

# INVT Medium and Large-scale PLC

# Software Manual



SHENZHEN INVT ELECTRIC CO., LTD.

# Preface

# Overview

Thank you for choosing our medium and large-scale PLC.

This manual contains the information necessary for using the medium and large-scale PLC. Please read this manual carefully before use to fully understand the functions and performance of the product, and complete system construction, which helps to give full play to the product's superior performance.

# **Target Audience**

This manual is intended for personnel with professional knowledge of electrical engineering (e.g., qualified electricians or personnel with equivalent knowledge).

# **Scope of Application**

This manual is applicable to the TM and TP series PLCs.

# **Online Support**

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

Visit our website (www.invt.com), choose **Support**→**Download**, enter a keyword, and click **Search**.

Scan the QR code on the product housing $\rightarrow$ Enter a keyword and download the manual.

# **Revision History**

Due to product version upgrades or other reasons, this manual is subject to changes from time to time without prior notice.

Number	<b>Revision Description</b>	Version	Release Date
1	First release.	V1.0	September 2024

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# **1** Introduction to the PLC

# **1.1 Overview**

# **1.1.1 Product Overview**

INVT's medium and large-scale PLCs currently include two series: TM700 and TP6000, which follow the IEC 61131-3 programming language system and support six standard programming languages: IL, LD, FBD, ST, SFC, and CFC. Through the EtherCAT bus, they can realize high-level motion control functions such as electronic cam, electronic gear, synchronous control, and positioning. Owing to rich communication interfaces and versatile I/O modules, they can provide users with flexible and intelligent automation solutions to meet their diverse application needs.

The TM700 series is a high-performance PLC with a modular structure design. It is mainly used in scenarios with high motion control requirements and complex control networks. It has greatly improved control performance, communication capabilities, programming efficiency, etc., allowing you to build a control network more flexibly and realize data interaction with the information layer through OPC UA more conveniently, further improving device productivity, shortening development cycles, and bringing a more excellent experience.

The TP6000 series is based on the X86 architecture and EtherCAT bus technology, and meets the needs of high-standard on-site control systems with extremely high performance and rich interfaces and functions. The dual EtherCAT interfaces can realize multi-tasking and ring network control, thereby bringing more reliable solutions. It is widely used in various high-speed, high-precision, and high-response devices and medium and large-scale production lines.

Model	TM750	TM751	TM752	TM753	TP6210-1201	TP6211-2201	TP6214-2201
Rated working voltage	DC24V (-1	5%-+20%	)				
	Memory						
Program		20	MD			256 MP	
capacity		20	MD		256 MB		
Data capacity		64	MB			256 MB	
Data capacity in							
power failure		1	MB		5 MB		
retention mode							
Max. capacity of							
expanded SD		3	2G		-		
card							
				I/O			
Number of local			16				
IO modules		-	10			-	
High-speed input	4 groups supporting CW/CCW,	ig of hi g single and pulse	gh-speed phase, p e+directior	counters, hase A/B, n, of which	2 groups of ph differential inp	ase AB or 1 gro out	oup of ABZ

# 1.1.2 Product Specifications

Model	TM750	TM751	TM752	TM753	TP6210-1201	TP6211-2201	TP6214-2201
	phase A/ frequenci	B suppor	rts 1x, 2>	, and 4x			
High-speed output	8-channel output, su control	3-channel 200kHz sink-type high-speed output, supporting 4-axis pulse motion control				-	
Support for I/O interruption	8-channel high-speed interruption					-	
PWM output	4-channel	PWM out	out			-	
		Comm	unication	Network a	nd Interface		
Ethernet	×2, RJ45, Support f EtherNet I	100Base-T or PLC sof IP	X tware dov	vnload, Mo	dbus TCP, TCF	P// IP, OPC UA	protocol, and
EtherCAT	×1, RJ45, 100Base-TX, distance between two slaves < 100 m slaves < 100 m		100Base-TX, etween two m	× 2, RJ45, support for dual masters, 100Base-TX, distance between two slaves < 100 m			
Serial communication (RS485)	×2, Modb	us RTU ma	ster/slave	, plug-in te	rminal		
USB	×1, Type- download	C, PC com I and debu	munication Igging	n, program	×4,	USB 3.0, file c	ору
Memory card	×1, Micro	SD, for up	grading ap	plications	х	х	х
Communication expansion		CANoper	ı, 4G, Wi-Fi		х	х	х
			Moti	on Contro	l		
Maximum number of controlled axes	4	4 8 16 32				128	256
Motion control functions	Point-to-p electronic etc.	Point-to-point motion, interpolation motion (straight line, circular arc, etc.), electronic gear, electronic cam (flying shear, tracking shear, etc.), axis group, CNC, etc.					, etc.), group, CNC,
		C	onfigurat	ion Progra	mming		
Programming language			IL,	ST, FBD, LI	D, CFC, and SFC	2	

# 1.1.3 Product Configuration and Module Description

The TM700 series's CPU can be directly connected to the Flex series I/O modules, or expanded to the Flex series I/O modules through a communication coupler, as shown in the figure below.



#### Figure 1-1 System Integration Diagram 1

The TP6000 series's CPU cannot be directly connected to the Flex series I/O modules. It can only be expanded to the Flex series I/O modules through a communication coupler, as shown in the figure below.





# **1.1.4 System Application Process**



# 1.2 Invtmatic Studio Overview

Invtmatic Studio is a programming platform developed by Shenzhen INVT Electric Co., Ltd. It supports the IEC 61131-3 programming language system and six standard programming languages: IL, LAD, FBD, SFC, ST, and CFC.

# 1.2.1 Software Installation and Uninstallation

## 1.2.1.1 Software Obtaining

INVT's PLC user programming software contains the Invtmatic Studio platform, installation files, and related reference materials. You can obtain them by the following ways:

- 1. Visit our website www.invt.com and go to Support > Download > Software to download the software installation package for free.
- 2. Obtain software installation CDs from INVT distributors at all levels.

## **1.2.1.2 Software Installation Requirements**

You can install the software on a desktop PC or a laptop:

- Operating system: Windows 7/Windows 8/Windows 10
- CPU clock speed: 2 GHz or higher
- Memory: 2 GB or higher
- Available hardware space: 5 GB or higher
- Installation requirements:
  - ♦ Use an administrator account
  - ♦ Turn off the antivirus software
  - ♦ Disable the encryption system
  - ♦ Do not use Chinese paths

#### 1.2.1.3 Preparation

- If it is the first time to install Invtmatic Studio, check whether your computer meets the software installation requirements. If yes, you can install it directly.
- If you want to install the latest version of Invtmatic Studio, check the version information about the installed software by choosing **Help** > **About**. If it is not the latest version, you can upgrade the software using the online upgrade method.



Figure 1-3 Version Information Display Interface

#### 1.2.1.4 Installing the Software

- Step 1 Locate the installation file storage path, and double-click Invtmatic Studio Setup 64 Vx.x.x.exe (taking V1.3.5 as an example).
- Step 2 The installation starts. See the following figure.

Figure 1-4 Installation Preparation interface

Invtmat	ic Studio V1.3.5.1 - InstallShield Wizard	
کا	Invtmatic Studio V1.3.5.1 Setup is preparing the In Wizard, which will guide you through the program Please wait.	nstallShield setup process.
Extract	ing: Invtmatic Studio Setup 64 V1.3.5.1.msi	
		Cancel

Step 3 When the dialog box shown in the following figure appears, click **Next**.

#### Figure 1-5 Installation Wizard Interface

🖟 Invtmatic Studio V1.3.5.1 ·	InstallShield Wizard X
<u>æ</u> .	Welcome to the InstallShield Wizard for Invtmatic Studio V1.3.5.1
	Please note:
	§ 1 Please close the security software before installation.
	§ 2 Please exit the encryption system before installation.
	§ 3 The installation directory does not allow the use of Chinese paths.
	The InstallShield(R) Wizard will install Invtmatic Studio V1.3.5.1 on your computer. To continue, dick Next.
	WARNING: This program is protected by copyright law and international treaties.
	< Back Next > Cancel

Step 4 Then the License Agreement dialog box appears. Check I accept the terms of the license agreement, and then click Next.



#### Figure 1-6 License Agreement Interface

Step 5 Set the software installation path, and click Next.

**Note:** The software installation path cannot be in Chinese.

Figure 1-7 Installation Path Confirmation

47	1 o. 11 Ma o 5 a	SET LLANCE - L		
Thytmat	ic Studio V1.3.5.1 - Installs	shield Wizard		×
Destinati	ion Folder			-44
Click Nex	xt to install to this folder, or clid	k Change to install	to a different folde	r. C
		-		
<b>~</b>	Install Invtmatic Studio V1.3.	5.1 to:		
	C:\Program Files\Invtmatic St	udio		Change
InstallShield -				1
		< Back	Next >	Cancel

Step 6 The installation component selection interface appears. You can select the Complete or Custom installation mode. If you have no special requirement, keep the default selection, and click **Next**.

Figure 1-8 Installation Mode Selection Interface



#### Step 7 When the following interface appears, click **Install**.

Figure 1-9 Installation Preparation Interface

🕼 Invtmatic Studio V1.3.5.1 - InstallShield Wizard	×
Ready to Install the Program The wizard is ready to begin installation.	と
Click Install to begin the installation.	
If you want to review or change any of your installation settings, exit the wizard.	, click Back. Click Cancel to
InstallShield	
< Back	nstall Cancel

Step 8 An installation progress bar appears. Click Finish when the installation is completed.

#### Figure 1-10 Installation Progress Interface

🛃 Invtmati	c Studio V1.3.5.1 - Installs	Shield Wizard		—		$\times$
Installing The prog	Invtmatic Studio V1.3.5.1 ram features you selected are	being installed.				と
17	Please wait while the InstallSI This may take several minute	hield Wizard installs s.	Invtmatic S	tudio V1.	3.5.1.	
	Status:					
	Copying new files					
InstallShield –				_		_
		< Back	Next >		Cano	el

#### Figure 1-11 Installation Complete Interface

🕼 Invtmatic Studio V1.3.5.1 ·	InstallShield Wizard	Х
	InstallShield Wizard Completed The InstallShield Wizard has successfully installed Invtmatic Studio V1.3.5.1. Click Finish to exit the wizard.	
	Show the Windows Installer log	
	< Back Finish Cancel	

### 1.2.1.5 Uninstalling the Software

Uninstall Invtmatic Studio by using the standard software uninstallation method of a Windows system. The procedure is as follows:

- Step 1 Shut down Invtmatic Studio running programs, including the backend running program.
- Step 2 Enter the control panel, find and right-click Invtmatic Studio, and click Uninstall.
- Step 3 Wait until the software is uninstalled.

## **1.2.2 Hardware Connection**

The hardware connection between an upper computer and the TM700 series PLC can be realized by two methods:

- 1. Using a LAN network cable
- 2. Using a Type-C cable

Figure 1-12 Hardware Connection between an Upper Computer and the TM700 Series PLC



The hardware connection between an upper computer and the TP6000 series PLC can only be realized through a LAN network cable.

#### Figure 1-13 Hardware Connection between an Upper Computer and the TP6000 Series PLC



# **1.3 PC Communication Configuration**

# 1.3.1 PC and TM700 Communication Configuration

#### Using a LAN network cable

If the hardware is connected with a LAN network cable, ensure that the IP address of the PC and the IP address of the controller are in the same network segment. The factory default IP address of the TM700 series is as follows: Ethernet1: 192.168.1.10; Ethernet2: 192.168.2.10, both having program debugging and downloading functions. Please make sure the network cable is connected to Ethernet1/Ethernet2. The IP address of the PC should be set to 192.168.1.xxx/192.168.2.xxx (xxx means any integer value in the range of 1 – 254 except 10).

Figure 1-14 PC and TM700 Communication Configuration Using a LAN Network Cable

Organize  Disable this network device	Diagnose this con	nection Rename this connection	Change settings of this connect
Bluetooth Network Connection Not connected Bluetooth Device (Personal Area	Network of Karley Karle	cable unplugged hernet Connection (13)	Ethernet 2 Unidentified network USB Ethernet/RNDIS Gadget
Ethernet Properties	×		Ethernet10
		Internet Protocol Version 4 (TCP/IP	v4) Properties >
Networking Sharing		General	
Connect using:			
Intel(R) Ethemet Connection (13) I219-V		this capability. Otherwise, you need for the appropriate IP settings.	tomatically if your network supports d to ask your network administrator
This connection uses the following items:	Configure	Obtain an IP address automati	ically
Client for Microsoft Networks	^	Ose the following IP address:	
File and Printer Sharing for Microsoft Net	works	IP address:	192.168.1.40
<ul> <li>VirtualBox NDIS6 Bridged Networking D</li> <li>VirtualBox Recket Driver (NPCAP)</li> </ul>	river	Subnet mask:	255 . 255 . 255 . 0
		Default gateway:	
Microsoft Network Adapter Multiplexor P	rotocol V	Obtain DNS server address au	tomatically
		Use the following DNS server a	addresses:
Install Uninstall	Properties	Preferred DNS server:	
Description Transmission Control Protocol/Internet Protocol	I. The default	Alternate DNS server:	
wide area network protocol that provides comr across diverse interconnected networks.	nunication	Validate settings upon exit	Advanced
ОК	Cancel		OK Cancel

#### Using a Type-C cable

• Install the USB driver

When the PC runs Windows 10, install the USB driver as follows:

Here we take the USB driver file of kindle\_rndis.inf\_amd64 as an example.

Step 1 Right-click the file "RNDIS\_Windows\_Driver.cab" and unzip it.

🗄 RNDIS_Windows_Driver.cab	7/25/2024 10·01 ΔM	Cabinet File	22 KB
	Open		
	Open in new window		
	Share with Skype		
	7-Zip	> Open ar	rchive
	Pin to Start	Open ar	rchive
	🖻 Share	Extract f	files
	Scan with OfficeScan	Extract H	Here
	Open with	Extract t	to "RNDIS_Windows_Driver\"
	· · · · · · · · · · · · · · · · · · ·	Test arch	hive

Step 2 When the following interface appears, press any key.

	Ô	Ŕ	Û	₽	Sort ~	$\equiv$ View $^{\scriptscriptstyle \vee}$			
N	ame	^			Date mo	dified	Туре	Size	
2	rndis.cat				3/12/201	10 10:59 PM	Security Catalog	7 KB	
	RNDIS.inf				2/3/2010	) 1:42 AM	INF File	4 KB	

Step 3 Connect the computer and the PLC with a USB cable: Open **Device Manager**, select **Ports** > **USB serial device**, and right-click **Update driver**.



Step 4 Click Browse my computer for drivers and select the driver folder.

×



		×
←	Update Drivers - USB Ethernet/RNDIS Gadget	
	Browse for drivers on your computer	
	Search for drivers in this location:	
	tmatic Studio\CODESYS\Common\Drivers\RNDIS_Windows_Driver v Browse	
	Include subfolders	
	→ Let me pick from a list of available drivers on my computer This list will show available drivers compatible with the device, and all drivers in the same category as the device.	
	Next Cance	

Step 5 Wait for the installation process to complete, and then click **Close**.



• Configure the USB network port

The USB RNDIS item has been added to the **Network adapters** under **Device Manager**.

占 D	evice	e Manager	-	×
File	Act	ion View Help		
<hr/>	▶   [	☑   🖸   📓 🖬   暴   🖳   💺 🗙 💿		
× 🗄	010	)8252-xbx		
>	- 1	Audio inputs and outputs		
>	- 1	Audio Processing Objects (APOs)		
>	۵	Batteries		
>	8	Bluetooth		
>	۲	Cameras		
>		Computer		
>	_	Disk drives		
>		Display adapters		
>	$\square$	Firmware		
>	(AHO	Human Interface Devices		
>	-	IDE ATA/ATAPI controllers		
>	-	Jungo Connectivity		
>	20002	Keyboards		
>		Mice and other pointing devices		
>		Monitors		
- ×	-	Network adapters		
		🚽 Bluetooth Device (Personal Area Network) #2		
		🚽 Intel(R) Wi-Fi 6 AX201 160MHz		
		🚽 Realtek PCIe GbE Family Controller		
		🚽 Realtek USB FE Family Controller		
		😨 Sangfor a Trust VNIC		
		🗇 USB Ethernet/RNDIS Gadget		
		🚽 VMware Virtual Ethernet Adapter for VMnet1		
		🚽 VMware Virtual Ethernet Adapter for VMnet8		
		WAN Miniport (IKFv2)		

Step 1 Right-click the **Ethernet**.

←	Settings	
ណ	Home	Ethernet
Fi	nd a setting $ ho$	Unidentified network
Net	work & Internet	No Internet
₽	Status	Not connected
(i.	Wi-Fi	
貯	Ethernet	
C	Dial-up	
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	VPN	
ър	Airplane mode	
(p)	Mobile hotspot	
⊕	Proxy	

#### Step 2 Click Change adapter options.



Step 3 Right-click the Unidentified network (with USB RNDIS in its name), and select Properties.



Step 4 Check Internet Protocol Version 4 and click Properties to set the IP address.

Ethernet 2 Properties	$\times$						
Networking Sharing							
Connect using:							
USB Ethemet/RNDIS Gadget							
Configure							
This connection uses the following items:							
Client for Microsoft Networks Client for Microsoft Networks File and Printer Sharing for Microsoft Networks VitualBox NDIS6 Bridged Networking Driver VitualBox NDIS6 Bridged Networking Driver QoS Packet Driver (NPCAP) QoS Packet Scheduler QoS Packet Scheduler Internet Protocol Version 4 (TCP/IPv4) Microsoft Network Adapter Multiplexor Protocol <							
Install Uninstall Properties							
Description Transmission Control Protocol/Internet Protocol. The default wide area network protocol that provides communication across diverse interconnected networks.							
OK Cancel							

Step 5 Set the IP address manually.

**Note:** The IP address must be in the network segment 192.168.3.xxx (xxx means any integer value in the range of 1 - 254 except 10).

k Connection Ethernet Personal Area X Wetwork cable unplugged Intel(R) Ethernet Connection (13)	Ethernet 2 Unidentified network USB Ethernet/RNDIS Gadget
Ethernet 2 Properties ×	Internet Protocol Version 4 (TCP/IPv4) Properties X
Networking Sharing	General
Connect using:	You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
Configure This connection uses the following items:	Obtain an IP address automatically
Elient for Microsoft Networks     A     Grad Antipart Sharing for Microsoft Networks	Use the following IP address:     IP address:     I92 . 168 . 3 . 50
TritualBox NDIS6 Bridged Networking Driver     TritualBox NDIS6 Bridged Networking Driver     TritualBox NDIS6 Bridged Networking Driver	Subnet mask: 255 . 255 . 255 . 0
QoS Packet Scheduler	Default gateway:
Internet Protocol Version 4 (TCP/IPV4)	Obtain DNS server address automatically
< >>	Ouse the following DNS server addresses:
Install Uninstall Properties	Preferred DNS server:
Description	Alternate DNS server:
wide area network protocol internet Protocol. The default wide area network protocol that provides communication across diverse interconnected networks.	Validate settings upon exit Advanced
OK Cancel	OK Cancel

# 1.3.2 PC and TP6000 Communication Configuration

If the hardware is connected with a LAN network cable, ensure that the IP address of the PC and the IP address of the controller are in the same network segment. The factory default IP address of the TM700 series is as follows: Ethernet1: 192.168.1.10; Ethernet2: 192.168.2.10, both having program debugging and downloading functions. Please make sure the network cable is connected to Ethernet1/Ethernet2. The IP address of the PC should be set to 192.168.1.xxx/192.168.2.xxx (xxx means any integer value in the range of 1 – 254 except 10).

Figure 1-15 PC and TP6000 Communication Configuration Using a LAN Network Cable

Bluetooth Network Connection Not connected Bluetooth Device (Personal Area	Ethern Unider Intel(R	<b>et</b> itified network I Ethernet Connection (13)	Ethernet 3 Disabled VirtualBox Host-Only Ethernet Ad
Ethernet Properties	×	Internet Protocol Version 4 (	TCP/IPv4) Properties X
Networking Sharing Connect using:  Intel(R) Ethemet Connection (13) I219-V This connection uses the following items:   This connection uses the following items:   This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items:  This connection uses the following items: This connection uses the following items: This connection uses the following items: This connection uses the following items: This connection uses the following items: This connection uses the following items: This connection uses the following items: This connection uses the following items: This connection uses the following items: This connection uses the following items: This connection uses the following items: This connection uses the following items: This connection uses the following items: This connection uses the following items: This connection uses the following items: This connection uses the following items: This connection uses the following items: This con	Configure orks er ocol Properties The default nication	General You can get IP settings assistis capability. Otherwise, y for the appropriate IP settin Obtain an IP address a Obtain DNS server add Obtain DNS	In exit Advanced
ОК	Cancel		OK Cancel

# 2 Getting Started

# 2.1 Project Creation

# 2.1.1 Starting the Programming Environment

Taking Invtmatic Studio V1.3.5 as an example, start the programming environment in the following steps:

Step 1 Double-click the software icon of Invtmatic Studio 🚨. The programming environment is as follows:



Step 2 In the tool bar, select **Tools > Device Repository** to add a device profile.

**Note:** Invtmatic Studio V1.3.5 is installed with the INVT device profile by default. For third-party devices, it needs to be added manually.



Step 3 In the Device Repository pop-up window, click Install.

😤 Device R	epository						×
Location	System Repositor (D:\Program Files	y \Invtmatic St	udio\Invtmat	icStudioReposit	ory\Devices)	✓ Edit Locat	ions
Installed de	evice descriptions						
String for a	a fulltext search		Vendor:	<all vendors=""></all>	~	Instal	I
Name		Vendor	Version	Description		Uninst	all
● ∭ Mi ● ∭ Fi ● ∰ Fi ● ∰ PL ● ∲ Sc	scellaneous eldbuses MI devices Cs oftMotion drives					Export	t.,
						Detail	S
						Close	e

Step 4 From the pop-up window, select the device profile to be installed from a local folder and then click **Open**.

S Install Device Descr	ription								×
$\leftarrow \rightarrow \checkmark \uparrow$	🚞 > D	esktop > phy > EtherCAT > xml		~	C	Search xml		۶	þ
Organize 🔻 New	v folder						≣ •		?
A Home	1	Name	Date modified	Туре	Size				
		64_0000 1002_3.5.17.0.devdesc.xml	11/7/2023 7:20 PM	Microsoft Edge H		40 KB			
		64_0000 1002_4.4.0.0.devdesc.xml	11/6/2023 10:30 AM	Microsoft Edge H		43 KB			
		64_0000 1002_4.5.0.0.devdesc.xml	10/20/2023 10:28 PM	Microsoft Edge H		44 KB			
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**Note:** Here you can follow the above steps to add all device profiles provided by INVT, or add third-party device profiles.

# 2.1.2 Creating a New Project

Click the project creation icon at the upper left corner or select **File** > **New Project**, or directly click **New Project** in the window to quickly create a project. Select the project category, template, name, and storage directory, as shown in the following figure.

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A project c	Untitled9	oplication, and an	empty implemen	tation for PLC_	PRG
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Click **OK**. On the standard project setting interface that appears, select the device type and programming language.

Standard F	Project		×					
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	Device	TM753 (INVT)						
	PLC_PRG in	Structured Text (ST)	$\sim$					
		OK Cancel						

After completing the above operations, go to the configuration and programming interface of Invtmatic Studio, double-click **PLC\_PRG(PRG)** to write programs.

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# 2.2 Typical Steps of Project Writing

From the above example given in section 2.1.1 Starting the Programming Environment, writing a user program with MC motion control functions generally requires the following steps:

Step 1 Application system hardware configuration

Configure the network according to the main controller, expansion modules, network type, servo slave, and other hardware used.

Step 2 User program writing

According to the control function to be implemented, write motion control with one POU (such as POU1), and write common logic control with another POU (such as POU2).

Step 3 Servo drive parameter configuration

Configure the objects of SDO and PDO according to the servo name and running mode in the hardware configuration, and ensure that the communication objects required between the MC function block of the user program and the servo are filled in the configuration table.

Step 4 Servo motor parameter configuration

Correctly fill in the resolution of the servo motor encoder, the transmission ratio of the mechanical structure, the characteristics of the axis movement range, and other parameters so that the displacement instruction imposed on the control object corresponds accurately to the actual displacement.

#### Step 5 Task arrangement

Based on the real-time requirements of control, execute the motion control function POU1 in the EtherCAT task; set the cycle to 500  $\mu$ s, 1 ms, 2 ms, or 4 ms and make it the same as the EtherCAT master synchronization cycle, with the priority of 0; execute the common logic control POU2 in MainTask or other common tasks and set the cycle to 1 ms, 4 ms, or 20 ms, with the priority of 1.

Step 6 Online debugging

Connect the TM Series PLC to the PC via a LAN network cable correctly and then power on the PLC. Download and debug the user program to eliminate user program bugs (if possible, you can connect the servo drive system to the TM series PLC, and then perform debugging. If the servo system is not available, you can set the servo drive system as a virtual axis; if the TM series PLC is not available, you can simulate and

debug the user program on the PC to eliminate possible errors in the user program until it is compiled without errors).

# 2.3 Examples of Program Writing and Debugging

Here is an example of a basic servo control program to give you a first glimpse of the programming process before you go through the principle of the programming system and the method of compiling the motion control program. Write a simple program that allows the TM series PLC to implement the following functions: the servo motor repeats rotating forward 50 revolutions, and then reversing 50 revolutions.

The programming method and steps are as follows:

- Step 1 Add the corresponding devices: EtherCAT master, servo drive, and motor shaft.
- Step 2 Handle the motion control of the servo in the high real-time EtherCAT task cycle.
- Step 3 Set relevant parameters.
- Step 4 Write the program.

### 2.3.1 Adding a Device

Step 1 Right-click **Device** in the device tree of the software interface, select **Add Device** and then **Fieldbuses > EtherCAT > Master > EtherCAT Master SoftMotion** (corresponding master), and click **Add Device**.

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Step 2 Double-click **Device** on the left side of the software interface, and click **Scan for Network** on the pop-up window. When the PLC light on the right is green, it indicates the PLC device is connected successfully and you can download the PLC program.

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		Access Rights				1631 0053		
	S - ∰ <sub>0</sub> Gateway	A1 55-C [000B]		Device Name: TM733-C Device Address: 0008 Block driver: UDP Number of channels: 4 Target ID: 1631 0053 Target Name: Shereen INVT-	Stan Network Wink	Shenhen INVT Eletric Co., Ltd. Target Version 3.5.15.20		
		Symbol POIL	Variable	OK Access Type A	Cancel	Object		

#### Step 3 Add a slave.

There are two methods to add a slave: automatic scanning for device configuration, and offline device configuration, which are introduced below respectively.

#### Automatic scanning for device configuration

Usually, after the PLC and EtherCAT devices are powered on and the EtherCAT bus has connected EtherCAT devices such as the servo motor and IO modules, the bus devices are scanned by software to automatically complete the configuration. The operation steps are as follows:

Step 1 Right-click the required master device in the device tree and select **Scan For Devices**, as shown in Figure 2-1. Then, the slave devices can be scanned and the scanning result window will pop up, as shown in Figure 2-2.

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Figure 2-1 EtherCAT Master Scanning Interface

Step 2 Click **Copy to project** on the **Scan Devices** interface. The servo drive and the corresponding 402 axis will be automatically added.

**Note:** INVT servo motors do not require manual axis addition later, but third-party servo motors require it.

Figure 2-2 Adding a Slave to the EtherCAT Master

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#### Offline Device Configuration

If the network connection for the PLC, the servo motor, and other devices is not available, you can perform device configuration directly on the Invtmatic Studio software.

#### Right-click EtherCAT\_Master\_SoftMotion in the device tree, and select Add Device.

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#### Figure 2-3 Adding an EtherCAT Slave Offline



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Group by category Display all versions (for experts only) Display outdated versions  Name: DA300-N EtherCAT(CoE) Drive Vendor: INVT Categories: Version: Revision=16#0000064 Order Number: INVT_DA300_101 Description: EtherCAT Slave imported from Slave XML: INVT_DA300 _EtherCAT_V101.xml Device: DA300-N EtherCAT(CoE) Drive	□ Inverter □ InvT_ECAT_ □ InvT_ECAT_ □ DA200 N Eth □ DA200 N Eth □ DA200 N Eth □ DA300 N Eth □ DA300 N Eth □ MA300 N Eth □ N = 0 = 0 = 0 = 0 = 0 = 0 = 0 = 0 = 0 =	102 BRIDGE HerCAT(CoE) Drive V265 HerCAT(CoE) Drive V265 HerCAT(CoE) Drive A_EtherCAT_1.0.1.0	INVT INVT INVT INVT INVT	Revision = 16#00000 102 Revision = 16#00010 101 Revision = 16#000000AB Revision = 16#00000AB Revision = 16#00000AB	Ether Ether Ether Ether Ether
	Group by category Display all ve Name: DA300-N EtherCAT(CoE) I Vendor: IN/T Categories: Version: Revision=16#00000066 Order Number: IN/T_DA300_10 Description: EtherCAT Slave imp _EtherCAT_V101.xml Device: DA3	Srive Srive Strive State	Display T_DA300	outdated versions	

After the servo slave and 402 axis are added to EtherCAT, it is shown as below.

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-	Cross Reference List							j×⊜-j⊴ • ≉
	Device.Application.PLC_PRG	🔍 🔶 🛛	Filter by Symbol,	POU, Variable, Access, T	ype, Address, Ol	bject	•	) ti 🔤 🤅
	Symbol POU =-PLC_PRG PLC_PRG L_PLC_PRG Task Configuration	Variable	Access Declaration Call	Type Address PLC_PRG PLC_PRG	Location Line 1 (Ded)	Object PLC_PRG [Device: PLC Logic: Application MainTask [Device: PLC Logic: Application	n] n: Task Cor	Cinfiguration]

# 2.3.2 Writing a Function to Handle POUs

In Invtmatic Studio programming environment, there is an EtherCAT\_Task task and a MainTask task for the default task configuration. The MainTask task contains a POU named PLC\_PRG which is created when the new project is created, as shown in Figure 2-5. We need to create a POU dedicated to servo control and put it under the EtherCAT\_Task task. The creation steps are as follows:

Figure 2-5 PLC\_PRG Programming Interface

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18 <b>₽ 8 8</b> 1 <b>8</b> 10 0 × 3 16 18 × 1 <b>8</b> % (	≜ %≦   II = % *N	🆄 🖳 🛅 🕤 🕮 🗛	lication [De	vice: PLC Logi	c] • 😋 🕬	$\rightarrow \pm q$	( CE eE eE	*≣ \$   ¢   ∰   =   %		
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🖷 🗿 Untitled9 🔹	1 PROGE	RAM PLC_PRG							V Filter •	Sort by •
Device (TM753)	2 VAR								2 Sort order	-
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Task Configuration				A	v			100 % [50		
								100 % (	Description	n an incidentia
	Cross Reference List									- 4 ×
	Device.Application.	PLC_PRG	) 💌 🗹	Filter by Symb	ol, POU, Variab	le, Access, T	/pe, Address, Ob	oject		• * = = #
	Symbol	POU	Variable	Access	Туре	Address	Location	Object		Com
Pevines 10 POLIS	B-PLC_PRG	PLC_PRG Task Configuration.MainTask		Declaration Call	PLC_PRG PLC_PRG		Line 1 (Ded)	PLC_PRG [Device: PLC Logic: Appl MainTask [Device: PLC Logic: Appl	ication] ication: Task Conf	figuration]
Marranae - Total Samor(s) () warning(s) () marranae	3									
Core:17	21 Ka	Memory:74%	Last build: 🤅	30 🖲 0 🛛	recompile 🧹	65	Project	user: (nobody) INS	Ln 1 Col :	1 Ch 1 💮

Step 1 Right-click **Application** in the device tree, select **Add Object** > **POU**, and add a POU dedicated to EtherCAT servo control.

B Untitled9.project* - Invtmatic Studio File Edit View Project Build Online Debug 한 ☞ 문   종   ♡ ○ 상 ☜ 등 X   44 않 성 성	Tools	Window Help	- □ × ₹
Device • 9 × · ③ Unisses · ③ Device (14753) · ④ Perkit degrees summary · ③ Perkit degrees summary · ③ Perkit degrees · ④ Perkit degrees · ● ◎ Perkit degrees · ● ○	Device	ROGRAN FLC_FRG AR ND_VAR	Propertes     • • • • ×     *     *     Property     Value
Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy Copy		Atarm Configuration Application Avis Group Cont table CNC program Otk Sources Manager Duta Sources Manager DUT External File Global Variable Lit Image Pool	
	ss Refe evice.Af pmbol -PLC_P -PLC_P -PLC_P -PLC_P -PLC_P -PLC_P -PLC_P -PLC_P -PLC_P -PLC_P -PLC_P -PLC_P -PLC_P -PLC_P -PLC_P -PLC_P 	Interface     Network Variable List (Receiver)     Network Variable List (Receiver)     Persistent Variables     POU     POU     POU for implicit checks     Recipe Manager     Redundary Configuration     Symbol Configuration     Text Im     Trace     Trace     Trace Recording Manager	100 %     Perciption       100 %     Pro       Pro     Pro
Messages - Total 5 error(s), 0 warning(s), 2 message(s)		Unit Conversion Visualization	Memory:74% Last build: 🗘 0 🕐 0 Precompile 🗸 🖓 Project user: (nobody) 🖗

Step 2 Double-click **EtherCAT\_Task** in the device tree, click **Add Call** on the configuration interface, and select a **POU**.

Catheled V		10001										
Construct (14/73)     Construct (14/73)	Configuration Prionity (03 Type © Cyclic Watchdog Finable Time (e.g. 1 Sensitivity	1 ): 0 \$200ms) X Remove Cal	Interval (e.4	all ( @ Move Up	⊕ Meve Down //	+ Open P	00		ms v	<b>交 To</b> ,@	Pro (#) VI	sualizatio.
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	Sumbol	concorrosco	POU		Variable	, variable, A	Access	Time	Address	Location	Object	
	CalTask_ CalTask_	EtherCAT_Task EtherCAT_Task	Task Configura Task Configura	tion.EtherCAT_Task tion.EtherCAT_Task	CallTask_Ether	CAT_Task	Declaration Declaration	CalTask_EtherCAT_Task BOOL	Audress	Location	EtherCAT_Ta EtherCAT_Ta	ssk (Device ssk (Device

Figure 2-6 Calling a POU for the EtherCAT task

Type		
Cyclic V I	terval (e.g. t#200ms) 4000	μs 🗸
Watchdog	Input Assistant X	
Enable	T LO L Character	
Time (e.g. t#200ms)	Text Search Categories	ms $ \smallsetminus $
Sensitivity 1	Image: Application     Application       Application     Application       Image: Application     Application       Image: Application     Application       Image: Application     Application	
🖶 Add Call 🗙 Remove Call 🔁		
POU		
eg rourke		
	I Structured view	
	Insert with arguments Insert with namespace prefix	
	Documentation	
Ressages - Total U error(s), U warning(		÷ ‡
Description		Object Position
Oreated task 'EtherCAT_Task'.	OK Cancel	
	e.	

# 2.3.3 Setting Motor Parameters

For precise control of the movement position, the PLC must accurately calculate the position of the servo motor. Based on the operating characteristics and stroke characteristics of the application system, as shown in the figure below, select **Axis type and limits** so that the PLC can calculate the feedback information from the motor encoder to obtain the accurate position and avoid errors caused by the accumulation of encoder pulses.

Figure 2-7 Motor Parameter Settings

ces 🗸 🗸 X	Device PLC_PRG	🕂 POU 🔮 Ett	erCAT_Task	Axis X			
J Untitled9	Scaling	Axis type and limits	1			Velocity ramp type	
Auto scan		Virtual mode	Software limits			Trapezoid	
Rault diagnosis summary	Homing Setting	Madula	Activated	Negative [u]:	0.0	◯ Sin <sup>2</sup>	
PLC Logic				Positive [u]:	1000.0	Ouadratic	
Application	Automatic mapping	O Finite			-	Ouadratic (smo	
Library Manager	General		Software error reac	tion	1. 0	Quadratic (dillo	
PLC_PRG (PRG)				Deceleration [u/s-	-]: U	Identification	
POU (PRG)	Scaling/Mapping			Max. distance [u]:	0	ID: 0	
Task Configuration	· · · · · · · · · · · · · · · · · · ·	Dynamic limits				Position lag supervisi	
EtherCAT_Task	Commissioning	Valasity Su/al	Assolatation [1/22]	Deceleration [u/a2]	Jack Fulle 31	deactivated	
🖃 🎯 MainTask	SM_Drive_ETC_GenericDSP402: I/O	velocity [u/s]:	Acceleration [u/s*]	Deceleration [u/s*]	Jerk [u/s*]:		
PLC_PRG	Mapping	30	1000	1000	10000	Lag limit [u]: 1.	
TM75x-HSIO (TM75x-HSIO)	SM_Drive_ETC_GenericDSP402: IEC Objects						
ExtCard (ModuleScan)	Status						
INVT_DA200_265 (DA200-N EtherCAT(Co	Information						
- 11 INVT DA300 101 (DA300-N EtherCAT(Co							
Axis 1 (Axis)							
Coffee Consul Avia Deal							

#### Note:

• For the reciprocating mechanism of the lead screw type, **Finite** is preferred as the lead screw stroke is limited and we should know its absolute position within the stroke range.

