TM700 Series Programmable Controller

User Manual

SHENZHEN INVT ELECTRIC CO., LTD.

Preface

Overview

Thank you for choosing TM700 series programmable controller (programmable controller for short).

The TM700 series programmable controllers are a new generation of medium PLC products independently developed by INVT, which support EtherCAT bus, Ethernet bus, RS485, on-board high-speed I/O interfaces, and up to 16 local expansion modules. Additionally, functions such as CANopen/4G can be expanded through extension cards.

The manual mainly introduces the installation and wiring of the product, including product information, mechanical installation, and electrical installation.

Read through this manual carefully before installing the programmable controller. For details about the user program development environments and user program design methods, see INVT Medium and Large PLC Programming Manual and INVT Medium and Large PLC Software Manual.

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

Audience

Personnel with electrical professional knowledge (such as qualified electrical engineers or personnel with equivalent knowledge).

About documentation obtaining

This manual is not delivered along with the product. To obtain an electronic version of the PDF file, you can:

Visit www.invt.com, choose **Support** > **Download**, enter a keyword, and click **Search**.

Scan the QR code on the product housing→Enter a keyword and download the manual.

Change history

The manual is subject to change irregularly without prior notice due to product version upgrades or other reasons.

No.	Change description	Version	Release date
1	First release.	V1.0	August 2024

Contents

1 Safety precautions

1.1 Safety declaration

Read this manual carefully and follow all the safety precautions before moving, installing, wiring, commissioning and running the programmable controller. Otherwise, equipment damage or physical injury or death may be caused.

We shall not be liable or responsible for any equipment damage or physical injury or death caused due to failure to follow the safety precautions.

1.2 Safety level definition

To ensure personal safety and avoid property damage, you must pay attention to the warning symbols and tips in the manual.

Warning symbols	Name	Description
	Danger	Severe personal injury or even death can result if related requirements are not followed.
	Warning	Personal injury or equipment damage can result if related requirements are not followed.

1.3 Personnel requirements

Trained and qualified professionals: People operating the equipment must have received professional electrical and safety training, and must be familiar with all steps and requirements of equipment installing, commissioning, running and maintaining and capable to prevent any emergencies according to experiences.

1.4 Safety guidelines

General principles	
	● Only trained and qualified professionals are allowed to carry out related operations. ● Do not perform wiring, inspection or component replacement when power supply is applied.

Delivery and installation	
	● Do not install the product on inflammables. In addition, prevent the product from contacting or adhering to inflammables. ● Install the product 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 product if it is damaged or incomplete. ● Do not contact the product with damp objects or body parts. Otherwise, electric shock may result.

Wiring	
	● Fully understand the interface types, specifications, and related requirements before wiring. Otherwise, incorrect wiring cause abnormal running. ● Before power-on for running, ensure that each module terminal cover is properly installed in place after the installation and wiring are completed. This prevents a live terminal from being touched. Otherwise, physical injury, equipment fault or misoperation may result. ● Install proper protection components or devices when using external power supplies for the product. This prevents the programmable controller from being damaged due to external power supply faults, overvoltage, overcurrent, or other exceptions.

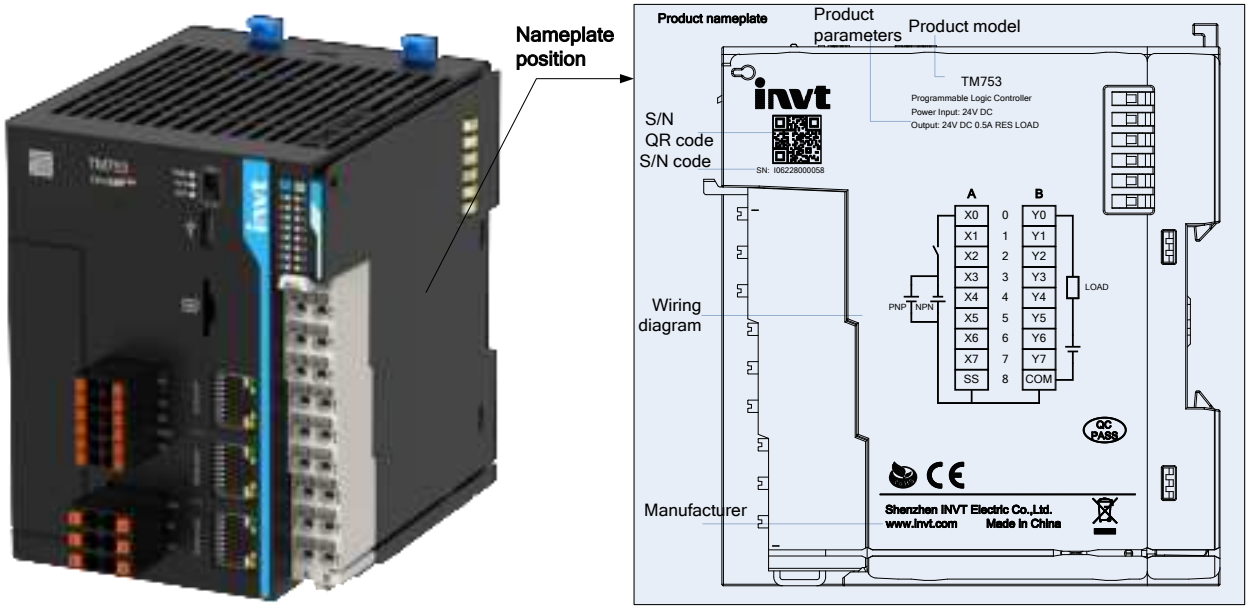
Commissioning and running	
	● Before power-on for running, ensure that the working environment of the product meets the requirements, the input power specifications meet the requirements, the wiring is correct, and a protection circuit has been designed to protect the product so that the product can 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.

