.	See the slave device user guide to find the error cause and the solution in "Return Error Code" section.
E0C	SDO downloading timeout	1 Check the network connection status of the slave. 2 Check user programs, reduce the scheduling times of SDO, EOE, and SOE function blocks to reduce the communication load.
E0D	Slave emergency event error	See the slave device user guide to find the error cause in "Emergency Event Error Code", "Error Register", and "Manufacturer Custom Error Code" sections.
E0E	Failed to download EtherCAT SOE.	1 See the slave device user guide to find the error cause in "Return Error Code" section. 2 Reconnect the slave to the network.
E0F	SOE downloading timeout	1 Check the network connection status of the slave. 2 Check user programs, and reduce the number and frequency of SDO, EOE, and SOE function blocks.

Error Code	Error Message	Solution
E10	Master request state machine timeout	1 In the overview interface of EtherCAT master, check the network cable connection status and the slaves with a non-zero receive error counter value. 2 Check that the device is properly grounded. 3 Restart EtherCAT master. 4 Replace the slave device.
E20	Slave alias address conflict: multiple slaves in the actual network are configured with the same alias address.	In the EtherCAT scanning interface, reconfigure the alias address of the conflicting slaves. After successful writing, power off and restart the slaves to take effect.
E21/E12D (E2D)	IN/OUT connection error between slaves	1 Check if the slaves are interconnected at OUT ports. 2 Connect the OUT port of the slave to the master.
E22	EEPROM access failed: master failed to access EEPROM of the slave during startup.	Power off and restart the slave.
E30	Continuous frame drop error	1 Check that the network cable is connected. 2 Replace the network cable. 3 Replace the slave. 4 Add a magnetic ring or replace with a higher-grade network cable.
E31	Slave connection disconnected	1 Check that the network cable connector is connected properly. 2 Check that the network cable is connected. 3 Replace the network cable.
E32	Occasional frame drop warning	1 Replace the network cable. 2 Replace the current or the previous slave. 3 Add a magnetic ring or replace with a higher-grade network cable.
E64	Failed to switch the communication status	1 Power on the controller again. 2 Contact the agent or Inovance.
E65	Slave unspecified error	1 Power on the controller again. 2 Contact the agent or Inovance.
E66	Slave mailbox memory allocation failed	1 Power on the controller again. 2 Contact the agent or Inovance.
E6A	Firmware mismatch: the slave firmware version EEPROM storage information is inconsistent.	Replace the firmware program.
E6B	Failed to upgrade slave firmware.	Check the master state machine switchover request process; cross-level requests to change the slave state machine are prohibited.
E75	State machine error	Check the master state machine switchover request process; cross-level requests to change the slave state machine are prohibited.
E76	The slave received an unknown state change request.	Check the master state machine switchover request process; cross-level requests to change the slave state machine are prohibited.

Error Code	Error Message	Solution
E77	State machine error: the slave does not support boot mode.	1 Power on the controller again. 2 Contact the agent or Inovance.
E78	Invalid firmware program	1 Power on the controller again. 2 Contact the agent or Inovance.
E79	Mailbox configuration error is detected in the slave boot state.	1 Power on the controller again. 2 Contact the agent or Inovance.
E7A	The mailbox configuration is incorrect. The slave pre-running state detects that the mailbox configuration is incorrect	1 Power on the controller again. 2 Contact the agent or Inovance.
E7B	Sync manager error: invalid sync manager configuration is detected in the slave.	1 Power on the controller again. 2 Contact the agent or Inovance.
E7C	Input data invalid	Reconfigure slave input PDO data.
E7D	Output data invalid	Reconfigure slave output PDO data.
E7E	Sync error	1 Power on the controller again. 2 Contact the agent or Inovance.
E7F	Sync manager watchdog timeout	1 Power on the controller again. 2 Contact the agent or Inovance.
E80	Sync manager type invalid	1 Power on the controller again. 2 Contact the agent or Inovance.
E81	Output PDO configuration invalid	The slave does not support the configuration quantity of output PDO object dictionary. Adjust the output PDO.
E82	Input PDO configuration invalid	The slave does not support the configuration quantity of output PDO object dictionary. Adjust the input PDO.
E83	Watchdog configuration invalid	1 Power on the controller again. 2 Contact the agent or Inovance.
E84	Slave needs cold restart.	1 Power on the controller again. 2 Contact the agent or Inovance.
E85	Slave needs initialization status.	1 Power on the controller again. 2 Contact the agent or Inovance.
E86	Slave needs pre-operational status.	1 Power on the controller again. 2 Contact the agent or Inovance.
E87	Slave needs safe-operational status.	1 Power on the controller again. 2 Contact the agent or Inovance.
E88	Input mapping invalid: the slave does not support input PDO parameter configuration.	1 Check if input PDO object dictionary entries do not match the slave firmware program. 2 Check if Vendor ID verification is disabled in slave configuration and check if Product ID is inconsistent between slave configuration and actual hardware.