• For a single-direction axis, **Modulo** is preferred as the linear mode may cause position counting overflow, resulting in position calculation errors.

The encoder parameters of the motor (such as resolution) and the mechanical reduction ratio of the application system may be different. They need to be set based on the actual situation during programming, as shown in the following figure.

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🗎 🛩 🔛 🖽 🗠 🗠 ங 🛍 🗙 👫 🌿	乳乳液	🖞   Application [Device: PLC Logic] 🔹 🧐 👂 📄 💘   🗊 🕾 🔄 🐄   🖗   🗮   🖘   🛒				
Devices 🗸 🕂 🗙	K Axis X	•				
Untitled9     Ovice (TM753)	Scaling	Scale Propertionally				
Auto scan     Auto scan     Agentation and the scale of the scale	Homing Setting	10000 Increments <=> motor turns 1				
PLC Logic     Application	Automatic mapping	1 motor turns <=> gear output turns 1				
Library Manager     Ilibrary Manager     Ilibrary Manager	General	1 gear output turns <=> units in application 1				
POU (PRG)	Scaling/Mapping					
EtherCAT_Task	Commissioning					
PLC_PRG	Mapping	w w				
TM75x+ISIO (TM75x+ISIO)	SM_Drive_ETC_GenericDSP402: IEC Objects					
EtherCAT_Master_SoftMotion (EtherCAT Mast	Status	Remarks: I when the motor is runing, the controller sends the pulse to the servo driver through Ethercat communication to control the servo operation. Therefore, the resolution of the				
INVT_DA200_265 (DA200-N EtherCAT(Co	Information					
INVT_DA300_101 (DA300-N EtherCAT(Co Axis_1 (Axis)		distribution rate of the serve motor is 20bit. it means that the motor rotates 1 turn and needs to receive to receive 1048, 576 pulses				
SoftMotion General Axis Pool		2、Set the corresponding parameters (electronic gear ratio) according to the actual mechanical structure;				
		3. Note: Each parameter input in the figure above can only input integer data. in order				

#### Figure 2-8 Motor Encoder Parameter Settings

When the motor is running, the PLC sends the required number of pulses to the servo drive through EtherCAT communication to control the servo operation. Therefore, the encoder resolution needs to be accurately set according to the actual situation. For example, if the resolution of the servo motor is 20 bits, it means that for the motor to make one revolution, 1,048,576 pulses need to be received.

You need to set the corresponding parameters (electronic gear ratio) according to the actual mechanical structure.

**∠Note:** Please note that only integer values can be entered for the parameters shown in the above figure. In order to ensure that the ratio of the parameters in the corresponding rows on the left and right sides is effective, you can adjust the integer values on the left and right sides appropriately. For example, a 20-bit servo motor drives a lead screw of 16 mm (the screw slider moves 16 mm when the screw rod rotates 1 circle) after passing through a mechanical reduction mechanism with a ratio of 3.75:1. The parameter settings are shown in the figure below.



-Scale Propertional	ly		
<ul> <li>Invert direct</li> </ul>	tion		
1048576	Increments <=> motor turns	1	
375	motor turns <=> gear output turns	100	
1	gear output turns <=> units in application	16	

# 2.3.4 Writing a Function for Forward/Reverse Motor Direction Control

For the motion control of the servo axis, the default synchronization period is 4 ms, and you can select it according to actual needs, as shown in the figure below.

Figure 2-10 Servo Axis Motion Control Cycle Setting

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🛅 🚅 📕   🚳   🕫 🗠 🗈 🛍 🗙   🖊 🎲 🐴 🔮	刘刘洵  昌  徳- 🖞	* 🔛 🛛 Application [Device: PLC Logic] 🔹 👒 🕠 🕨	■ 🌂   @ ☜ ☜ 🕸   ㅎ   麗   🐨   🏷
Devices 👻 🕂 🗙	EtherCAT_Master_SoftMo	otion x	-
S Untitled9			
Device (TM753)	General	Autoconfig Master/Slaves	Ether CAT.
	Function Code	EtherCAT NIC Setting	
PLC Logic	Sync Unit Assignment	Destination address (MAC) FF-FF-FF-FF-FF-FF	Broadcast Enable redundancy
Library Manager	Log	Source address (MAC) 00-00-00-00-00	Browse
PLC_PRG (PRG)	EtherCAT I/O Mapping	Select network by MAC     Select network by MAC	vork by name
EtherCAT_Task	EtherCAT IEC Objects	✓ Distributed Clock	▲ Options
⊟- 🌮 MainTask	Status	Cycle time 🕴 μs	Use LRW instead of LWR/LRD
면데 PLC_PRG	Information	Sync offset 20 🖨 %	Automatic restart slaves
TM75x-HSIO (TM75x-HSIO)		Sync window 1 🜲 µs	
EtherCAT_Master_SoftMotion (EtherCAT Mast			
= 1 INVT_DA200_265 (DA200-N EtherCAT(Co			
Avis 1 (Avis)			
SoftMotion General Axis Pool			

The program in the figure below is written in the ST language, and the relevant code is as follows.

Figure2-11 ST Code

•	2 3 4 5 6	VAR MC_Power: MC_Power; MC_MoveAbsolute: MC_MoveAbsolute; iStatus: INT:=0; i:UINT:=1000; //力相限書創
	7	END VAR
		-
		10
	1	CASE IStatus OF
	2	0:
	3	<pre>MC_Power(Axis:= SM_Drive_GenericDSP402, Enable:= TRUE, bRegulatorOn:= TRUE, bDriveStart:=TRUE , );</pre>
	4	IF MC_Power.Status
	5	THEN
	6	iStatus:=iStatus+1;
	7	END_IF
	8	1:
	9	<pre>MC_MoveAbsolute(Axis:=SM_Drive_GenericDSP402 , Execute:= TRUE, Position:=200 , Velocity:=5 , Acceleration:= 5, Deceleration:= 5,);</pre>
	10	IF MC_MoveAbsolute.Done
	11	THEN
	12	MC_MoveAbsolute(Axis:=SM_Drive_GenericDSP402 , Execute:= FALSE,);
	13	lstatus:=1status+1;
	15	
	16	2: MC Mourabeclute/Avis-SM Drive CenericDSD402 Evenute: TDHE Dosition:-( Velocity:-( Acceleration:- 5 Deceleration:- 5);
	17	IF M Musshedute Inte Inte
	18	
	19	MC MoveAbsolute(Axis:=SM Drive GenericDSP402 , Execute:= FALSE.):
	20	iStatus:=1;
	21	END IF
	22	END CASE

# 2.3.5 Compiling the User Program

If there is a writing error, the error type and reason will be listed in Figure2-11. Once you double-click the error description, the cursor will jump to the corresponding program editing window to facilitate revision. After the revision, compile it again until all compilation problems are eliminated. The operation steps are as follows:

- Step 1 Double-click **Device** in the device tree, and select **Communication Settings > Scan Network**.
- Step 2 After selecting the corresponding device, click **Flash**. At this time, the RUN and ERR lights of the connected device will flash three times.
- Step 3 After confirming the device, download the user program to the CPU module.

Figure 2-12 Program Compilation Interface

	-			
Devices 🗸 🗸 🗙	EtherCAT_Master_Soft	tMotion X		
Untitled9     Device (TM753)	General	Autoconfig Master/Slaves	EtherCAT	
- Auto scan	Function Code	EtherCAT NIC Setting		
PLC Logic     Application	Sync Unit Assignment	Destination address (MAC) FF-FF-FF-FF-FF	Broadcast Enable redundancy	
Ubrary Manager	Log	Source address (MAC) 00-00-00-00-00 Network Name ETH0	Browse	
POU (PRG)	EtherCAT I/O Mapping	Select network by MAC Select netw	vork by name	
EtherCAT_Task	EtherCAT IEC Objects	J Distributed Clock	J Options	
😑 🕪 MainTask	Status	Cycle time 4000 🛓 µs	Use LRW instead of LWR/LRD	
Variable usage	Information	Sync offset 20 👻 %	Enable messages per task     Automatic restart slaves	
ExtCard (ModuleScan)		Sync window 1 🌲 µs		
HeneCAT_Master_SoftMotion (EtherCAT Mast     InvT_DA20_255 (DA200+N EtherCAT(Co     Master_SoftMotion)     InvT_DA300_101 (DA300+N EtherCAT(Co     InvT_DA300+N EtherCAT				
				📌 To

#### Figure 2-13 Connecting to the PLC



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🎦 🛩 🖬 🕼 🗠 🗠 🖻 💼 🗙 🕍 😫	% % A 🛱 🛅 🖬 👘	Application [Device: PLC	Logic 🗸 🥳 🦚 🖒 💼 🤻 🖓 🕫 🖆 🤊	= 8   +   <b>∭</b>   <del>=</del>   ₹/
Devices 👻 👎 🗙	EtherCAT_Master_SoftMotion	Device X	Login (Alt+F8)	•
Untitled9	Backup and Restore			
Auto scan	Files	•		
- 🔍 Fault diagnosis summary			Gateway	• • •
PLC Logic	Log		Gateway-1	[000B] (active)
Library Manager	PLC Settings		IP-Address: localhost	Device Name: TM753-C
PLC_PRG (PRG)	PLC Shell		Port:	Device Address:
King Task Configuration     Section EtherCAT_Task	Users and Groups		1217	OOOB
POU	Access Rights			1631 0053
PLC_PRG	Symbol Rights			Target Type: 4102
TM75x-HSIO (TM75x-HSIO)	IEC Objects			Target Vendor: Shenzhen INVT Electric Co., Ltd.
[]] ExtCard (ModuleScan) 	Task Deployment			Target Version: 3.5.15.20
INVT_DA200_265 (DA200-N EtherCAT(Co M Axis (Axis)	Status			
INVT_DA300_101 (DA300-N EtherCAT(Co	Information			
SoftMotion General Axis Pool		Your device can be secured.	_earn more	1
		1		

#### Figure 2-14 User Program Download

## 2.3.6 Running the Monitor Program

As shown in Figure 2-14, after logging in to the device, you can know the program is running by observing the actual operation of the servo or checking the position value of the servo axis of the upper computer. At this point, the required servo jogging and 2-cycle running triggering functions have been implemented, which means the programming process is complete. You can also view the CPU and memory usage in the lower left corner of the interface, as shown in Figure 2-15. In the task configuration interface, you can view the execution cycle time of each task (after the program is powered on for the first time, you need to right-click and select Reset to view the accurate time), as shown in Figure 2-16.

- <b>→ ↓</b> X	EtherCAT_Master_SoftMotion	X Device X			✓ Properties ✓
(Juneary Connected) (TM753)      (Juneary Connected) (TM753)      (Juneary Connected) (TM753)      (Juneary Connected)     (Juneary Conneced)     (Juneary Connected)	CommunicationSecting passe Joint CommunicationSecting Passe Joint CommunicationSecting Passe Joint CommunicationSection Passe Joint CommunicationSect	Gateway -	Device - Gateway- Device B-Address: Decalhors 1217	V (0008) (active) Device Name: TM753-C Device Address: 0008 Target ID: 1651 1003 Target ID: 1651 1003	Agisntorder • Property Value
C WIT_DA200_265 (DA200 + EtherCAT(CoE) Driv C WIT_DA200_265 (DA200 + EtherCAT(CoE) Driv C WIT_DA200_101 (DA300 + EtherCA	Symbol Rights IEC Objects Task Deployment Status Information			TIDE Target Vendor: Shenzhen INVT Electric Co. Target Version: 3.5.15.20	Description
					Pr., 🖶 Visualiz
	Watch 1	Application	Tura Valua	Descenducture Excendion activ	

Figure 2-15 Device Monitoring
### Figure 2-16 Task Monitoring

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日本の公式時間×日本	SA 1 11 11	ા ગામતા હ	à 🍋 🖻 🕮 I	Application [D	evice: PLC Logic] •	CS CE	1 S = 4 + 3	히房글장						
Devices 👻 🔻 🛪	Et Et	herCAT_Master	_SoftMotion	Device	EtherCAT_Task	Task Configu	ration X					•	Properties	• # X
🖃 🗿 Untitled9 💌	United9 V Monitor Variable Usage System Events Properties V F									V Filter •	Sort by •			
🖹 😏 👔 Device [connected] (TM753)	Task	Status	IEC-Cycle Count	Cyde Count	Last Cycle Time (us)	Average Cycle Time (us)	Max, Cycle Time (us)	Min. Cycle Time (us)	Jitter (us)	Min, Jitter (us)	Max, Jitter (us)		Sort order	
Auto scan	@EtherCA	Vaid	1837	1837	205	203	315	172	81	-41	40	i II	Property/	Value
- 🔍 Fault diagnosis summary	MainTas	k Valid	Reset 1837	1837	19	16	26	15	202	-86	116		rioperty	Voluc
PLC Logic														
= C Application [run]														
Drary Manager												- 11		
Task Configuration														
EtherCAT Task														
- #1 POU														
🖻 😏 🥵 MainTask														
B) PLC_PRG														
- 🚱 📆 TM75x-HSIO (TM75x-HSIO)														
- 😏 🗊 ExtCard (ModuleScan)														
🖹 😏 📆 EtherCAT_Master_SoftMotion (EtherCAT Ma												- 11	Description	
😑 😏 🛗 INVT_DA200_265 (DA200-N EtherCAT(0														
- 🔂 🖬 Axis (Axis)														
🖹 😳 🚮 INVT_DA300_101 (DA300-N EtherCAT(0												Πi	🗐 Pr. 🗿 Vi	uaiz 🐼 T
Axis_1 (Axis)													<u>.</u>	
SoftMotion General Axis Pool	Watch 1													- 4 X
	Expression			Application	Type	Value	Prepared value	Execution point			Address Con	nm		
	00-100011	-C - Landronn												
eron(s), 0 warning(s), 7 message(s)			Least b		Descenaio d	0-	Des seconda se d					Destas		- C
Core:11% Memory:74%	Dev	nce user: Anon	ymous Last b	uiu. 🕹 0 🕕 0	erecomple 🗸	RON RON	Program load	ea	Progra	im unchanged		нтојес	t user: (noboo	9) 🧏

# **3 Basic Functions**

# 3.1 Interface Layout

Search in the **Start** menu of the Windows system or click the shortcut on the desktop to open the Invtmatic Studio software.

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File Edit View Project FBD/LD/IL Build	Online Debug Tools Window Help		₹.
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2 ··· · · · · · · · · · · · · · · · · ·	B####→#+#11目目測12F15名5		
Devices 👻 🔻 🛪	< 🛐 Device 🙀 Task Configuration 👔 EtherCAT_Master 🚯 EtherCAT_Task 🙆 POU x	ToolBox	- # X
	FIGURAR FOT FIGURAR FOT FIG	General     Thetwork     Box     Box	
	1         EtherCAT_Master.sDistributedClockTnSync         EtherCAT_Master.sConfigTailabed         EtherCAT_Master.sError         EtherCAT_SError	Hath Operators     Other Operators     Function Blocks     Ladder Elements     POUs	
Ang (Ang)     Ang (Ang)     Song (Ang (Ang) (Ang (Ang))     Ang (Ang) (Ang)     Ang (Ang)     Ang (Ang)     Ang (Ang)     Ang (Ang)	0     Hc_powr_0.5stow_0       1     Hc_sovelative_0       1     Hc_sov		
		🖈 TooBox 🛅 Properties 🕘 Visual	Ization ToolBox
	Cross Reference Lat		- 8 X
	Device Application. IoComfg. Globalis. Avis Q, • Y Filter by Symbol, POU, Variable, Access, Type, Address, Object	4 9 9	1 🗐 🚳
	Symbol         POU         Address         Location	Object ois [Device: EtherCAT_Master: INVT_DA2	100_265]
👷 Devices 👔 POUs			
Messages - Total 0 error(s), 0 warning(s), 7 message(s			
m			

Figure 3-1 PLC Project Interface of Invtmatic Studio

The interface mainly includes the following content:

- PLC device information, you can right-click **Device** to change the PLC model;
- Application, i.e. the user program management unit;
- EtherCAT\_Task, i.e. the EtherCAT bus task;
- MainTask, i.e. the main program task;
- Local module configuration TM75x-HSIO;
- EtherCAT\_Master\_SoftMotion, i.e. the EtherCAT bus configuration;
- EtherCAT bus slave (INVT\_DA200\_265) and 402 axes, or remote IO modules.
- Shortcut keys for compilation, login, and debugging.

# 3.2 Compile Menu

The **Compile** menu integrates diverse functions such as compilation and clearing, which are described as follows:

- Compile: Compile and link all codes into those that can be executed by the PLC.
- Recompile: Clear the last compiled information and re-execute the compilation instruction.

- Generate Code: For the Generate File function required for symbol configuration in label communication, you can click the Compile button to implement it, or click the shortcut key
- Generate Runtime File: used for R&D testing.
- Clear: Clear the last compiled and downloaded information.
- Clear All: Clear compiled information, downloaded information, and reference information, and refresh all library and project data compilation information.



Figure 3-2 Compile Menu

# 3.3 Variable Usage Table

### 3.3.1 Overview

The variable usage table has the following functions:

- Display the address usage of I/Q/M areas, including the classified display of used addresses, conflicting addresses, and free addresses.
- Display the used size, available size, and usage rate of the program area, data area, power failure retention area, and I/Q/M areas.

### **3.3.2 Function Introduction**

Select **Device** > **Variable Usage** in the device tree and double click **Variable Usage** to open the interface as shown in the figure below.

**∠Note:** The maximum storage capacities of the TM series program area, the data area, the power failure retention area, the M area, the I area, and the Q area are 20M, 64M, 1M, 5M, 128K, and 128K, respectively.

evices 👻 🕂 🗙	<u>_</u>	/ariable usage	×			$\frown$						
Chatters	Hint: The project Program (B) App Data (B) Persistent (B) S I Zone (B) S J Zone (B)		Hint: The project is latest,not need Program (B) Total size: App Data (B) Total size: Persistent (B) Total size: S W Zone (B) Total size:		to complie! 20971520 67108864 1048576 5242880	compliel 0971520 Free size: 7108864 Free size: 1048576 Free size: 5242880 Free size:		Used size: Used size: Used size: Used size:	1757336 243574 0 122880	Used rate: Used rate: Used rate: Used rate:	8.39% 0.36% 0% 2.34%	
● POU (PRG) ■ 愛 Task Configuration ■ 愛 Etherct_Task ● POU ■ 愛 MainTask ● Ag. (PRG)	s q : % M Zor St	Kone (B) ne %IZone % atus: All	Total size: Q Zone Function bl	131072 ock	Free size:	131013 131027 5242879	Used size: Variable	45 e name:	Used rate:	0. 03%		
C Martiak     C C Martiak     C C Martiak     C Marti	•	Serial No	address 94x80-94x8524 94x85120000 94x85180000 94x85180000	POU 		variabie name SD元件 SM元件 系动先保留		nane type	Addr rat %4480-% %448518 %448518 %448518	99 682542879 0000-MuRS179999 0000-MuRS119999 0000-MuRS1242879	sothal Free System used System used System used	

Table 3-1 Description of Variable Usage

Number	ltem	Description
1	Data refresh area	If you click the <b>Compile</b> button, the interface will extract the information it needs based on the generated data and conduct a refresh once the compilation is succeeded. Alternatively, you can click the menu <b>Compile</b> > <b>Generate Code</b> in Figure 3-2 to trigger an interface refresh. <b>Note:</b> This function will refresh the interface only after successful compilation.
2	Area usage information area	It mainly displays the basic information of the program area, data area, power failure retention area, and I/Q/M areas, including the total capacity of the area, the size of the used area, the size of the available area, and the area utilization rate.
3	Detailed I/M/Q area usage information and function block information display area	It displays the address usage of I/M/Q areas, including address-associated variable information, address conflict status, information of unused address areas, etc. The function block information mainly includes the type and size of the function block called in the program. It also supports functions such as search, address range setting, and page number positioning.

The information display interface is shown in the figure below. It is divided into 4 display options, namely **%M area**, **%I area**, **%Q area**, and **Function block size**, which display the usage information of the corresponding areas respectively.

Variable usage	×										
Hint: The proje	ect is latest,not need	to complie!		Compile							
Program (B)	Total size:	20971520	Free size:	19214184	Used size	: 1757336	Used rate:	8.38%			
App Bata (B)	Total size:	67108864	Free size:	66865290	Used size	: 243574	Used rate:	0.36%			
Persistent (B)	Total size:	1048576	Free size:	1048576	Used size	: 0	Used rate:	0%			
S I Zone (B)	Total size:	5242880	Free size:	5120000	Used size	: 122880	Used rate:	2.34%			
% I Zone (B)	Total size:	131072	Free size:	131015	Used size	: 67	Used rate:	0.04%			
% Q Zone (B)	Total size:	131072	Free size:	131027	Used size	: 45	Used rate:	0.03%			
% M Zone % I Zone %	Q Zone Function b	lock									
Status: All	~ Add	r range: 0	÷.	5242879	Variab	ole name:		Query			
Serial No	Address	POU		Variable name		Variable type	Addr r	inge	Status		
▶ 1	%MB0-%MB524					%MB0-%MB524		%MB5242879	Free	1	
2	%MB5120000			SD元件				20000-%MB5179999	9 System used	_	
3	%MB5180000			SM元件			%MB5	80000-%MB5219999	9 System used	_	
4	%MB5220000			系统保留			%MB52	20000-%MB524287	9 System used		
First page	Previous pag	e 1	/ 1	Next p	page	Last page		Page size: 10	~		
					-			-			

## 3.3.3 Menu Options

Menu options include display options, query, address range settings, and page turning options.

Number	Item	Description						
	Display	For the <b>%M area</b> , <b>%I area</b> , and <b>%Q area</b> , the status options include <b>All</b> , <b>In</b>						
1		use, System use, Conflict, and Idle;						
T	options	For the Function block size, the status options include All, Function block,						
		Union, Structure, and Alias.						
	Query options	You can perform character matching on the names in the four columns of						
2		Address, POU, Variable name, Variable type, and Address range. If any						
		one of them matches, the condition is met.						
		<b>Note:</b> Any changes in the query options will trigger a table refresh.						
	Address	You can check the address range set by you according to actual needs, and						
2		the range cannot exceed the limit of the corresponding area. You need to						
3	range	click the <b>Query</b> option to enable the range display.						
	settings	<b>Note:</b> This item is not available in the function block size interface.						
		To ensure the table refresh performance, you can add a maximum of 1,000						
	Page	address segment units by default. When the data exceeds 1,000 address						
4	turning options	segment units, the system will use paging display. You can click Previous						
		Page/Next Page or enter a specified page number, and the system will jump						
		to the corresponding page.						

Table 3-2 Description of Variable Usage Statistics Menu

Table options: They mainly display the usage information of address segments that meet the filter conditions.

Number	Item	Description
		The address area is displayed in ascending order, with the smallest unit
1	Address	being Byte. When the address occupied by a variable does not conflict, it
		will be displayed in the form of an address area (e.g.: %MB0–%MB3). One

Table 3-3 Description of Variable Usage Statistics Table

Number	Item	Description					
		address may be associated with one or multiple variables. When there are					
		multiple variables, the address bar will display multiple duplicate					
		addresses.					
2	POU	All POU names of variables area displayed.					
2	Variable	The variable name acceptiated with the area is displayed					
3	Name	The variable name associated with the area is displayed.					
4	Variable	The variable type is displayed					
4	type	The valiable type is displayed.					
5	Address	The entire address range of the variable is displayed					
5	Range	The entire address fange of the variable is displayed.					
		The usage of the address area is displayed. When it is used, the status is <b>In</b>					
		Use; when there is a conflict, the status is Conflict; when it is free, the					
		status is <b>Idle</b> .					
		∠Note:					
		• Address conflict detection is performed based on the byte position.					
6	Stato	When different variables use different bits of the same address, the					
0	Slale	system will mark it as an address conflict during detection. The					
		specific conflict situation is based on the actual bit usage.					
		• When a user-defined variable conflicts with the IO address assigned to					
		the device, it only means that the same address is used in multiple					
		places. You can determine whether there is a problem based on					
		whether the actual function is used.					

## 3.3.4 Direct Address Storage Area

Different PLCs provide different direct storage areas. For PLC data, the addresses in the %I and %Q areas cannot be saved after a power failure, but the addresses in the %M area can still be saved. The TM700 series programming system provides a 128kB (Byte) input area (%I area), a 128kB (Byte) output area (%Q area), and a 512kB (Byte) storage area (%M area). The first 480kB in the storage area can be used directly by users, and the last 32kB is the system area (mainly used as soft components) and should not be used directly by users. During programming, you can directly access addresses or define variables and map them to addresses for indirect access. The definition of storage areas and the address range used by them are shown in the following table.

Area	Purpose	Size	Address Range		
l area (%l) 128kB	User area	64k Words	%IW0-%IW65535		
Q area (%Q) 128kB	User area	64k Words	%QW0-%QW65535		
	User area	240k Words	%MW0-%MW245759		
	SD components	10000Words	%MW245760-%MW255759		
M area (%M) 512KB	SM components	10000Bytes Words	%MB511520-%MB521519		
	Reserved	2768Bytes	%MB521520-%MB524287		

Table 3-4 Description of Storage Areas and Address Range Used by Them

# 3.4 Fault Diagnosis

Diagnosis is intended to quickly locate errors that occur during PLC operation and find solutions according to the error information and status. The diagnostic interface of Invtmatic Studio can only be obtained and displayed after logging in to the PLC. The Invtmatic Studio programming system supports the diagnosis of

various communication devices and can generate fault information, offline information, and other information according to the actual running status of each communication device. The module types involved in fault diagnosis mainly include CPU module, Modbus, ModbusTCP, etc. The Invtmatic Studio programming system mainly provides four diagnosis routes: configuration diagnosis, diagnostic information list, device self-diagnostic information list, and diagnostic programming interface. All diagnoses are obtained through fault code analysis, and the fault codes correspond to the diagnostic programming interface.

Fault diagnosis can be used to display fault information of all devices, and provide detailed description of relevant fault information and methods for troubleshooting the causes. It can also provide more detailed diagnostic information for special situations. After the device is connected, double-click **Fault diagnosis summary** in the device tree to open the device fault diagnosis interface.

Devices 👻 👎 🗙	PLC_PRG 😸 MainTask	Fault diagnosis summer summ	mary x		•
■ ]] Unsted1	Device Type ALL	- Module Name ALL	+ 🔍 Quar	y 🕼 Refresh 🛔 Clear 🛃 Export EXCEL	Statistics of fault information 0
🖻 💮 Device (TM753)					-
- 🗋 Auto scan	Device Type	Module Name	Error code		Error name
- Q, Fault diagnosis summary					
PLC Logic					
Application					
Library Manager					
PLC_PRG (PRG)					
Task Configuration					
- 🛞 EtherCAT_Task					
🖹 🚱 MainTask					
- D PLC_PRG					
- 🜔 Variable usage					
TM75x-HSIO (TM75x-HSIO)					
ExtCard (ScanModule)					
EtherCAT_Master_SoftMotion (EtherCAT Master SoftMotion)					
INVT_DA200_F66 (DA200-N EtherCAT(CoE) Drive V1266)					
Axis (Axis)					
SoftMotion General Axis Pool					
	Error Detais Cause troubleshooting D	epth diagnosis			
	1				

The functions of the fault diagnosis interface are described as follows:

#### • Device Type Window

It displays the current fault type and provides the fault display filter function, which can display fault information by device type. Device types include CPU module, Modbus module, Modbus TCP module, and local module. You can select a different device type, and the diagnostic display list will show the corresponding type of diagnosis. All device diagnoses are displayed by default.

#### • Description of Interface Options

- ♦ Device Type: Filter a certain type of faulty bus device.
- ♦ Module Name: Filter faulty devices with a specific name.
- ♦ Search: Search for matching fault information based on the device type or module name.
- ♦ Refresh: Used to refresh device fault information.
- ♦ Clear: Clear the fault information in the table.
- ♦ Export to Excel: Export fault information in the table.
- ♦ Fault Information Count: Display the number of faults.
- ✤ Fault Information List: mainly used to display specific module fault information, including device type, module name, error code, and error name.
- Detailed Information window: When a certain piece of fault information is selected in the Fault Information List, the detailed information of the fault will be displayed in the detailed information

window, which includes three options: Error Details, Troubleshooting, and In-depth Diagnosis. Error Details window: Display possible causes of the fault. Troubleshooting window: used to provide the specific operation method for troubleshooting. In-depth Diagnosis window: For some complex errors, more detailed information is needed to locate them.

# 3.5 Automatic Scanning

If you need to increase the number of IO ports, you can expand the IO module. The steps to add an expansion module to the PLC body in the software are as follows:

- Step 1 Open the Invtmatic Studio programming software, create a new project, and select the programming language.
- Step 2 Connect to the PLC and scan local expansion modules. You need to log in to the PLC, but you may not start it.
- Step 3 Double-click Automatic Scanning in the device tree, and click Scan in the automatic scanning interface. Then, the installed extension modules will be automatically scanned in the list. Click Add to Configuration in the upper right corner to complete the scanning and configuration addition of the expansion module.

Untitled9.project - Invtmatic Studio											
le Edit View Project Build Online Debr	ug '	Tools Wir	ndow Help								
🛎 🖬 📾 🗠 a 🕉 🖻 🖻 🗙 🛤 😫 🐴	241	用名号	11 1 1 1 1 1 1 1 1	Application [Devi	ce: PLC Logic] + 👀 😋	> = 4	101 101 101 101 101 101	中   罰   示   引			
vices 👻 🔻 🛪 🗙	1	Auto sca	n x								
Untitled9		C	class								
O      Device [connected] (TM753)		Scan	Clear								
Auto scan		Serial	Device	Device	Device	Position	Device type(exist)	Device name(exist)	Is exist in configuration	Is add to configuration	结果
- 🤤 Fault diagnosis summary	<u> </u>	NO	type(scanned)	version(scanned)	name(scanned)			E 2224 222200			
E PLC Logic	<u>۲</u>	1	30909	1.0.0.0	PL2201_00080K	1	30909	PL2201_0008DK			
= O Application [run]	<u> </u>	2	36969	1.0.0.0	FL2201_0008DR_1	2	36969	FL2201_0008DR_1			
Library Manager	<u> </u>	3	0			3					
		4	0			4					
E Configuration		5	0			5					
G S EtherCAT Task		6	0			6					
- (H) POU		7	0			7			0	0	
🖹 😏 🥵 MainTask		8	0			8					
- 롄 PLC_PRG		9	0			9				0	
Variable usage		10	0			10			0	0	
<ul> <li>III TM75x-HSLO (TM75x-HSLO)</li> </ul>		11	0	-		11					
		10	0			10			0	0	
ExtCard (ModuleScan)		12	-			12					
B O II EtherCAT_Master (EtherCAT Master SoftMo		13	U			13				0	
- G 1 INVT_DA200_265 (DA200-N EtherCAT(0		14	0	_		14				U	
😔 🛤 🛛 Axis (Axis)	_	15	0			15					
- G I INVT_DA300_101 (DA300-N EtherCAT(0		16	0			16			0		
- 🔂 🖬 Axis_1 (Axis)		17	0			17					
- 😯 🥻 SoftMotion General Axis Pool		18	0			18					

# 3.6 Cross-reference

The cross-reference function can be used to quickly find the calling location of the target object in the entire project. The operation steps are as follows:

Step 1 Find the object you want to cross-reference, right-click and select **Browse > Browse cross References:xEnCntCout**.



Step 2 View the usage of the "target object" in the entire project from the **Cross-reference List** under the project. Double-click the information in the cross-reference list to jump to the specific usage location in the project.

2	EtherCAT_	Master.xDistr;	ibutedClockInSyn MC_MoveRt	c EtherCAT	Master.xConfigFinished	EtherCAT_Mas	er.xError	Aris - Aris THUE - Eable DEFENSE Aris THUE - Eable DEFINE THUE - DEpulatoria	MC_Power_0 MC_Power Status bRegulatorRealState bDriveStartRealFtate Busy Error ErrorID	PLISE PLISE TLISE TLISE PLISE PLISE PLISE PLISE
	bMoveRela	Axis	MC_BOVES Execute Distance Velocity Acceleration Deceleration Jeck BufferMode	ELECTIVE Do Bu Acti CommandAbort Error	NO e 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.55 74.					
	-									
Cross Referen	nce List									
Device.Appl	cation.POU.bPowe	r	🔍 🔶 🍸 Filter	vy Symbol, POU, Va	riable, Access, Type, Address, Object	t				
Symbol	POU Vari	able Access er Declaration	Type Addres BOOL	Location	Object POU [Device: PLC Logic: Application	Comment				

# 3.7 Monitor List

The Monitor List function can be used to monitor variables and addresses. During program running, the Monitor List can be used to view the data type and current value of the monitored variable, and the variable can be assigned a value by writing a value. The operation steps are as follows:

Step 1 Click **View** > **Watch** in the Toolbar, and add **Watch 1** to the monitor options.

🔁 Un	titled9.p	roject	t - Invtmatic Studio										
File	Edit	Viev	v Project FBD/LD/IL Build	Online	Debug	g Tools	Window	Help					
1 🖆	i 🖬 🖡	32	Devices	Alt+0	19	91 M 1	🗟 i 🛅 - 🖸	្វី 🛗 Application [Device: PLC L	ogic] • 💖 🗳 🕞 📲 🔧   (= 🕾 🗠 +=	8   •   🛒   🛒	132		
1000 (cr.	-005	۵	POUs	Alt+1	÷	IB -011 <sup>≤</sup>	4 0 0	国際も振発力					
Device	s	82	Modules	Alt+2	to se	an 21	POUX						
- )	Untitlea		Messages	Alt+3	App	lication.PC	00						
Ē	•		Element properties							Tune		Value	P
	0	*	ToolBox		Γ.					MC P	0.00	Volue	11
	-0		Watch	•	2	Watch 1				BOOI	me	FALSE	
		3	Cross Reference List		1	Watch 2				MC M	oveRelative		
		¢2	Call Tree		50	Watch 3				BOOL		FALSE	
		5	Bookmarks		1	Watch 4							
		Ð	Breakpoints		ø	Watch al	II Forces						
		靍	Call Stack		-								
		۵,	Memory										
			Online Change Memory Reserve Se	ttings									
		۲	Start Page			EtherC.	AT_Maste:	r.xDistributedClockInSync	EtherCAT_Master.xConfigFinished	EtherCAT_Mast	er.xError		
		Ø	Security Screen										
	-0	Ξ,	Store										Ax
	-0		Choose Perspective	•								bPower	1R SAR
	-0		Full Screen Ctrl+Sh	ift+F12									TR
	-0	a	Properties										
			INIT, DA200, 265 (DA200-N EtherCAT	6	- 1								
	T	~	1441_DA200_205 (DA20044 EBEICAT	9									

Step 2 Add the variables you want to monitor under the project bar, or right-click **Variable** and select **Add to Watchlist**.



# 3.8 Sampling Tracking

Invtmatic Studio can display the trace curve of variable changes during program debugging. The operation steps are as follows:

Step 1 Right-click **Application > Add Object > Trace** in the project tree.



Step 2 In the pop-up dialog box, fill in a name for the trace curve, such as Trace in the figure below. Double-click the trace curve name in the project tree to open the trace curve interface. In the upper right corner of the trace curve interface, click **Configuration**. Then, a dialog box pops up as shown below. In the Task Options box, select **EtherCAT\_Task**.



Trace Configuration		>
Trace Record Trace Trace	Record Settings         Enable Trigger         Trigger variable         Trigger edge         Posttrigger (samples         0       200ms         Trigger Level         Task         Record condition         Comment	····
Time axis Diagram 1 Yaxis Shown variables	Resolution ms ~ Automatic restart Advanced	
dd Variable	Reset Display settings	OK Cancel

Step 3 Click **Advanced** in the Trace Configuration interface to show the **Advanced Trace Settings** Interface, in which you can set **Measure in every n-th cycles** as the sampling period and add **Trace editor buffer size per variable (samples)** to extend the tracking time.