Maintenance and component replacement	
	● During maintenance and component replacement, take measures to prevent screws, cables and other conductive matters from falling into the internal of the product.

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

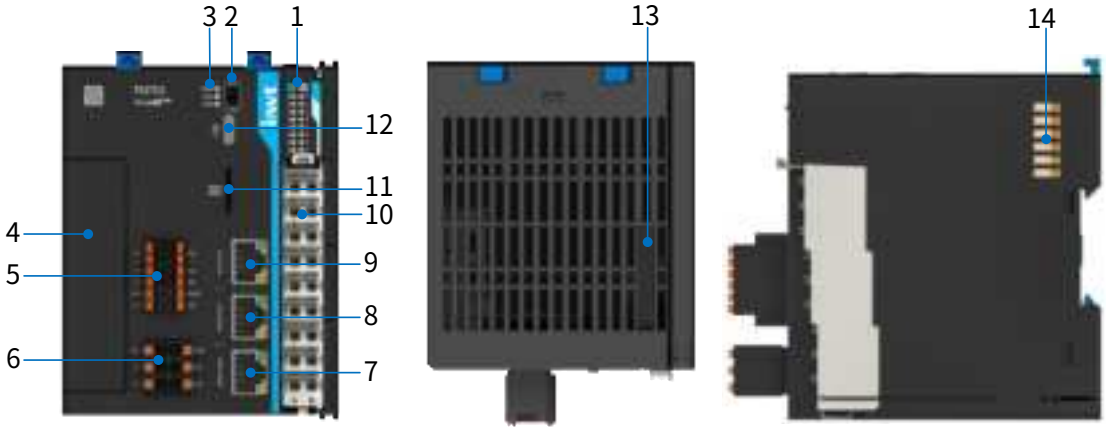
2 Product overview

2.1 Product nameplate and model



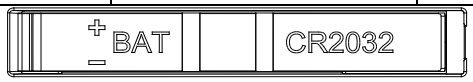
Model	Specifications
TM750	Finished controller; medium PLC; EtherCAT; 4 axes; 2×Ethernet; 2×RS485; 8 inputs and 8 outputs.
TM751	Finished controller; medium PLC; EtherCAT; 8 axes; 2×Ethernet; 2×RS485; 8 inputs and 8 outputs.
TM752	Finished controller; medium PLC; EtherCAT; 16 axes; 2×Ethernet; 2×RS485; 8 inputs and 8 outputs.
TM753	Finished controller; medium PLC; EtherCAT; 32 axes; 2×Ethernet; 2×RS485; 8 inputs and 8 outputs.

2.2 Interface description



No.	Port type	Interface sign	Definition	Description
1	I/O indicator	-	I/O state display	On: The input/output is valid. Off: The input/output is invalid.

No.	Port type	Interface sign	Definition	Description
2	Start/stop DIP switch	RUN	User program running state	Turn to RUN: The user program runs. Turn to STOP: The user program stops.
		STOP		
3	Operation status indicator	PWR	Power state display	On: The power supply is normal. Off: The power supply is abnormal.
		RUN	Running state display	On: The user program is running. Off: The user program stops.
		ERR	Running error state display	On: A serious error occurs. Flash: A general errors. Off: No error occurs.
4	Expansion card slot	-	Expansion card slot, used for function extension.	See section Appendix A Expansion card accessories.
5	RS485 interface	R1	Channel 1 terminal resistor	Built-in 120Ω resistor; short-circuit indicates the connection of a 120Ω terminal resistor.
		A1	Channel 1 485 communication signal+	-
		B1	Channel 1 485 communication signal-	-
		R2	Channel 2 terminal resistor	Built-in 120Ω resistor; short-circuit indicates the connection of a 120Ω terminal resistor.
		A2	Channel 2 485 communication signal+	-
		B2	Channel 2 485 communication signal-	-
		GND	RS485 communication signal reference ground	-
		PE	PE	-
6	Power interface	24V	DC 24V power supply+	-
		0V	DC 24V power supply-	-
		PE	PE	-
7	Ethernet port	Ethernet2	Ethernet communication interface	Default IP: 192.168.2.10 Green indicator on: It indicates that the link has been established successfully. Green indicator off: It indicates that the link is not established. Yellow indicator flashing: It indicates that communication is in progress. Yellow indicator off: It indicates that there is no communication.

No.	Port type	Interface sign	Definition	Description
8	Ethernet port	Ethernet1	Ethernet communication interface	Default IP: 192.168.1.10 Green indicator on: It indicates that the link has been established successfully. Green indicator off: It indicates that the link is not established. Yellow indicator flashing: It indicates that communication is in progress. Yellow indicator off: It indicates that there is no communication.
9	EtherCAT interface	EtherCAT	EtherCAT communication interface	Green indicator on: It indicates that the link has been established successfully. Green indicator off: It indicates that the link is not established. Yellow indicator flashing: It indicates that communication is in progress. Yellow indicator off: It indicates that there is no communication.
10	I/O terminal	-	8 inputs and 8 outputs	For details, see section 4.2 I/O terminal wiring.
11	MicroSD card interface	-	-	Used for firmware programming, file reading and writing.
12	Type-C interface		Communication between USB and PC	Used for program download and debugging. Default IP: 192.168.3.10
13	Button battery slot	CR2032	RTC clock button battery slot	Applicable to CR2032 button battery
 **Note:** The product is not equipped with the button battery as standard configuration by default. The button battery is user purchased, and the model is CR2032.				
14	Backplane connector	-	Local expansion backplane bus	Connected to the local expansion modules