Error Code	Error Message	Solution
E89	Output mapping invalid: the slave does not support output PDO parameter configuration.	1 Check if output PDO object dictionary entries do not match the slave firmware program. 2 Check if Vendor ID verification is disabled in slave configuration and check if Product ID is inconsistent between slave configuration and actual hardware.
E8A	Slave settings inconsistent	1 Power on the controller again. 2 Contact the agent or Inovance.
E8B	Mode configuration error: the slave does not support free-run mode.	1 Power on the controller again. 2 Contact the agent or Inovance.
E8C	Mode configuration error: the slave does not support synchronization mode.	1 Power on the controller again. 2 Contact the agent or Inovance.
E8E	Parameter configuration error: the slave free-run mode requires configuration of three buffers.	1 Power on the controller again. 2 Contact the agent or Inovance.
E8F	Input and output invalid	1 Power on the controller again. 2 Contact the agent or Inovance.
E90	DC synchronization error: the watchdog timed out for Sync0 in slave DC mode	1 Power on the controller again. 2 Contact the agent or Inovance.
E91	DC synchronization error: no Sync0 interrupt signal is detected during the switchover from slave safety mode to operation mode.	1 Power on the controller again. 2 Contact the agent or Inovance.
E92	DC synchronization error: the slave synchronization cycle time is too short.	1 Power on the controller again. 2 Contact the agent or Inovance.
E94	DC synchronization configuration invalid	1 Power on the controller again. 2 Contact the agent or Inovance.
E95	DC latch configuration invalid	1 Power on the controller again. 2 Contact the agent or Inovance.
E96	PLL error: slave synchronization lost, master failure detected.	1 The slave reconnects after network disconnection, and the error is automatically reset. 2 The bus cycle is unreasonable, recommended parameters: 125us to 8000us; the master synchronization offset is unreasonable, adjustment range: -50% to -50%.
E97	DC Invalid	1 Power on the controller again. 2 Contact the agent or Inovance.
E98	DC timeout error	1 Power on the controller again. 2 Contact the agent or Inovance.
E99	Synchronization cycle time error	1 Power on the controller again. 2 Contact the agent or Inovance.
E9A	Sync0 configuration error: the Sync0 cycle of the slave is out of range.	Adjust the DC cycle setting of Sync0.
E9B	Sync1 configuration error: the Sync1 cycle of the slave is out of range.	Adjust the DC cycle setting of Sync1.

Error Code	Error Message	Solution
EA5	Slave MBX_AOE error	1 Power on the controller again. 2 Contact the agent or Inovance.
EA6	Slave MBX_EOE error	1 Power on the controller again. 2 Contact the agent or Inovance.
EA7	Slave MBX_COE error	1 Power on the controller again. 2 Contact the agent or Inovance.
EA8	Slave MBX_FOE error	1 Power on the controller again. 2 Contact the agent or Inovance.
EA9	Slave MBX_SOE error	1 Power on the controller again. 2 Contact the agent or Inovance.
EB3	Slave MBX_VOE error	1 Power on the controller again. 2 Contact the agent or Inovance.
EB4	Slave EEPROM address not accessible	Change the EEPROM access address or data length.
EB5	Slave EEPROM error	1 Power on the controller again. 2 Contact the agent or Inovance.
EB6	Slave external hardware not ready	1 Power on the controller again. 2 Contact the agent or Inovance.
EC4	Slave restarted locally	1 Power on the controller again. 2 Contact the agent or Inovance.
ED4	Slave configuration error: the mounted module configuration of the slave coupler does not match the actual setup.	Use EtherCAT scanning function to compare the project configuration with scanning results.

8.4 Other Display Codes

Screen Display Code	Description
P.OF	The controller is saving data upon power failure.
U.UU	InoProshopTool is upgrading board firmware.
U.CC	InoProshopTool successfully upgraded board firmware.
P.UU	The application is being upgraded through the USB drive.
P.CC	The application was successfully upgraded through the USB drive.
P.Er	Failed to upgrade the application through the USB drive.
F.UU	The board firmware is being upgraded through the USB drive.
F.CC	The board firmware was successfully upgraded through the USB drive.
F.Er	Failed to upgrade the board firmware through the USB drive.

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Shenzhen Inovance Technology Co., Ltd.

www.inovance.com

Add.: Inovance Headquarters Tower, High-tech Industrial Park,
Guanlan Street, Longhua New District,
Shenzhen 518000, P.R. China
Tel: (0755) 2979 9595 Fax: (0755) 2961 9897

Suzhou Inovance Technology Co., Ltd.

www.inovance.com

Add.: No.52, Tian E Dang Road, Wuzhong District,
Suzhou 215104, P.R. China
Tel: (0512) 6637 6666 Fax: (0512) 6285 6720