Adv Me Re	vanced Trace Settings vasure in every n-th cycle commended runtime huffer size (samples)	5 v 20ms	_
Presentation (diagrams) Time axis Diagram 1 Yaxis Shown variables	Override runtime buffer size ace editor buffer size per variable (samples) Automatic restart	101 2s 20001 6m40s OK Cancel	

Step 4 Select **IOConfig\_Globals** > **Axis** from Variables in the Trace Configuration interface, find the axis position variable **fActPosition**, click **OK**, and then add the axis speed variable **fActVelocity**.

**Basic Functions** 



Trace Record	Variable settings		
Trace	Variable 👻	Axis.fActVelocity	
Axis.fActVelocity	Graph color	Blue	~
	Line type	Line	~
	Point type	• Dot	~
	Activate minimum warning		
	Critical lower limit	0	
Presentation (diagrams)	Warning minimum color	Black	~
Time axis	Activate maximum warning		
Y axis	Critical upper limit	0	
Shown variables	Warning maximum color	Red	~

# 3.9 Persistent Variable

### **3.9.1 Characteristics**

Power failure retention variables can retain their original values after the PLC loses power or the program is downloaded. They are often used to define important parameters in the project to prevent the loss of important parameters due to sudden power failure of the PLC or program download. The power failure retention feature is mainly declared through the attribute keyword PERSISTENT RETAIN.

Code example for setting a power failure retention variable:

```
VAR_GLOBAL PERSISTENT RETAIN
iVarPers1 AT %MW100: DINT;
bVarPers AT %MX1.1 : BOOL;
END_VAR
```

The following table lists the response actions of different power failure retention variables after a reset, power failure, or other events.

Action	VAR	VAR PERSISTENT RETAIN/ VAR RETAIN PERSISTENT	VAR RETAIN
Power failure	Initialization	Retain the original value	Retain the original value
Warm reset	Initialization	Retain the original value	Retain the original value
Cold reset	Initialization	Retain the original value	Initialization
Initial value reset	Initialization	Initialization	Initialization

Table 3-5	Variable	Response	Actions
Table J-J	variable	NC3p0113C	ACTIONS

Action	VAR	VAR PERSISTENT RETAIN/ VAR RETAIN PERSISTENT	VAR RETAIN
Program download	Initialization	Retain the original value	Initialization
Online modification	Retain the original value	Retain the original value	Retain the original value

**∠**Note:

- RETAIN and PERSISTENT RETAIN variables are both persistent variables, but they have different characteristics.
- Direct variables mapped to %M addresses can be declared as persistent variables, while direct variables mapped to %I and %Q addresses cannot be declared as persistent variables.

### 3.9.2 Power Failure Retention Variable List

If power failure retention variables are defined in the project, a power failure retention variable list must be generated; otherwise, the defined variables will not have the power failure retention function. You can use the power failure retention variable list to add power failure retention variables. The operation steps are as follows:

- Step 1 Right-click **Application** in the device tree, select **Add Object > Persistent Variables**....
- Step 2 In the pop-up dialog box, enter the name of the power failure retention variable list and click **Open** to open it.



You can also declare power failure retention variables directly in the power failure retention variable list, as indicated by  $\oplus$  in the figure below. However, this method has a disadvantage that it does not support variables defined by direct addresses (such as MX0.0). It is recommended to declare the PERSISTENT RETAIN or RETAIN keyword in the global variable list, and then right-click a blank area on the interface to select **Add all Instance Paths** to generate an instance path in the power failure retention variable list, as indicated by @ in the figure below.

**Note:** Among the PERSISTENT RETAIN or RETAIN variables declared in the global variable list, at least one variable is used in the program before it can be added to the power failure retention variable list.



# 3.10 Recipe Manager

A recipe is a set of parameter values that provides the information required to produce a product and control the production process. For example, the raw materials of biscuits such as sugar, eggs, butter, and flour, baking time, and other parameters. Recipes can also be used to set and monitor PLC control parameters.

In order to save the information required in the production process, you can read recipes from the PLC, write data to it, load recipes from files, or save recipes as files. These interactions can be achieved through the view elements that have been set up.

Step 1 Right-click **Application** in the device tree, and select **Add Object** > **Recipe Manager** to add a recipe manager.



Step 2 After adding a recipe manager, you need to set the manager name. Click **Open** to show the configuration interface of the recipe manager in the figure below.

The Device Storage General	💫 Recipe Manager 🕻	(	
Storage type File path File extension	Textual Binary Textual .txtrecipe		~
Separator	○ Semicolon • :=	○ Comma ○ I	
Available Column Type Name Comment Minimal Value Maximal Value	e e	Selected Columns	
Save as Default	t	Up	Down

Storage Type: You can select Textual or Binary storage type.

File Path: You can specify the storage location through the file path, or define the file extension for storing the recipe; the storage of text will be separated according to the selected separator, and the separator is only effective when the Textual storage type is enabled.

Available Columns: The right side contains the columns defined for the current recipe, i.e. **Selected Columns**, and the content of the selected columns will be stored. You can click the icon button  $\square$  or  $\triangleleft$  to shift between **Available Columns** and **Selected Columns**. You can also shift all entries from one side to the other at once by clicking the icon button  $\square$  or  $\triangleleft$ . The icon buttons  $\square$  and  $\square$  can be used to adjust the order of the selected columns, which represents the order of the columns in the storage file.

Step 3 After the Configuration page is set up, right-click **Recipe Manager** in the device tree and select **Add Object > Recipe Definition…** to add a new recipe definition.



Step 4 Set the name of the new recipe and click Open to show the added recipe in the figure below. You can right-click a blank area and select **Add a New Recipe** to configure different recipe values. You can also select a recipe value (such as recipe 1) and right-click it to delete, load, or save the recipe.

Device	F	lecipes X						▼ ToolBox ▼ ₽ X
Variable	Туре	Name	Comment	Minimal Val	Maximal Va	Current	Val	
						[	ß	Paste
							+⊳	Insert Variable
							₩	Add Child
							⇒	Add Sibling
							C)	Update Structured Variables
							<u>Q</u>	Add a New Recipe
							R	Remove Recipe
							e <sup>71</sup>	Load Recipe
							eĽ	Save Recipe
								Visual Element Repository
								🛠 🗃 P., 🖷 Visu

In addition to editing recipe files directly on the interface, you can also add "Recipe Management" library files and use code to create, delete, load, and save recipes.



Step 5 After adding a recipe, you need to define the variables that the recipe needs to use in the program, and then insert the variables into the recipe and click .



After the variables are inserted, you can fill in the parameters in Recipe 1 and Recipe 2.

🕥 Device 🔍 Recipes 🗙 👔 Library 1	1anager	🧭 GVL						
Variable	Туре	Name	Comment	Minimal Val	Maximal Va	Current Val	Recipe2	Recipe1
IrVel	LREAL						20	10
bMoveRelative	BOOL						0	0
bPower	BOOL						1	0

After login online, you can click **Write Recipe** to write the currently selected recipe value to the controller, or click **Read Recipe** to read the current value from the controller into the recipe.

💮 Device 🔍 Recipes 🗙	🎁 Library Manager 🛛 🎽 GVL							
Changed recipe definition configuration	will be transferred with the next downlo	oad or online o	hange					
Variable	Type Name	Comm	Minim	Ma	Current Value	Recip	be2	Recipe1
IrVel	LREAL				30	30		10
bMoveRelative	BOOL				FALSE	FALSE		0
bPower	BOOL				FALSE	FALSE	ž	Cut
								Copy
								Paste
							$\sim$	Delete
								Select All
								Browse +
							₩	Insert Variable
							ф.	Add Child
							₩	Add Sibling
							C,	Update Structured Variables
							<b>Q</b>	Add a New Recipe
							Q	Remove Recipe
							2	Load Recipe
							Ľ.	Save Recipe
							-	Read Recipe
							£7)	Read and Save Recipe
							-	Write Becine
							л,	Load and Write Becipe
							e.* 	
							3	Upload Recipes from Device
							1	New Breakpoint
								Toggle Breakpoint

# 3.11 Symbol Configuration

The symbol configuration feature is used to configure project variables as symbols that require special access. With these symbols, variables can be accessed by external applications, such as an OPC server. If you select **Generate Code** in the **Compile** menu bar, a symbol configuration file (with the suffix \*.xml in the project directory) is generated. The naming method is as follows: device name + application name.xml, which contains the description of the symbol. For example, import the XML into the HMI for label communication and access to variables.

Right-click **Application** in the device tree, and select **Add Object > Symbol Configuration**.

Devices	<b>→</b> ₽ X	Device X					
Untitled9	•	Communication Setting	s		Scan Network	Gateway 👻	Device
Device (TM753)		Applications			]		
🔍 Fault diagnosis su	immary	Applications					
🗐 🗐 PLC Logic		Backup and Restore					
😑 🚫 Applica			1				
- 🧭 GVL 💑	Cut						
👘 Libra	Сору						
PLC 🖷	Paste						Gatew
POL 🔨	Delete						IP-Add
🖹 🙀 Reci	Refactoring	•					localho
	Properties						Port: 1217
i - 🕸 🛅	Add Object	•		Alarm	Configuration		
Ľ., 🛅	Add Folder		0	Appli	cation		
- <b>*</b> ⊡	Edit Object		$\overline{\mathcal{O}}$	Axis (	Group		
	Edit Object w	ith	8	Cam	table		
🚭 Trac 😋	Login		8	CNC	program		
T Pers	Delete applica	ation from device		CNC	settings		
Variable usa	Manual Element	• D 10		Data	Sources Manage	er	
TM75x-HSIC	Visual Elemen	It Repository	<b>*</b>	DUT			
FL2201_0008DR	(FL2201-0008DR)			Extern	nal File		
FL2201_0008DR_	1 (FL2201-0008D)		1	Globa	al Variable List		
ExtCard (Modules	ican)			Imag	e Pool		
EtherCAT_Master	CETHERCAT Maste		~	Interf	ace		
	_265 (DA200-N Et		۲	Netw	ork Variable List	(Receiver)	
	5)		2	Netw	ork Variable List	(Sender)	
Mi Avia 1 (/	_101 (DA30044 Ed		≞	POU			
SoftMation Cener	al Avis Pool		≞	POU	for implicit check	cs	
a solutiouoli dener	al Axis Pool		ø	Redu	ndancy Configur	ation	
			T	Symb	ol Configuration		
				Text l	list		
			œ	Trace			
			2	Trend	Recording Mar	nager	
		Cross Reference List	3	Unit (	Conversion		
		Device.Application.GVL.b	1	Visua	lization		
		Cumbral		Visua	lization Manage	r	

After selecting symbol configuration, a pop-up window appears as shown below.

Add Symbol Configuration	×
Create a remote access symbol configuration.	
Name	
Symbol Configuration	
Include comments in XML	
Support OPC UA features	
Add library placeholder in Device Application (recommended, but may trigger download)	
Client Side Data Layout	
Compatibility Layout	
<ul> <li>Optimized Layout</li> </ul>	
Add Cancel	

#### Table 3-6 Description of Symbol Configuration

Option	Description
Include comments in XML	The exported XML contains comments assigned to variables
Support OPC UA features	The symbol variables can be accessed by OPC UA
	The offset size is consistent with the type member definition. If the
Compatibility layout	type member does not fully support symbol access, the offset size is
	the actual compilation offset, and there will be a blank in the middle
	The offset is calculated based on the selected type member, and no
Optimized layout	offset calculation will be performed if the type member is not
	selected.

#### Symbol configuration-Settings

After generation, the Symbol Configuration Settings interface is as shown in the figure below.

	Device 📑 Sy	mbol Configuration 🗙			
	🛛 🛛 View 👻 🛗 Build	Settings - Tools -			
	Execute "Build" comm	Support OPC UA features	🔛 Build	Details	
	Changed symbol configu	Include Comments in XML	F		
	Symbols	Include Node Flags in XML	Members	Comment	_
	B. Constants	Configure comments and attributes			
	⊕	Configure synchronisation with IEC tasks			
	🗷 🔲 📄 IoConfig_Glo	Optimized Layout			
	🗄 🔲 📄 PersistentVar	Lise empty pameroaces by default (//2 compatibility)			
l	🖲 📄 📄 SD0_SD511	ose empty namespaces by default (v2 compaublicy)			
l	🖳 📄 📄 SD1024_SD15	Enable direct I/O Access			
	B SD1536 SD20	Include call information in XML			
	B SD2048_SD25	Enable Symbol Sets			
1					

The configuration comments and attributes are as shown in the figure below. The upper left side shows the data downloaded to the PLC, and the upper right side shows the exported XML data format.

Symbol Table Contents	XML Symbol File Contents						
Enable extended OPC UA Information	Include namespace node flags						
🗌 Include comments 🗌 Include attributes	Include comments						
Also include comments and attributes for type nodes	tes for type nodes Also include comments and attributes for type no						
Select Comments	Filter Attributes (Case Insensitive)						
🔵 Include docu comments:	<ul> <li>Include all attributes ("foo", "bar", "foo.bar")</li> </ul>						
/// They start with triple slash and are usually /// formatted in ReST (library documentation)	O Match simple identifiers ("foo", "bar")						
Include normal comments: (* IEC / Pascal style comments *) // C++-Style comments with double-slash	O Include attributes starting with:						
Always include both types of comments	○ Filter Attributes with regular expression:						
Prefer docu comments, fallback to normal ones							
O Prefer normal comments, fallback to docu comments							

#### Table 3-7 Description of Symbol Configuration Comments and Attributes

Option	Description					
Symbol	Generally, symbols represent variables, and symbol attributes represent variable characteristics (Attribute information).					
Comment format	It indicates the comment download or display format.					
Attribute matching	It indicates which attribute information is included when the XML file is exported or downloaded to the PLC.					

Symbol: Generally, symbols represent variables, and symbol attributes represent variable characteristics (Attribute information).

Comment format: It indicates the comment download or display format.

Attribute matching: It indicates which attribute information is included when the XML file is exported or downloaded to PLC.

Four matching rules: Include all attributes, Match simple identifiers, Include attributes starting with:, and Filter Attributes with regular expression.

Configure synchronization with IEC tasks: In the **Device Properties** options, select whether to synchronize with IEC tasks when other interfaces access symbol variables. Access cannot be made during IEC execution to prevent variables from being out of sync.

roperties - Devi	ce			:
Common Acces	s Control Option	IS		
Monitoring	Interval (ms)	200		* *
- Interactive	Login Mode			
None				
O Enter ID				
O Press K	ey			
🔿 Wink (=	blink an LED)			
Symbol Cor	figuration			
Access	variables in sync	with IEC tasks	s	
If enabled,	the jitter for all IE	C applications	on the device	
may increas	se!			
	_			
		OK	Cancel	Apply

#### Symbol Configuration-Tools

You can use it to save the file in XML format to export an XML data model, which can be used as a reference if a third party parses symbols offline

1	Device Symbol Config	juration	×							
	📉 View 👻 🎬 Build 🛛 🛱 Settings 🔹 1	Tools 👻								
	Changed symbol configuration will be t	Save	e XML Sch	ema File			1			
	Symbols	Access	Rights	Maximal	Attribute	Туре	·	Members	Comment	
	🗉 🔲 📑 Constants		Gets th	e current X	SD Schema	file for t	ne generat	ed symbol XN	ML file, so it o	an be used with 3rd party tools.
	GVL									
l	📈 🕢 MC MoveRelative O	5	<b>b</b>	Ma		MC Mov	eRelative		]	

#### Symbol Configuration Process Example

Create new global variables bLatch and iMasterYout, and apply at least one of them in the user program, as shown in the figure below.

	í 👔	Device 📲 Symbol Configuration 🖉 🎯 GVL 🗙
	1	<pre>//{attribute 'qualified_only'}</pre>
B	2	VAR_GLOBAL
	3	<pre>MC_Power_0: MC_Power;</pre>
	4	
	5	<pre>MC_MoveRelative_0: MC_MoveRelative;</pre>
	6	
	7	END_VAR
	8	
B	9	VAR_GLOBAL PERSISTENT
	10	bPower: BOOL;
Ш.	11	bMoveRelative: BOOL;
Ш.	12	<pre>lrVel:LREAL;</pre>
μų,	13	END_VAR

**Note:** If any variable in a single global variable list is not used in the user program, the corresponding variable list will not appear in symbol configuration.

The steps to configure the sample are as follows:

Step 1 After adding Symbol Configuration in Application, check Include comments in XML, and click Build > Build in the upper Toolbar. At this time, the corresponding variable list and variables appear in the right symbol configuration. Check the variable list to be configured, configure the corresponding access rights (read-only, write-only, read/write), and select Build > Generate code in the upper Toolbar.



Step 2 You can find the generated file with the suffix .xml in the directory folder where the project is located, which is imported into the touch screen for label communication, as shown in the figure below.

名称	修改日期	类型	大小
🗋 Untitled9.project.~u	7/23/2024 8:37 PM	~U 文件	1 KB
C Untitled9.Device.Application.xml	7/23/2024 8:36 PM	Microsoft Edge	2 KB
Untitled9.project	7/23/2024 8:34 PM	CODESYS project	455 KB

Step 3 After completing the above steps on the PLC, taking VS-102QS touch screen as an example, open the HMITOOL software, click New Project, Select "VS-102QS" as the Model, "Ethernet Port" as the Connection Port, and "CodeSys" and "CodeSys TCP V3 Communication Optimum" as the Connectivity Service, as shown in the figure below.

🔤 New Project		×
Project Properties		
Project Name: Test		
Path: C:\Users\Administrator\Desktop\		Browse
Size/Series: 10.2	VS-102QS	~
Show Model: Horizontal		~
Model Parameters		
Remote: NO		
Size: 10.2 inch		
Pixel: 1024x600 Pixels (VGA)		
Color: 262,144 Colors TFT LCD		
Memory: 12M		
Power: DC24V(+/-15%)		
COM1: RS232		
COM2: RS422/RS485		
COM3: RS485		
CAN: None		
LAN: RJ45		
USB: 2 Ports B-type/A-Type		
		Back Next Cancel

l Link In	Link ID: terface:	3 Ethernet						
Li	nk Name:	CodeSys TCP	V3 Communic	ation Optim	ատ			_
H	MI Site:	Local	$\sim$	Setting	ster-	slave mode)	) port	
Connection S	ervices:	CodeSys		∼ Code	Sys IC	9 V3 Commun	nicati	`
Ip: Subnet mask: Gateway:	192 255 192	• 168 • 255 • 168	• 1 • 255 • 1	• 100 • 0 • 1		nport Pro	otocol	t
Notes Please use th the <configur the 4G/WIFI n</configur 	he≺DIP S ation≻in module.	witch 1+3 Fu the <remote (<="" td=""><td>nction Settin Configuration</td><td>ngs&gt;in the&lt; n Tool&gt;to u</td><td>Functic pdate t</td><td>n Button&gt;o he paramet</td><td>r use ers of</td><td></td></remote>	nction Settin Configuration	ngs>in the< n Tool>to u	Functic pdate t	n Button>o he paramet	r use ers of	

Step 4 Click Import Communication Labels, select the XML label just generated, and click Open. If Imported successfully is displayed, click OK, as shown in the figure below.

	Link TD.	3
Link T	ntorfogo:	
LINK I	interrace.	Colema TCD V2 Commination Optimum
L	ink Name:	
	HMI Site:	Local Setting ster-slave mode) port:
Connection	Services:	CodeSys 🗸 CodeSys TCP V3 Communicati
Gateway Notes	·· 255	ok
Please use the <configu the 4G/WIFI</configu 	the <dip s<br="">ration&gt;in module.</dip>	witch 1+3 Function Settings>in the <function button="">or use the<remote configuration="" tool="">to update the parameters of</remote></function>

Step 5 Set the **IP address** of communication parameters to "192.168.1.10" and **Port number** to "11740", and then click **OK**, as shown in the figure below.

Communication Port Properties		?	×
General Parameter			
Connected equipment ip	Other		
IP Address: 192 .168 .1 .10	HMI Address: 0		-
Port number: 11740	Plc station: 0		÷
	Communication time: 5	÷ (	ms)
	Overtime time 1: 1000	÷ (	ms)
	Overtime time 2: 5	÷ (	ms)
	Retries: 3		$\sim$
	Address mode: Standard Mode		$\overline{}$
	PLC address interval: 32		$\overline{}$
Spare set parameters Spare parameter 1: 0	Spare parameter 3: 0		
Spare parameter 2: 0	Spare parameter 4: 0		
	ok a	cancel	

Step 6 Select **Input Box** in the figure above, and bind the corresponding PLC address, as shown in the figure below. After completion, label communication can be implemented.

rement type	General Picture	Advanced Visibilit	У		
Numentric Display D: ND0003	Border Color:	BG Color:			Shape
iew	FG Color:	Text Color:			
	Data Tuma:	4-Bit Floating Point	`		
	Display Type: 6	4-Bit Floating Point			
388888888888888888888888888888888888888	Monitor Address: 3	/Application.GVL.lrVel0	I		
rompt	Address Entry			? ×	fication
unction: Monitor egister value	- Standard Ethernet		Address library	~	o Header
nile change	s TCP V3 Communic	ation Optimum 🗹 🛛 🖉	Address:		ice neader
	Application.GVL.	LrVel 🗸 Da	ataType:		
	0				
	0	5 CLR			
	0 1 2 3 4 6 7 8 9	5 CLR 0 BS			cel Help
	0 1 2 3 4 6 7 8 9 A B C D	5 CLR 0 BS E ESC			cel Help

# 3.12 Task Configuration

Each PLC application (project) contains "Task Configuration" in the project directory tree. In Task Configuration, one or more tasks can be defined to control and execute the application in the controller. After a "task" is configured, a series of programs or function blocks can be executed cyclically or triggered by a specific event to start executing the program. A task can call one or more program blocks (POUs). By setting priorities and conditions for tasks, you can define the order in which the tasks are processed. You can also configure a watchdog for each task, and the controller will prompt an exception when the execution cycle of the task is too long.

# 3.12.1 Adding a Task

After creating a new project, Invtmatic Studio will automatically add **Task Configuration**, the automatically generated tasks are shown in the figure below.



If you need to add a new task, you can right-click **Task Configuration** and select **Add Object** > **Task**. After entering a custom task name in the pop-up window, click **Open** to add the task, as shown in the figure below.

Devices	•	<b>д X</b>	Device	<b>•</b> •••••••••••••••••••••••••••••••••••	Symbol Configuration	
□ 📋 Untitled9		-	Monitor Variat	ole Usage S	ystem Events Prop	erties
🖃 💮 Device (TM753)			Task	Status	IEC-Cycle Coun	t Cy
- 🗋 Auto scan			EtherCA			
🔍 🔍 Fault diagnosis summa	ary		MainTask			
💷 🗐 PLC Logic						
😑 🔘 Application						
🧭 GVL						
👔 Library Manag	jer					
PLC_PRG (PR	G)					
POU (PRG)						
🗏 🙀 Recipe Manac	ier					
Recipes						
Symbol Confi	Jura	tion				
= 144 Task Configur	atio					
EtherC	К	Cut				
	b	Сору				
	2	Paste				
	ĸ	Delete				
	` =	D				
	=	Proper	ues			
🗋 Variable usage		Add Ol	oject	•	🔮 Task	
TM75x-HSIO (TM75		Add Fo	lder			
FL2201 0008DR (F	ີ	Edit Ob	ject			
FL2201 0008DR 1		Edit Ob	ject with			
ExtCard (ModuleSca	Ð	Visual E	Element Reposi	tory		
EtherCAT Master (EtherCAT Master (EtherC	nerC	AT Maste		-	1	
. INVT DA200 265	(DA	200-N Et				
Axis (Axis)						
E 1 INVT DA300 101	(DA	300-N Eti				
Axis 1 (Axis)						
SoftMotion General A	cis Pr	ool				
Add Task					×	
An IEC t	ask					
Name						
Task						
			bbA	Car	cel	

### 3.12.2 Task Settings

riority ( 031 ): 2		0
🕑 Cyclic	V Interval (e.g. t#200ms) 20	ms 🗸
Watchdog		
🗌 Enable		
Time (e.g. t#200ms)		ms 🗸
Sensitivity	1	
🖡 Add Call 🗙 Rem	nove Call 📝 Change Call 🕸 Move Up 🔍 Move Down	o   → Open POl
POU	Comment	

After opening the newly created task, the Settings interface shown in the figure below appears.

- Priority: 0–31. The larger the value, the lower the priority, and 0 indicates the highest priority.
- Type: Task type and its execution logic. See the table below for details.

#### Table 3-8 Task Type

Туре	Execution Logic	Variable
Cyclic	The task is executed cyclically according to the	Timo intonvol
Cyclic	set interval	Time intervat
	The task starts execution at the rising edge of	
Event	the set global variable associated to the trigger	Trigger variable
	event	
	The task automatically starts execution at the	
Freewheeling	beginning of the program and at the end of the	-
	complete process in a continuous cycle	
State	When the set global variable is TRUE, the task	Triggerveriable
State	starts execution	ringger variable

• Watchdog: If a task exceeds the currently set time of the watchdog, the task will be suspended in an error state (exception). The application in which the task with the error occurs and its child applications will also be suspended. All tasks of the affected application will also be stopped. The watchdog-related functions are detailed in the table below.

#### Table 3-9 Watchdog Functions

Option	Function
Enable	It is used to enable the watchdog function
Time	It is used to set the watchdog timeout period
Soncitivity	It is used to set the value, that is, trigger the watchdog after exceeding the
Sensitivity	set time by several times

• POU call: You can set the POU called by the task, and the order of POU calls will be affected.

)

## 3.12.3 TP6000 Multi-core Task Configuration

The TP6000 series PLC supports dual-core configuration. In the Task Configuration interface, there are 2 task groups by default. You can add task groups as needed, which can be assigned to use Core 0 or Core 1. You can assign a priority to each task. Generally, it is required that the EtherCAT\_Group containing EtherCAT\_Task be configured as Core 1 for better real-time performance.

evices 👻 🕂 🗙	Task Configuration 🗙		
🖻 📆 Device (TP6210-xxxx) 🛛 💌	Task Groups Monitor Variable Usage System Events Pr	operties	
🔍 Fault diagnosis summary	🖶 Add Group 🔀 Remove Group		
PLC Logic	Group name	Core	Priority
Application	E IEC-Tacks	0	
● Cam ● Cam_1 ● Cam_2 ● Cam_2 ● Axis (STRUCT) ● な DeviceStates (STRUCT) ● な DUT (ENUM)	■ LLC-Tasks ● 登 HSI ● 愛 PLC_Task ● 愛 温度 ■ EtherCAT_Group ■ EtherCAT_Task	Sequentially Pinned 0 1 1 1	1 3 5 6 0
hAxisStruct (STRUCT)			15

# **4 Hardware Configuration**

# 4.1 High-speed I/O Configuration

For the TM700 series PLC, double-click **TM75x-HSIO** in the device window. Then, the HSIO parameter configuration interface will pop up. You can configure high-speed I/O functions and associated parameters on this interface, including high-speed counter, high-speed output, and high-speed input edge interrupt.

#### **∠**Note:

- 1. If **Counter** is not checked, it can be used as a normal input port.
- 2. To use the counter function, check **Counter 0 (1, 2, 3)**. Then, the corresponding input port is used as the input signal source of the counter. X0 and X1 are the input signal sources of counter 0 by default. The corresponding relationship between subsequent counters and high-speed input ports is similar. Once the counter function is enabled, a Counter device is generated and you can make detailed settings.





### 4.1.1 Counter Interface Configuration

You can set 5 functions for the input port: normal input, counter, trigger latch, Z signal, and pulse width measurement. The counter function module can count and calculate the input pulses, detect position, speed, frequency, etc. The maximum frequency of the input pulse is 200 kHz.

You can double-click **Counter** under **TM75x-HSIO** to make detailed settings for the high-speed counter.

Counter Setting	Counter mode	
CI-Bus IEC Objects	Counter mode A/B Phase Multiple 1 V A/B Phase Multiple 1	Signal source X0-A Phase,X1-B Phase $\vee$
Parameters	A/B Phase Multiple 2 A/B Phase Multiple 4 CM/CGM	
'O Mapping	Pulse + Direction	
atus	Input port	
ormation	Prob	
	Prob1 Input port	Prob2 Input port 🗸 🗸
	Output preset value	
	Input port Soft mode ~	
	Compare output	
	Output port Y6 🗸 🗸	
	Encoder Axis	
	O Linear O Ring	Foward O Negative

#### Figure 4-2 High-speed Counter Parameter Configuration

- Counter mode: It indicates the counter mode, which can be selected from the following 6 options: phase A/B 1x, phase A/B 2x, phase A/B 4x, pulse+direction, single phase, and CW/CCW. If you choose to use phase A/B 1x/2x/4x, pulse+direction, or CW/CCW, X0 and X1 are the default input signal sources of counter 0, and the corresponding relationship between subsequent counters and high-speed input ports is similar. The signal source can also be set as needed; if single phase is selected, the input signal source of counter 0 can be selected from X0 to X7.
- Input counting direction: positive or negative.
- Counting mode: rotary or linear.
- Max. number of pulses: 2147483647 by default, ranging from -2147483648 to 2147483647.

**Note:** The upper limit value cannot be less than the lower limit value. If the set value is less than the lower limit value, the system will automatically change the lower limit value to be consistent with the upper limit value.

- Min. number of pulses: -2147483648 by default, ranging from -2147483648 to 2147483647.
- Preset input terminal: When the preset function is configured as external DI preset mode, this input port needs to be configured. You can select any input port from IN0 to IN7 to implement the preset value function, or you can set it as a software-triggered preset input.
- Probe: Each counter can be configured with 2 probe input ports to realize the function of latching the counter value. Probe 1 is #1 probe input port and can be configured as any input port from IN0 to IN7. Probe 2 is #2 probe input port and can be configured as any input port from IN0 to IN7.
- Output comparison terminal: When using the high-speed output comparison (single point/linear/queue) function, configure this output port in the range of OUT0–OUT7.
- Hardware reset: When the count value reset function is configured as external DI mode, you need to configure this input port. You can select any input port from IN0 to IN7 to realize the count value clearing function.

## **4.1.2 Counter Functions**

For counter function control, for example in I/O mapping, you can set the counter clear and enable control bits.



Figure 4-3 High-speed Counter Parameter Mapping

Controlword/Reset is the counter reset control bit; while Controlword/Start is the counter enable control bit. Other functions can be configured as described in the table below.

Parameter Name	Туре	Description
Controlword	BYTE	Counter control parameter. Bit0: Counter enabled, valid if TRUE Bit1: Counter cleared, valid at the rising edge
Preset Value	DINT	Preset value of the counter.
Preset command	BYTE	Preset function control. Bit0: Software preset enabled, valid at the rising edge Bit1: Preset reset Bit2: Preset done signal cleared
Touch probe command1	ВҮТЕ	Probe 1 function control word. Bit0: Probe start signal, valid is TRUE Bit1: Probe reset signal Bit2: Probe done cleared signal, valid is TRUE
Touch probe command2	BYTE	Probe 2 function control word. Bit0: Probe start signal, valid is TRUE Bit1: Probe reset signal Bit2: Probe done cleared signal, valid is TRUE

Table 4-1 Description of Counter Control Word and Status Word

Parameter Name	Туре	Description
		Comparison function control word.
Compare command	DVTE	Bit0: Start
	DIIE	Bit1: Enable
		Bit2: Reset
Compare Value	DINT	Compare values.
Compare Output Keen Value	LUNT	Hardware output comparison result
	0111	retention value.
Compare Output Unit	BVTE	Output comparison retention unit.
	DITE	0: 100 µs, 1: pulse
		Counter status feedback.
		Bit0: Counter running status feedback (1:
		running)
		Bit1: Counter direction feedback (1:
Statusword	BYTE	reverse)
		Bit2: Positive limit status feedback (1:
		reaching cntMax)
		Bit3: Negative limit status feedback (1:
		reaching cntMin)
	DINT	Bit4: Counter error status (1: error)
Counter_Value	DINI	Counter value.
		Preset status feedback.
		Bitu: Preset completed status feedback (1:
Preset Status	BYTE	done)
		<b>ZNOLE:</b> The preset done signal needs to be
		modified before it is cleared
		Counter probe 1 status feedback
		Bit0: Probe busy status feedback
		Bit1: Probe done status feedback
Touch Probe Status1	BYTE	<b>Note:</b> The preset done signal needs to be
		cleared, and the preset value cannot be
		modified before it is cleared.
		Counter probe 2 status feedback
		Bit0: Probe busy status feedback
		Bit1: Probe done status feedback
Touch Probe Status2	UDINT	<b>Note:</b> The preset done signal needs to be
		cleared, and the preset value cannot be
		modified before it is cleared.
	DINT	Probe 1 latches the rising edge acquisition
Laten rising post	DINT	position.
Latch rising pas2		Probe 2 latches the rising edge acquisition
	ואוע	position.
Latch falling post		Probe 1 latches the falling edge acquisition
		position.
Latch falling pos2		Probe 2 latches the falling edge acquisition
		position.
Compare Status	RVTE	Comparator status.
compare status	DIIC	Bit0: Output comparison busy status

Parameter Name	Туре	Description
		feedback
		Bit1: Output comparison done status
		feedback

**Note:** For counter preset control, the Preset command can use software operation to preset the counter value. After successfully presetting the counter value using PresetActiveSoft, you must use PresetDoneClean to clear the Preset Status before you can reset the counter value again.

### 4.1.3 Description of Output Port Functions

You can set 3 functions for the output port: normal output, high-speed pulse output, and output comparison. As shown in the figure below, the normal output port ranging from Y0 to Y7 is used by default. When the pulse output function is required, you need to check the pulse axis of the corresponding channel.



Figure 4-4 High-speed Output Port Configuration

### 4.1.4 Normal Output

The normal output port ranging from Y0 to Y7 is used by default.

The output port of the TM series PLC contains 8 output signals, Only single-ended outputs are supported, and the output signal is of the source type Y0–Y7 share the common port COM.

Table 4-2 Description of the Normal	Output Port of the TM700 Series PLC
-------------------------------------	-------------------------------------

Schematic Diagram	Left Signal	Left Terminal	Right Terminal	Right Signal
1	X0 input	A0	B0	Y0 output
6 <b>86</b> 8	X1 input	A1	B1	Y1 output
1009	X2 input	A2	B2	Y2 output
400B2	X3 input	A3	B3	Y3 output
	X4 input	A4	B4	Y4 output
	X5 input	A5	B5	Y5 output
60 08	X6 input	A6	B6	Y6 output
	X7 input	A7	B7	Y7 output
\$ <b>86</b> 8	SS common input	A 0	DO	COM common output
AB	terminal	Að	Dõ	terminal

### 4.1.5 High-speed Pulse Output

Once the pulse axis is checked, the signal port is configured as high-speed pulse output, and all 8 output ports can be configured as high-speed pulse outputs.

High-speed pulse output supports four modes: pulse+direction, FWD/REV pulse, quadrature-encoded pulse, and PWM.

#### Figure 4-5 High-speed Output Modes

— Pulse axis					
Pulse axis0Puls	se Axis0				
Output mode	Pulse + Direction	$\sim$	YO	L .	Pulse avis0 Pulse
Z signal		$\sim$			
			Y1	L .	Pulse axis0 Direction
✓ Pulse axis1Puls	se Axis1				
Output mode	Pulse + Direction	$\sim$	Y2		Dulas suist Dulas
🗌 Z signal		$\sim$			Puise axis1 Puise
			Y3		Dulas suist Dissetion
Pulse axis2Puls	se Axis2				Pulse axis1 Direction
Output mode	Pulse + Direction	$\sim$	Y4		Pulse axis2 Pulse
Zsignal		$\sim$			
			Y5		Pulse axis2 Direction
Pulse axis3 Puls	se Axis3				
Output mode	Pulse + Direction	$\sim$	V6		Pulse axis3 Pulse
Z signal		$\sim$			
			¥7		Pulse axis3 Direction
					and and and bricklon

### 4.1.6 Output Comparison

The output comparison function outputs the result of the counter single value comparison, and each counter channel has an output comparison function. If the counter value is equal to the set comparison value, a high output will be given; and if it is not equal, a low output will be given.