2.3 Product specifications

2.3.1 General specifications

Item	TM750	TM751	TM752	TM753
Ethernet interface	2 channels	2 channels	2 channels	2 channels
EtherCAT interface	1 channel	1 channel	1 channel	1 channel
Max. number of axes (bus+pulse)	4 axes + 4 axes	8 axes + 4 axes	16 axes + 4 axes	32 axes + 4 axes
RS485 bus	2 channels, supporting Modbus RTU master/slave function and free port			

Item	TM750	TM751	TM752	TM753
	function.			
EtherNet bus	Supports Modbus TCP, OPC UA, TCP/UDP, program upload and download, and firmware upgrade.			
Type-C interface	1 channel, supporting program upload and download, and firmware upgrade.			
DI	8 inputs originally, including 200kHz high-speed inputs			
DO	8 outputs originally, including 200kHz high-speed outputs			
Pulse axis	Supports up to 4 channels			
Input power	24VDC (-15%–+20%)/2A, supporting reversal protection			
Standalone power consumption	<10W			
Backplane bus power supply	5V/2.5A			
Power-failure protection function	Supported **Note:** Power-down retention is not performed within 30 seconds after power-on.			
Real-time clock	Supported			
Local expansion modules	Up to 16, disallowing hot swapping			
Local expansion card	One expansion card, supporting CANopen card, 4G IoT card and so on.			
Program language	IEC61131-3 programming languages (SFC, LD, FBD, ST, IL, CFC)			
Program download	Type-C interface, Ethernet port, MicroSD card, remote download (4G IoT expansion card)			
Program data capacity	20MByte user program 64MByte custom variables, with 1MByte supporting power-down retention			
Product weight	Approx. 0.35 kg			
Dimension dimensions	See section Appendix B Dimension drawings.			

2.3.2 DI input specifications

Item	Description
Input type	Digital input
Number of input channels	8 channels
Input mode	Source/sink type
Input voltage class	24VDC (-10%–+10%)
Input current	X0–X7 channels: Input current is 13.5mA when ON (typical value), and less than 1.7mA when OFF.
Max. input frequency	X0–X7 channels: 200kHz;
Input resistance	Typical value of X0–X7 channels: 1.7kΩ
ON voltage	≥15VDC
OFF voltage	≤5VDC
Isolation method	Integrated chip capacitive isolation
Common terminal method	8 channels/common terminal
Input action display	When the input is in the driving state, the input indicator is on (software control).

2.3.3 DO output specifications

Item	Description
Output type	Transistor output
Number of output channels	8 channels
Output mode	Sink type
Output voltage class	24VDC (-10%–+10%)
Output load (resistance)	0.5A/point, 2A/8 points
output load (inductance)	7.2W/point, 24W/8 points
Hardware response time	⩽2μs
Load current requirement	Load current ⩾ 12mA when output frequency is greater than 10kHz
Max. output frequency	200kHz for resistance load, 0.5Hz for resistance load, and 10Hz for light load
Leakage current at OFF	Below 30μA (current value at a typical voltage of 24VDC)
Max. residual voltage at ON	⩽0.5VDC
Isolation method	Integrated chip capacitive isolation
Common terminal method	8 channels/common terminal
Short-circuit protection function	Supported
External inductive load requirement	Flyback diode needed for external inductive load connection. Refer to Figure 2-1 for wiring diagram.
Output action display	When the output is valid, the output indicator is on (software control).
Output derating	The current at each group of common terminal cannot exceed 1A when the ambient temperature is 55°C. Refer to Figure 2-2 for the curve of derating coefficient.

Figure 2-1 Inductive load flyback diode connection

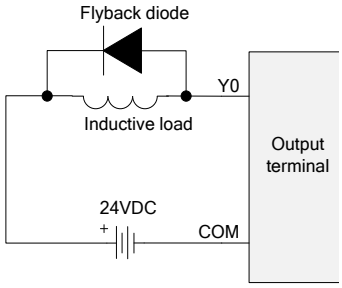
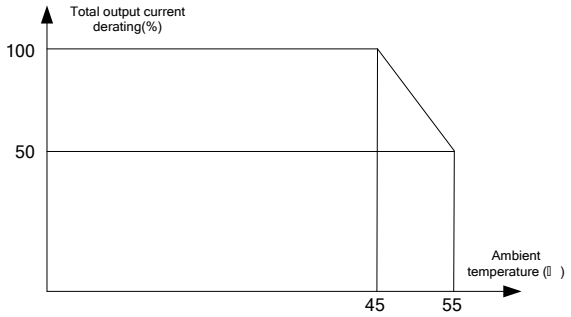


Figure 2-2 Output current derating curve



2.3.4 RS485 specifications

Item	Description
Supported channels	2 channels
Hardware interface	In-line terminal (2×6Pin terminal)
Isolation method	Integrated chip capacitive isolation
Terminal resistor	Built-in 120Ω terminal resistor, selectable by shorting R1 and R2 on the 2×6 PIN in-line terminal.
Number of slaves	Each channel supports up to 31 slaves
Communication baud rate	9600/19200/38400/57600/115200bps
Input protection	Supports 24V misconnection protection

2.3.5 EtherCAT specifications

Item	Description
Communication protocol	EtherCAT
Supported services	CoE (PDO/SDO)
Synchronization method	Distributed clocks for the servo; I/O adopts input and output synchronization
Physical layer	100BASE-TX
Baud rate	100Mbps (100Base-TX)
Duplex mode	Full duplex
Topology structure	Linear topology structure
Transmission medium	Category-5 or higher network cables
Transmission distance	The distance between two nodes is less than 100m.
Number of slaves	Supports up to 72 slaves
EtherCAT frame length	44 bytes–1498 bytes
Process Data	Up to 1486 bytes for single Ethernet frame

2.3.6 Ethernet specifications

Item	Description
Communication protocol	Standard Ethernet protocol
Physical layer	100BASE-TX
Baud rate	100Mbps (100Base-TX)
Duplex mode	Full duplex
Topology structure	Linear topology structure
Transmission medium	Category-5 or higher network cables
Transmission distance	The distance between two nodes is less than 100m.