The output comparison port is configured in the corresponding counter channel

Counter Setting	Counter mode			
CI-Bus IEC Objects	Counter mode	A/B Phase Multiple 4 $$	Signal source X0-A	Phase,X1-B Phase $\vee$
Parameters				
/O Mapping	Hard Reset			
atus	Input port	~	Trigger mode 🛛 U	p 💽 Down
ormation	Prob			
	Prob1 Input port	~	Prob2 Input po	rt 🗸 🗸
	- Output preset v	alue		
	Input port	Soft mode $\sim$		
	Compare output-			
	Output por	t		
	Encoder Axis	Y0 Y1 Y2 Y3		
	O Linear	Y4 Y5	Foward	○ Negative
	Min pulse count	Y7	Max pluse count 214	7483647

#### Figure 4-6 Output Comparison Configuration

#### Output Comparison Control



ouncer occurry	Find		Filter Show all		-	- Ado	d FB for IO Channel → Go to Instance
CI Rus IEC Objects	Variable	Mapping	Channel	Address	Туре	Unit	Description
Pous iec objects	B 🍫		Statusword	%IB4	BYTE		Counter status word
rameters	🍫		Counter Value	%ID2	DINT		Counter value
	¥ø		Preset Status	%IX12.0	BOOL		Preset completion feedback value
Mapping	🕀 - 🍫		Touch Probe Status1	%IB13	BYTE		Touch probe 1 status
	÷-*		Touch Probe Status2	%IB14	BYTE		Touch probe 2 status
s	**		Latch rising pos 1	%ID4	DINT		Latch rising edge acquisition position of touch probe 1
			Latch rising pos2	%ID5	DINT		Latch rising edge acquisition position of touch probe 2
Information	**		Latch falling pos1	%ID6	DINT		Latch falling edge acquisition position of touch probe 1
			Latch falling pos2	%ID7	DINT		Latch falling edge acquisition position of touch probe 2
	- <b>*</b>		Compare Status	%IB32	BYTE		Comparator status
	-**		Busy	%IX32.0	BOOL		
			Done	%IX32.1	BOOL		
	B 🔷		Controlword	%QB4	BYTE		Counter control word
	**		Preset Value	%QD2	DINT		Counter preset value
			Preset command	%QB12	BYTE		Preset command control
	iii - <b>*</b> ∳		Touch probe command1	%QB13	BYTE		Touch probe 1 command control word
			Touch probe command2	%QB14	BYTE		Touch probe 2 command control word
	B- 🐠		Compare command	%QB15	BYTE		Comparison command control word
	**		Start	%QX15.0	BOOL		
	**		Enable	%QX15.1	BOOL		
	L. **		Reset	%QX15.2	BOOL		
	- <b>`</b> Ø		Compare Value	%QD4	DINT		Comparison value
	**		Compare Output Keep Value	%QW10	UINT		Hardware output holding value of comparison result
	<b>*</b>		Compare Output Unit	%QB22	BYTE		Comparison output holding unit: 0100us, 1pulse

# 4.1.7 Description of External Interrupt

An interruption refers to the process in which the CPU suddenly stops the execution of task A to complete task B, and then comes back to continue executing task A.

The steps to implement the external interrupt function are as follows:
Step 1 Set the input port for the interrupt function, select rising edge, falling edge, or rising/falling edge trigger, and set the filter parameter which is 0.5µs (2\*0.25µs) by default.

Figure 4-8 External Interrupt Input Configuration



#### Step 2 Select an interrupt task

In the Invtmatic Studio task, select External as the task type, select the event inxInterrupt of the input port X0–X7, where x ranges from 0 to 7, and trigger the corresponding POU\_1 program by the interrupt task.

Figure 4-9 Task Triggering by an External Interrupt

External      Watchdog     Enable  Time (e.g. t#200ms  Sensitivity	)	External evert	in0Interrupt in0Interrupt in1Interrupt in3Interrupt in4Interrupt in6Interrupt in7Interrupt		

# 4.2 Local I/O Expansion Module Configuration

The PLC body can be directly expanded with Flex series modules, or connected to the FK1100 coupler via the EtherCAT bus to use expansion modules. A single TM700 series PLC or FK1100 coupler can be expanded with up to 32 Flex series modules (plus the power relay). The TP6000 series PLC body cannot be directly connected to the Flex series modules, but it can be connected to the FK1100 coupler via the EtherCAT bus and the expansion modules can be assembled to the coupler. For the models and functions of Flex series modules, see Table 4-3 for details.

Module Name	Flex Series Module	Description
Coupler	FK1100	EtherCAT bus adapter, expandable to 32 bus nodes
Digital Input	FL1001	16-channel digital input module, source/sink input
Module	FL1002	32-channel digital input module, source/sink input
Disital Output	FL2002	16-channel digital output module, source output
Digital Output	FL2003	32-channel digital output module, source output
Module	FL2102	16-channel digital output module, sink output

Module Name	<b>Flex Series Module</b>	Description
	FL2103	32-channel digital output module, sink output
	FL2201	8-channel relay output
Analog Input	FL3003	4-channel analog input module, current/voltage
Temperature	FL3103	4-way temperature module, thermal resistance type
Module	FL3203	4-way temperature module, thermocouple type
Analog Output	FL4003	4-channel analog output module, current/voltage
Hybrid input	FL5005	16-channel digital input + 16-channel digital output
module	FL5105	16-channel digital input + 16-channel digital output

### 4.2.1 Expansion Module Configuration

For TM700 series and TP6000 series PLCs, you can configure expansion modules through two methods: manual addition and automatic scanning. Automatic scanning takes precedence.

#### Method 1: manual addition

Open the Invtmatic Studio programming software, create a new project, select the programming language (for details, see chapter 2 Getting Started), and add the required extension modules.

- 1. Add the FK1100 coupler module
- Step 1 Right-click **Device** in the left device tree, click **EtherCAT\_Master\_SoftMotion** to add it, right-click **EtherCAT\_Master\_SoftMotion**, select **Add Device**, and add the coupler to the device tree.

Add Device		:
Name		
Action		
• Append device	evice OU	Ipdate device
String for a fulltext search	Vendor	<all vendors=""></all>
Name		
🖃 🗊 Fieldbuses		
Brow EtherCAT		
🖃 📴 🔐		
🗄 🖓 🚞 Bosch Rexroth AG		
🖿 🚞 Delta Electronics, Inc.		
🗄 🗁 🚞 Festo		
🖲 🖓 🚞 Hitachi Industrial Equipment S	ystems Co.,l	.td.
💷 🧰 ifm electronic - ifm electronic E	therCAT De	vices
EtherCAT Coupler		
EtherCAT Slave Modu	le	
W FK1100_ECT_Copuler	_1.0.2.0	
IN FK1100_ECT_Coupler	_1.0.5.1	
Inverter		
EB Automation KG - C6 PRO/		trive controllers
RED Addimination (Corporation, Applia	nces Compa	ny - AC Servo Driver
		,
Group by category Display all versions (f	or experts o	nly) 🗌 Display outdated versions
Please select a device t	from the list	above.

Figure 4-10 Adding a Coupler Manually

Step 2 Select the **FK100\_ECT\_Coupler** in the device tree, click **Add Device**, select the required module in the Module Device column, and click **Add Device** to add it into the device tree.

🖞 Add Device			>
Name El 1001 1600DI			
Action O Append device  Insert device	🔿 Plug dev	rice 🔿 Up	date device
String for a fulltext search		Vendor	ráll vendore>
Name	Vendor	Version	Description
Eieldhuses	. chaoi		Description
EtherCAT			
FL 100 1-1600DI	INVT	0	EtherCAT Module imported from Slave XML: FK1100
FL 1002-3200DI	INVT	0	EtherCAT Module imported from Slave XML: FK1100
FL2002-0016DP	INVT	0	EtherCAT Module imported from Slave XML: FK1100
FL2003-0032DP	INVT	0	EtherCAT Module imported from Slave XML: FK1100
FL2102-0016DN	INVT	0	EtherCAT Module imported from Slave XML: FK1100
I FL2103-0032DN	INVT	0	EtherCAT Module imported from Slave XML: FK1100
🗊 FL2201-0008DR	INVT	0	EtherCAT Module imported from Slave XML: FK1100
🔟 FL3003-4AD	INVT	0	EtherCAT Module imported from Slave XML: FK1100
🔟 FL3103-4PT	INVT	0	EtherCAT Module imported from Slave XML: FK1100
🗊 FL3203-4TC	INVT	0	EtherCAT Module imported from Slave XML: FK1100
🔟 FL4003-4DA	INVT	0	EtherCAT Module imported from Slave XML: FK1100
👔 FL5005-1616DP	INVT	0	EtherCAT Module imported from Slave XML: FK1100
👔 FL5105-1616DN	INVT	0	EtherCAT Module imported from Slave XML: FK1100
🗊 FL6002-2ES	INVT	0	EtherCAT Module imported from Slave XML: FK1100
🔟 FL6112-2EI	INVT	0	EtherCAT Module imported from Slave XML: FK1100
🖬 FL6121-1EI	INVT	0	EtherCAT Module imported from Slave XML: FK1100
Group by category 🗌 Display all v	ersions(for	experts onl	y) Display outdated versions
Name: FL1001-1600DI Vendor: INVT Categories: Module			
Version: 0			
Order Number: FL 1001-1600D			
Description: EtherCAT Module i	mported from	m Slave XML	FK1100
_ECI_Coupler_1.0.5.1_BYTE.xm	Device: FL1	1001-1600DI	
Append selected device as last chile FK1100_ECT_Coupler	d of		
<ul> <li>(You can select another target no</li> </ul>	de in the na	vigator whi	e this window is open.)
			Add Device Close

Figure 4-11 Adding an Expansion Module Manually

#### 2. Add modules to the controller (TM700 series PLC)

Right-click **Device** in the device tree, choose **Add Device**, select the required module in the Dedicated Device bar, and click **Add Device** to add it into the device tree.

Figure 4-12 Adding an Expansion Module to the PLC

Add Device				;
AX EM 0016DN				
Action				
	e () Plug de		odate device	
String for a fulltext search		Vendor	<all vendors=""></all>	~
Name	Vendor	Version	Description	1
Miscellaneous				
🗄 🛅 Analog IO Module				
🖹 🛅 Digital IO Module				
AX_EM_0016DN	INVT	1.1.1.0	AX_EM_0016DN for the I	OO module
AX_EM_0016DP	INVT	1.1.1.0	AX_EM_0016DP for the E	O module
AX_EM_1600D	INVT	1.1.1.0	AX_EM_1600D for the DI	module
FL1001-1600DI	INVT	1.0.0.0	16 Channels Digital Input	ts Module
FL 1002-3200DI	INVT	1.0.0.0	32 Channels Digital Input	ts Module
FL2002-0016DP	INVT	1.0.0.0	16 Channels Digtal Outpu	uts PNP Module
FL2003-0032DP	INVT	1.0.0.0	32 Channels Digtal Outpu	uts PNP Module
FL2102-0016DN	INVT	1.0.0.0	16 Channels Digtal Outpu	uts NPN Module
FL2103-0032DN	INVT	1.0.0.0	32 Channels Digtal Outpu	uts NPN Module
FL2201-0008DR	INVT	1.0.0.0	8 Channels Digtal Output	s Relay Module
FL5005-1616DP	INVT	1.0.0.0	16 Channels Digital Input	ts 16 Channels Digital O
FL5105-1616DN	INVI	1.0.0.0	16 Channels Digital Input	s 16 Channels Digital Oi
			To char	iners Digital inputs 10
■ Madeus DT I				
Modbus KTU				
Modbus ICP     Townseet up TO Madula				
				_
Group by category 🗌 Display a	all versions (fo	r experts on	ly) 🗌 Display outdated v	versions
Name: AX_EM_0016DN				
Vendor: INVT				
Categories:				<u></u>
Order Number: AX-EM-0016	5DN			~
Description: AX_EM_0016D	N for the DO m	odule		
ppend selected device as last c	hild of			
levice				
You can select another target	node in the n	avigator wh	ile this window is open.)	
			Add D	evice Close



#### Method 2: automatic scanning (recommended)

- 1. Scan EtherCAT bus configuration
- Step 1 Open the Invtmatic Studio programming software, create a new project, and select the programming language.
- Step 2 Connect to the PLC and add EtherCAT master. For details, see chapter 2 Getting Started.
- Step 3 Right-click **EtherCAT\_Master\_SoftMotion** and select **Scanned Devices**. The connected device will be automatically displayed. Click **Copy All devices to Project**.

Figure 4-13 Scanning Couplers and Expansion Modules

Device name	Device type	Alias Address	
■- FK1100_ECT_Coupler	FK1100_ECT_Coupler_1.0.5.1	15	
FL6112_2EI	FL6112-2EI		

Figure 4-14 Couplers and Expansion Modules Added after Scanning

vices 👻 🕈 🗙
🗿 Untitled9 💽
Device (TM753)
Auto scan
🔍 Fault diagnosis summary
I BI PLC Logic
Variable usage
TM75x-HSIO (TM75x-HSIO)
FL2201_0008DR (FL2201-0008DR)
FL2201_0008DR_1 (FL2201-0008DR)
ExtCard (ModuleScan)
🗐 🌐 💼 EtherCAT_Master (EtherCAT Master SoftMotion)
FK1100_ECT_Coupler (FK1100_ECT_Coupler_1.0.5.1)
FL6112_2EI (FL6112-2EI)
SoftMotion Genera FL6112_2EI (FL6112-2EI)

2. Scan local expansion modules

De

- Step 1 Open the Invtmatic Studio programming software, create a new project, and select the programming language.
- Step 2 Connect to the PLC and scan local expansion modules. You need to log in to the PLC, but you may

not start it. For details, see chapter 2 Getting Started.

Step 3 Double-click **Automatic Scanning** and click **Scan**. The list shows the expansion modules connected to the device. Click **Add to configuration**. At this time, the configuration is completed.

Too 1 *1	Tools Window Help M A B B G B AppEation [Device: PLC Logic] · S S → B S [I] G G G B S   S   S   S   S   S   S   S   S   S										
	Serial No	Device type(scanned)	Device version(scanned)	Device name(scanned)	Position	Device type(exist)	Device name(exist)	Is exist in configuration	Is add to configuration	结果	
•	1	36947	1.0.0.0	FL1002_3200DI	1			0			
	2	36963	1.0.0.0	FL2103_0032DN	2						
	3	37033	1.0.0.0	FL3203_4TC	3						
	4	36946	1.0.0.0	FL 100 1_1600DI	4						
	5	37001	1.0.0.0	FL4003_4DA	5						
	6	36993	1.0.0.0	FL3003_4AD	6						
	7	37025	1.0.0.0	FL3103_4PT	7			0			
	8	36978	1.0.0.0	FL5005_1616DP	8						
	9	36982	1.0.0.0	FL5105_1616DN	9						
	10	0			10						

# 4.2.2 Digital Input Module

The digital input module is mainly used to configure filter parameters and has I/O Mapping, Status, and Information pages. Generally, you only need to map the I/O variables on the I/O Mapping page to obtain the digital input values. The 32-point digital input module is taken as an example in the figure below.

• Filter parameters: 10 ms (1000\*10 µs) by default.

Figure 4-16	Input	Module	Configuration
-------------	-------	--------	---------------

FL1002_3200DI X		
3200DI Settings	Filter Settings	
PCI-Bus IEC Objects	Filter 0	1000 (10us)
CPU DI32 Parameters		
CPU DI32 I/O Mapping	Filter 1	1000 🔹 (10us)
Status	Filter 2	1000 🗘 (10us)
Information		1 - 1
	Filter 3	1000 文 (10us)
	Slot(Compiled): 0	Version V

#### • DI32 I/O mapping: You can get the input state through the BYTE or BOOL type.

I Settings	ind		Filter Shov	vall		-	A
s IEC Objects	Variable	Mapping	Channel	Address	Туре	Unit	Description
	🗐 🦄		DIO	%IB2	BYTE	_	
I32 Parameters	****		10	%IX2.0	BOOL	_	
I32 I/O Mapping	***		I1	%IX2.1	BOOL	_	
D2 1/0 Hupping	****		12	%IX2.2	BOOL		
-	🍫		13	%IX2.3	BOOL		
	<b>*</b> >		14	%IX2.4	BOOL		
ation	🍫		15	%IX2.5	BOOL		
	*		16	%IX2.6	BOOL		
	🧤		17	%IX2.7	BOOL		
	🗄 🍫		DI1	%IB3	BYTE		
	🖻 🍫		DI2	%IB4	BYTE		
	🗄 🧤		DI3	%IB5	BYTE		
	M						
	i 🍫		DI_ErrId	%IW3	WORD		
	L		DI_ErrId	%IW3	WORD		

Figure 4-17 Variable Mapping of the Input Module

# 4.2.3 Digital Output Module

The digital output module is mainly used to set the output state selection after stopping and has I/O Mapping, Status, and Information pages. Generally, you only need to map the I/O variables on the I/O Mapping page to obtain the digital output values. The 16-point digital output module is taken as an example in the figure below.

16DN Settings	Channel 1			
	Filter 0 1000 ᆃ	[10us]		
I-Bus IEC Objects	- 00 Output status after	-01 Output status after	- 02 Output status after	03 Output status after
U DI DO 16 Parameters	STOP / POWER FAILURE O Holding	STOP / POWER FAILURE O Holding	STOP / POWER FAILURE O Holding	STOP / POWER FAILUR
J DI DO 16 I/O Mapping	○ Resetting	Resetting	Resetting	Resetting
	Presetting	Presetting	O Presetting	Presetting
us				
rmation	04 Output status after STOP / POWER FAILURE	05 Output status after STOP / POWER FAILURE	06 Output status after STOP / POWER FAILURE	07 Output status after STOP / POWER FAILUR
	O Holding	O Holding	O Holding	O Holding
	○ Resetting	Resetting	○ Resetting	○ Resetting
	O Presetting	Presetting	Presetting	O Presetting
	Channel 2			
	Channel 2 Filter 1 1000	[10us]	12 Output status after	13 Output status after
	Channel 2 Filter 1 1000	[10us] 11 Output status after STOP / POWER FAILURE	12 Output status after STOP / POWER FAILURE	13 Output status after STOP / POWER FAILUR
	Channel 2 Filter 1 1000 🛊 10 Output status after STOP / POWER FAILURE O Holding	[10us] 11 Output status after STOP / POWER FAILURE Holding	12 Output status after STOP / POWER FAILURE Holding	13 Output status after STOP / POWER FAILUR Holding
	Channel 2 Filter 1 1000 🐳 10 Output status after STOP / POWER FAILURE O Holding Resetting	[10us] 11 Output status after STOP / POWER FAILURE Holding Resetting	12 Output status after STOP / POWER FAILURE Holding Resetting	13 Output status after STOP / POWER FAILUR Holding Resetting
	Channel 2 Filter 1 1000 10 Output status after STOP / POWER FAILURE Holding Resetting Presetting	[10us] 11 Output status after STOP / POWER FAILURE Holding Resetting Presetting	12 Output status after STOP / POWER FAILURE Holding Resetting Presetting	13 Output status after STOP / POWER FAILUF Holding Resetting Presetting
	Channel 2 Filter 1 1000 10 Output status after STOP / POWER FAILURE Holding Resetting Presetting 14 Output status after STOP / POWER FAILURE	[10us] 11 Output status after STOP / POWER FAILURE Holding Resetting Presetting 15 Output status after STOP / POWER FAILURE	12 Output status after STOP / POWER FAILURE Holding Resetting Presetting 16 Output status after STOP / POWER FAILURE	13 Output status after STOP / POWER FAILUR Holding Resetting Presetting 17 Output status after STOP / POWER FAILUR
	Channel 2 Filter 1 1000 10 Output status after STOP / POWER FAILURE Presetting 14 Output status after STOP / POWER FAILURE Holding	[10us] 11 Output status after STOP / POWER FAILURE Holding Resetting Presetting 15 Output status after STOP / POWER FAILURE Holding	12 Output status after STOP / POWER FAILURE Holding Resetting Presetting 16 Output status after STOP / POWER FAILURE Holding	13 Output status after STOP / POWER FAILUR Holding Resetting Presetting 17 Output status after STOP / POWER FAILUR Holding
	Channel 2 Filter 1 1000 10 Output status after STOP / POWER FAILURE Holding Presetting 14 Output status after STOP / POWER FAILURE Holding Resetting	[10us] 11 Output status after STOP / POWER FAILURE Holding Resetting Presetting 15 Output status after STOP / POWER FAILURE Holding Resetting	12 Output status after STOP / POWER FAILURE Holding Resetting Presetting 16 Output status after STOP / POWER FAILURE Holding Resetting	13 Output status after STOP / POWER FAILUR Holding Resetting Presetting 17 Output status after STOP / POWER FAILUR Holding Resetting

Figure 4-18 Output Module Configuration

DN16 I/O mapping: You can control the output state through the BYTE or BOOL type.

Figure 4-19 Variable Mapping of the Output Module

1616DN Settings	Find		Filter Show	v all			- 🕂 Add	FB for IO Channe
PCI-Bus IEC Objects	Variable	Mapping	Channel DI0	Address %IB94	Туре ВҮТЕ	Unit	Description	
CPU DI DO 16 Parameters	*		10	%IX94.0	BOOL			
CPU DIIDO 16 I/O Manning			I1	%IX94.1	BOOL			
crobilbo to to mapping	•		I2	%IX94.2	BOOL			
Status	*		13	%IX94.3	BOOL			
			I4	%IX94.4	BOOL			
Information	- *		15	%IX94.5	BOOL			
	<b>*</b>		16	%IX94.6	BOOL			
	· · · · · · · · · · · · · · · · · ·		17	%IX94.7	BOOL			
	🗎 🏘		DI1	%IB95	BYTE			
	*>		DI_ErrId	%IW48	WORD			
	÷		DO0	%QB16	BYTE			
	😐 🍢		DO1	%QB17	BYTE			
			DO_ErrId	%IW49	WORD			

# 4.2.4 Analog Input Module

#### General Configuration

The analog input module includes 4 channels, each of which has parameter configuration and I/O mapping register (16 bits) settings. Only one channel of each module is described below.

fl3003_4AD X	
4AD Settings	Chanel 0
Fault diagnosis	Chanel Eable Break Check Over Limit
PCI-Bus IEC Objects	Over Range Ovst Filter
CPU AI4 Parameters	Mode 0~5V (0~20000) ∨ Filter Param 8 🖨 (1~255)
CPU AI4 I/O Mapping	Chanel 1
Status	Chanel Eable 🛛 Break Check 💭 Over Limit
Information	Over Range Ost Filter
	Mode 0~10V (0~20000) ∨ Filter Param 8 🔷 (1~255)
	Chanel 2 Chanel Eable Break Check Over Limit Over Range Post Filter
	Mode 4~20mA (0~20000) V Filter Param 8 (1~255)
	Chanel 3
	Chanel Eable Break Check Over Limit
	Over Range Ost Filter
	Mode -10~10V (-20000~200( ∨ Filter Param 8 (1~255)
	Slot(Compiled): 0 Version V

#### Figure 4-20 Analog Input Module Configuration

- Channel enable: The channel can only be used after it is enabled.
- Filter parameter: Analog input channel filter, ranging from 1 to 255.
- Conversion mode: Set the analog input conversion type, which determines the channel input conversion type and the range of the conversion value. For details on the conversion type, see Table 4-4.
- Disconnection detection: Set whether the analog input channel performs disconnection detection. Since it is impossible to distinguish between analog input 0 and disconnection, the disconnection flag cannot be activated in all conversion modes that include 0 value input.
- Over-limit detection: Set whether the analog input channel performs over-limit detection.
- Over-range detection: Set whether the analog input channel performs over-range detection.
- Enhanced filtering: Set whether the analog input channel uses enhanced filtering.

#### 4AD I/O Mapping

4AD means 4-channel analog input. Each channel of analog input corresponds to a 16-bit integer value. For the relationship between analog value and digital value, see the general analog input configuration. You can map a variable to each 16-bit integer value on this interface to obtain the digital value corresponding to the analog value of an input channel. For details, see Table 4-4.

4AD Settings	Find		Filter Shov	v all			- +
Fault diagnosis	Variable	Mapping	Channel	Address	Туре	Unit	Description
			AIO	%IW24	INT		
PCI-Bus IEC Objects	🍫		AI1	%IW25	INT		
			AI2	%IW26	INT		
CPU AI4 Parameters	<b>*</b>		AI3	%IW27	INT		
CPU AI4 I/O Mapping	- *>		AI0_Err	%IW28	WORD		
	···· *>		AI1_Err	%IW29	WORD		
Status	- *		AI2_Err	%IW30	WORD		
			AI3_Err	%IW31	WORD		



FL3003_4AD X	
4AD Settings	General
Fault diagnosis	Vendor: INVT
PCI-Bus IEC Objects	Type: 36993
CPU AI4 Parameters	Version: 1.0.0.0 Order Number: El 3003
CPU AI4 I/O Mapping	Description: 4 Channels Analog Inputs Module
Status	
Information	

Table 4-4 Correspondence between Mapped and Actually Input Analog Values

Туре	Enter the Rated Range	Rated Corresponding Digital Quantity
	-10V–10V	-20000-+20000
Analogyaltagainnyt	0V-10V	0–20000
Analog voltage input	-5V–+5V	-20000-+20000
	0V–5V	0–20000
	-20mA-20mA	-20000–20000
Analog current input	0mA-20mA	0–20000
	4mA–20mA	0–20000

# 4.2.5 Analog Output Module

#### General Configuration

The analog output module includes 4 channels, each of which has parameter configuration and I/O mapping register (16 bits) settings. Only one channel of each module is described below.

DA Settings	- 🗖 Chanel 0			
	Chanel Eable	Output fault check		
aurt uragnosis	Mode	0~5V (0~20000)		
CI-Bus IEC Objects	- Output status after			
PU AO4 Parameters	O Hold Outp	it		
	Output Reset			
PU AO4 I/O Mapping	Output Pre	set		
tatus				
formation	Chanel 1			
	🗸 Chanel Eable	Output fault check		
	Mode	0~10V (0~20000) V		
	Output status after	STOP / POWER FAILURE		
	O Hold Outpu	.t		
	Output Res			
		SCL		
	Chanel 2			
	Chanel 2-	Output fault check		
	Chanel 2 Chanel Eable Mode	Output fault check -10~10V (-20000~20000)		
	Chanel 2 Chanel Eable Mode Output status after :	Output fault check -10~10V (-20000~20000)		
	Chanel 2 Chanel Eable Mode Output status after 1 Hold Output Output Res	Output fault check -10~10V (-20000~20000) V STOP / POWER FAILURE It et		
	Chanel 2 Chanel Eable Mode Output status after : Hold Output Output Res Output Pre	Output fault check -10~10V (-20000~20000) STOP / POWER FAILURE ut et set		
	Chanel 2 Chanel Eable Mode Output status after 3 Hold Output Output Res Output Pre	Output fault check -10~10V (-20000~20000) V STOP / POWER FAILURE It et set		
	Chanel 2 Chanel Eable Mode Output status after Hold Output Output Res Output Pre	Output fault check -10~10V (-20000~20000) STOP / POWER FAILURE It et set		
	Chanel 2 Chanel Eable Mode Output status after Hold Output Output Res Output Pre Chanel 3 Chanel Eable	Output fault check -10~10V (-20000~20000) STOP / POWER FAILURE It et set Output fault check		
	Chanel 2 Chanel Eable Mode Output status after Hold Output Output Res Output Pre Chanel 3 Chanel Eable Mode	Output fault check -10~10V (-20000~20000)  STOP / POWER FAILURE it et set Output fault check 4~20mA (0~20000)		
	Chanel 2 Chanel Eable Mode Output status after Hold Output Output Res Output Pre	Output fault check -10~10V (-20000~20000)   STOP / POWER FAILURE ut et set Output fault check 4~20mA (0~20000)  STOP / POWER FAILURE		
	Chanel 2 Chanel Eable Mode Output status after 3 Output status after 3 Output Res Output Pre Chanel 3 Chanel Sable Mode Output status after 3 Output status after 3	Output fault check -10~10V (-20000~20000) STOP / POWER FAILURE it et set Output fault check 4~20mA (0~20000) STOP / POWER FAILURE it		
	Chanel 2 Chanel Eable Mode Output status after : Output Res Output Pre Chanel 3 Chanel 3 Chanel Eable Mode Output status after : Output status after : Output Res	Output fault check -10~10V (-20000~20000)  STOP / POWER FAILURE it et Set Output fault check 4~20mA (0~20000)  STOP / POWER FAILURE it et		

Figure 4-23 Variable Mapping of the Analog Output Module

- Conversion mode: Set the analog output conversion type, which determines the channel output conversion type and the range of the conversion value. For details on the conversion type, see Table 4-5.
- Keep output: After the module stops running, the output will keep the last output value.
- Clear output: After the module stops running, the output is always 0.
- Output preset value: After the module stops running, the output is always the preset value. The preset value range is related to the current conversion mode. See Table 4-5 for details.

Table 4 C Camera				
Table 4-5 Corres	pondence betwee	n Mapped and A	Actually in	but Analog values

Туре	Enter the Rated Range	Rated Corresponding Digital Quantity
Analog voltage	-10–10 V	-20000-+20000
output	0–10 V	0–20000

Туре	Enter the Rated Range	Rated Corresponding Digital Quantity
	-5–+5 V	-20000-+20000
	0–5 V	0–20000
Analog current	4–20 mA	0–20000
	0–20 mA	0–20000
output	-20–20 mA	-20000-+20000

#### 4DA I/O Mapping

4DA means a 4-channel analog output. Each channel of analog output corresponds to a 16-bit integer value. For the relationship between analog value and digital value, see Table 4-5. You can map a variable to each 16-bit integer value on this interface to output the variable value to the current channel, and then convert it into an analog value output through the analog output module.

Figure 4-24 Variable Mapping of the Analog Output Module

4DA Settings	Find		Filter Shov	v all			- +
Fault diagnosis	Variable	Mapping	Channel	Address	Туре	Unit	Description
CI-Bus IEC Objects	· · · · · · · · · · · · · · · ·		AO0 AO1	%QW3 %QW4	INT		
PU AO4 Parameters			AO2	%QW5	INT		
PU AO4 I/O Mapping	*		AO0_Err	%IW20	WORD		
tatus	····· *		AO1_Err AO2_Err	%IW21 %IW22	WORD		
6	-		AO3_Err	%IW23	WORD		

#### Information

It displays the basic information of 4DA module devices: name, manufacturer, group, type, ID, version, model number, and description. In addition, after login, the Information interface will read and display the single-board software version (4DA embedded software version) and logic software version (FPGA software version in the 4DA module) of the 4DA module.

FL4003_4DA X	
4DA Settings	General
Fault diagnosis	Name: FL4003-4DA Vendor: INVT
PCI-Bus IEC Objects	Type: 37001
CPU AO4 Parameters	Version: 1.0.0.0 Order Number: FL4003
CPU AO4 I/O Mapping	Description: 4 Channels Analog Outputs Module
Status	
Information	

Figure 4-25 4DA Information Interface of the Analog Output Module

### 4.2.6 Temperature Module

The temperature module includes two types: 4TC (4-channel temperature detection module, supporting thermocouples) and 4PT (4-channel temperature detection module, supporting thermal resistors).

#### 4.2.6.1 4TC Temperature Module

The 4TC temperature module (4-channel temperature detection module, supporting thermocouples) has corresponding general configuration and channel configuration. The general configuration is used to configure the unit type and sampling period of the temperature module, while the channel configuration is used to configure the sensor type, filter time, over-limit, temperature offset, and other parameters of each channel.

#### Channel Configuration

Different types of modules support different channels, and 4TC supports 4 channels. Since the configuration parameters of each channel are basically the same, only one channel is described here. The configuration of a 4TC channel is shown in the figure below.

4TC Settings Close	Temperature Unit Setting	
Fault diagnosis	<ul> <li>Centigrade(°C)</li> </ul>	○ Fahrenheit degree(°F)
PCI-Bus IEC Objects	Chanel 0	
CPU TC4 Parameters	Chanel Eable	
CPU TC4 I/O Mapping	Filter Param 8 (1-255)	Over Range
Status	Offset (°C) 0.0 (-204. 8-204. 7)	- Upper And Lower Temperatrue Limits
Information	Mode K ~	Upper Limit (°C) 1370.0 -270~1370
Information		Lower Limit (°C) -270.0 -270~1370

Figure 4-26 4TC Temperature Module Configuration

- Temperature unit: The unit used by the temperature module input, which supports Celsius or Fahrenheit.
- Channel enable: The channel can only be used after it is enabled.
- Sensor type: 4TC sensor type. See Table 4-6 for the sensor specifications. The K sensor is used by default.
- Filter parameter: The filter used by this channel of the temperature module, ranging from 1 to 255, 8 by default.
- Over-range detection: When it is enabled, if the temperature is not between the upper and lower limits, an over-limit fault will be reported. For details, see Table 4-6.
- Offset value (°C): It is used to set the temperature module offset compensation value, ranging from -204.8 to 204.7.

#### I/O mapping

Different types of temperature modules contain different numbers of channels and IO mappings. The figure below shows the I/O mapping interface of 4TC. The parameter value of each channel is the temperature value.

4TC Settings	Find		Filter Show al	I			- 🕂 Ad
Fault diagnosis	Variable	Mapping	Channel	Address	Туре	Unit	Description
	( p 🐪		Temp0	%ID3	REAL		
CI-Bus IEC Objects	<b>*</b> >		Temp1	%ID4	REAL		
	- *		Temp2	%ID5	REAL		
CPU TC4 Parameters	¥ø		Temp3	%ID6	REAL		
PU TC4 I/O Mapping	¥ø		Temp0_ErrId	%IW14	WORD		
	¥ø		Temp1_ErrId	%IW15	WORD		
Status	¥ø		Temp2_ErrId	%IW16	WORD		
	- V.		Temp3 ErrId	%IW17	WORD		

Figure 4-27 Variable Mapping of the 4TC Temperature Module

#### 4.2.6.2 4PT Temperature Module

The 4PT temperature module (4-channel temperature detection module, supporting thermal resistors) has corresponding general configuration and channel configuration. The general configuration is used to configure the unit type and sampling period of the temperature module, while the channel configuration is used to configure the sensor type, filter time, over-limit, temperature offset, and other parameters of each channel.

#### Channel configuration

4PT supports 4 channels. Since the configuration parameters of each channel are basically the same, only one channel is described here. The configuration of one channel of 4PT is shown in the figure below.

PT Settings	Temperature Unit Setting	
ault diagnosis	<ul> <li>Centigrade(°C)</li> </ul>	○ Fahrenheit degree(°F)
CI-Bus IEC Objects	Chanel 0	
PU PT4 Parameters	Chanel Eable	Hot Wire type 🔹 2-Wire 🔷 3-Wire 🔷 4-Wire
PU PT4 I/O Mapping	Filter Param 8 (1-	-255) Over Range
	Offset (°C) 0.0 -20	04. 8`204. 7
tatus		Upper Limit (°C) 850.0 -200~850
oformation	Mode PT100	Lower Limit (°C) -200.0 + -200~850

Figure 4-28 4PT Temperature Module Configuration

- Temperature unit: The unit used by the temperature module input, which supports Celsius or Fahrenheit.
- Channel enable: The channel can only be used after it is enabled.

- Thermal resistor wiring mode: 2-wire, 3-wire, or 4-wire.
- Sensor type: 4PT sensor type. See Table 4-6 for the sensor specifications. The PT100 sensor is used by default.
- Filter parameter: The filter used by this channel of the temperature module, ranging from 1 to 255, 8 by default.
- Over-range detection: When it is enabled, if the temperature is not between the upper and lower limits, an over-limit fault will be reported. For details, see Table 4-6.
- Offset value ((°C): It is used to set the temperature module offset compensation value, ranging from -204.8 to 204.7.

I/O mapping

Different types of temperature modules contain different numbers of channels and IO mappings. The figure below shows the I/O mapping interface of 4PT. The parameter value of each channel is the temperature value.

4PT Settings	Find		Filter Show a	I			- ⊕ Ad
Fault diagnosis	Variable	Mapping	Channel	Address	Туре	Unit	Description
	I 👘 🦘		Temp0	%ID16	REAL		
PCI-Bus IEC Objects	¥ø		Temp1	%ID17	REAL		
CPU PT4 Parameters	🍬		Temp2	%ID18	REAL		
	···· 🍫		Temp3	%ID19	REAL		
CPU PT4 I/O Mapping	¥ø		Temp0_ErrId	%IW40	WORD		
ci o i i i qo i i i pping	¥ø		Temp1_ErrId	%IW41	WORD		
Status	<b>*</b> >		Temp2_ErrId	%IW42	WORD		
	- L. 🍫		Temp3_ErrId	%IW43	WORD		

#### Figure 4-29 Variable Mapping of the 4PT Temperature Module

#### Information

Figure 4-30 Information Interface of the 4PT Temperature Module

4PT X	
General	
Name: Fi	3103- <del>4</del> PT
Vendor:	INVT
Categor	es:
ojects Type: 37	)25
ID: 1631	2041
neters Version: Order N	1.0.0.0 Imber El 3103
apping Descript	ion: 4 Channels Resistance Temperature Detector Inputs Module
apping	3103-4PT INVT es: )25 20A1 1.0.0.0 Imber: FL3103 ion: 4 Channels Resistance Temperature Detector Inputs Module

ltem	Sensor Type	Temperature Range in Celsius	Temperature Range in Fahrenheit
	PT100	-200.0–850°C	<b>-328.0–1562.0</b> ℃F
Thermal resistor	PT500	-200.0–850°C	<b>-328.0–1562.0</b> °F
type	PT1000	-200.0–850°C	<b>-328.0–1562.0</b> °F
	CU100	-50.0–150°C	-58.0–302.0°F
	В	200.0–1800°C	<b>392.0–3272.0</b> °F
	E	-270.0–1000°C	<b>-454.0–1832.0</b> °F
	Ν	-200.0–1300°C	<b>-328.0–2372.0</b> °F
Thermocouple	J	-210.0–1200°C	<b>-346.0–2192.0</b> ℉
type	К	-270.0–1370°C	<b>-454.0–2498.0</b> ℃F
	R	-50.0–1765°C	-58.0–3209.0°F
	S	-50.0–1765°C	- <b>58.0–3209.0</b> °F
	Т	-270.0–400°C	- <b>454.0–752.0</b> °F

#### Table 4-6 Supported Sensor Types and Measurement Ranges

# 4.3 Priority Setting for Each Module (Recommended Value)

If the created project contains multiple functional modules, create multiple tasks and set the task priority as follows. For the recommended value of task priority, see Table 4-7.

Devices	▼ ₽ X StherCAT_Task X
Chittled9     Device (TM753)     Auto scan     Q Fault diagnosis summary     PLC Logic     Optication     Optication     PLC_PRG (PRG)     PLC_PRG (PRG)     PLC (PRG	▼       Configuration         Priority (031):       0         Type

Figure 4-31 Example of Project Task Priority Setting

Devices 👻 🕂 🗙	Counted S MainTask X
- Didded I	Configuration
🖹 🛅 Device (TM753)	
- 🗋 Auto scan	Priority (0.31):
- 🔍 Fault diagnosis summary	
E I PLC Logic	Type
🖹 🔘 Application	⊕ Cyclic ∨ Interval (e.g. t#200ms) 20 ms ∨
- 🧭 GVL	
👕 Library Manager	Wathdog
PLC_PRG (PRG)	□ Enable
🖷 🧱 Task Configuration	
EtherCAT_Task	Time (e.g. t#200ms) ms >>
😑 🥵 MainTask	Savelbicky 1
B) PLC_PRG	wasarny x
- 🗬 Trace	
T PersistentVars	
- 🚺 Variable usage	💠 Add Call 🔀 Remove Call 🛃 Change Call 🔮 Move Up 🚸 Move Down (**) Open POU
TM75x-HSIO (TM75x-HSIO)	POU Comment
- 🕤 Counter0 (HiSpeedCounter)	All are not
Counter1 (HiSpeedCounter)	
FL2201_0008DR (FL2201-0008DR)	
- 📆 FL4003_4DA (FL4003-4DA)	
ExtCard (ScanModule)	

Table 4-7 Priority Setting
----------------------------

Function Module	Recommended Priority
PlcCfg Module	31
Modbus TCP	15–30
Modbus RTU	15–30
High-speed I/O (default configuration to MainTask)	1
Analog input/output	1–15
Temperature Module	1–15
EtherCAT	0

# **5 Network Configuration**

The PLC network configuration mainly involves the following networks: Modbus TCP, Modbus RTU, EtherCAT, and CANopen.

# 5.1 Modbus TCP

# 5.1.1 Modbus TCP Master Configuration

When the PLC is used as a Modbus TCP master, right-click **Device** in the left device tree, select **Add Device**, and then **Dedicated Device** > **Modbus TCP Protocol** > **Modbus TCP Master 1** in the pop-up window, and click **Add Device** in the lower right corner.



Figure 5-1 Adding a Modbus TCP Master

Double-click the master device **Modbus\_TCP\_Master 1** in the device tree to open the Modbus master configuration window, as shown in the figure below. The frame interval (ms) refers to the time interval between the master receiving the last response data frame and the next request data frame. This parameter can be used to adjust the data exchange rate.



Table 5-2 Modbus TCP Master Settings

The number of variables accessible by ModbusTCP is defined as follows:

- Read coils (0x01): quantity of coils: 1–2000 (0x7D0)
- Read discrete coils (0x02): quantity of coils: 1–2000 (0x7D0)
- Read holding registers (0x03): quantity of registers: 1–125 (0x7D)
- Read input registers (0x04): quantity of registers: 1–125 (0x7D)
- Write single coil (0x05)
- Write single register (0x06)
- Write multiple coils (0x0F): quantity of coils 1–1968 (0x7B0)
- Write multiple registers (0x10): quantity of registers: 1–123 (0x7B)

Table 5-1 Definition of the Number of Variables Accessible by Modbus TCP

Variable	Qty.
Read coils (0x01)	1–2000 (0x7D0)
Read discrete coils (0x02)	1–2000 (0x7D0)
Read holding registers (0x03)	1–125 (0x7D)
Read input registers (0x04)	1–125 (0x7D)
Write single coil (0x05)	-
Write single register (0x06)	-
Write multiple coils (0x0F)	1–1968 (0x7B0)
Write multiple registers (0x10)	1–123 (0x7B)

### 5.1.2 Modbus TCP Master Communication Configuration

#### Adding a Modbus TCP Slave

Right-click **Modbus\_TCP\_Master 1** in the left device tree, select **Add Device**, and then **Modbus TCP Slave 1** in the pop-up window, and click **Add Device** in the lower right corner.

Devices	- 4 X 📶 Ma	lodbus_TCP_Master1 🗙	
Devices Devices Device (TM753) Devic	<ul> <li>▼ X</li> <li>Modbus</li> <li>PCI-Bus</li> <li>Internal</li> <li>Status</li> </ul>	Iodbus_TCP_Master1 X usTCP mastersettings Is IEC Objects al Parameters	
(introduction)     (introdu	er SoftMotion) therCAT(COE) Drive V26: therCAT(COE) Drive)	lation	Add Device X  Name Modbus_TCP_Slave1  Action  Action  Append device Insert device Update device
Modbus_TCP_Master 1 (Modt)     SoftMotion General Axis Pool     K	Copy Paste Delete Refactoring Properties Add Object Add Folder	•	String for a fulltext search     Vendor     c.Al vendors>       Name     Vendor     Version     Description       Image: Model and the second
L L J	Add Device Disable Device Update Device Edit Object Edit IO mapping Import mappings from CSV Export mappings to CSV Visual Element Repository		Image: Market Stop Slave 1         Vendor: INIT         Categories:         Version: 1.0.0.0         Order Number.*         Description:    Append selected device as last child of Hodbus_TCP_Haster1

Figure 5-3 Adding a Modbus TCP Slave

Setting the Modbus TCP Slave



ModbusTCP slave settings		
1odbusTCP communication settings	ModbusTCP slave settin	gs
Fault diagnosis	IP address	192 . 168 . 1 . 🚹
PCI-Bus IEC Objects	Port	502
Internal Parameters	Station number	1
Status	Timeout(ms)	(0~255) 1000
Information		(2~65535)
	Slave enable variable SM	4001

#### Table 5-2 Description of Modbus TCP Slave Parameter Settings

Parameter	Function
IP address	IP address for connecting the master to the Modbus TCP slave
Port	TCP port number for connecting the master to the Modbus TCP slave

Parameter	Function
Node number	Protocol node number for connecting the master to the Modbus TCP slave
Timeout period (ms)	After the master sends a frame, if the slave does not respond within the time period, the master reports a receive timeout.
Slave enable	After programming and enabling this variable, the master starts to send communication frames to the slave.

#### Modbus TCP master to Modbus TCP slave communication settings

Each channel represents an independent Modbus TCP request, as shown in the figure below. The third line defines an operation of writing a single register (function code 0x06) at a cycle of 10 ms, i.e. writing 2 bytes of data to the register with an offset address of (0x0014)20 (1 register occupies 2 bytes).

Figure 5-5 Modbus TCP Master to Modbus TCP Slave Communication Settings

Modbus_TCP_Slave1 ×													
ModbusTCP slave settings		Name	Function code	Enable type	Enable variable(SM)	Circle time(ms)	ReadAddress	ReadLength	Error handling	WriteAddress	WriteLen	Retry times	Comment
1odbusTCP communication settings	0	Channel 00	(0x03) Read holding registers	Loop execute		100	(0x0064) 100	1	Keep last value			1	
ault diagnosis													
CI-Bus IEC Objects													
ternal Parameters													
ternal I/O Mapping													
tatus													
nformation													
									Add	Delete	Edit	Export EX	CE

- Add: Click **Add** to open the dialog box for adding a new channel for the Modbus TCP slave, and then click **OK** to create a new channel.
- Edit: Select a channel in the Modbus TCP slave channel list and click **Edit** to open the dialog box for changing the channel configuration by modifying the parameters in it, and then click **OK** to update channel settings.
- Export to EXCEL: Click **Export EXCEL** to export channel parameters to an EXCEL table in batches, and then click **Import** to import channel parameters into the settings in batches.

When adding or editing a channel, you will see the following pop-up dialog box:

Figure 5-6 Dialog Box for Modbus TCP Master to Modbus TCP Slave Communication Settings

lame	Channel 00				
unction code	(0x03) Read holding regi	sters			~
nable type	Loop execute				~
ircle time(ms)	100	÷	Enable variable	e (SM)	* *
	(1~65535)			(0~7999)	
letry times	1	-	Comment		
ead					
ddress(Hex)	100		Length(WORD)	1	<b></b>
	(0~0xFFFF)			(1~125)	
error handling	Keep last value				~
rite					
ddress(Hex)	0		Length(WORD)	1	* *

#### Table 5-3 Description of Modbus TCP Communication Parameter Settings

Parar	neter	Description					
Na	me	A string that names the channel					
		Read coils (function code 0x01)					
		Read input coils (function code 0x02)					
		Read holding registers (function code 0x03)					
Euro eti e	un aa da	Read input registers (function code 0x04)					
Functio	on code	Write single coil (function code 0x05)					
		Write single register (function code 0x06)					
		Write multiple coils (function code 0x15)					
		Write multiple registers (function code 0x16)					
		Cyclic: requests triggered cyclically					
		Cycle time: time for execution again					
Enabl	e type	Level trigger: triggered when programming changes					
		Trigger variable (SM): SM element triggered (after enabling, the trigger					
		variable is set after the communication is completed)					
Dotro	times	If a communication failure occurs and no slave return frame is obtained,					
Retry	umes	resending is performed according to the retry times.					
Com	ment	A short text area that describes the data					
Deed	Starting address	The starting position of the register read					
Read	Length	Number of registers read					
register	Error	Keep the last value: Keep the data at the last valid value					
	processing	Set to 0: Set all values to zero					
Write	Starting	The starting position of the register written					
vinte	address	The starting position of the register written					
register	Length	The length of the register written					

#### Internal I/O Mapping of Modbus TCP Slave

After adding the master-slave communication configuration to the Modbus TCP slave communication settings, the mapping address of each configuration will be automatically assigned in the internal I/O mapping. For example, %IW98 in the third line of the figure below means that the read coil value is mapped to the address %IW98. In addition, you can also map custom variables in the program to I/O addresses by using the Input Assistant or by directly entering the example variable path.

to dbusTCP slave settings	Find		Filter Show al	1		Add	I FB for IO Channel * Go to Insta	ince	
fodbusTCP communication settings	Variable ≡- *	Mapping	Channel Channel 01	Address %QW38	Type ARRAY [029] OF WORD	Unit	Description (0x10) Write multiple registers		
ault diagnosis	÷.*		Channel 00	%IW52	ARRAY [019] OF WORD		(0x03) Read holding registers		
nternal I/O Mapping									
atus									
formation									
							aller aller aller aller		

Figure 5-7 Internal I/O Mapping for Modbus TCP Master Connection to Slave

# 5.1.3 Modbus TCP Slave Configuration

When the PLC is used as a Modbus TCP slave, right-click **Device** in the left device tree, select **Add Device**, and then **Dedicated Device** > **Modbus TCP Slave Device1** in the pop-up window, and then click **Add Device** in the lower right corner.

Figure 5-8 Adding a Modbus TCP Slave

Devices	<b>→</b> ∓ X	
🗆 🎒 Untitled9		
🖮 👚 Device (TM753)		
📄 Auto scan 🗎	Сору	Add Device
🔍 Fault diagi 🛍	Paste	Name Morthus TCP Slave Device1
🖻 🗐 PLC Logic 🗙	Delete	Action
🖹 🚫 Appli	Refactoring	Append device Insert device Plug device Update device      String for a fullext search      Vendor      rall vendore      Vendor      rall vendore      Vendor      Vendo
Variable u	Properties	Name Vendor Version Description
FL 1002_3	Add Object	s → hSrByt
🖳 📆 ExtCard († 🚞	Add Folder	A Modous KTU
🖻 📆 EtherCAT	Add Device	Modeus TCP Master 1 INVT 1.0.0.0
🖻 🕤 INVT_	Update Device	Modbus TCP Slave Device1 INVT 1.0.0.0
	Edit Object	ModbusTCP Slave Device2 INVT 1.0.0.0
		Group by category Display all versions (for experts only) Display outdated versions
Modbu	Edit IO mapping	Name: Modbus TCP Slave Device 1     Name: Modbus TCP Slave Device 1
SoftMotion	Import mappings from CSV	Categories:
	Export mappings to CSV	Version: 1.0.0.0 Order Number: ???
*	Online Config Mode	Append selected device as last child of
	Reset Origin Device [Device]	Vevice     (You can select another target node in the navigator while this window is open.)
	Simulation	Add Device Close

Double-click the slave device in the device tree to open the Modbus TCP slave configuration window, as shown in the figure below.



Devices – 🕂 🗙	Modbus_TCP_Slave_Device1	٢	
Untitled9	ModbusTCPslave devices ettings		
Device (TM753)	hood as for share defices eachings		
Auto scan	Fault diagnosis	-Modbusi CP slave device set	tings
PLC Logic	PCI-Bus IEC Objects	Port	502 🔶
Application			(1~65535)
🚺 Variable usage	Internal Parameters		
TM75x-HSIO (TM75x-HSIO)	Status	Frame interval(ms)	1
👔 FL 1002_3200DI (FL 1002-3200DI)	-		(1~1000)
👔 ExtCard (ModuleScan)	Information	Station number	1
🗐 🌐 EtherCAT_Master (EtherCAT Master SoftMotion)			
🖲 🗃 INVT_DA200_265 (DA200-N EtherCAT(CoE) Drive V26			
🗉 🗃 INVT_DA300_101 (DA300-N EtherCAT(CoE) Drive)			
Modbus_TCP_Master 1 (Modbus TCP Master 1)			
Modbus_TCP_Slave1 (Modbus TCP Slave1)			
Modbus_TCP_Slave_Device1 (Modbus TCP Slave Device1)			
SoftMotion General Axis Pool			

Table 5-4 Modbus TCP Slave Parameter Settings
-----------------------------------------------

Parameter	Function				
Port	TCP port number of the Modbus TCP slave				
Frame interval	The delay time for the Modbus TCP slave to send a response frame after				
(ms)	receiving a communication frame				
Node number	The number to identify the node				

The Modbus\_TCP\_Slave defines storage areas accessible by external devices, which are shown in the following table.

Table 5-5 Modbus_TCP_S	Slave Function Codes
------------------------	----------------------

TCP Master Function Code	Address name	Range	Offset from Standard Modbus Address
0x01	%QX	0–65535	None
0x05/0x15	%QX	0–65535	None
0x02	%IX	0–65535	None
0x04	%IW	0–65535	None
0x03	%MW	0–65535	None
0x06/0x16	%MW	0–65535	None

Table 5-6 Example of Correspondence between Controller Bit, Byte, Word, and Double Word

%_X	195.7–195.0	194.7–194.0	193.7–193.0	192.7–192.0			
%_B	195 (8 MSBs)	194 (8 LSBs)	193 (8 MSBs)	192 (8 LSBs)			
%_W	97 (16 MSBs) 96 (16 LSBs)						
%_D		48					

# 5.1.4 Modbus TCP Device Diagnosis

The Modbus TCP master device diagnosis interface displays slaves and communication parameters with errors.

#### Figure 5-10 Modbus TCP Master Device Diagnosis Interface

Modbus_TCP_Slave1 🗙	Modbus_TCP_Slave1 ×						
ModbusTCP slave settings							
		Serial No	Error code	Error name	Solution		
ModbusTCP communication settings	•	1	Er00A0-000f	Communication Timeout	Check whether the master and slave networks		
Fault diagnosis							
PCI-Bus IEC Objects							
Internal Parameters							
Internal I/O Mapping							
Status							
Information							

# 5.2 Modbus RTU

The PLC supports two Modbus serial port communications, namely COM1\_RS485 and COM2\_RS485, both of which support the standard Modbus RTU protocol and can be independently configured as a master or slave station, supporting seven baud rates: 2400, 4800, 9600, 19200, 38400, 57600, and 115200.

The number of variables accessible by Modbus RTU is defined as follows:

- Read coils (0x01), number of coils 1–2000 (0x7D0)
- Read discrete coils (0x02), number of coils 1–2000 (0x7D0)
- Read holding registers (0x03), number of registers 1–125 (0x7D)
- Read input register (0x04), number of registers 1–125 (0x7D)
- Write single coil (0x05)
- Write single register (0x06)
- Write multiple coils (0x0F): quantity of coils 1–1968 (0x7B0)
- Write multiple registers (0x10): quantity of registers: 1–123 (0x7B)

Table 5-7 Definition of the Number of Variables Accessible by Modbus RTU

Variable	Qty.
Read coils (0x01)	1–2000 (0x7D0)
Read discrete coils (0x02)	1–2000 (0x7D0)
Read holding registers (0x03)	1–125 (0x7D)
Read input registers (0x04)	1–125 (0x7D)
Write single coil (0x05)	-
Write single register (0x06)	-
Write multiple coils (0x0F)	1–1968 (0x7B0)
Write multiple registers (0x10)	1–123 (0x7B)

#### 5.2.1 Modbus RTU Master Configuration

When the PLC is used as a Modbus RTU master, right-click **Device** in the left device tree, select **Add Device**, and then **Dedicated Device** > **Modbus RTU Protocol** > **Modbus Master 1** in the pop-up window, and click **Add Device** in the lower right corner.

Devices	<b>→</b> ∓ × /		
🗆 🎒 Untitled9		Add Device	×
	Copy Paste Delete Refactoring Properties Add Object Add Folder Add Device Update Device Edit Object Edit IO mapping Impact mapping (S)	Add Device  Name Modbus_Master1_1  Action Action Append device Insert device Plug  String for a fullext search  Name Vence  analog 10 Module  Analog 10 Mod	device     Update device       Vendor     call vendors>       dor     Version       Description     ftme Modbus Master 1 Device       1.0.0.0     Description of the Modbus Master 2 Device       1.0.0.0     Modbus Device1       1.0.0.0     Modbus Device2       (for experts only)     Display outdated versions
Modbus_TCP_	Export mappings from CSV Export mappings to CSV Online Config Mode Reset Origin Device [Device] Simulation	Categories: Version: 1.0.0.0 Order Number: - Append selected device as last child of Device (You can select another target node in the	e navigetor while this window is open.) Add Device Close

Figure 5-11 Adding a Modbus RTU Master

Open the Modbus master configuration window, as shown in the figure below.

**Note:** Normal communication is possible only when the Modbus master and slave communication parameters are consistent.



Modbus master settings					
Modbus broadcast settings	Serial port setting	gs	Modbus maste	er settings	1
PCI-Bus IEC Objects	Baudrate	19200	✓ Frame inter	val(ms)	3
internal Parameters	Parity bit	EVEN	$\sim$		3~200
Status	Data bit	8	$\checkmark$		
Information	Stop bit	1	~		

Table 5-8 Description of Modbus Master Parameter Settings

Parameter	Description					
Baud rate	Communication rate: 2400, 4800, 9600, 19200, 38400, 57600, 115200					
Check bit	Communication frame check mode: None Parity, Odd Parity, Even Parity					
Data bit	The actual data bits contained in the communication frame					
Stop bit	Identify the last bit of a single packet during communication					
Frame interval	The time interval between the master receiving the last response data frame					
(ms)	and the next request data frame					

# 5.2.2 Modbus RTU Master Communication Configuration

#### Adding a Modbus Slave

When the PLC is used as a Modbus master, right-click **Modbus Master 1** in the left device tree, select **Add Device**, and then **Dedicated Device** > **Modbus RTU Protocol** > **Modbus RTU Slave1** in the pop-up window, and click **Add Device** in the lower right corner.

#### Figure 5-13 Adding a Modbus RTU Slave When the Port Is Used as a Master

 Modbus_TCP_Maste Modbus_TCP_SI Modbus_TCP_Slave_ Modbus_Master 1 (M SoftMotion General /	r1 (Mo ave1 ( Devic	dbus TCP Master 1) Modbus TCP Slave 1) e1 (Modbus TCP Slave Device 1) Montest		Add Device Name Modbus Slave 1					×
		Paste		Action					
	$\sim$	Refactoring	•	Append device Insert de     String for a fulltext search	vice O Plug	device O	Vpdate device <all vendors=""></all>		~
	ħ	Properties		Name	Vendor	Version	Description		
	12. 1 0.0 2 0.0	Add Object		Modbus Slave 1	INVT	1.0.0.0	Description of the Modbus Slave	1	
	$\bigcirc$	Add Folder		Modbus Slave2	INVT	1.0.0.0	Description of the Modbus Slave:	1	
		Add Device							
		Disable Device		Group by category Displ	ay all versions	(for experts	only) Display outdated ver	ions	
		Update Device		Vendor: INVT					
	ſ	Edit Object		Categories: Version: 1.0.0.0				Ż	
		Edit IO mapping		Description: Description	of the Modbus	Slave1			
		Import mappings from CS	SV	Append selected device as las	st child of				-
		Export mappings to CSV		Modbus_Master1 (You can select another tar	get node in th	e navigator	while this window is open.)		
	₽	Visual Element Repository					Add Devi	ce C	lose

#### Setting the Modbus Slave

Double-click the slave device in the device tree to open the Modbus slave configuration window as shown in the figure below.

#### Figure 5-14 Modbus RTU Slave Settings When the Port Is Used as a Master

Devices 🗸 🕈 🗙	Modbus_Slave1 🗙		
□ 1 Untitled9	Modbus slave settings		
🗋 Auto scan 🔍 Fault diagnosis summary	Modbus communication settings	Modbus slave settings	
⊟ · ÈI PLC Logic	Fault diagnosis	Station number	1
Application     Variable usage	PCI-Bus IEC Objects	Timeout(ms)	1000
TM75x-HSIO (TM75x-HSIO)	Internal Parameters		(100~65535)
ExtCard (ModuleScan)	Status	Slave enable variable(SM)	1001
EtherCAT_Master (EtherCAT Master SoftMotion)     Modbus_TCP_Master 1 (Modbus TCP Master 1)	Information		(0 1999)
Modbus_TCP_Slave_Device 1 (Modbus TCP Slave Device 1)			
Modbus_Slave1 (Modbus Slave1)			

Table 5-9 Description of Modbus RTU Slave Parameter Settings When the Port Is Used as a Master

Variable	Function
Node number	The number to identify the salve, ranging from 1 to 247

Variable	Function
	After the master sends a frame, if the slave does not respond within the
nimeout period (ms)	time period, the master reports a receive timeout.
Clause angelie (CM)	After programming and enabling this variable, the master starts to send
Slave enable (SM)	communication frames to the slave.

#### Modbus master to Modbus slave communication settings

Switch to the Modbus slave communication settings window and add a Modbus slave communication configuration. The configuration table supports up to 60 configurations.

Each channel represents an independent Modbus request, where the first line defines a request to execute the action of writing a single register cyclically (function code 0x06), i.e. writing one word of data to a register at an offset of 0x2000.

Figure 5-15 Modbus Slave Communication Settings When the Port Is Used as a Master

modbus_RTU_Slave2 X													
Modbus slave settings						a 1 a 7 3							
nouses share seeings	▲_	Name	Function code	Enable type	Enable Variab	Circle time(ms)	ReadAddress	ReadLength	Error handling	WriteAddress	writeLen	Retry times	Comment
Modbus communication settings	0	Channel 00	(0x03) Read ho	Loop execute		200	(0×0000) 0	10	Keep last value			1	
-													
Fault diagnosis													
PCI-Bus IEC Objects													
Internal Parameters													
Internal I/O Mapping													
Status													
Information													
										ADD	Delete	Edit	Εχροπ

- Add: Click **Add** to open the dialog box for adding a new channel for the Modbus slave. Click **OK** to create a new channel.
- Edit: Select a channel in the Modbus slave channel list and click **Edit** to open the dialog box for changing the channel configuration by modifying the parameters in it, and then click **OK** to update channel settings.
- Export to EXCEL: Click **Export to EXCEL** to export channel parameters to an EXCEL table in batches, and then click **Import** to import channel parameters into the settings in batches.

When adding or editing a channel, you will see the following pop-up dialog box:

Figure 5-16 Dialog Box for Modbus Slave Communication Settings When the Port Is Used as a Master

Dase Conrig							
Name	Channel 00						
Function code	(OxO3) Read holding registers						
Enable type	Loop execute			~			
Circle time(ms)	200	🜩 Enable varia	ble(SM)	*			
	(1~65535)		(0~7999)				
Retry times	1	🗧 Comment					
Read							
Address(Hex)	0	Length(WORD)	10	-			
	(0~0xFFFF)		(1~125)				
Error handling	Keep last value			$\sim$			
Write							
Address(Hex)	0	Length(WORD)	1	* *			

#### Table 5-10 Description of Modbus Communication Parameter Settings

Parar	neter	Description					
Na	me	A string that names the channel					
		Read coils (function code 0x01)					
		Read input coils (function code 0x02)					
		Read holding registers (function code 0x03)					
Function code		Read input registers (function code 0x04)					
Functio	on code	Write single coil (function code 0x05)					
		Write single register (function code 0x06)					
		Nrite multiple coils (function code 0x15)					
		Write multiple registers (function code 0x16)					
		Cyclic: requests triggered cyclically					
		Cycle time: time for execution again					
Enabl	e type	Level trigger: triggered when programming changes					
		Trigger variable (SM): SM element triggered. After triggered successfully, the					
		element will be automatically reset.					
Dotro	times	If a communication failure occurs and no slave return frame is obtained,					
Reliy	umes	resending is performed according to the retry times.					
Com	ment	A short text area that describes the data					
	Starting address	The starting position of the register read					
Read	Length	Number of registers read					
register	Error	Keep the last value: Keep the data at the last valid value					
	processing	Set to 0: Set all values to zero					
141-11-	Starting	The standard states of the second states with a second state of the second states of the seco					
write	address	The starting position of the register written					
register	Length	The length of the register written					

#### Internal I/O Mapping of Modbus Slave

After adding the master-slave communication configuration to the Modbus slave communication settings, the mapping address of each configuration will be automatically assigned in the internal I/O mapping. For example, %QW1 in the first line of the figure below means that the read coil value is mapped to the address %QW1. In addition, you can also map custom variables in the program to I/O addresses by using the Input Assistant or by directly entering the example variable path.

Figure 5-17 Internal I/O Mapping of Modbus Slave When the Port Is Used as a Master

Modbus slave settings	Find	Filte	r Show all		- d Ad	dd FB fo	or IO Channel → Go to Ii
Modbus communication settings	Variable	Mapping	Channel Channel 00	Address %IW70	Type ARRAY [09] OF WORD	Unit	Description (0x03)读保持寄存器
ault diagnosis	i		Channel 00[0]	%IW70	WORD		READ 16#0000(=0000)
	🗈 🦘 Application.GVL.iRtu_2	۵	Channel 00[1]	%IW71	WORD		READ 16#0001(=0001)
CI-Bus IEC Objects	😐 🍫		Channel 00[2]	%IW72	WORD		READ 16#0002(=0002)
nternal Parameters	🗎 - 🦄		Channel 00[3]	%IW73	WORD		READ 16#0003(=0003)
	🔜 🗈 🖷 🦘		Channel 00[4]	%IW74	WORD		READ 16#0004(=0004)
ternal I/O Mapping	🗎 🏘		Channel 00[5]	%IW75	WORD		READ 16#0005(=0005)
	🗈 🍫		Channel 00[6]	%IW76	WORD		READ 16#0006(=0006)
atus	🗎 - 🍫		Channel 00[7]	%IW77	WORD		READ 16#0007(=0007)
formation			Channel 00[8]	%IW78	WORD		READ 16#0008(=0008)
	💼 - 🍫		Channel 00[9]	%IW79	WORD		READ 16#0009(=0009)

# 5.2.3 Modbus RTU Slave Configuration

When the PLC is used as a Modbus slave, right-click **Device** in the left device tree, select **Add Device**, and then **Dedicated Device > Modbus RTU Protocol > Modbus RTU Slave Device1** in the pop-up window, and click **Add Device** in the lower right corner.

Double-click the slave device in the device tree to open the Modbus slave configuration window as shown in the figure below.

In the Modbus slave parameter settings, the serial port configuration has the same meaning as that of the Modbus master. The node number in the Modbus slave configuration refers to the node number of this device; the frame interval refers to the delay time for response to the master after receiving the communication frame sent by the master.

Modbus slave settings					
Fault diagnosis	Serial port settings			Modbus slave settings	
PCI-Bus IEC Objects	Baudrate	19200	$\sim$	Station number	1
Internal Parameters	Parity bit	EVEN	$\sim$		1~247
Status				Frame interval(ms)	3
Information	Data bit	8	~		3~200
	Stop bit	1	$\sim$		

Figure 5-18 Configuration When Modbus RTU Is Used as a Slave

**Note:** Normal communication is possible only when the Modbus master and slave communication parameters are consistent.

The Modbus\_RTU\_Slave defines storage areas accessible by external devices, which are shown in the following table.

RTU Master Function Code	Address name	Range	Offset from Standard Modbus Address
0x01	%QX		
0x05/0x15	%QX		
0x02	%IX	0 05525	Nana
0x04	%IW	0-65535	None
0x03	%MW		
0x06/0x16	%MW		

#### Table 5-11 Modbus\_RTU\_Slave Function Codes

# 5.2.4 Modbus RTU Device Diagnosis

Modbus RTU Slave2 ¥

The Modbus master device diagnosis interface displays slaves and communication parameters with errors.

Modbus slave settings					
-		Serial No	Error code	Error name	Solution
Modbus communication settings	۶.	1	Er0041-0005	Communication Timeout, communication time ex	Check if the serial port connection is working pr
Fault diagnosis					
PCI-Bus IEC Objects					
Internal Parameters					
Internal I/O Mapping					
Status					
Information					

Figure 5-19 Modbus Master Device Diagnosis

# 5.2.5 Common Faults of Modbus RTU

The main faults that occur when the Modbus master is connected to the slave are as follows:

- The configurations of the Modbus master and slave are inconsistent, resulting in the inability to establish communication between the master and the slave.
- The Modbus master accesses an illegal address of the Modbus slave and an error response is returned.
- The Modbus master operates the Modbus slave to write a register, but the Modbus slave only supports read actions on this register. The Modbus master will receive an error response returned by the Modbus slave.

Error response frame format: slave address + (instruction code + 0x80) + error code + CRC check.

**∠Note:** This error frame applies to all operation instruction frames.

Number	Data (Byte) Meaning	Number of Bytes	Description
1	Slave address	1 byte	Value range: 1–247
2	Instruction code + 0x80	1 byte	Error instruction code
3	Error code	1 byte	1–4

Table 5-12 Description of Modbus Error Response Frames

# 5.3 EtherCAT Master

EtherCAT (Ethernet for Control Automation Technology) is an open-architecture, Ethernet-based fieldbus system. Compared with other fieldbuses, EtherCAT has the characteristics of good performance, high device synchronization accuracy, flexible topology, easy application, and low cost. Currently, more and more devices use the EtherCAT bus for communication.

# 5.3.1 EtherCAT Master Configuration

#### 5.3.1.1 Adding a Device Profile

INVT EtherCAT slave devices have been pre-added in Invtmatic Studio. If you use an INVT product, you can skip this step directly. When using an EtherCAT slave without a device profile added to the software, you need to add the corresponding profile to the software. The operation steps are as follows:

Step 1 Open Invtmatic Studio and select **Tools > Device Repository** in the Toolbar.



Figure 5-20 Selecting a Device Repository



Figure 5-21 Installing the Device Repository

	System Repositor	у			$\sim$	Edit Locations
	(D:\Program Files	s\Invtmatic S	tudio\Invtma	ticStudioRepository\Devi	ces)	
stalled d	evice descriptions					
String for	a fulltext search		Vendor:	<all vendors=""></all>	~	Install
Name		Vendor	Version	Description		Uninstall
🖭 🖬 M	fiscellaneous					Export
🖻 🔟 F	ieldbuses					
⊞ - 📶 F ⊞ - 🔜 H	ieldbuses MI devices					
⊞ 🚹 F ⊞ 🚮 H ⊞ 🚮 P	ieldbuses IMI devices LCs					
≌ ∰ F ⊪ 🚰 H ⊞ 🚰 P ⊞ 🔗 S	ieldbuses IMI devices LCs oftMotion drives					
È - ∭ F ₽ H ₽ H ₽	ieldbuses IMI devices LCs oftMotion drives					
●	ieldbuses IMI devices LCs oftMotion drives					
● ● ● ● S	ieldbuses IMI devices LCS oftMotion drives					
₩- ∰ F ₩- ₩ H ₩- ∯ P ₩- Ø S	ieldbuses IMI devices LCs oftMotion drives					Details

Step 3 In the pop-up window, find the path where the device profile is stored.

**Note:** Here, select EtherCAT XML device profile as the file type. If you select other file types, you will not be able to select the XML file normally. After finding the corresponding XML, click **Open**.

				De 🕶 🗾 (
Name	Date modified	Туре	Size	
1005.xml 1002.00 WherCAT_V261_191025.xml	10/25/2019 6:44 PM	XML File	234 KB	
INVT_DA200_EtherCAT_V262_200313.xml	3/13/2020 2:50 PM	XML File	238 KB	
1NVT_DA200_EtherCAT_V265_220120.xml	1/20/2022 6:48 PM	XML File	232 KB	
V INVT_DA260_EtherCAT_V265_220120.xml	2/17/2022 11:04 AM	XML File	232 KB	
V INVT_EtherCAT_110.xml	6/19/2017 11:54 AM	XML File	95 KB	
V INVT_EtherCAT_171.xml	9/4/2018 5:31 PM	XML File	231 KB	
				Sercos XML device description :
				Open Cancel

Figure 5-22 Selecting Device Profile Path and Type

Step 4 After opening the file, the software will automatically import the device. At this time, you can observe the information output box and confirm that the installation is complete. Then, Click **Close**.