3 Mechanical installation

3.1 Installation environment requirements

When installing this product on a DIN rail, full consideration should be given to operability, maintainability, and environmental resistance before installation.

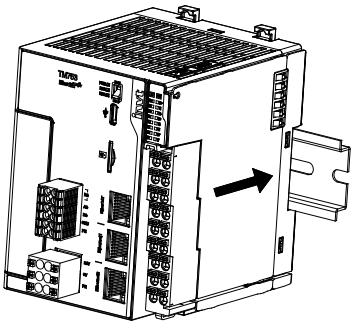
Item	Specification
IP class	IP20
Pollution level	Level 2: Generally there is only non-conductive pollution, but you shall consider transient conductivity accidentally caused by condensation.
Altitude	⩽2000m(80kPa)
Overcurrent protection device	3A fuse
Max. working temperature	45°C in full load. Derating is required when the ambient temperature is 55°C. For details, see Figure 2-2.
Storage temperature and humidity range	Temperature: -20°C–+60°C; relative humidity: less than 90%RH and no condensation
Transportation temperature and humidity range	Temperature: -40°C–+70°C; relative humidity: less than 95%RH and no condensation
Working temperature and humidity range	Temperature: -20°C–+55°C; relative humidity: less than 95%RH and no condensation

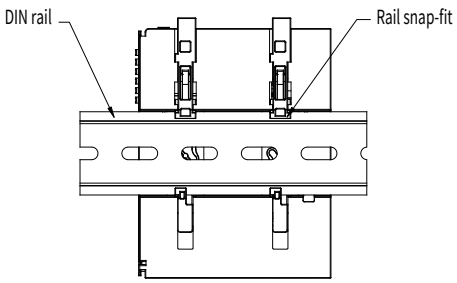
3.2 Installation and disassembly

3.2.1 Installation

3.2.1.1 Master installation

Align the master to the DIN rail, and press it inwards until the master and the DIN rail are clamped (there is an obvious sound of clamping after they are installed in place).

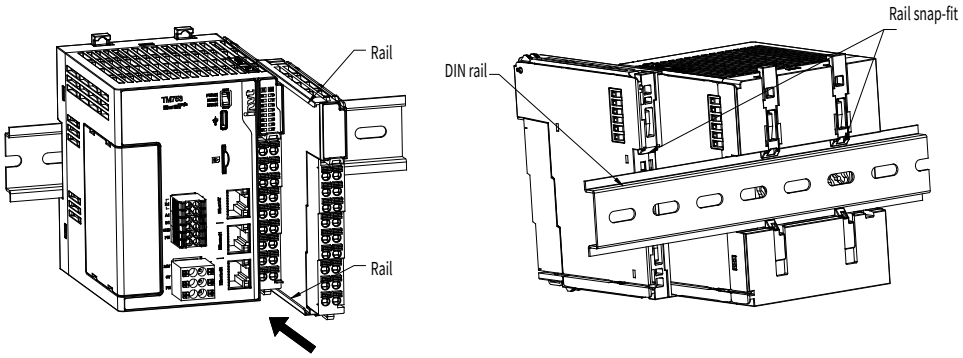




Note: The master uses DIN rail for installation.

3.2.1.2 Installation between the master and the module

Align the module with the connection rail with the master sliding rail, and push it inward until the module engages with the DIN rail (there is a noticeable sound of engagement when installed in place).

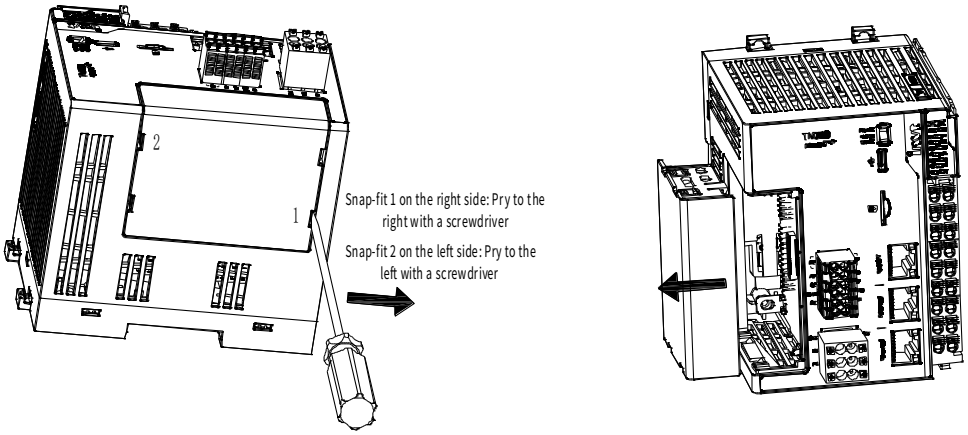


Note: The master and the module use DIN rail for installation.