Figure 5-23 Importing the Device Profile into the Device

(D:\Program Files\Invtmatic Studio\InvtmaticStudioRepository\Devices)         Installed device descriptions         String for a fulltest search       Vendor:         Name       Vendor:         Vendor:       Vendor:         Vendor: </th <th>cation</th> <th>System Repository</th> <th></th> <th>v</th> <th>Edit Locations</th>	cation	System Repository		v	Edit Locations
stalled device descriptions String for a fulltext search Vendor All vendors> Vendor Ver  Name Vendor Ver  Vendor Ver  Vendor Ver  Ver  Ver  Ver  Ver  Ver  Ver  Ver		(D:\Program Files\Invtmatic	Studio\InvtmaticStudioRepositor	ny\Devices)	
Imm Vendor     Name Vendor     Vendor Ver     Ur     Imm     Vendor     Vendor     Ver     Vendor     Ver     Ver <td>stalled d</td> <td>evice descriptions</td> <td></td> <td></td> <td></td>	stalled d	evice descriptions			
Name     Vendor     Ver       Image: Festo     Image: Festo       Image: Festo <td>tring for</td> <td>a fulltext search</td> <td>Vendor: <all vendors=""></all></td> <td>~ ~</td> <td>Install</td>	tring for	a fulltext search	Vendor: <all vendors=""></all>	~ ~	Install
	Name			Vendor Ver ^	Uninstall
		😟 🧰 Festo			Export.
		🖲 🚞 Hitachi Industrial Equ	uipment Systems Co.,Ltd.		
		🖲 🚞 ifm electronic - ifm el	lectronic EtherCAT Devices		
Evidence The Stop UNT_DA200_Ether CAT_V265_22010.xml      C:\\Sees \Administrator \Pesktop \UNT_DA200_Ether CAT_V265_22010.xml       C:\\Sees \Administrator \Pesktop \UNT_DA200_Ether CAT_V265_22010.xml       C:\\Sees \Administrator \Pesktop \UNT_DA200_Ether CAT_V265_22010.xml       C:\\Sees \Administrator \Pesktop \UNT_DA200_Ether CAT_V265_22010.xml       C:\\Sees \Administrator \Pesktop \UNT_DA200_Ether CAT_V265_22010.xml       C:\\Sees \Administrator \Pesktop \UNT_DA200_Ether CAT_V265_22010.xml       C:\\Sees \Administrator \Pesktop \UNT_DA200_Ether CAT_V265_22010.xml       C:\\Sees \Administrator \Pesktop \UNT_DA200_Ether CAT_V265_22010.xml       C:\\Sees \Administrator \Pesktop \UNT_DA200_Ether CAT_V265_X2010.xml        C:\\Sees \Administrator \Pesktop \UNT_DA200_		🗉 🚞 Inovance			
		🖲 🧰 INVT			
Servo Drives     DA200-N EtherCAT(CoE) Drive V265     INVT INDUSTRIAL     Rev     Da20-N EtherCAT(CoE) Drive V265     INVT INDUSTRIAL     Rev     De		😑 🚞 INVT INDUSTRIAL			
C:\Users\Udministrator\Desktop\UNIT_DA200_EtherCAT_V265_22010.xml      C:\Users\Udministrator\UNIT_DA200_EtherCAT_V265_22010.xml      C:\Users\Udministrator\UNIT_DA200_EtherCAT_V265_22010.xml      C:\Users\Udministrator\UNIT_DA200_EtherCAT_V265_22010.xml      C:\Users\Udministrator\UNIT_DA200_EtherCAT_V265_22010.xml      C:\Users\Udministrator\UNIT_DA200_EtherCAT_V265_22010.xml      C:\Users\Udministrator\UNIT_DA200_EtherCAT_V265_V265_V265_V265_V265_V265_V265_V265		🖹 🚞 Servo Drives			
C C:\Users\Administrator\Decktop\UNIT_DA200_EtherCAT(V265_220120.xml C D D D C:\Users\Administrator\Decktop\UNIT_DA200_EtherCAT(V265_220120.xml C D D C:\Users\Administrator\Decktop\UNIT_DA200_EtherCAT(V265_UCINIC C D D D C:\Users\Administrator\Decktop\UNIT_DA200_EtherCAT(V265_UCINIC C D D D C:\Users\Administrator\Decktop\UNIT_DA200_EtherCAT(V265_UCINIC C D D C:\Users\Administrator\Decktop\UNIT_DA200_EtherCAT(V265_UCINIC C D D C:\Users\Administrator\Decktop\UNIT_DA200_EtherCAT(V265_UCINIC C D D C:\Users\Administrator\Decktop\UNIT_DA200_EtherCAT(V265_UCINIC C D C:\Users\Administrator\Decktop\UNIT_D C D C:\Users\Administrator\Decktop\UNIT_D C:\Users\Administra		- 🔟 DA200-N Et	herCAT(CoE) Drive V265	INVT INDUSTRIAL Revi	
C: VJsers VAdministrator (265) Installed to device construct		🚹 DA260-N Et	herCAT(CoE) Drive V265	INVT INDUSTRIAL Revi	
C:\Users\Administrator\Desktop\UNT_DA200_EtherCAT_V265_220120.xml      C:\Users\Administrator\Desktop\UNT_DA200_EtherCAT_V265_220120.xml		🗄 🚞 KEB Automation KG ·	- C6 PRO/ADVANCED drive controlle	ers	Details
		🖲 🚞 Nanjing Solidot Elect	ronic Technology Co., Ltd		
Parker Hannin     Parker Hannin     Citylerer Mannistrator/Desktop/UNT_DA200_EtherCAT_V265_220120.xml     Davies TA200A/EtherCAT_C2E) Drive V265"installed to device reporting		🗷 🚞 Panasonic Corporati	on, Appliances Company - AC Servo	o Driver	
		🖲 📄 Parker Hannifin			
C:\Users\Administrator\Desktop\UNYT_DA200_EtherCAT_V265_220120.xml  D Davies T0.200.ALEtherCAT_CCE\Drive V265"installed to device reporting:		🖲 🚞 Schneider Electric		· · · · · · · · · · · · · · · · · · ·	
C:\Users\Administrator\Desktop\UNYT_DA200_EtherCAT_V265_220120.xml				>	
• bevice bizzo in Edicion (cost) bine vzos instalica to device repository.	- 0 c	Users\Administrator\Desktop\ Device "DA200-N EtherCAT(	INVT_DA200_EtherCAT_V265_2201 CoE) Drive V265" installed to device	120.xml e repository.	

#### 5.3.1.2 Slave Configuration

In the Invtmatic Studio software, you can configure the EtherCAT slave through two methods: automatic scanning and manual addition. For detailed operation steps, see section 2.3 Examples of Program Writing and Debugging. When adding an EtherCAT slave by automatic scanning, you must first ensure that the slave device hardware used in the project is correctly connected to the PLC. Only when normal communication is possible can the PLC scan the EtherCAT slave device.

#### 5.3.1.3 Master Settings

You can set the EtherCAT master parameters on the EtherCAT Master Settings interface. As shown in Figure 5-24, you need to set the cycle and synchronization offset of the distributed clock.

- Cycle: The interval for sending EtherCAT data frames, which must be the same as the cycle time of the EtherCAT task.
- Synchronization offset: The percentage of the relative offset of the EtherCAT task relative to the Sync0 interrupt of the slave, which is 20% by default, and cannot be modified generally.

General	Autoconfig Master/Slave	Autoconfig Master/Slaves			
Function Code	EtherCAT NIC Setting —				
Sync Unit Assignment	Destination address (MAC)	FF-FF-FF-FF-FF-FF	🕑 Broadcast 🛛 Enable redundancy		
Log	Source address (MAC)	00-00-00-00-00	Browse		
	Network Name	ETH0			
EtherCAT I/O Mapping	Select network by MAC	<ul> <li>Select net</li> </ul>	work by name		
EtherCAT IEC Objects	Jistributed Clock		- A Options		
Status	Cycle time 4000	↓ µs	Use LRW instead of LWR/LRD		
	Sync offset 20	\$ %	Enable messages pertask		
Information	Sync window monitoring		Automatic restart slaves		
	Sync window 1	≜ us			

Figure 5-24 Setting Master Cycle and Synchronization Offset

Devices 👻 🕂 🗙	Counter0 😵 MainTask	Modbus_TCP_Slave_1 EtherCAT_Master_SoftMotion X
Contend of the second sec	General Function Code Sync Unit Assignment Log EtherCAT I/O Mapping EtherCAT IEC Objects Ratus Information	Bus cycle task EtherCAT_Task
1		

In the DC mode of EtherCAT communication, after parsing the data transmitted by the master, the slave also needs to process the data in the DC interrupt. Since the time it takes for the master to transmit data to each slave varies, in order to ensure data synchronization, there must be enough time between the data frame and the synchronization interrupt for the slave to receive and process the data. This period of time is the offset time.

**Note:** When using it, you need to add the master name. For example, if the master name is EtherCAT\_Master\_SoftMotion, then when restarting the master, the variable that needs to be triggered is EtherCAT\_Master\_SoftMotion.xRestart. Common parameters of the EtherCAT master are listed in Table 5-13.

Variable Name	Function
xRestart	Rising edge trigger, restarted after being triggered
EtherCAT	Master
xConfigFinished	Master configuration completed
xDistributedClockInSync	EtherCAT distributed clock synchronization
xError	Error in the EtherCAT master

#### Table 5-13 Common Parameters of EtherCAT Master

# 5.3.2 EtherCAT Slave Configuration

#### 5.3.2.1 General Settings

#### EtherCAT address

The configuration address of the EtherCAT slave refers to the sequential address of the slave device in the Invtmatic Studio device tree, starting from 1001 and increasing in sequence, as shown in Figure 5-25. You can find the EtherCAT address of the slave on the Slave Settings interface. This address will be used when the SDO read/write function block is called, as shown in Figure 5-26.

INVT_DA200_265 X						
General	Address	Additional				
Servo Function Code	AutoInc address EtherCAT address	0		< Enable e: 🗌 Optional	xpert settings	Ether <b>CAT</b>
Expert Process Data	▲ Distributed Clock					
Process Data	Select DC	DC for synd	hronization		$\sim$	
Startup Parameters	🖂 Enable	4000	Sync uni	t cycle (µs)		
EtherCAT I/O Mapping	Sync0: Sync0 Enable Sync 0					
EtherCAT IEC Objects	Sync unit cycle	x 1	$\sim$	4000	Cycle time (µs	)
Status	O User-defined			0	Shift time (µs)	)
Information	Sync1:					
	Sync unit cycle	x 1	$\sim$	4000 🔹	Cycle time (µs	)
	User-defined			0	Shift time (µs)	)

Figure 5-25 EtherCAT Slave Address



Figure 5-26 SDO Read Function Block

#### Distributed clock

This option is used to set the synchronous running mode of the slave. There are three synchronization modes: freewheeling (FreeRun), synchronization with an input/output event (SM-Synchron), and synchronization with a distributed clock (DC-Synchron).

The options supported by the synchronization mode will vary with the selected slave. Generally, you do not need to modify this option, as long as the synchronization unit cycle in DC-Synchron mode is consistent with the EtherCAT task cycle, as shown in the figure below.

General	Address	Additional				
Servo Function Code	AutoInc address	0	*	🔽 Enable e:	opert settings	EtherCAT.
	EtherCAT address	1001	*	Optional		
Expert Process Data	Distributed Clock					
Process Data	Select DC	DC for synch	ronization	I	$\sim$	
Startup Parameters	🕑 Enable	4000	Sync uni	it cycle (μs)		
EtherCAT I/O Mapping	Sync0: Enable Sync 0					
EtherCAT IEC Objects	<ul> <li>Sync unit cycle</li> </ul>	x 1	$\sim$	4000	Cycle time (µ	s)
Status	◯ User-defined			0	Shift time (µs	)
Information	Sync1:					

Figure 5-27 Distributed Clock Parameters

#### Node alias

When EtherCAT addresses are used, if the actual device connection order is inconsistent with the configuration order, the bus will not operate normally. If you hope that the actual slave connection order
will not be affected by the configuration order, you can use the alias function to rename the servo. During the connection process, the servo is no longer identified by the automatically assigned node address, but by the name. To use the node alias function correctly, you need to set the node alias of the slave first. The operation steps are as follows:

Step 1 Set the alias address after scanning the relevant device.

n Devices			
canned Devices			
Device name	Device type	Alias Address	
INVT_DA200_F66	DA200-N EtherCAT(CoE) Drive V1266	11 1	
		Instructio Studio	
			~
		After writing the EEprom al	ias address a reboot of the device
		After writing the EEprom al is necessary. Please switch	ias address a reboot of the device off and on again.
		After writing the EEprom al is necessary. Please switch o	ias address a reboot of the device off and on again.
		After writing the EEprom al is necessary. Please switch o	ias address a reboot of the device off and on again.
		After writing the EEprom al is necessary. Please switch r	ias address a reboot of the device off and on again.
		After writing the EEprom al	ias address a reboot of the device off and on again. 3 OK
		After writing the EEprom al	ias address a reboot of the device off and on again. 3 OK
		After writing the EEprom al is necessary. Please switch r	ias address a reboot of the device off and on again. 3 OK
Assign Address	2	After writing the EEprom al is necessary. Please switch i	ias address a reboot of the device off and on again. <u>3</u> OK Show differences to project

Figure 5-28 Setting a Node Alias

Step 2 After the assignment is completed, Power off and restart the servo to activate it. Perform scanning again. At this time, the alias address has been written.

Figure 5-29 Restart to Activate the Node Alias

in Devices			— 🗆 🗆
Scanned Devices			
Device name	Device type	Alias Address	
INVT_DA300_101	DA300-N EtherCAT(CoE) Drive	11	
Assign Address			Droject
an Device			Copy All Devices to Projec Close

Step 3 Double-click the EtherCAT slave device INVT\_DA200\_265 in the device tree, check Enable Expert Settings and select Configured Node Alias in the Identification options, and fill in the correct alias address, as shown in the figure below. Then, restart the controller.

General	Address		Additional –		The second
Servo Function Code	AutoInc address	0	Enable ex	pert settings	EtherCAT.
Expert Process Data	EtherCAT address	1001	Optional		
December Decks	Distributed Clock				
Process Data	Select DC	DC for synchronization	l .	$\sim$	
Startup Parameters	Enable	4000 Sync un	it cycle (µs)		
Online	Sync0: Enable Sync 0				
CoE Online	Sync unit cycle	x 1 ~	4000	Cycle time (µs)	
EtherCAT I/O Mapping	O User-defined		0	Shift time (µs)	
EtherCAT IEC Objects	Sync1: Enable Sync 1				
Status	Sync unit cycle	x 1 ~	4000	Cycle time (µs)	
Information	O User-defined		0	Shift time (µs)	
	Diagnostics Current State ‡	操作			
	> Startup Checking		> Timeouts		
	DC Cyclic Unit Cont	trol: Assign to Local	JC		
	Vatchdog				
	Identification				
	Configured station a	lias (ADO 0x0012)	Value	11	-
	Write to EEprom		Actual address	11	
	<ul> <li>Explicit device identition</li> </ul>	fication (ADO 0x0134)			
	🔵 Data Word (2 Bytes)		ADO (hex)	16;	#12 <b>*</b>

Figure 5-30 Filling in the Node Alias

#### 5.3.2.2 Process Data Object (PDO)

After the slave enables expert settings, an expert process data interface will be added. The interface will display the input and output PDOs that come with the slave profile. You can add and delete them as needed, such asFigure 5-31 Output PDO (usually control word and given parameters), such as the Input PDO in Figure 5-32 (usually status word and feedback parameters). In the EtherCAT I/O mapping interface, you can map the corresponding variables and call them in the program, as shown in Figure 5-33.

INVT_DA200_265 ×									
General	Sync Manager	🕂 Add 📝 Edit 🗙 Delete							
Servo Function Code	SM Size Type 0 0 Mailbox Out	PD0 List Index Size	e Name	Fla SM					
Expert Process Data	1 0 Mailbox In	16#1600 19.0 16#1A00 23.0	0 D0 Outputs	2					
Process Data	3 23 Inputs								
Startup Parameters									
EtherCAT I/O Mapping									
EtherCAT IEC Objects									
Status									
Information									
	PDO Assignment (16#1C12):	🕂 Insert 📝 Edit 🗙	Delete 🏦 Move Up 🖶 Move Down						
	IC# 10#1000	PDU Content (16#1600	o):	-					
		16#6040:00	2.0 0.0 Control Word	lype					
		16#607A:00	4.0 2.0 Target Position	DINT					
		16#60FF:00	4.0 6.0 Target Velocity	DINT					
		16#6060:00	1.0 10.0 Mode of Operation	SINT					
		16#6071:00	2.0 11.0 Target torque	INT					
		16#60B8:00	2.0 13.0 Touch probe control	UINT					
		16#607F:00	4.0 15.0 Max profile velocity	UDINT					
			19.0						

Figure 5-31 Output PDO

#### Figure 5-32 Input PDO

General	Sync Manager	🕂 Add 📝 Edit 🔀 Delete
Carrie Constitue Conda	SM Size Type	PDO List
Servo Function Code	0 0 Mailbox Out	Index Size Name Fla SM
xpert Process Data	1 0 Mailbox In	16#1600 19.0 DO Outputs 2
	2 19 Outputs	16#1A00 23.0 DI Inputs 3
rocess Data	3 23 Inputs	
Startup Parameters		
therCAT I/O Mapping		
therCAT IEC Objects		
tatus		
nformation		
	PD0 Assignment (16#1C13):	
	PDO Assignment (16#1C13): V 16#1A00	
	PDO Assignment (15#1C13):	Insert         Image: Content (16#1600):           Index         Size         Offs         Name         Ty           16#6040:00         2.0         0.0         Control Word         UII           15#6047:00         4.0         2.0         Target Velocity         DIN           16#60FF:00         4.0         6.0         Target Velocity         DIN
	PDO Assignment (16#1C13): ☑ 16#1A00	Insert         Edit         > Delete         № Move Up         ♦ Move Down           PD0 Content (16#1600):         Index         Size         Offs         Name         Ty           16#6040:00         2.0         0.0         Control Word         UII           16#6040:00         2.0         0.0         Control Word         UII           16#607A:00         4.0         2.0         Target Position         DIII           16#60FF:00         4.0         6.0         Target Velocity         DIII           16#6060:00         1.0         10.0         Mode of Operation         SIN
	PDO Assignment (16#1C13):	Insert         Zefit         ∑ Delete         Move Up         Move Down           PDO Content (16#1600):         Index         Size         Offs         Name         Ty           Index         Size         Offs         Name         Ty           I5#6040:00         2.0         0.0         Control Word         UII           15#6074:00         4.0         2.0         Target Position         DII           15#6070:00         1.0         10.0         Mode of Operation         SIN           15#6071:00         2.0         11.0         Target torque         INT
	PDO Assignment (16#1C13):	Insert         Edit         Delete         Move Up         Move Down           PDO Content (16#1600):         Index         Size         Offs         Name         Ty           15#5040:00         2.0         0.0         Control Word         UII           15#5074:00         4.0         2.0         Type Position         DII           15#5076:00         1.0         10.0         Mode of Operation         DIII           15#5070:00         2.0         11.0         Target torque         INII           15#5071:00         2.0         11.0         Target torque         INII           15#5081:00         2.0         13.0         Touch probe control         UII
	PDO Assignment (16#1C13): 16#1A00	Insert         Edit         > Delete         > Move Up         > Move Down           PD0 Content (16#1600):         Index         Size         Offs         Name         Ty           16#6040:00         2.0         0.0         Control Word         UP           16#607A:00         4.0         2.0         Target Position         DIN           16#607F:00         4.0         6.0         Target Velocity         DIN           16#607D:00         2.0         11.0         Target torque         INN           16#6080:00         2.0         13.0         Touth probe control         UN           16#607F:00         4.0         15.0         Max profile velocity         UD

#### Figure 5-33 EtherCAT I/O Mapping

General	Find	Find Filter Show all							
anyo Eurotion Code	Variable	Mapping	Channel	Address	Туре	Unit	Description		
			Control Word	%QW2	UINT		Control Word		
opert Process Data			Target Position	%QD2	DINT		Target Position		
			Target Velocity	%QD3	DINT		Target Velocity		
ocess Data			Mode of Operation	%QB16	SINT		Mode of Operation		
Startup Parameters	💼 🍫		Target torque	%QW9	INT		Target torque		
	• • • • • • • • • • • • • • • • •		Touch probe control	%QW10	UINT		Touch probe control		
herCAT I/O Mapping	🗎 <b>*</b> ø		Max profile velocity	%QD6	UDINT		Max profile velocity		
	😟		Status Word	%IW4	UINT		Status Word		
herCAT IEC Objects	🗄 🦄 Application.diActposition	~	Position Actual Value	%ID3	DINT		Position Actual Value		
atus	🗐 🗉 🧤		Speed Actual Value	%ID4	DINT		Speed Actual Value		
	🖷 - 🏘		Torque Actual Value	%IW10	INT		Torque Actual Value		
formation			Operation Mode Display	%IB22	SINT		Operation Mode Display		
	- No.		Touch Probe Status	%IW12	UINT		Touch Probe Status		
	1		Touch Probe 1 Positive value	%ID7	DINT		Touch Probe 1 Positive value		
	💼 - 🍫		Digital inputs	%ID8	UDINT		Digital inputs		

#### 5.3.2.3 Startup Parameters

Some startup parameters can be written to the slave by the SDO write function when the slave is in the PreOP state, as shown in the figure below.

#### Figure 5-34 Startup Parameters

eneral	🕂 Add	🖉 Edit 🗙 Delete 🔞	🗈 Move Up 🐥 Move Down						
ervo Function Code	Line	Index:Subindex	Name	Value	Bit Length	Abort on Error	Jump to Line on Err	Next Line	Commer
Servo Function Code	A0	16#6098:16#00	Homing method	1	8			0	
xpert Process Data	- 2	16#6099:16#01	Speed during search for switch	100000	32			0	
	- 3	16#609A:16#00	Homing acceleration	1000000	32			0	
ocess Data	- 4	16#6099:16#02	Speed during search for zero	20000	32			0	

In actual use, you can add startup parameters as needed. Taking DA200 servo drive as an example, if you need to change the homing method to 35 at startup, follow the steps blow:

- Step 1 Click Add on the Startup Parameters interface, as shown in Figure 5-34.
- Step 2 In the pop-up window, find the object dictionary 16#6098, namely the homing method, as shown in Figure 5-35, set the value to 35, and then click **OK**.

	Name	Flags	Туре
16#6091:16#0	0 Gear ratio		
16#6093:16#0	0 Position factor		
16#6098:16#0	0 Homing method	RW	SINT
16#6099:16#0	0 Homing speeds		
16#609A:16#0	0 Homing acceleration	RW	UDINT
16#60B0:16#0	0 Position offset	RW	DINT
16#60B1:16#0	0 Velocity offset	RW	DINT
16#60B2:16#0	0 Torque offset	RW	INT
16#60B8:16#0	0 Touch probe control	RW	UINT
16#60E0:16#0	0 Positive torque limit	RW	UINT
	0 Negtive torque limit	RW	UINT
16#60FE:16#0	0 Digital outputs		
16#60FF:16#0	0 Target Velocity	RW	DINT

Figure 5-35 Selection of the Homing Method

Step 3 Once added, the corresponding item will be displayed in the list, indicating that the startup parameter has been added successfully, as shown in Figure 5-34.

#### 5.3.2.4 CiA 402 Axis

When using the motion control function in Invtmatic Studio, you need to first add a 402 axis under the EtherCAT slave, which will be used as the control object in the program. For details on the corresponding parameter configuration of the EtherCAT master, see section 5.3.1 EtherCAT Master Configuration. Here, the EtherCAT master connected to DA200 servo drive slave is taken as an example, which is for reference only.

If you use a slave from INVT, Invtmatic Studio has already pre-processed it and will automatically add the corresponding axis when you add the slave. If you use a third-party slave, you need to manually add the 402 axis when using it, and add the library file "INVT\_DA200\_xxx.devdesc.xml" required by this module. Taking INVT\_DA200\_265 as an example, the operation steps are as follows:

#### **∠**Note:

- The highest task priority 0 is recommended for the creation of EtherCAT Master SoftMotion projects.
- It is recommended to keep the synchronization cycle and the task cycle consistent and set them ≥ 4 ms.
- To create EtherCAT Master SoftMotion, it is recommended to use separate tasks. For example, tasks such as I/O, analog input and output, and Modbus communication need to be separated from EtherCAT Master SoftMotion tasks.

Step 1 Right-click **Device** in the device tree, select **Add Device** and then **Fieldbus** > **EtherCAT** > **Maser** > **EtherCAT Master SoftMotion**.

Figure 5-36 Process of Adding the EtherCAT Motion Control Master

Add Device					×
Name EtherCAT_Master_SoftMotion					
Action					
• Append device	evice OU	Ipdate device			
String for a fulltext search	Vendor	<all vendors=""></all>			~
Name	Vendo	r		Version	De
🖻 🚞 编码器模块					
Fieldbuses					
CAN CANbus					1
Brand EtherCAT					
Broth Master					
EtherCAT Master	3S - Sm	art Software Solu	itions GmbH	3.5.15.30	Ethe
🛗 EtherCAT Master SoftMotion	3S - Sm	art Software Solu	itions GmbH	3.5.15.30	Ethe
Group by category Oisplay all versions (for a second se	or experts o	nly) 🗌 Displa	y outdated ve	rsions	
Mame: EtherCAT Master SoftMotion					
Vendor: 3S - Smart Software Solutions Gm	ЬН				
Categories: Master				3	D
Order Number:				2	<b>b</b>
Append selected device as last child of Device					
(You can select another target node in the r	navigator w	hile this window	is open.)		
		(	Add Dev	rice	Close

Step 2 Right-click **EtherCAT\_Master\_SoftMotion** and select **Add Device** to add the INVT DA200 servo drive. The operation steps are shown in the figure below.

Figure 5-37 Adding DA200 Servo Drive



Step 3 Select INVT\_DA200\_265 in the device tree, right-click and add **SoftMotion CiA 402 Axis**, and add the calling program, as shown in the figure below.

#### Figure 5-38 DA200 Servo Drive Application Example

🗎 🖨 📕 🖨 🗠 🗠 🖄 🛤 🛣 🗙 🛤 🍇	<b>#</b>	<u>a</u>   I	19	🧃 🎕   📾   ஊ - 🔓   幽   Application [Device: PLC 逻辑] → 🧐 🧐 🕨 🔳 🔏   〔目 9回 4回 4回 50   中   第   云   示	
·문화 · · · · · · · · · · · · · · · · · ·		হা ল	IC PRG	「あま SM Drive GenerichSP402 ) SoftMation nou メノ酒 EtherCAT Master SoftMation ) 商 INVT DA200 252	
Invt AXZX proi	7	1	PRO	RAM SoftMotion pou	A 100
B-fill Device (INVT AX7X)	16	2	VAR		
H BID or case		3		MC_Power: MC_Power;	= =
		4		MC_MoveRelative: MC_MoveRelative;	
Application		5		iStatus : INT :=0;	100 % 🔞 👻
一 臣 定理器		1	CAR		
PLC_PRG (PRG)		2	0:	s locates or	1
SoftMotion_pou (PRG)		3		MC Power(Axis:= SM Drive GenericDSP402, Enable:= 1, bRegulatorOn:= 1, bDriveStart:= 1,	
🖻 🧱 任务配置		4		<pre>Status=&gt; , bRegulatorRealState=&gt; , bDriveStartRealState=&gt; , Busy=&gt; , Error=&gt; , ErrorD=&gt; );</pre>	
😑 🥩 EtherCAT_Task		5			
SoftMotion pou	B	6		IF MC_Power.Status THEN	
□ S MainTask		7		iStatus := 1;	
P) n c mc		8		END_IF	
E FLC_FKG		9	1:		
a HIGH_PULSE_IO		10		MC_MoveRelative(Axis:= SM_Drive_GenericDSP402, Execute:= TRUE,	
EtherCAT_Master_SoftMotion (EtherCAT Master_SoftMotion)	as	12		Distance:= 60, Velocity:= 5, Acceleration:= 50, Deceleration:= 50, Verk:= 100,	
INVT_DA200_262 (DA200-N EtherCAT)	C	12		bole->, busy->, commandadoreet->, Errorib->,,	
SM_Drive_GenericDSP402 (SM_Dr	tiv 👝	14		TF MC NoveRelative.Done THRN	5
SoftMotion General Axis Pool	1	15		MC MoveRelative (Axis:= SM Drive GenericDSP402, Execute:= FALSE, );	
		16		iStatus := 2;	
		17		END IF	
	B	18	2:		
		19		<pre>MC_MoveRelative(Axis:= SM_Drive_GenericDSP402, Execute:= TRUE,</pre>	
		20		Distance:= -60, Velocity:= 5, Acceleration:= 50, Deceleration:= 50, Jerk:= 100,	
		21		Done=> , Busy=> , CommandAborted=> , Error=> , ErrorID=> );	
		22			
		23		IF MC_MOVERELATIVE.Done THEN	
		25		Re_ROVEREIGLIE (AAIS SR_DIIVE_GEREIGDDIEGE, EAEGUE FALDE, ); iStatus = 1:-	
		26		END TF	_
		27	END	CASE	100 % 🔞 .
	Sales	a m:	山小田		
4 III III	洞题	3-20	エルトパ増り		* 4 X
Se 25.25 🗋 pro la	- 预维	昌祥			-
	4222				
				↓ ■	0

### 5.3.2.5 Common Parameters of EtherCAT Slave

Common parameters of the EtherCAT slave are listed in Table 5-14. When using it, you need to add the slave name. For example, if the slave name is INVT\_DA200\_265, when the slave state is read, the corresponding variable is INVT\_DA200\_265.wState.

Variable Name	Function
	1: ETC_SLAVE_INIT
	2: ETC_SLAVE_PREOPERATIONAL
wState	3: ETC_SLAVE_BOOT
	4: ETC_SLAVE_SAVEOPERATIONAL
	8: ETC_SLAVE_OPERATIONAL
SlaveAddr	Slave address

Table 5-14 Common Parameters of EtherCAT Slave

### 5.3.2.6 Enabling/Disabling a Slave

In actual applications, you may encounter situations where the configuration is inconsistent with the actual hardware connection, resulting in the inability of the bus to operate normally. In view of this situation, Invtmatic Studio provides a solution that allows users to disable unconnected slaves to ensure that the bus can operate normally. When variables associated to a device are used in the program, disabling the device will prevent compilation errors.

EtherCAT Master (E	therCAT Master SoftMotion)	
	Сору	
Axis (	Paste	
	Delete	
Axis_	Refactoring +	
Modbus_TCP_	Properties	
Modbus_TCP_	Add Object	
🗐 🔟 Modbus_Masti 🗀	Add Folder	
Modbus_S	Disable Device	
ModbusDevice	Update Device	
🍐 SoftMotion Ge 📑	Edit Object	
	Edit IO mapping	
	Import mappings from CSV	
	Export mappings to CSV	fer
evices POUs Messages - Total 0 erro	Add SoftMotion CiA402 Axis Add SoftMotionLight CiA402 Axis	Ap

#### Figure 5-39 Disabling a Device

#### **∠**Note:

• Disabled devices in the device tree are displayed in light gray color, as shown in the figure below.



Figure 5-40 Device Disabled State

• When you log in to the system, the running states of disabled devices will not be displayed, as shown in the figure below.

Figure 5-41 Program Running While Disabled Devices Inactive



• When you need to re-enable the device, click "Enable Device", as shown in the figure below.

Devices	-	п	~	
Devices	•	4	<u>^</u>	
Untitled9				
🖻 📲 Device (TM753)				
🚺 Auto scan				
	ary			
PLC Logic				
Variable usage				
TM75x-HSIO (TM75x-	HSIO)			
FL1002 3200DI (FL10	002-3200DI)			
ExtCard (ModuleScan	)			
EtherCAT Master (Et	, herCAT Master SoftMotion)			
	(DA200-A) EtherCAT(CoE) D		V261	
	Сору			
	Paste			
	Delete			
Axis_1	Delete			
Modbus_TCP_M	Refactoring			+
Modbus_TC	Properties			
Modbus_TCP_S	Properties			
🖃 👚 Modbus_Master 🛅	Add Object			
🕤 Modbus_Sla 🗀	Add Folder			
ModbusDevice2	Enable Device			
SoftMotion Gen	Update Device			
- °	Edit Object			
	Edit Object			

Figure 5-42 Enabling a Device

### 5.3.3 EtherCAT Redundancy Ring Network Function

EtherCAT can use the cable redundancy technology to meet the rapidly growing system reliability requirements. This technology can ensure that devices can be replaced without shutting down the network. Adding redundancy is not expensive: Just add a standard Ethernet port (no dedicated network card or interface required) and a cable to the master device to transform the linear topology into a ring topology. When a device or cable fails, switching can be completed in just one cycle. Therefore, even for applications with motion control requirements, there will be no problems in the event of a cable failure.

EtherCAT uses hot backup to support master redundancy. Once an outage, device failure, or other issues occur, the EtherCAT slave controller can automatically return Ethernet frames immediately, so the entire network will not be shut down. For example, the standard EtherCAT topology is shown in Figure 5-43 a). If

there is a network interruption between Slave 2 and Slave N-2 in this topology, as indicated by the red part in the figure, the communication of all slaves after Slave N-2 will also be interrupted accordingly, which is also a disadvantage of the standard topology.



Figure 5-43 EtherCAT Redundancy

Figure 5-43 b) shows the topology of EtherCAT in redundancy mode. The master only needs two standard network ports to implement this topology. Using these two network ports, all slaves can form a loop. Even if the network is interrupted during use, as indicated by the red part in Figure 5-43, the master will immediately detect the error and automatically divide the communication into two paths, while the slaves can continue communication to ensure the stable operation of the system.

**Note:** According to the EtherCAT protocol standard, the first slave is the standard clock, so the failure of the first slave will affect the communication of the entire bus.

As shown in Figure 5-44, you can configure a redundancy ring network as follows:

Double-click **Slave EtherCAT\_X3** to open it, and check **Enable redundancy** to show **Redundancy EtherCAT NIC Setting** parameters. For both **EtherCAT NIC Setting** and **Redundancy EtherCAT NIC Setting**, it is recommended to check **Select network by MAC** or **Select Network by name**. The latter one is used in Invtmatic Studio by default. Click **Browse** to confirm that the corresponding EtherCAT network interface is well configured, and then check **Automatic restart slaves**.

**Note:** When the network cable between the first and second slaves is unplugged, the three slaves on the bus can still operate normally.

Devices 👻 🕂 🗙	📑 EtherCAT_Master 🗙 🗃 De	evice		
Untitled9     Vice [connected] (TM753)	General	Autoconfig Master/Slave	5	Ether CAT
- 🗋 Auto scan - 🔍, Fault diagnosis summary	Function Code	EtherCAT NIC Setting — Destination address (MAC)	FF-FF-FF-FF-FF-FF	Broadcast Seable redundancy
Wind HLC Logic     Variable usage     Sim TM75x:HSIO (TM75x:HSIO)	Log	Source address (MAC)	00-00-00-00-00 ETH0	Browse
	EtherCAT I/O Mapping	Select network by MAC	Select network	by name
C III EtherCAT_Master (EtherCAT Master SoftMotion)     O III INVT_DA300_101_1 (DA300-N EtherCAT(CoE) D     Avis (Avis)	EtherCAT IEC Objects Status	Redundancy EtherCAT NIC Destination address (MAC)	Setting	🕑 Broadcast
G → Complet (FK1100_ECT_Coupler_1.(	Information	Source address (MAC) Network Name	00-60-6E-C5-73-0B eth2	Browse
Gim Modbus_TCP_Master 1 (Modbus TCP Master 1)     Gim Modbus_TCP_Slave_Device 1 (Modbus TCP Slave Dev		Select network by MAC	Select network	by name
Modbus_Master 1 (Modbus Master 1)     G      ModbusDevice2 (ModbusDevice2)     S SoftMotion General Axis Pool		Cycle time 4000 Sync offset 20 Sync window monitoring Sync window 1	<ul> <li>μs</li> <li>φ</li> <li>μs</li> </ul>	Upuns

Figure 5-44 EtherCAT Redundancy Ring Network Configuration

### 5.3.4 Dual EtherCAT Masters

TP6214 supports dual EtherCAT masters. In Invtmatic Studio, when you select the device TP6214, you can add two EtherCAT masters and automatically assign EtherCAT network ports X3 and X2, as shown in Figure 5-45. It is generally recommended to connect the servo and 402 axis with higher real-time performance to EtherCAT\_X3, and couplers to EtherCAT\_X2.



Figure 5-45 Dual EtherCAT Master Connection Effect

**Note:** For the dual-master task configuration, it is required to set the priority of EtherCAT\_X3\_Task to the highest 0, the priority of EtherCAT\_X2\_Task to 1, and the priority of other tasks to start from 2, as shown in the figure below.



Figure 5-46 Dual-master Task Priority Configuration

### 5.4 CANopen

CANopen is a high-level communication protocol that is based on the CAN (Controller Area Network) protocol, including communication profile and device profile.

The communication model defines four types of messages (communication objects)

1. Management message

It mainly involves layer management, network management, and ID assignment services: such as initialization, configuration, and network management (including: node protection). The services conform to the LMT, NMT, and DBT services of the CAL, and uses the master-slave communication mode, which means there can only be one LMT, NMT, or DBT master node and one or more slave nodes in a CAN network.

2. Service Data Object (SDO)

By using indexes and sub-indexes (in the first few bytes of a CAN message), the SDO enables clients to access items (objects) in the device (server) object dictionary.

SDO is implemented through a multi-domain CMS object in CAL that allows the transfer of data of any length (The data will be split into several messages when it exceeds 4 bytes).

SDO communication has the service type defined: generating an answer for each message (two IDs are required for an SDO).SDO

SDO request and answer messages always contain 8 bytes (meaningless data lengths are indicated in the first byte which carries the protocol information).

3. Process Data Object (PDO)

PDO is used to transfer real-time data from a creator to one or more recipients. Data transfer is limited to 1 to 8 bytes (for example, one PDO can transfer up to 64 digital I/O values, or 4 16-bit AD values).

PDO communication has no protocol defined. PDO data content is defined only by its CAN ID, assuming that the creator and recipients know the data content of the PDO.

Each PDO is described by two objects in the object dictionary:

- A. PDO communication parameters determine which COB-ID will be used by the PDO, transmission type, prohibition time, and timer cycle.
- B. PDO mapping parameter: a list of objects in the object dictionary that are mapped to the PDO, including their data lengths (in bits). The creator and recipients must know this mapping to interpret PDO content.

PDO message content is predefined (or configured at network startup). Mapping application objects to the PDO is described in the device object dictionary. If the device (creator and recipients) supports variable PDO mappings, the PDO mapping parameters can be configured using SDO messages.

PDO can be delivered in the following modes:

A. Synchronization (by receiving SYNC objects)

Acyclic: The transmission is pre-triggered by a remote frame or by an object-specific event defined in the device profile.

Cyclic: The transmission is triggered after every 1 to 240 SYNC messages.

B. Asynchronization

The transmission is triggered by a remote frame or

by an object-specific event defined in the device profile.

- 4. Predefined messages or special function objects
  - A. SYNC
  - B. Time stamp
  - C. Emergency
  - D. Node guarding

### 5.4.1 CANopen Master Node Configuration

#### 5.4.1.1 Master Node Usage Process

The associated CANopen slave device profile must first be installed into the system. The device profile can be a \*.Devdesc.xml file or an EDS (Electronic Data Sheet) file for the manufacturer.

Install the corresponding CANopen slave device. For example, if the TM series PLC uses CANopen, you need to install the expansion module first. The operation steps are as follows:

Step 1 Double-click **ExtCard** in the device tree and enter the Settings interface. There is no device option by default.



Figure 5-47 ExtCard Expansion Card Interface

Step 2 Select **CanOpen**. Then the left device tree will automatically add **CANbus** Bus and **CANopen\_Manager**.



Figure 5-48 Selecting CANopen Extension

#### 5.4.1.2 Adding a CANopen Slave Node

Take our DA200 CANopen slave node as an example. Add DA200 slave device under CANopen Manager after adding the EDS file of this slave node, as shown in the following diagram.

File Edit View Project Build Online Debug 1 ] 🗃 💭 😂   🗠 여 ங 🏗 🗙   🎮 🎲 🐴 🌿   📕 🎾	Fools Window Help 케계 🛍 🛅 💣 A	pplication [Device: PLC Logic] 🝷 😋 🥨
evices 🗸 🗸 🛪	DA200_Drive X	
(Intitled9     (TM753)	General	General
Auto scan     Eault diagnosis summary	PDOs	Node ID 1
E I PLC Logic	SDOs	Enable expert settings
Application     Variable usage	Log	Enable SYNC producing
TM75x-HSIO (TM75x-HSIO)	CANopen I/O Mapping	Guarding     Emergency (EMCY)
Modbus_TCP_Slave_Device 1 (Modbus TCP Slave Device 1)	CANopen IEC Objects	Checks at Startup
Modbus_Master1 (Modbus Master1)	Status	
ExtCard (ModuleScan)	Information	
GANOPEN_Manager (CANopen_Manager)		
DA200_Drive (DA200 Drive)		

Figure 5-49 Device Tree Structure with a CANopen Slave

At this time, the software configuration of the CANopen master node is completed.

### 5.4.2 CANopen Master Parameter Configuration

- Network and baud rate configuration parameters
  - Network: the number of CAN networks connected via the CANbus, range: 0–100.
  - Baud rate: the baud rate used for transmission on the bus. Different baud rates can be set (for example, 10 kbps, 20 kbps, 50 kbps, 100 kbps, 125 kbps, 250 kbps, 500 kbps, 800 kbps, 1000 kbps).

Figure 5-50 CANbus Master Parameter Configuration

CANbus X			
General	General		
Log	Network	þ 🗧	CAN
CANbus IEC Objects	Baudrate (kbit/s)	250 ~	
Status			
Information			

#### Master Configuration Parameters

CANopen Management is a node under the CANbus node that supports CANbus configuration through internal functions. It is generally used as the CANbus master. The configuration page is shown in the following figure.



Devices 👻 🕂 🗙	CANbus CANopen_Ma	anager 🗙
	General	General
🛄 Auto scan 🔍 Fault diagnosis summary	Log	Node ID 127 🔄 Check and Fix Configuration CRNOPCO
PLC Logic	CANopen I/O Mapping	🧹 Autostart CANopen Manager 🛛 🗹 Polling of optional slaves
Variable usage	CANopen IEC Objects	Start Slaves NMT error behaviour Restart Slave
TM75x-HSIO (TM75x-HSIO)  M Modbus TCP Master1 (Modbus TCP Master1)	Status	Invertised and (in possible)
Modbus_TCP_Slave_Device1 (Modbus TCP Slave Device1)	Information	Enable heartbeat producing
ModbusDevice2 (ModbusDevice2)		Node ID
ExtCard (ModuleScan)		Producer time (ms) 200
CANOUS (CANOUS)		▲ SYNC
DA200_Drive (DA200 Drive)		Enable SYNC producing
SoftMotion General Axis Pool		COB ID (Hex) 16# 80 🔹
		Cycle period (µs) 1000 🗘
		Window length (µs) 1200 ≑
		Enable SYNC consuming

- Node ID: It provides an array pair module that CANopen Manager can correspond to one-to-one, with ID values of 1-127 (must be a decimal integer).
- Guarding: Different from node protection, the heartbeat mode is a traditional protection mechanism that can be handled by the master and slave modules. Normally, the master is configured to send a heartbeat to the slave.
- Enable heartbeat generation: If this option is enabled, the master will send heartbeats continuously according to an internally defined "heartbeat time". Node ID under Guarding: It is the unique identifier of heartbeat generation (1–127) on the bus.
- Generation time (ms): It defines the internal heartbeat time in milliseconds.

# 6 Diagnosis

# 6.1 Diagnosis Overview

Diagnosis is intended to quickly locate errors that occur during PLC operation and find solutions according to the error information and status. The diagnostic interface of Invtmatic Studio can only be obtained and displayed after logging in to the PLC. The Invtmatic Studio programming system supports the diagnosis of various communication devices and can generate fault information, offline information, and other information according to the actual running status of each communication device. The module types involved in fault diagnosis mainly include: CPU, Modbus, ModbusTCP, EtherCAT, CANopen, etc. The Invtmatic Studio programming system mainly provides four diagnosis routes: configuration diagnosis, diagnostic information list, device self-diagnostic information list, and diagnostic programming interface. All diagnoses are obtained through fault code analysis, and the fault codes correspond to the diagnostic programming interface.

In the configuration, different icons represent different diagnostic states of each communication module: running, standstill, and fault.

Indicate the running state. The device has no faults.

▲: Indicate the standstill state. The device is not running.

<sup>1</sup> Indicate a fault state. In EtherCAT and CANopen, it indicates that a fault has occurred but has been recovered. In Modbus, it is displayed as a device in a fault state.

The running state of the device can be directly viewed in the configuration.

### 6.1.1 Fault Diagnosis

Fault diagnosis can be used to display fault information of all devices, and provide detailed description of relevant fault information and methods for troubleshooting the causes. It can also provide more detailed diagnostic information for special situations. After the device is connected, double-click **Fault Diagnosis Summary** in the device tree to open the device fault diagnosis interface.

/0,	Fault diagnosis summary	×		
Devic	ce Type ALL	<ul> <li>Module Name</li> </ul>	ALL	🝷 🍳 Quary 🛛 🎸 Refresh  🛔 Clear 🔮 Export EXCEL 🛛 Statistics of fault information 4
	Device Type	Module Name	Error code	Error name
۱.	ModbusTCP	Modbus_TCP_Slave1	Er00A0-000f	Communication Timeout
	Modules	FL4003_4DA	Er0032-2003	Module Output Port Power Fault
	Modules	FL3003_4AD	Er0032-0015	Chanel 0 Signal Source Open Circuit Fault
	ModbusRTU	Modbus_Slave1	Er0040-0005	Communication Timeout, communication time exceeded the maximum time set by the user communication error occurred

Figure 6-1 Fault Diagnosis Summary
------------------------------------

The Device Type window displays the current fault type and provide the fault display filter function, which can display fault information by device type. Device types include CPU module, Modbus module, Modbus TCP module, and local module. You can select a different device type, and the diagnostic display list will show the corresponding type of diagnosis. All device diagnoses are displayed by default.

- Search: Search for matching fault information based on the device type or module name.
- Refresh: Used to refresh device fault information.
- Clear: Clear the fault information in the table.

- Export to EXCEL: Export fault information in the table.
- Fault Information List: mainly used to display specific module fault information, including device type, module name, and fault information. Device Type: Filter a certain type of faulty bus device; Module Name: Filter faulty devices with a specific name.
- Detailed Information window: When a certain piece of fault information is selected in the Fault Information List, the detailed information of the fault will be displayed in the detailed information window, which includes three options: Error Details, Troubleshooting, and In-depth Diagnosis. The first column of Error Details describes the possible cause of the fault, followed by four additional items, which are mainly used to provide more information about the fault; Troubleshooting is used to provide specific operation methods for cause investigation; and In-depth Diagnosis describes some complex errors that require more detailed information for troubleshooting.

# 6.2 Device Self-diagnostic Information List

### 6.2.1 I/O Diagnosis

I/O can be added to the CPU local backplane bus. Its diagnostic information is shown as follows. For specific error codes and information, please refer to I/O module error codes.

FL3003_4AD X					
4AD Settings					
-		Serial No	Error code	Error name	Solution
Fault diagnosis	•	1	Er0032-0015	Chanel 0 Signal Source Open Circuit Fault	Check Chanel 0 signal source physical connection
PCI-Bus IEC Objects					
CPU AI4 Parameters					
CPU AI4 I/O Mapping					
Status					
Information					

#### Figure 6-2 I/O Device Self-diagnostic Information

### 6.2.2 Modbus RTU Diagnosis

Modbus RTU supports two serial ports: Modbus serial ports 0 and 1. Modbus serial port 0 or 1 can be used as a Modbus master or slave.

When the Modbus serial port is used as a master, slaves (remote slaves) can be added to the master. On the slave configuration interface, each slave has an "Error Diagnosis" interface, which details the parameter with an error.

When the Modbus serial port is used as a slave, there is also an "Error Diagnosis" interface to display communication errors between the slave and the master.

### 6.2.3 Modbus TCP Diagnosis

The PLC can be used as a Modbus TCP master or slave. When Modbus TCP is used as the master, slaves (remote slaves) can be added to the master. On the slave configuration interface, there is an "Error Diagnosis" interface, which details the parameter with an error.

When ModbusTCP is used as a slave, there is also an "Error Diagnosis" interface to display communication errors between the slave and the master.

# 6.3 Online Log

An online log displays program, device, and system-related log information online in real time after connection to the PLC device. This function is used to help you quickly locate errors, solve problems timely, and ensure the normal operation of the device.

Login to the PLC: Click Login. When the software and PLC are connected, the log function will be started. The log interface is as shown in the figure below.

Device X				
Communication Settings	12 warning	(s) 🤨 437 error(s) 📧 0 excep	tion(s) 651 information(s) 0 debug message(s) <all components<="" td=""><td>&gt; • Logger -</td></all>	> • Logger -
Applications	Offline log	ging 🔲 UTC time		
	Severity	Time Stan. 435 error(s)	Description	Component
Backup and Restore	0	14.07.2024 06:52:57.320	NetID 0: CAN driver signals BusAlarm.	CANbus
Files	0	14.07.2024 06:52:57.320	NetID 0: Bus State: BUSOFF	CANbus
	0	14.07.2024 06:52:57.314	NetID 0: No more BusAlarm.	CANbus
Log	0	14.07.2024 06:52:57.314	NetID 0: No more bus error.	CANbus
	0	14.07.2024 06:52:56.329	NetID 0: CAN driver signals BusAlarm.	CANbus
PLC Settings	0	14.07.2024 06:52:56.325	NetID 0: Bus State: PASSIVE	CANbus
PLC Shall	0	14.07.2024 06:52:56.315	NetID 0: No more BusAlarm.	CANbus
	0	14.07.2024 06:52:56.315	NetID 0: No more bus error.	CANbus
Users and Groups	0	14.07.2024 06:52:55.326	NetID 0: CAN driver signals BusAlarm.	CANbus

Figure 6-3 PLC Log

The meanings of the parameters in the Toolbar of the interface are listed in the table below.

Parameter Name	Parameter Description
Warning/Error/Exception/Info/Debugging	Display and filter different levels of information during
Information	diagnosis.
	Clear the currently displayed diagnostic information.
Clear	After clearing, when there is new log information, the
	system will refresh the latest information.
Export	Export all log information in CSV format.
Import	Import log information.
Refresh	Refresh and view log information.
	View the log information of all components, or choose
All Components	to display the log information of a single component.
Offlinglag	Import the saved log information in CSV format in
Unine log	offline state.

The meanings of the parameters in the table of the interface are listed in the table below.

Parameter Name	Parameter Description
Class	Display the level of information.
Time	Display the time when the information is generated.
Description	Describe the phenomenon and cause of the error.
Component	Display the component where the error occurred.

# 6.4 Diagnostic Programming Interface

The diagnostic interface library CmpErrDiagnose provides a solution for obtaining diagnosis in the user program. It can determine the diagnostic information of each device module in the user program and make relevant processing.

The diagnostic programming interface exists in the form of a library and can be added in **Library Manager**, as shown in the figure below.



👔 Device 🏾 🎁 Library Manager 🗙					
🗄 Add Library 🗙 Delete Library 📑 Properties 📷 Details 🗐 Placeholders	Library Repos	itory 🕦 Icon legend			
Name		Namespace	Effe	ective version	on
CAA CiA405 = CAA CiA 405, 3.5.15.0 (CAA Technical Workgroup)		CIA405	3.5.	15.0	
CAA Device Diagnosis = CAA Device Diagnosis, 3.5.15.0 (CAA Technical Workgroup)		DED	3.5.	15.0	
CANbusDevice = CANbusDevice, 3.5.15.0 (3S - Smart Software Solutions GmbH)		CANbusDevice	3.5.	15.0	
CmpErrDiagnose, 1.0.1.0 (INVT)		CmpErrDiagnose	1.0.	1.0	
IecVarAccess = IecVarAccess, 3.5.15.20 (System)		IecVarAccessLibrary	3.5.	15.20	
IODrvEtherCAT = IODrvEtherCAT, 3.5.15.30 (3S - Smart Software Solutions GmbH)		IoDrvEthercatLib	3.5.	15.30	
B-I InStandard = InStandard 3 5 15 0 (System)		InStandard	35	15.0	
🖃 🎒 CmpErrDiagnose, 1.0. 1.0 (INVT) 💽 💌	Inputs/Outputs Gr	aphical Documentation			
🗏 🧰 ErrCodeDataType	FUNCTION_BLO	CK CPU_ERR_DIAGNOSE			
CpuErrCodeStruct					
-*\$ IOErrCodeStruct	Name	Туре	Inherited from	Address	Initial
	😻 xEnable	BOOL			FALSE
ModbusSlaveErrStruct	V CpuErrData	POINTER TO CpuErrCodeStruct			
😑 🧰 ErrFunctionBlock	🗇 xDone	BOOL			
CPU_ERR_DIAGNOSE					
DI IO_ERR_DIAGNOSE CPU ERR DIAGNOSE 4.10.0.0 (3S - Smar	t Software Solution	ns GmbH) (			
MODBUS_RTU_MASTER_DIAGN Library is not signed					
MODBUS_RTU_SLAVE_DIAGNOSE					
MODBUS_TCP_MASTER_DIAGNOSE					

The diagnostic programming interfaces corresponding to CPU, Modbus, ModbusTCP, and backplane I/O are provided. Each type of diagnosis corresponds to a set of function blocks for obtaining the corresponding error codes. The custom diagnostic results and states in the diagnostic data are displayed in **ErrCodDataType** (as sh in Figure 6-4). For example, Figure 6-5 shows the Modbus master diagnostic function block, with three slaves added to the serial port 1. The strRtuDia is declared as a structure array, and each array corresponds to the fault information of a slave channel. The diagnostic result is that the slave 1 has two channel errors, and slaves 2 and 3 each have one channel error.

#### Figure 6-5 Adding a Modbus Master Diagnostic Function Block



Figure 6-6 Description of Modbus Master Diagnostic Function Block Parameters

Inputs/Outputs Graphica	al Documentation			
FUNCTION_BLOCK M	IODBUS_RTU_MASTER_DIAGNOSE			
Name	Туре	Inherited from	Address	Initial
🍬 xEnable	BOOL			FALSE
🍫 ComId	BYTE			
ModbusErrData	POINTER TO ModbusMasterErrStruct			
🍢 xDone	BOOL			

# **6.5 Application Diagnosis**

The programming language used by Invtmatic Studio has the characteristics of high execution efficiency and flexible programming, but it also has high requirements on users' programming ability. When writing programs, you need to avoid abnormal operations such as illegal pointer access, division by 0, array out of bounds, implicit type conversion, and infinite loops; otherwise, the PLC system may be executed abnormally or even crash. This chapter mainly provides troubleshooting methods for exceptions that may occur in the PLC. You can refer to them according to actual conditions.

After compiling a project, the Invtmatic Studio software displays the compilation output error information by default. In the compilation output window, you can view the compilation errors. Double-click the error display line to locate the error code, as shown in the figure below.



Figure 6-7 Locating an Error Code

Algorithm library error message: Switch to **Library Manager** by the same method to view the algorithm library error message, as shown in Figure 6-8. Open **Library Manager**, as shown in Figure 6-9. If this library is not used, you can delete it; if it is used, you need to install the algorithm library manually.



Control (Control (	Devices - 4 ×	Library Manager X			•
Conceptions amery     And dogress smary	= Unstied I	🕼 Add Library 🗙 Delete Library 🔄 Properties 💿 Details 😽 Try to Rreload Library 🛛 🚯 Download Missing Libraries	II Placeholders	Repository 🕕 Icon legend	
A loc del	🖹 💮 Device (TM753)	Huma	Mamaganas	Effective version	0
In traditions	- 🙆 Auto scan				
Club Club Club Club Club Club Club Club	<ul> <li>— Q Fault diagnosis summary</li> </ul>	Sucense = Joudense, 3.5.14.0 (Jo - Smart Sortware Soutions GmbH)	_35_LICENSE	3.5.14.0	
Applicable     A	😑 🔛 PLC Logic	BreakpointLogging = breakpoint Logging Punctions, 3.5.5.0 (35 - Smart Software Solutions GmbH)	BPLOG	3.5.5.0	
ork       Implementation       Implementation </td <td>Application</td> <td>CAA Device Diagnosis = CAA Device Diagnosis. 3.5.15.0 (CAA Technical Workgroup)</td> <td>DED</td> <td>3.5.15.0</td> <td></td>	Application	CAA Device Diagnosis = CAA Device Diagnosis. 3.5.15.0 (CAA Technical Workgroup)	DED	3.5.15.0	
Use relations of the second	- 🎒 GVL	CP PD = ICP PID_10.4.0, 10.4.1 (DWT)	CP_PID_1_0_4_0	1.0.4.1	
Control Con	Library Manager	Louvemercal = Louvemercal, 3.3.15.30 (JS - Smart Sortivare Soutions Gmbri)	10Urvethercatub	3.5.15.30	
Output     Out	PLC_PRG(PRG)	<ul> <li>Lostandaro - Jostandaro, 3.5.15.0 (System)</li> <li>Ref. Ref. Ref. Ref. A 19.0.0 (20)</li> </ul>	lostandard	3.5.15.0	
International Second	POU (PRG)	SHS_Basic = SHS_Basic, 4.10.0.0 (JS - Smart Software Solutions GmbH)	SM3_pasic	4.10.0.0	~
Intervent of the second of	Task Configuration	•			
Montanda Service Se	- 🕼 EtherCAT_Task				
In Case of the second of th	🖹 🎲 MainTask				
Procession     P	- D PLC_PRG				
Protections Vectors <p< td=""><td>- 💜 Trace</td><td></td><td></td><td></td><td></td></p<>	- 💜 Trace				
Versier lange Werke la	T PersistentVars				
<ul> <li>Tots-ttol(pt/s-ttol) Governing (Specific Advance) Governing (Specific Advance) Governing (Specific Advance) Tots-ttol(pt/s-ttol) Governing (Specific Advance) Tots-ttol(pt/s-ttol) Tots-ttol(pt/s-ttol) Governing (Specific Advance) Tots-ttol(pt/s-ttol) Tots-ttol(pt/s-ttol) Tots-ttol(pt/s-ttol) Tots-ttol(pt/s-ttol) Specific Advance) Tots-ttol(pt/s-ttol) Tots-ttol(pt/s-ttol) Specific Advance) Tots-ttol(pt/s-ttol) Specific Advance) Tots-ttol(pt/s-ttol) Specific Advance) Tots-ttol(pt/s-ttol) Specific Advance) Tots-ttol(pt/s-ttol) Specific Advance) Tots-ttol(pt/s-ttol) Specific Advance) Tots-ttol(pt/s-ttol) Specific Advance) Tots-ttol(pt/s-ttol) Specific Advance) Tots-ttol(pt/s-ttol) Specific Advance) Tots-ttol(pt/s-ttol) Specific Advance) Specific Advance) Specific Advance Adva</li></ul>	Variable usage				
Control (% Specific Active)     Control (% Specific Activ	TM75x+HSIO (TM75x+HSIO)				
Control 19 (Specific Control 1	Counter0 (HSpeedCounter)				
Process (process of the second of the s	Counter1 (HSpeedCounter)				
Provide (Provide)	- 🗃 FL2201_00080R (FL2201-00080R)				
Extrac (parwood)     Extr	- 💮 FL4003_4DA (FL4003-4DA)				
The CLT, Name, Joshtowing (BarcCLT) theory information (BarcCLT) and informating (BarcCLT) and information (BarcCLT) and information (BarcC	ExtCard (ScanModule)				
Marken_170 Asson /= (Buckbas TC Measer 1)     Masken_170 Asson /= (Buckbas TC Measer 2)     Masken_170 Asson	EtherCAT_Master_SoftMotion (EtherCAT Master SoftMotion)				
And (Add     A (B) (Add     A (	INVT_DA200_F66 (DA200-N EtherCAT(CoE) Drive V1266)				
<ul> <li>Windsa, TO, Mattin, L, Mattan, TO, Mattin, U., Mattan, Ma</li></ul>	Axis (Axis)				
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Softwice Grand Ask hold      Message: Total Server(b), Hessenge(b), Hessenge(b	Modbus_TCP_Slave_1 (Modbus TCP Slave 1)				
Heatages-Trick of every (b), 14 summp(b)        • • • • • • • • • • • • • • • •	SoftMotion General Axis Pool				
Build       • • • • 2 membrid)       • • Meaning(s))       Meaning(s))       • Meaning(s)) <td></td> <td>Messages - Total 3 error(s), 14 warning(s), 4 message(s)</td> <td></td> <td></td> <td>+ # ×</td>		Messages - Total 3 error(s), 14 warning(s), 4 message(s)			+ # ×
Decorption         Project         Object         Project         Object         Project         Object         Project         Project         Object         Project         Project <th< td=""><td></td><td>Build     Build</td><td></td><td></td><td></td></th<>		Build     Build			
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		C0100: Library System_VisuElemsWinControls has not been added to the Library Manager, or no valid license could be found	Untitled1	Libra	ry Manager [De
CODD: Usery System_ValueBerline have been added to the Usery Manager, are notable found     CODD: Usery System_ValueBerline have been added to the Usery Manager, are notable found     Utilitati		C0100: Library System_VisuElemTextEditor has not been added to the Library Manager, or no valid license could be found	Untitled1	Libra	ry Manager [De
		C0100: Library System_VisuElemTrace has not been added to the Library Manager, or no valid license could be found	Untitled1	Libra	ry Manager [De
C 1000. Usery System, "Jac.Emediate has not been able to be targe Yangeor, or no able found utilitati. Usery Yangeor, Pro- C 1000. Usery System, "Jac.Emediate has not been able to be targe Yangeor, or no able found utilitati. Usery Yangeor, Pro- C 1000. Usery System, "Jac.Emediate has not been able to be targe Yangeor, or no able found utilitati. Usery Yangeor, Pro- C 1000. Usery System, "Jac.Emediate has not been able to be targe Yangeor, or no able found utilitati. Usery Yangeor, Pro- C 1000. Usery System, "Jac.Emediate has not be target for targeor, or no able found utilitati. Usery Yangeor, Pro- C 1000. Usery System, "Jac.Emediate has not be target for targeor, or no able has not be target. Utilitati. Usery Yangeor, Pro- C 1000. Usery System, "Jac.Emediate has not be target for target, or no able has not be target. Utilitati. Usery Yangeor, Pro- C 1000. Usery System, Target, Pro- C 1000. Usery System, Target, Ta		C0100: Library System_VisuNativeControl has not been added to the Library Manager, or no valid license could be found	Untitled1	Lbra	ry Manager [De
		C0100: Library System_VisuElemsAlarm has not been added to the Library Manager, or no valid license could be found	Untitled1	Libra	ry Manager [De
		CO 100: Library System_VisuElemCamDisplayer has not been added to the Library Manager, or no valid license could be found	Untitled1	Libra	ry Manager [De
		C0100: Library System_VisuElem3DPath has not been added to the Library Manager, or no valid license could be found	Untitled1	Libra	ry Manager [De
		CO 100: Library System_VisuElemsDateTime has not been added to the Library Manager, or no valid license could be found	Untitled1	Libra	ry Manager [De
C 0007: bitwinn the: 1310, //      C 0007: bitwinn the: 1310, //      C 0007: bitwinn the: 1310, //      C 0005: bitwinnthe: 1310, //      C 0005: bitwinnthe: 1310, //      C 0005: bitwi		C0100: Library system visuinputs has not been added to the Library Manager, or no valid license could be found	Untitled1	Libra	ry Manager [De
CO35: Related poston     CO32: Related po		C0077: Unknown type: 'ISTD_P'	Untitled1	PLC_	PRG (Device: P Line 3 (Ded)
● Cill: Mainté posten Unitéd: PLC_PAS [Pesce P Line 1 [Dec) Unitéd: PLC_PAS [Pesce P Line 1 [Dec)		C0035: Program name, function or function block instance expected instead of 'ISTD_P_1'	Untitled1	PLC_	PRG (Device: P Line 2, Column 1 (Impl)
c Complete 2 errors, 14 warnings		C0181: Related position	Untitled1	PLC_	PRG (Device: P Line 3 (Ded)
		Comple complete 2 errors, 14 warnings			

Figure 6-9 Viewing a Missing Library, and Adding or Removing a Library

PLC_PRG Ibrary Manager 🗙		
🛃 Add Library 🗙 Delete Library 🛛 🚰 Properties 👘 Details 😽 Try to Rreload Library 🛛 🕭 Download Missi	ng Libraries 🛛 📑 Placeholders 🛛	🎁 Library Repository 🕕 Icon legend
Name	Namespace	Effective version
🕮 - 💟 3SLicense = 3SLicense, 3.5.14.0 (3S - Smart Software Solutions GmbH)	_3S_LICENSE	3.5.14.0
🕮 📙 BreakpointLogging = Breakpoint Logging Functions, 3.5.5.0 (3S - Smart Software Solutions GmbH)	BPLog	3.5.5.0
🕮 📙 CAA Device Diagnosis = CAA Device Diagnosis, 3.5.15.0 (CAA Technical Workgroup)	DED	3.5.15.0
CAA DTUtility = CAA DTUtil Extern, 3.5.12.0 (CAA Technical Workgroup)	DTU	3.5.12.0
OF PLS, 1.0.1.0 (INVT)	ICP_PLS	1.0.1.0
E lecVarAccess = IecVarAccess = 16 10 (Custom)	IecVarAccessLibrary	3.5.15.20
Library is not available	ToDrvEthercatLih	3 5 15 30

# 6.6 Handling of PLC Program Running Exceptions

### 6.6.1 Common Exceptions and Solutions

You may encounter the following exceptions during the process of writing and debugging software:

- After downloading the program, the programming software cannot scan the corresponding PLC device. In this case, you need to set the PLC toggle switch to stop and then power it on again.
- When you download a program or after running for a period of time, the PLC information display bar prompts the error "Program download exception", as shown in Figure 6-10.





At this time, you can see that there is a type error on the log interface, and the program cannot run normally, as shown in Figure 6-11.

#### INVT Medium and Large-scale PLC Software Manual

Library Manager	Device X	LC_PRG		
Communication Settings	! 1 warning(s	318 error(s) E 0 exception(	s) • 722 information(s) • 0 debug message(s) <all components=""> • Logger <default logger=""></default></all>	• 🗗 🖻 🕈 🗙
Applications	Offline log	iging 🔲 UTC time		
Applications	Severity	Time Stamp	Description Co	mponent
Backup and Restore	0	01.01.1970 10:28:07.004	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d	DrvEtherCAT
	0	01.01.1970 10:28:02.816	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d	rvEtherCAT
Files	0	01.01.1970 10:27:58.636	Checking slaves; perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d IoD	rvEtherCAT
	0	01.01.1970 10:27:54.456	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d Iot	InvEtherCAT
Log	0	01.01.1970 10:27:50.276	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d IoI	rvEtherCAT
DLC Sattings	0	01.01.1970 10:27:46.096	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d IoD	InvEtherCAT
PLC Settings	0	01.01.1970 10:27:41.916	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d Iot	PrvEtherCAT
PLC Shell	0	01.01.1970 10:27:37.736	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d IoD	PrvEtherCAT
	•	01.01.1970 10:27:33.556	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d Iot	PrvEtherCAT
Users and Groups	0	01.01.1970 10:27:29.376	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d IoD	PrvEtherCAT
	•	01.01.1970 10:27:25.196	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d Iot	PrvEtherCAT
Access Rights	0	01.01.1970 10:27:21.016	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d Iot	PrvEtherCAT
	0	01.01.1970 10:27:16.836	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d IoD	PrvEtherCAT
Symbol Rights	0	01.01.1970 10:27:12.656	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d Iot	InvEtherCAT
TEO OLIVIATI	0	01.01.1970 10:27:08.476	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d IoD	PrvEtherCAT
IEC Objects	0	01.01.1970 10:27:04.296	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d IoD	InvEtherCAT
Task Deployment	0	01.01.1970 10:27:00.116	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d IoD	PrvEtherCAT
rusk o oproyment	0	01.01.1970 10:26:55.936	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d Iot	PrvEtherCAT
Status	0	01.01.1970 10:26:51.756	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d Iot	PrvEtherCAT
	0	01.01.1970 10:26:47.576	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d IoD	rvEtherCAT
Information	0	01.01.1970 10:26:43.396	Checking slaves: perhaps slave(s) missing, mismatch to configuration or no communication at all. Use scan for d IoD	InvEtherCAT

When you download the program, a dialog box prompting "Download Failed" pops up, as shown in the figure below.

Figure 6-11 Program	Download Failed	<b>Prompt Dialog Box</b>
---------------------	-----------------	--------------------------

Invtmatic	Studio	×
$\bigotimes$	Download failed: PLC in exception. See Log Page in Device Dialog for details	
	OK Details	

Three causes lead to the above exception:

1. Null pointer (i.e. the pointer value is equal to 0).

Figure 6-12 Prompt of a Program Download Exception Due to Invalid Pointer Reference

	7		iRtu_1 2 := 0;								
	8 END_IF										
	9										
	10	0	uiDate[2] 0 := pOut^	??? ;							
B	11	•	IF diCountValue[iRtu_1 2	2 ] 0 >=	79995 AND diCo	untValue[0] 0					
B	12		<pre>IF diCountValue[1]</pre>	0 >= 79995	AND diCountVal	ue[1] 0 -	(= 8				
B	13		<pre>IF diCountValue[2</pre>	2] 0 >= 79	995 AND diCoun	tValue[2] 0					
	14		<pre>IF diCountVal</pre>	ue[3] 0 >	= 79995 AND di	CountValue[3]	0				
B	15										
	16		iMasterPI	C_Xin 0 :=100	00;						
	17		END_IF								
	18		END_IF			100 %	R				
-											
Wat	tch 1										
					_						
Exp	pres	sior	1	Application	Туре	Value	Prep				
8	Wato	h 1	L例」Breakpoints								
s)											
: Ano	nymo	ou t	build: 😳 0 🕐 0 🛛 Precompile 🧣	STOP Program l	baded - EXCEPTIO	Program unchange	d				

2. Division by 0.

#### Figure 6-13 Prompt of a Program Download Exception Due to Division by 0

-							
	1 🔴	SM5001 TRUE :	=TRUE;				
	2 🔴	SM2001 TRUE :	=TRUE;				
	3 🔴	SM4001 TRUE :	=TRUE;				
	4						
	5 🖷	iRtu_1 1 :	= iRtu_1 1	+1;			
B	6 🔴	IF iRtu_1 1	> 1000 THE	EN			
	7 🔿	iRtu_l 1	:= 0;				
	8	END_IF					
	9 🗘	uiDate[2] 0	<b>:=</b> 10/p0ut	t 0 <mark>;</mark>			
B	10 🔴	<pre>IF diCountVal</pre>	ue[iRtu_1 1	1]]0	>= 79995 AND	diCountValue[0]	100 %
4 =							•
Wat	ch 1						
Exp	ressio	n		Application	Туре	Value	Prepa
-							
ا میچ	Natch 1	🔊 Breakpoints					
		_					
s)							

#### 3. Array out of bounds.

Figure 6-14 Array Out of Bounds

		A 7
	4	
	- 5 🖝 I	pout 7 := 7;
	6 🕢	<pre>iDate[pOut 7 ] ??? := 10;</pre>
	7	
B	8 🖷 1	<pre>IF diCountValue[0] 0 &gt;= 79995 AND diCountValue[0]</pre>
B	9 🔴	<pre>IF diCountValue[1] 0 &gt;= 79995 AND diCountValue</pre>
B	10 🔴	<pre>IF diCountValue[2] 0 &gt;= 79995 AND diCountV</pre>
<		

For a null pointer and division by 0, the monitor program will directly prompt them when running, but for the array out-of-bounds, the program can still run normally. The troubleshooting steps are as follows:

Step 1 Right-click **Application**, and select **Add Object > POU for implicit checks**.

Figure 6-15 Adding a POU for Implicit Checks



Step 2 On the pop-up interface, check Bound checks and click Add.

Add POU for implicit checks	×
Create special check functions for an application (for checking array bounds, divisions and pointer)	
Available functions	
Range checks	
LRange checks	
Pointer checks	
Note: Adding a check function will provoke a full recompile and prohibit an online change	
Add	

Figure 6-16 Checking "Bind Check"

- Step 3 Log in to the PLC, stop the program, add breakpoints in the code "CheckBounds := lower;" and "CheckBounds := upper;" of the newly added binding function "CheckBounds", and activate them (press the shortcut key F9).
- Step 4 Run the program. When the array is detected to be out of bounds, the program enters the breakpoint, detects the out-of-bounds value (7), and defines the upper limit (3) and lower limit (1) of the array, as shown in Figure 6-17.

Figure 6-17 Program Jumping to a Breakpoint due to Array Out of Bounds

1	// Implicitly generated code: Only an implementation suggestion
2	IF index < lower THEN
3	CheckBounds := lower;
4	ELSIF index > upper THEN
5	CheckBounds := upper;
6	ELSE
7	CheckBounds := index;
8	END_IF
9	
0	(*It is also possible to set a breakpoint, log messages or e.g. to halt on an exception:
1	Add CmpApp.library, SysExcept.library and SysTypes2_Itf as newest.
2	Declaration:
3	VAR
4	_pApp : POINTER TO CmpApp.APPLICATION;
5	_result : SysTypes.RTS_IEC_RESULT;
6	END_VAR
7	
8	Implementation:
9	_pApp := AppGetCurrent(pResult:=_result);
0	IF index < lover THEN
1	CheckBounds := lower;
2	IF pApp <> 0 THEN

Step 5 After locating the problematic program segment, you need to modify the program according to the actual situation to avoid exceptions.

### 6.6.2 Solutions for PLC Out of Control Due to Program Problems

Common PLC application problems include:

- An infinite loop or too many loops occur in the application.
- The application accesses a null pointer or a pointer out of bounds.
- The application calls an underlying function block, causing a runtime crash.

Due to improper program writing, when the program is downloaded to the PLC and started, the PLC resources may be exhausted and the Invtmatic Studio software may be unable to control the PLC, resulting in failure to scan devices, ping communication errors, connection errors, login errors, or PLC download errors. The method to restore the PLC to normal state is as follows:

Method 1: For a medium-scale PLC, set the RUN/STOP switch to STOP, restart it, scan the PLC, and download a correct application.