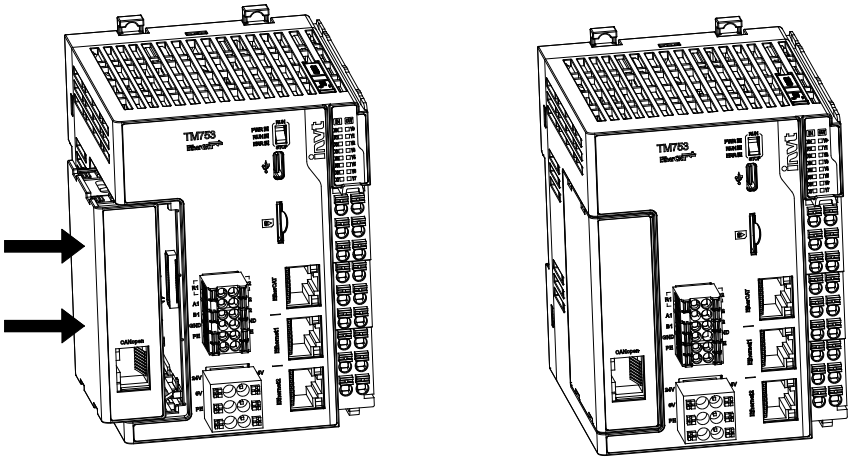
3.2.1.3 Expansion card installation

Take out the cover before installing the expansion card. The installation steps are as follows.

Step 1 Use a tool to gently pry the cover snap-fits on the side of the product (in sequence of position 1 and 2), and take out the cover horizontally to the left.



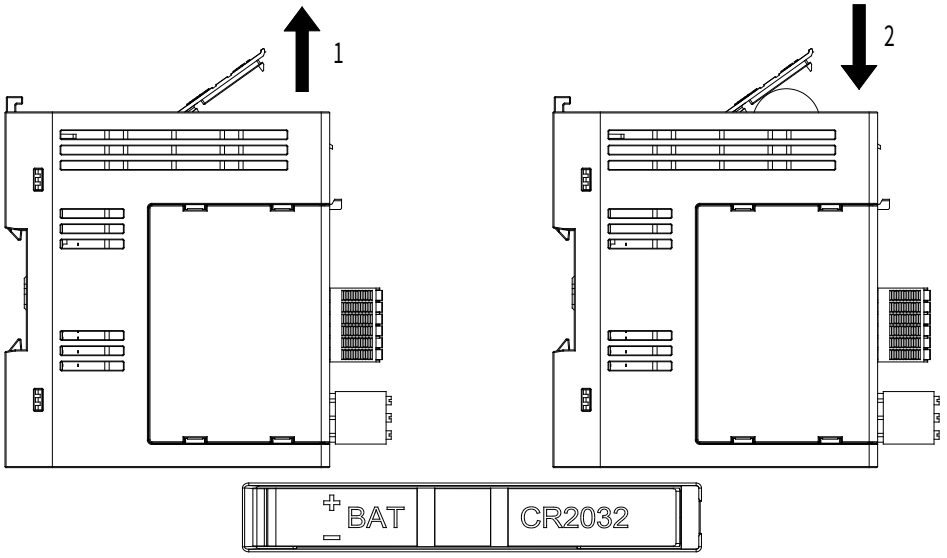
Step 2 Slide the expansion card into the guide slot in parallel, then press the clip positions on the upper and lower sides of the expansion card until the expansion card is clamped (there is an obvious sound of clamping after they are installed in place).



3.2.1.4 Button battery installation

Step 1 Open the button battery cover.

Step 2 Push the button battery into the button battery slot in the correct direction, and close the button battery cover.



Note:

- Please note the anode and cathode of the battery.
- When a battery is installed and the programming software reports an alarm of low battery, the battery needs to be replaced.

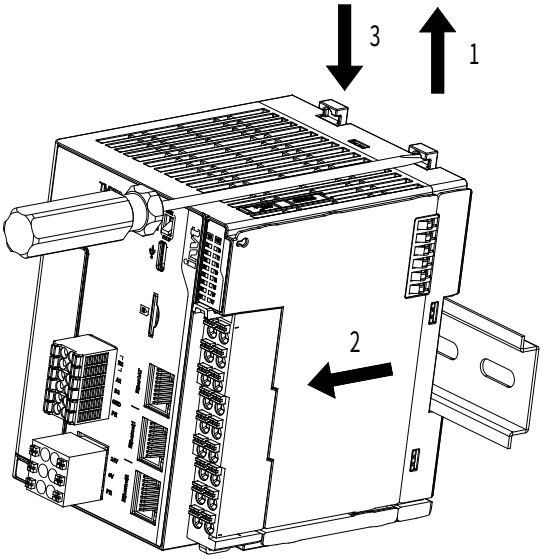
3.2.2 Disassembly

3.2.2.1 Master disassembly

Step 1 Use a straight screwdriver or similar tools to pry up the rail snap-fit.

Step 2 Pull the module straight ahead.

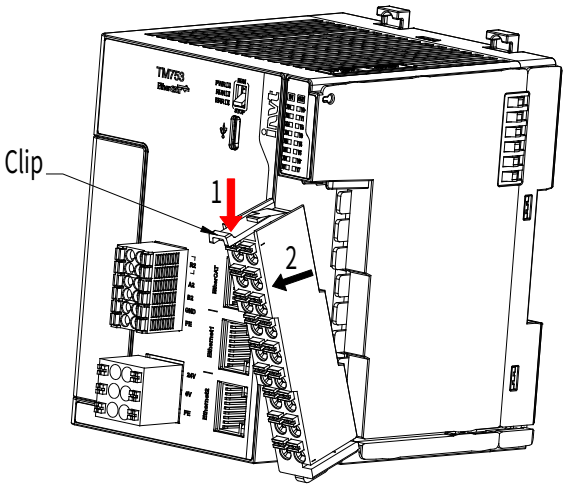
Step 3 Press the top of the rail snap-fit into place.



3.2.2.2 I/O terminal disassembly

Step 1 Press down the clip on the top of the terminal (raised part).

Step 2 Press and pull out the terminal simultaneously.



3.2.2.3 Button battery disassembly

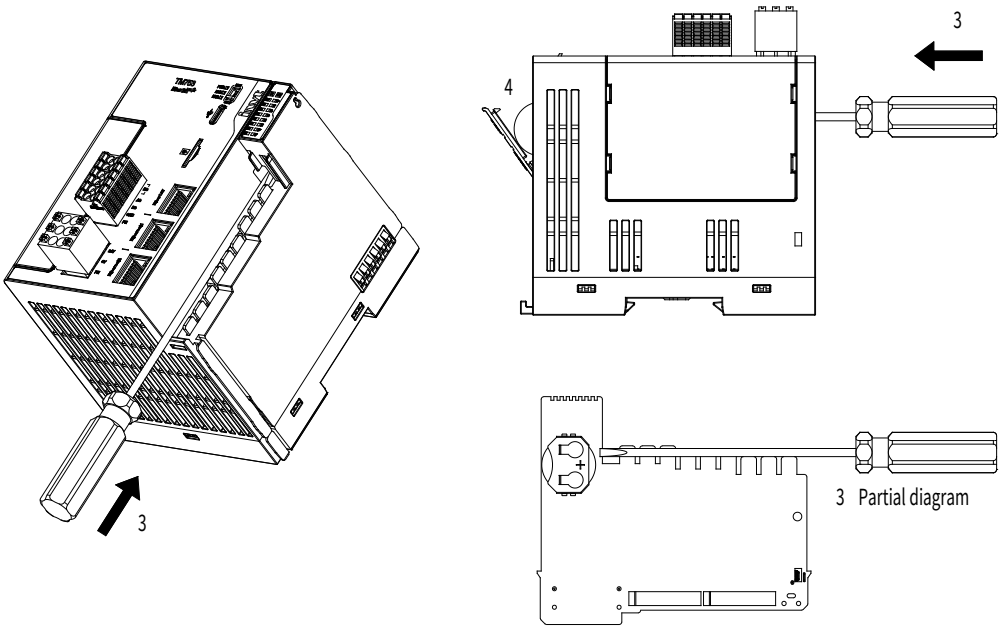
The disassembly steps are as follows:

Step 1 Open the button battery cover. (For details, see section 3.2.1.4 Button battery installation).

Step 2 Disassemble the I/O terminals (For details, see section 3.2.2.2 I/O terminal disassembly).

Step 3 Use a small straight screwdriver to gently push out the button battery, as shown in the following figure.

Step 4 Take out the battery and close the button battery cover.



4 Electrical installation

4.1 Cable specifications

Table 4-1 Cable dimensions for single cable

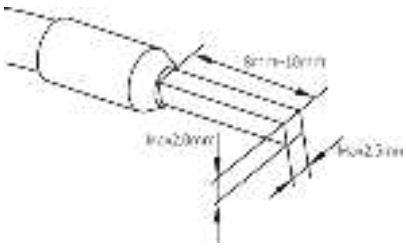
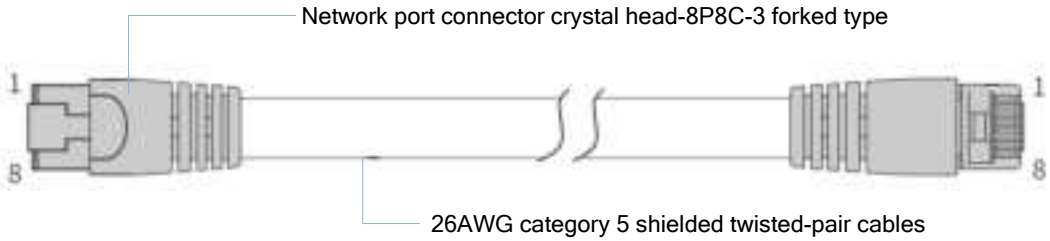
Applicable cable diameter		Tubular cable lug
Chinese standard/mm²	American standard/AWG	
0.3	22	
0.5	20	
0.75	18	
1.0	18	
1.5	16	

Figure 4-1 Ethernet cable



Pin	Signal	Signal direction	Signal description
1	TD+	Output	Data transmission+
2	TD-	Output	Data transmission-
3	RD+	Input	Data receiving +
4	-	-	Not used
5	-	-	Not used
6	RD-	Input	Data receiving-
7	-	-	Not used
8	-	-	Not used

4.2 I/O terminal wiring

4.2.1 Terminal definition

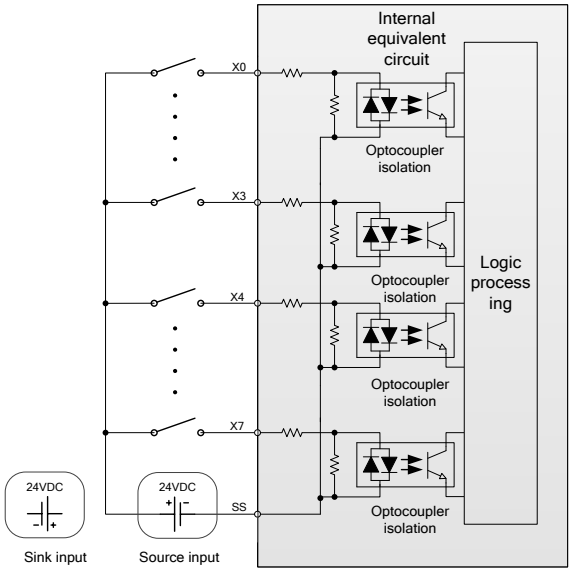
Schematic diagram	Left signal	Left terminal	Right terminal	Right signal
	X0 input	A0	B0	Y0 output
	X1 input	A1	B1	Y1 output
	X2 input	A2	B2	Y2 output
	X3 input	A3	B3	Y3 output
	X4 input	A4	B4	Y4 output
	X5 input	A5	B5	Y5 output

Schematic diagram	Left signal	Left terminal	Right terminal	Right signal
	X6 input	A6	B6	Y6 output
	X7 input	A7	B7	Y7 output
	SS input common terminal	A8	B8	COM output common terminal

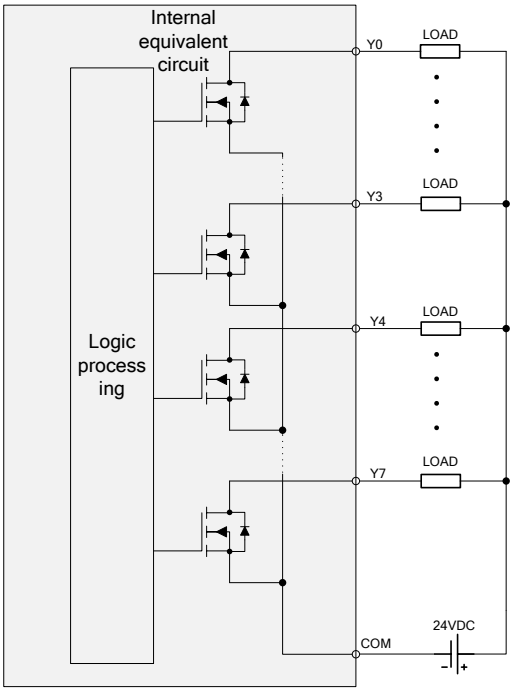
Note:

- The total extension length of high-speed I/O interface expansion cable shall be within 3 meters.
- During cable routing, the cables should be routed separately to avoid bundling with power cables (high voltage and large current) or other cables that transmit strong interference signals, and parallel routing should be avoided.

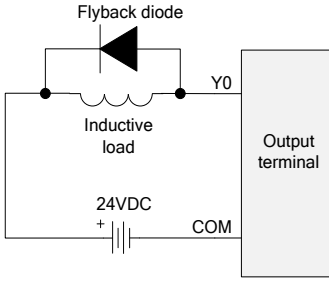
4.2.2 Input terminal wiring



4.2.3 Output terminal wiring



Note: The flyback diode is needed for external inductive load connection. The wiring diagram is shown as below.

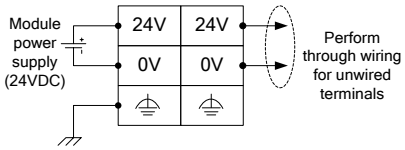


4.3 Wiring of power supply terminals

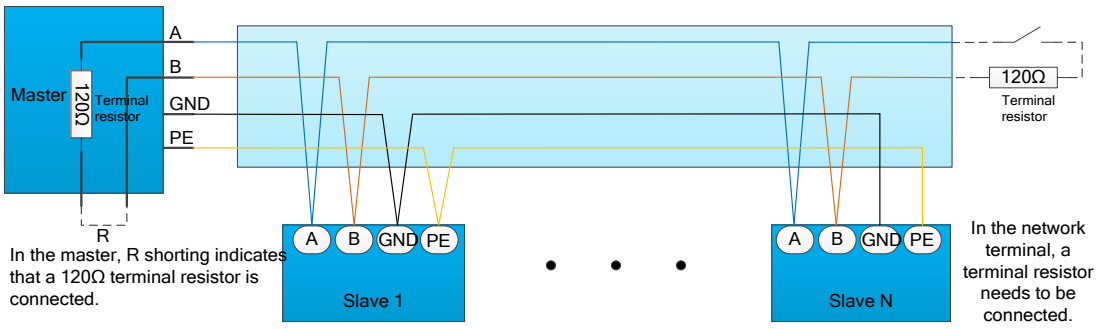
4.3.1 Terminal definition

Schematic diagram	Left signal	Left terminal	Right terminal	Right signal
	24V	**24V**	**24V**	24V
	0V	**0V**	**0V**	0V
	⏚	**PE**	**PE**	⏚

4.3.2 Terminal wiring



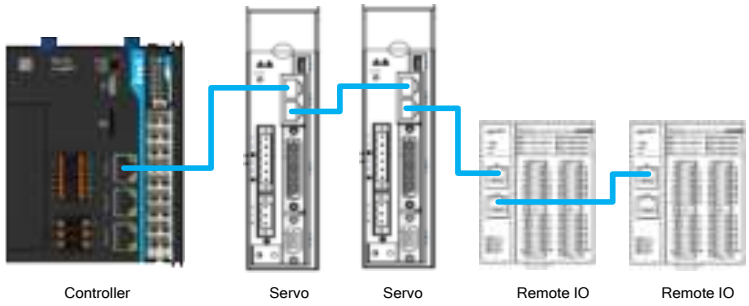
4.4 RS485 networking wiring



Note:

- Shielded twisted pair is recommended for RS485 bus, and A and B are connected by twisted pair.
- 120 Ω terminal matching resistors are connected at both ends of the bus to prevent signal reflection.
- The reference ground of 485 signals at all nodes is connected together.
- The distance of each node branch line should be less than 3m.

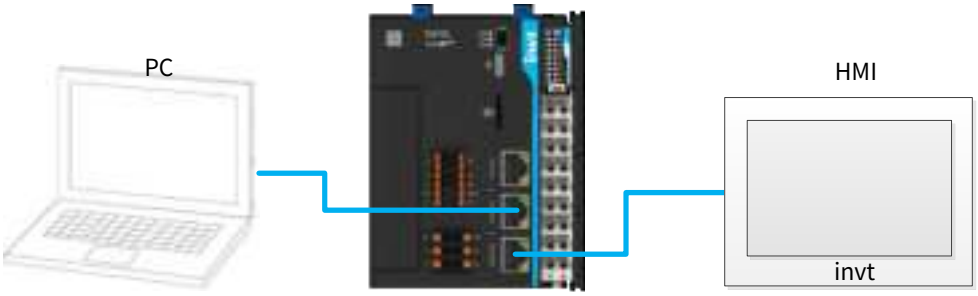
4.5 EtherCAT networking wiring



Note:

- It is required to use shielded twisted-pair cables of category 5, plastic injection moulded and iron shelled, compliant with EIA/TIA568A, EN50173, ISO/IEC11801, EIA/TIA bulletin TSB, and EIA/TIA SB40-A&TSB36.
- The network cable must pass the conductivity test 100%, without short circuit, opened circuit, dislocation or poor contact.
- When connecting the network cable, hold the crystal head of the cable and insert it into the Ethernet interface (RJ45 interface) until it makes a click sound.
- When removing the installed network cable, press the tail mechanism of the crystal head and pull out it from the product horizontally.

4.6 Ethernet wiring



5 Other description

5.1 Programming tool

Programming tool: Invtmatic Studio.

How to obtain programming tools: Visit www.invt.com, choose **Support** > **Download**, enter a keyword, and click **Search**.

5.2 Run and stop operations

After programs are written to the PLC, perform running and stopping operations as follows.

- To run the system, set the DIP switch to RUN, and ensure that the RUN indicator is on, displaying yellow-green color.
- To stop the operation, set the DIP switch to STOP (alternatively, you can stop the operation through the background of the host controller).

5.3 Routine maintenance

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

5.4 MicroSD card firmware upgrade

Step 1 Install the "Firmware upgrade MicroSD card" into the product.

Step 2 Power on the product. When the PWR, RUN and ERR indicators are on, it indicates that the firmware upgrade is complete.

Step 3 Power off the product, remove the MicroSD card, and then power on the product again.

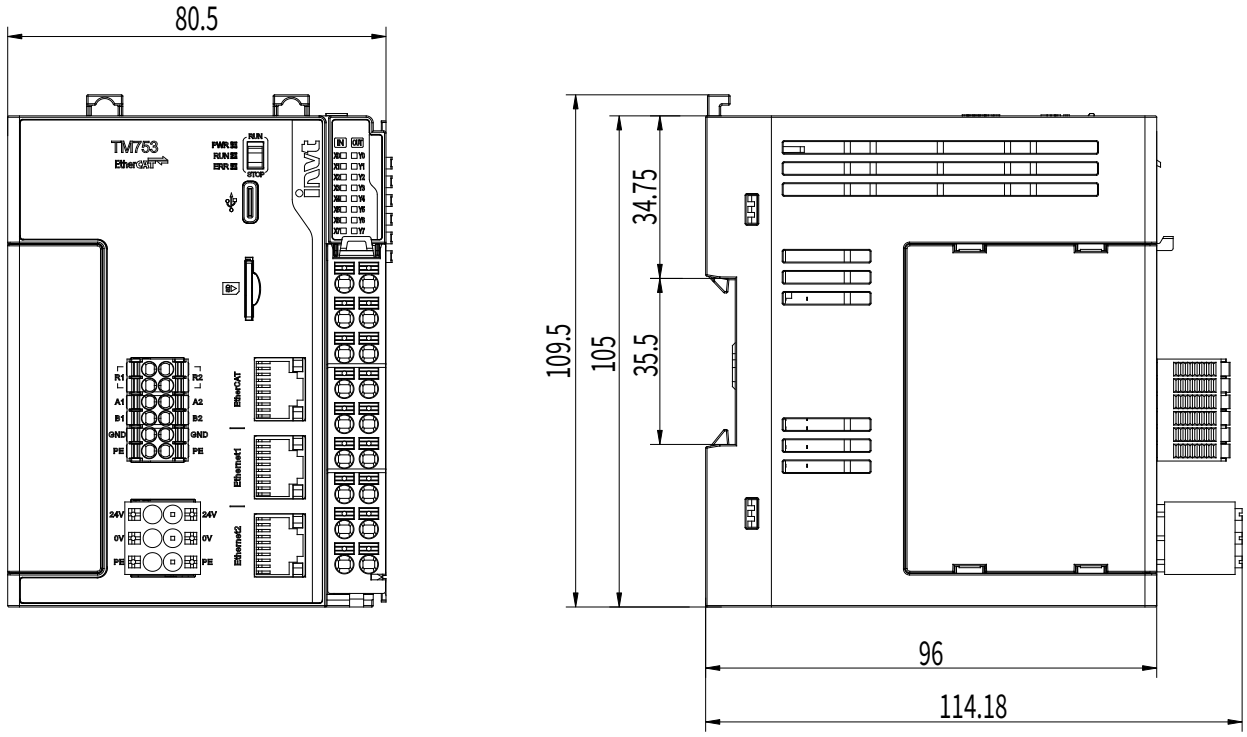
Note: The installation of the MicroSD card must be performed after the product is powered off.

Appendix A Expansion card accessories

No.	Model	Specification
1	TM-CAN	Supports the CANopen bus 
2	TM-4G	Supports 4G IoT 

Appendix B Dimension drawings

Figure B-1 Product dimensions (unit: mm)



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