Method 2: If the PLC network port can still be pinged, go to the Invtmatic Studio software, locate **Tool**s > **Invtmatic StudioTools**, and click **One-click Reset** on the factory settings screen to clear the APP.

Method 3: For the TP series large-scale PLC, download a correct PLC program via a USB flash drive and delete the previous application program. The operation steps are as follows:

**Note:** When this function is used, the USB flash drive can only have one partition, the controller can only connect one USB flash drive, and only one program can be saved in the root directory of the USB flash drive.

Step 1 After the user program project is opened in the programming software, click **Online** > **Create Boot Application** in the menu bar.



Step 2 Select the startup program APP storage path, keep the default file name unchanged, and click **Save**.

$\leftarrow \rightarrow$ $\checkmark$ $\uparrow$ $\frown$ This PC $\rightarrow$ Desktop	> New folder				~ č	Search New folde	r	P
Organize 🔻 New folder								?
A Name	Date modified	Туре	Size					
		No	items match ye	our search.				
> 🧝 "								
¥ 🔜								
> 🚔								
> 🕂								
> ) *								
Save as type: Boot applications (*.app)								~
∧ Hide Folders						Save	Cance	8

Step 3 Copy the user startup program files "Application.app" and "Application.crc" to the root directory of the USB flash drive.

Application.app	7/25/2024 1:54 PM	APP 文件	1,914 KB
Application.crc	7/25/2024 1:54 PM	CRC 文件	1 KB

Step 4 Insert the USB flash drive into any USB port of the controller, power off and restart the controller, and wait until the controller RUN indicator light turns on. At this time, the user program is loaded successfully.

**Note:** After restoring the PLC using the above method, you need to troubleshoot application errors before downloading the program.

# 6.7 Device Error Codes

**Note:** The backplane bus only applies to the TM series PLC.

Device	Error Type	Error Location	Major Error Code	Sub-error Code	Error Description
	System-re lated	Hardware error	0001	0001	Button cell not installed or battery voltage too low
				0002	Device supply voltage too low (less than 19V)
	System component-	Clock system	0008	0001	Error in setting time
		component		0002	Error in writing RTC clock
CPU		error		0003	Error in reading RTC clock
				0001	IP segments of IP1 and IP2 repeated
	related	IP system	0000	XXX	Reserved
		component	0009	0011	Read: IP1 module - Error in
		enor		0011	opening files
				0012	Read: IP1 module - Unable to get

Device	Error Type	Error Location	Major Error Code	Sub-error Code	Error Description
					IP information
				0012	Write: IP1 module - IP address
				0013	configuration error
				0014	Write: IP1 module - Mask
				0014	configuration error
				0015	Write: IP1 module - Gateway
				0015	configuration error
				0016	Write: IP1 module - Repeated
					Segments with USB
				0017	in different segments
				XXX	Reserved
					Read: IP2 module - Error in
				0021	opening files
				0022	Read: IP2 module - Unable to get IP information
				0023	Write: IP2 module - IP address
				0024	Write: IP2 module - Mask
				0025	Write: IP2 module - Gateway
					Write: ID2 module Popostod
			-	0026	segments with USB
				0007	Write: IP2 module - IP and gateway
				0027	in different segments
				0001	Module configuration error
		CPU IO error	0030	0002	Module parameter configuration error
				0001	DI - Module configuration error
				0002	DI - Module parameter configuration error
				XXX	Reserved
				2001	DO - Module configuration error
Backplane	Backplane	Digital quantity error	0031	2002	DO - Module parameter configuration error
bus	bus-related			2003	DO - Module output port power supply failure
				2004	DO - Module output error
				XXX	Reserved
				XXX	Reserved
				0001	Module configuration error
		Analag		XXX	Reserved
		Analog quantity error	0032	0012	AD - Channel 0 parameter configuration error
					0015

Device	Error Type	Error Location	Major Error Code	Sub-error Code	Error Description
					open-circuit
				0016	AD - Channel 0 sampling signal over-limit
				0017	AD - Channel 0 sampling signal above-upper-limit
				0018	AD - Channel 0 sampling signal below-lower-limit
				XXX	Reserved
				0022	AD - Channel 1 parameter configuration error
				0025	AD - Channel 1 signal source open-circuit
				0026	AD - Channel 1 sampling signal over-limit
				0027	AD - Channel 1 sampling signal above-upper-limit
				0028	AD - Channel 1 sampling signal below-lower-limit
				XXX	Reserved
				0032	AD - Channel 2 parameter configuration error
				0035	AD - Channel 2 signal source open-circuit
				0036	AD - Channel 2 sampling signal over-limit
				0037	AD - Channel 2 sampling signal above-upper-limit
				0038	AD - Channel 2 sampling signal below-lower-limit
				XXX	Reserved
				0042	AD - Channel 3 parameter configuration error
				0045	AD - Channel 3 signal source open-circuit
				0046	AD - Channel 3 sampling signal over-limit
				0047	AD - Channel 3 sampling signal above-upper-limit
				0048	AD - Channel 3 sampling signal below-lower-limit
				XXX	Reserved
				0003	Module output port power supply failure
				XXX	Reserved
				2012	Channel 0 parameter configuration error

Device	Error Type	Error Location	Major Error Code	Sub-error Code	Error Description						
				2014	Channel 0 output error						
				XXX	Reserved						
				2022	Channel 1 parameter						
				2022	configuration error						
				2024	Channel 1 output error						
				XXX	Reserved						
				2022	Channel 2 parameter						
				2032	configuration error						
				2034	Channel 2 output error						
				XXX	Reserved						
				2042	Channel 3 parameter						
				2012	configuration error						
				2044	Channel 3 output error						
				XXX	Reserved						
				0001	Module configuration error						
				XXX	Reserved						
					0012	Channel 0 parameter					
					configuration error						
				0015	Channel 0 signal source						
					open-circuit						
				0017	Channel 0 sampling signal						
				-			above-upper-limit				
						0018	Channel U sampling signal				
						~~~~	Beconved				
				-		Channel 1 parameter					
										0022	configuration error
							Channel 1 signal source				
						0025	open-circuit				
		Temperature					Channel 1 sampling signal				
		measuring	0033	0027	above-upper-limit						
		module error			Channel 1 sampling signal						
				0028	below-lower-limit						
				XXX	Reserved						
					Channel 2 parameter						
				0032	configuration error						
				0005	Channel 2 signal source						
				0035	open-circuit						
				0027	Channel 2 sampling signal						
				0037	above-upper-limit						
				0020	Channel 2 sampling signal						
				0030	below-lower-limit						
				XXX	Reserved						
				0042	Channel 3 parameter						
				0072	configuration error						
				0045	Channel 3 signal source						

Device	Error Type	Error Location	Major Error Code	Sub-error Code	Error Description
					open-circuit
				0047	Channel 3 sampling signal above-upper-limit
				0048	Channel 3 sampling signal below-lower-limit
				0001	Illegal function code
				0002	Illegal address
				0003	Wrong number of data
				0004	Slave device failure
				0005	Communication timeout. An error occurs since the communication time exceeds the maximum communication time set by the user
				ХХХ	Reserved
Fieldbus		Modbus_RTU Master1	0040	0008	Received data frame non-conforming to the Modbus protocol
				0009	CRC/LRC check error
				XXX	Reserved
	Modbus-rela ted			000B	The length of received data does not conform to the protocol or the number exceeds the maximum limit specified by the function code
				000C	The received slave address does not match the requested slave address
				000D	The received function code does not match the requested function code
				000E	Instruction execution failed
				0001	Illegal function code
				0002	Illegal address
				0003	Wrong number of data
				0004	Slave device failure
		Modbus_RTU	0041	0005	Communication timeout. An error occurs since the communication time exceeds the maximum communication time set by the
		MUSICIZ			user
				XXX	Reserved
					Received data frama
				0008	non-conforming to the Modbus
				0009	CRC/LRC check error

Device	Error Type	Error Location	Major Error Code	Sub-error Code	Error Description				
				XXX	Reserved				
				000B	The length of received data does not conform to the protocol or the number exceeds the maximum limit specified by the function code				
				000C	The received slave address does not match the requested slave address				
				000D	The received function code does not match the requested function code				
				000E	Instruction execution failed				
				0001	Illegal function code				
				0002	Illegal address				
		Madhua DTU		0003	Wrong number of data				
				0004	Slave device failure				
				0005	Communication timeout. An error occurs since the communication time exceeds the maximum communication time set by the user				
				XXX	Reserved				
			0042	0009	CRC/LRC check error				
		Slaver		XXX	Reserved				
				000B	The length of received data does not conform to the protocol or the number exceeds the maximum limit specified by the function code				
				000C	The received slave address does not match the requested slave address				
				000D	The received function code does not match the requested function code				
				000E	Instruction execution failed				
				0001	Illegal function code				
				0002	Illegal address				
		Modbus_RTU	0043	0003	Wrong number of data				
		Slave2	0045	0004	Slave device failure				
				0005	Communication timeout. An error occurs since the communication				

Device	Error Type	Error Location	Major Error Code	Sub-error Code	Error Description
					time exceeds the maximum
					communication time set by the
					user
				XXX	Reserved
					Received data frame
				0008	non-conforming to the Modbus
					protocol
				0009	CRC/LRC check error
				XXX	Reserved
				000B	The length of received data does not conform to the protocol or the number exceeds the maximum limit specified by the function
					code
				000C	not match the requested slave address does address
				000D	The received function code does not match the requested function code
				000E	Instruction execution failed
				0001	Illegal function code
				0002	Illegal address
				0003	Wrong number of data
				0004	Slave device failure
				0005	Communication timeout. An error occurs since the communication time exceeds the maximum communication time set by the user
				XXX	Reserved
	Modbus TCP-related	Modbus TCP Master1	00A0	0008	Received data frame non-conforming to the Modbus protocol
		indoter 1		0009	CRC/LRC check error
				XXX	Reserved
				000B	The length of received data does not conform to the protocol or the number exceeds the maximum limit specified by the function code
			-	000C	The received slave address does not match the requested slave address
				000D	The received function code does not match the requested function

Device	Error Type	Error Location	Major Error Code	Sub-error Code	Error Description	
					code	
				000E	Instruction execution failed	
				0001	Illegal function code	
				0002	Illegal address	
				0003	Wrong number of data	
				0004	Slave device failure	
				0005	Communication timeout. An error occurs since the communication time exceeds the maximum communication time set by the user	
				XXX	Reserved	
				0008	Received data frame non-conforming to the Modbus protocol	
		Modbus ICP	00A1	0009	CRC/LRC check error	
		Masterz		XXX	Reserved	
					000B	The length of received data does not conform to the protocol or the number exceeds the maximum limit specified by the function code
						000C
					000D	The received function code does not match the requested function code
				000E	Instruction execution failed	
				0001	Illegal function code	
				0002	Illegal address	
				0003	Wrong number of data	
				0004	Slave device failure	
		Modbus TCP	00A2	0005	communication timeout. An error occurs since the communication time exceeds the maximum communication time set by the user	
		Slave1		XXX	Reserved	
				0008	Received data frame non-conforming to the Modbus protocol	
				0009	CRC/LRC check error	
				XXX	Reserved	
				000B	The length of received data does not conform to the protocol or the	

Device	Error Type	Error Location	Major Error Code	Sub-error Code	Error Description
					number exceeds the maximum limit specified by the function code
				000C	The received slave address does not match the requested slave address
				000D	The received function code does not match the requested function code
				000E	Instruction execution failed
				0001	Illegal function code
				0002	Illegal address
				0003	Wrong number of data
				0004	Slave device failure
				0005	Communication timeout. An error occurs since the communication time exceeds the maximum communication time set by the user
				XXX	Reserved
	Madhua TOD		0008	Received data frame non-conforming to the Modbus protocol	
		Slave2	00A3	0009	CRC/LRC check error
		011102		XXX	Reserved
				000B	The length of received data does not conform to the protocol or the number exceeds the maximum limit specified by the function code
				000C	The received slave address does not match the requested slave address
			000D	The received function code does not match the requested function code	
				000E	Instruction execution failed

# **7 PLC Upgrades and Settings**

# 7.1 Software Upgrade

After opening the Invtmatic Studio software, click **Help** > **Software upgrade** in the menu to enable online software upgrades.

File Edit View Project Libraries Build Online Debug Tools Window Help	
🎦 😅 🔚   🚭   🗠 🖂 🐇 🛍 🋍 🗙   🛤 🎎 🍓 🌿   📕 🧌 🦄 🎼   🌆 🦷   🛅 - 😚   🕮 🧇 Contents Ctrl+Shift+F1 👘 🔾	ș oș
Index Ctrl+Shift+F2	
Devices v 4 X Device Library 🖗 Search	
B Untitled9  The Add Library X Delete Lib Program manual Pla	aceholo
Device (TM753)	
Auto scan Hardware manual	utions Gn
-Q Fault diagnosis summary Release Note	
BI PLC Logic     INVT Website     Sof	ftware Si
GAA CIA405 = CAA CIA 405     Software update	
GVL CAA Device Diagnosis = CA	orkgroup
Dibrary Manager	SmbH)

Figure 7-1 Software Upgrade Interface

If there is a new version, the software will automatically prompt you to upgrade it when you open it. After the download is complete, click **Upgrade**.

🚽 AP update tool v1.1.2				-		×
atest version info Notes: If the current version is lower than V1.3.4.13, please install the complete package of V1.3.4.13 before upgrading, otherwise it will cause the program to not function properly!!!	Component Main program Packages Online Help	Installed	Latest V1.3.5.4 V1.3.5.4 V1.3.4.13	Size 65M 14M 24M		_
<ul> <li>VI.3.5.4 (2024.7.4) update description:</li> <li>1. Updated ICP-PLS_1.0.1.0. compiled library to fix old version bugs.</li> <li>2. Added servo DA200A- EtherCAT_1.0.1.0.xml.</li> <li>3. TM700 has added three backplane modules FL6112-2EI FL6121-1EI vFL6002-2ES.</li> <li>4. Added coupler FK1100-ECT- Copuler_1.0.5.1.</li> <li>5. Optimized the servo 402 axis return to zero setting function to solve the problem of old versions of SDO being overwritten.</li> </ul>	1 21:07:17 2 21:07:18	Begin download Ur UpdateList_x64.Xml	dateList x64 Xml .Finish download			•
<ul> <li>V1.3.5.3 (2024.6.4) Update description:</li> <li>Add the self-update function of the online update program.</li> <li>Optimize the starting parameters of axis 402 to solve the problem of long starting time of EtherCAT bus.</li> </ul>						v
. Widget adds the subnet mask modification function (if you want to use this function, you	Check updat	e when start			Upda	te

Figure 7-2 Downloading and Installing the Upgrade Package

# 7.2 Firmware Upgrade

The TM/TP series supports firmware upgrades via a network port. Click **Tools > Invtmatic studio tools** in the menu.

**Note:** The Invtmatic Studio tool can be run as standalone software, and does not require to open the Invtmatic Studio programming software, making it easy to use.

#### Communication Connection

The TM series supports network connection via Ethernet1, Ethernet2, and TypeC, of which Ethernet1 supports broadcast communication connection (one-click IP scanning and automatic connection). The TP series X0 and X1 both support broadcast communication network connection.

😔 Invtmatic Studio Too	V1.0.28	_	
Connection 🔶	Device Connection		
Upgrade	Device Connection	Land 102 100 1 101	
RTC	n 192, 168, 1 , 10 n-t 9779	LOCAL 192.106.1.101	Disconnect
Network	PLC 17/753 Firmware V1.11.00		
Transfer	🛛 Version Prompt		
Language	The matching relationship between the current version of I IM75x: Supports all versions of firmware, and the file tre	Invasive Studio Tool and the PLC firmware version: ansfer function supports firmware versions V1.04.00 and above.	
Resetting	IP621x: Supports firmware versions V1.02.04 and above. AX7x: Supports firmware versions V210 and above.		
	camning device 1:08:36—712C Type: THT63 IF Address: 192.168.1.10 erice connected		
		Protoc	ol V1.3.2.2

Figure 7-3 PLC Tool Connection Interface

#### Firmware Upgrade

You can view the version number or select an upgrade package for upgrades.

Figure 7-4 Firmware Upgrade Interface

😔 Invtmatic Studio To	əi V1.0.28 –		×
Connection	Firmware Upgrade		
Upgrade 🔶	PLC IP 192.168.1.10 Port 9779		
RTC	PLC TIM753 Firmware V1.11.00 Tips	Chec	ĸ
Network	Firmware Info		
Transfer	Path C:\Users\Administrator\Desktop\phy\TM700-V1.11.00全型号升级包_7924620240722171719\Update_V111	Selec	t
Language			
Resetting			
	,	Start	

## 7.3 Time Settings

You can read or modify the system time.

Figure 7-	-5 System	Time Read	/Write	Interface
0	,		,	

😔 Invtmatic Studio Too	- V1.0.28 -	×
Connection	RTC Setting	
Connection Upgrade RTC – Network Transfer Language Resetting	RTC Setting PLC Time 2024-07-13 23:40:40 Time Setting Time 2024-07-24 Wednesd:  9:09:38 PM  Write	

# 7.4 Network Settings

Through network settings, you can read or modify the IP address and subnet mask of network ports 1 and 2.

Figure 7-6 Reading or modifying IP Addresses						
😔 Invtmatic Studio To	ol V1.0.28	-		×		
Connection	Network Setting			1842.2		
Upgrade	Network Setting					
RTC	IP: 192.168.1.10					
Network 📕	Gateway: 192.168.1.1					
Transfer	子网掩码: 255.255.0 Write					
Language						
Resetting						

# 7.5 Factory Settings Reset

Since the PC is connected to Ethernet1 of the PLC, it is not necessary to know the IP address of the PLC. The PLC can be reset to factory settings and the APP can be cleared by one click. If multiple PLCs are connected to the network, you need to disconnect other PLCs first and connect only the device that needs to be restored to factory settings.
Figure 7-7 Restoring the IP Address or Clearing the Program

🤨 Invtmatic Studio Too	ol V1.0.28 - 🗆 🗙
Connection	Restore Factory Settings
Upgrade	This program is used to restore factory settings for TP6000 and TM700 PLC
-F 0	Before reset operation:
RIC	<ol> <li>Flease disconnect all ports of the computer and WiFi</li> <li>Plaze find a naturark addle that compare one and to the computer part and the other and to the YO part of the davide</li> </ol>
Network	3 .Flease select the IP of the computer port connected to the entwork cable
Transfer	Sender IP Sender Port
Language	169.254.245.126 Unot 10002
Resetting 🔶	IF reset (Restore IF to factory settings)
	🛃 Clear App (Clear existing App of FLC)
	Reset

#### 7.6 File Transfer

The local computer file directory is displayed on the left side, and the PLC file directory is displayed on the right side. It is usually used for users to copy process files. For example, if you want to copy CNC files to the PLC, you can select the directory PlcLogic/\_cnc.

😔 Invtmatic Studio To	ol V1.0.28			– o x
Connection	File Transfer	TM753		È
Upgrade	Local Disk		PLC Disk	1
RTC	My Computer		CC. cnc CMC_1000. cnc	
Network	□		CNC_1001. cnc	
Transfer 🔶	□ □ □ □ □		E CNC_2000. enc	
Language			CNC_2001. cnc	6e1_76edfeccac2b. txt
Resetting		<b>«</b>		54d_95e6e68d53e6. txt
		>		
		_	File size: 1 KB	
			]	

Figure 7-8 File Transfer

## **Appendix A Project Examples**

### A.1 Example of RS485 Communication Configuration between the Controller and Goodrive20 Series VFD

Set the TM series controller as the master and Goodrive20 series VFD as the slave. The controller uses the Modbus RTU communication protocol, with the physical layer of two-wire RS485, and communicates with the VFD through the COM2 port. By writing a small program, use the upper computer to read and write the function parameters of Goodrive20 VFD. The A1 port of the PLC hardware is connected to the VFD 485+, and the B1 port is connected to the VFD 485-. The operation steps are as follows:



Step 1 Create a new project and select the menu **Projects** > **Standard project**. At this time, a new standard project has been created, the device is TM753, the programming language is structured text (ST), and the project information can be edited as needed.

categoria	1	Templates			
	ojects	Empty project	HMI project	Standard	Standard
				project	project w
A project o	ontaining one device, one	application, and an	empty implemen	tation for PLC_	PRG
	Untitled9				
Name					×

Standard	Project		×
	You are abou objects withi - One program - A program I - A cyclic tasl - A reference	It to create a new standard project. This wizard will create the following n this project: mmable device as specified below PLC_PRG in the language specified below k which calls PLC_PRG to the newest version of the Standard library currently installed.	
	Device	TM753 (INVT)	~
	PLC_PRG in	Structured Text (ST)	~
		OK Cancel	

Step 2 Add **Modbus\_Master1** and **Modbus\_RTU\_Slave1** by reference to section 5.2.1 Modbus RTU Master Configuration, set the communication parameters, and set the PLC as a Modbus\_TCP slave. Then, the variables can be displayed on the touch screen.



Step 3 Set the baud rate to 19200, the data bit to 8, the stop bit to 1, the check bit to EVEN (even parity), and the timeout period to 1000 ms; set the VFD node number (slave address) to 1, and the slave enable variable to 1001.

Modbus_RTU_Slave1 X			
Modbus slave settings			
Modbus communication settings	-Modbus slave settings-		
Fault diagnosis	Station number	1	<b>*</b>
PCI-Bus IEC Objects	T:+()	(1 247)	-
Internal Parameters	Timeout(ms)	(100~65535)	
Internal I/O Mapping	Slave enable variable(SM)	1001 (0~7999)	-
Status		(0.000)	

Step 4 In the Modbus Communication Settings window, add a Modbus slave communication configuration.

	Modbus_RTU_Slave1 x													
	Modbus slave settings		Name	Function code	Enable type	Enable variab	Circle time(ms)	ReadAddress	ReadLength	Error handling	WriteAddress	WriteLen	Retry times	Comment
1		0	Channel 00	(0x06) Write single register	Loop execute		1000				(0x2000) 8192			
	Modbus communication settings	1	Channel 01	(0x06) Write single register	Loop execute		1000				(0x2001) 8193	1	1	
		2	Channel 02	(0x03) Read holding registers	Loop execute		1000	(0x2100) 8448	1	Keep last value			1	
	Fault diagnosis		Channel 03	(0x03) Read holding registers	Loop execute		200	(0x3000) 12288	6	Keep last value			1	
	PCI-Bus IEC Objects													

Step 5 Double-click PLC\_PRG and enter the following code in the declaration editor to bind the variable address, so as to facilitate communication with the touch screen.

```
PROGRAM PLC_PRG
VAR
brun_pos AT %MX0.0 :BOOL; // Forward
bSet
           AT %MX0.1 :BOOL;// Frequency setting start
bStop
           AT %MX0.2 :BOOL;// Stop
                     :BOOL;// Reverse
brun_neg
           AT %MX0.3
breset
           AT %MX0.4
                     :BOOL;// Error reset
bJog Pos
           AT %MX0.5
                     :BOOL;// Forward jog
                     :BOOL;// Reverse jog
bJog_Neg
           AT %MX0.6
statusShow AT %MW100
                      :INT;// Running state display
fre
                   :INT;// Frequency
                   :INT;// Running state
bstatus
hfre
           AT %MW10
                     :INT;// Touch screen frequency value setting
canshu
          AT %MW200
                     : ARRAY[1..6] OF INT;
END_VAR
```

In the Modbus slave communication settings window, map the control variables in the program:

Modbus slave settings	Find		Filter Show all			- 🕆 Ada	IFB for IO Channel → Go to Ins	stance
Modbus communication settings	Variable	Mapping	Channel	Address	Туре	Unit	Description	
	≣*		Channel 00	%QW68	ARRAY [00] OF WORD		(0x06) Write single register	
Fault diagnosis	18 - <b>"</b> Ø		Channel 01	%QW69	ARRAY [00] OF WORD		(0x06) Write single register	
	🖹 🐐		Channel 02	%IW72	ARRAY [00] OF WORD		(0x03) Read holding registers	
Internal I/O Mapping	۰. ۲		Channel 03	%IW73	ARRAY [04] OF WORD		(0x03) Read holding registers	
Status								
Toformalian								
Information								
						Reset Map	ping Always update variables	Enabled 1 (use bus cycle task if not used in any task

In Channel03, read 6 addresses from 16#3000 and map them to the canshu array variable. In the array canshu[2], i.e. the address 3002H, if the value 3335 is read, it means that the bus voltage is 333.5 V. Please refer to the VFD product manual.

In Channel02, read 1 address from 16#2100 and map it to the status Show variable. If the value is 3, it means the VFD is stopped. Please refer to the VFD product manual.

Enter the following code in the main code editor:

```
SM1001:=TRUE;// Slave enable variable
IF brun pos THEN
  bstatus:=1;
END_IF
IF brun neg THEN
  bstatus:=2;
END IF
IF bJog Pos THEN
  bstatus:=3;
END IF
IF bJog Neg THEN
  bstatus:=4;
END IF
IF bStop THEN
  bstatus:=5;
END IF
IF bSet THEN
  fre:=hfre;
END IF
```

After connecting the VFD to the controller via two-wire RS485, start the VFD. Set the function code P00.01 to 2 through the VFD keypad so that its running instruction can be controlled by the upper computer through communication; set P00.06 to 8, that is, select the Modbus communication mode; set the serial communication parameters of the group P14 to make them consistent with the initialization setting parameters of the upper computer, including the baud rate, data bit, check bit, slave address, timeout period, etc.

Click the icon in the Toolbar to compile the code. After completing compilation without errors, click the button in the Toolbar to log in to the controller, and ensure that the Nixie tube of the controller has no error, Goodrive20 VFD is successfully connected to the controller, the communication is normal, and the touch screen interface is as shown in the figure below.

#### A.2 Example of Communication Configuration between the Controller and DA200 Series Servo Drive

Example: By writing a small program, control 4 DA200 series servo drives to drive 4 motor shafts to perform uniform forward and reverse motion. The operation steps are as follows:

Step 1 Create a new project and select the menu **Projects** > **Standard Project**. At this time, a new standard project has been created, the device is TM753, the programming language is structured text (ST), and the project information can be edited as needed.

[							×
							~
	Categories		Templates				
	Libraries		Empty project				
	A project contair	ing one device, one ar	plication, and an e	mpty implement	ation for PLC I	PRG	
			. ,				
	Name Unt	itled 10					
	Location C:	Jsers\Administrator\Do	cuments			~	
					ОК	Cancel	]
Standard	Project						×
	You are abo objects with	ut to create a nev in this project:	v standard pr	oject. This v	vizard will o	reate the f	ollowing
	- One progra - A program - A cyclic tas - A reference	mmable device a PLC_PRG in the l k which calls PLC to the newest v	s specified be anguage spec PRG ersion of the s	elow ified below Standard lib	rary curren	tly installed	d.
	Device	TM753 (INVT)					~
	PLC_PRG in	Structured Tex	t (ST)				~
						ж	Cancel

Step 2 Right-click **Device** in the device tree, and select **Add Device** to add an EtherCAT master device, **EtherCAT Master SoftMotion, Version 3.5.15.30** here.

therCAT_Master_SoftMotion_1						
tion						
Append device () Insert device () Plug (	fevice ()	Update device				
ing for a fulltext search	Vendor	<al vendors=""></al>				
lame	Vend	or	Version	Description		
Miscelaneous						
1 Fieldbuses						
8 CANBUS						
Brok EtherCAT						
B Bed Master						
EtherCAT Master	35 - S	nart Software Solutions GmbH	3.5.15.30	EtherCAT Master		
- 🗊 EtherCAT Master SoftMotion	35 - S	nart Software Solutions GmbH	3.5.15.0	EtherCAT Master SoftMotion	-	
EtherCAT Master SoftMotion	35 - S	nart Software Solutions GmbH	3.5.15.30	EtherCAT Master SoftMotion		
EtherCAT Master SoftMotion	35 - S	nart Software Solutions GmbH	3.5.16.30	EtherCAT Master SoftMotion		
Ethernet Adapter						
🖲 👄 EtherNet/IP						
Home&Building Automation						
* Modbus						
* Profibus						
<ul> <li>Profinet IO</li> </ul>						
S sercos						
Group by category 🔽 Display all versions (	for experts	only) 🔲 Display outdated ve	ersions			
Name: EtherCAT Master SoftMotion						
Vendor: 3S - Smart Software Solutions G	nbH					
Categories: Master						<u></u>
Order Number:						×.
Description: EtherCAT Master SoftMotio	n					
pend selected device as last child of						
vice						

Step 3 Right-click **EtherCAT Master SoftMotion** in the device tree, and select **Add Device** to add 4 servo drives, **DA200-N** here.

String for a fulltext search	Vendor	<all vendors=""></all>			~
Name			Vendor	Version	Des ^
E- I Fieldbuses					
Bud EtherCAT					
Bud Slave					
III - 🧰 AUTO					
Bosch Rexroth AG					
Delta Electronics, Inc.					
#- Carl Festo					
Hitachi Industrial Equipment Sy	stems Co.,L	.td.			
ifm electronic - ifm electronic El	therCAT Dev	vices			
Inovance					
INVT INDUSTRIAL					
= Servo Drives					
DA200-N EtherCAT(Co	E) Drive V2	65	INVT INDUSTRIAL	Revision=16#000000AB	Ethe
DA260-N EtherCAT(Co	E) Drive V2	65	INVT INDUSTRIAL	Revision=16#000000AB	Ethe
KEB Automation KG - C6 PRO/A	DVANCED o	drive controllers			
Nanjing Solidot Electronic Techi	nology Co.,	Ltd			
Panasonic Corporation, Appliar	nces Compar	ny - AC Servo Driver			
🗷 🧰 Parker Hannifin					
Schneider Electric					~

Step 4 Right-click **INVT\_DA200** in the device tree, select Add Device to add **SoftMotion CiA402 Axis**, and complete the addition of 4 servo motors.



Step 5 Double-click the PLC\_PRG and enter the following codes on the statement editor:

PROGRAM PLC\_PRG VAR iStatus: INT;

```
MC Power 0: MC Power;
      MC Power 1: MC Power;
      MC Power 2: MC Power;
      MC Power 3: MC Power;
      MC MoveAbsolute 0: MC MoveAbsolute;
      MC_MoveAbsolute_1: MC_MoveAbsolute;
      MC MoveAbsolute 2: MC MoveAbsolute;
      MC MoveAbsolute 3: MC MoveAbsolute;
      END VAR
Step 6 Enter the following code in the main code editor:
      CASE iStatus OF
      0:
      MC Power 0(Axis:= SM Drive GenericDSP402, Enable:= TRUE, bRegulatorOn:= TRUE,
      bDriveStart:=TRUE , );
      MC Power 1(Axis:= SM Drive GenericDSP402 1, Enable:= TRUE, bRegulatorOn:= TRUE,
      bDriveStart:=TRUE , );
      MC Power 2(Axis:= SM Drive GenericDSP402 2, Enable:= TRUE, bRegulatorOn:= TRUE,
      bDriveStart:=TRUE , );
      MC Power 3(Axis:= SM Drive GenericDSP402 3, Enable:= TRUE, bRegulatorOn:= TRUE,
      bDriveStart:=TRUE , );
      IF MC Power 0.Status AND MC Power 1.Status AND MC Power 2.Status
                                                                                  AND
      MC Power 3.Status THEN
              iStatus:=iStatus+1;
      END IF
      1:
      MC MoveAbsolute 0(Axis:=SM Drive GenericDSP402, Execute:= TRUE, Position:=50,
      Velocity:=3 , Acceleration:= 2, Deceleration:= 100,);
      MC MoveAbsolute 1(Axis:=SM Drive GenericDSP402 1, Execute:= TRUE, Position:=50,
      Velocity:=3 , Acceleration:= 2, Deceleration:=100,);
      MC MoveAbsolute 2(Axis:=SM Drive GenericDSP402 2, Execute:= TRUE, Position:=50,
      Velocity:=3 , Acceleration:= 2, Deceleration:=100,);
      MC MoveAbsolute 3(Axis:=SM Drive GenericDSP402 3, Execute:= TRUE, Position:=50,
      Velocity:=3 , Acceleration:= 2, Deceleration:=100,);
      IF MC_MoveAbsolute_0.Done AND MC_MoveAbsolute_1.Done AND MC_MoveAbsolute_2.Done
      AND MC MoveAbsolute 3.Done THEN
                  MC MoveAbsolute 0(Axis:=SM Drive GenericDSP402, Execute:= FALSE,);
```

MC\_MoveAbsolute\_1(Axis:=SM\_Drive\_GenericDSP402\_1 , Execute:= FALSE,);

```
MC MoveAbsolute 2(Axis:=SM Drive GenericDSP402 2
                                                                     Execute:=
FALSE,);
           MC_MoveAbsolute_3(Axis:=SM_Drive_GenericDSP402_3
                                                                     Execute:=
FALSE,);
           iStatus:=iStatus+1;
END IF
2:
MC MoveAbsolute 0(Axis:=SM Drive GenericDSP402, Execute:= TRUE, Position:=0,
Velocity:=3, Acceleration:= 2, Deceleration:= 100,);
MC MoveAbsolute 1(Axis:=SM Drive GenericDSP402 1, Execute:= TRUE, Position:=0,
Velocity:=3 , Acceleration:= 2, Deceleration:=100,);
MC_MoveAbsolute_2(Axis:=SM_Drive_GenericDSP402_2, Execute:= TRUE, Position:=0,
Velocity:=3, Acceleration:= 2, Deceleration:=100,);
MC MoveAbsolute 3(Axis:=SM Drive GenericDSP402 3, Execute:= TRUE, Position:=0,
Velocity:=3 , Acceleration:= 2, Deceleration:=100,);
IF MC MoveAbsolute 0.Done AND MC MoveAbsolute 1.Done AND MC MoveAbsolute 2.Done
AND MC MoveAbsolute 3.Done THEN
           MC MoveAbsolute 0(Axis:=SM Drive GenericDSP402, Execute:= FALSE,);
           MC MoveAbsolute 1(Axis:=SM Drive GenericDSP402 1
                                                                     Execute:=
FALSE,);
           MC MoveAbsolute 2(Axis:=SM Drive GenericDSP402 2
                                                                     Execute:=
FALSE,);
           MC MoveAbsolute 3(Axis:=SM Drive GenericDSP402 3
                                                                     Execute:=
FALSE,);
iStatus:=1;
END IF
END CASE
```

The main body of the program takes the form of a state machine that determines which part of the code to execute through the value of iStatus. When the program starts, the iStatus value is 0, and the program initializes the MC\_Power function block and enables the corresponding motor shaft. If the corresponding motor shaft is enabled successfully, the iStatus value is 1 and the program enters the next state. When the iStatus value is 1, the MC\_MoveAbsolute function block is executed, and the motor rotates to the specified position at the specified speed. If the motor moves normally to the specified position, the iStatus value is increased by 1, and the motor enters the next state. When the iStatus value is 2, the MC\_MoveAbsolute function block is executed in the other direction. The motor continues to rotate to the specified position at the speed specified by the function block. If the motor moves normally to the specified position, the iStatus value is reset to 1. The program is executed repeatedly to implement the forward and reverse movement of the motor.

Step 7 Double-click **EtherCAT\_Master\_SoftMotion** from the device tree and click **Browse** to select the corresponding EtherCAT communication network named **eth0**. Select the distributed clock as needed. In this example, select 4000 us as the cycle time.

General	Autoconfig Master/Slave	s	Ether CAT.
Function Code	EtherCAT NIC Setting —		
Sync Unit Assignment	Destination address (MAC)	FF-FF-FF-FF-FF-FF	Sroadcast 🗌 Enable redundancy
100	Source address (MAC)	00-00-00-00-00	Browse
Log	Network Name	ETH0	
EtherCAT I/O Mapping	<ul> <li>Select network by MAC</li> </ul>	<ul> <li>Select net</li> </ul>	work by name
EtherCAT IEC Objects	▲ Distributed Clock		Options
Status	Cycle time 4000	¢ μs	Use LRW instead of LWR/LRD
Information	Sync offset 20	÷ %	Enable messages pertask
Information	Sync window monitoring		Automatic restart slaves
	Sync window 1		

Step 8 Click the button in the Toolbar to compile the code. After compiling, click the button in the Toolbar to log in to the controller. The servo starts normally, the motor runs smoothly, and the upper computer interface is shown in the following figure.



PLC_PRG X      EtherCAT_Master_SoftMotion     PLC_PRG X	EtherCAT_Task	■ SM_Drive_G	enericDSP402	INVT_DA200_171
Device.Application.PLC_PRG				
表达式	类型	值	准备值	地址 ^
iStatus	INT	1		
	MC_Power			
MC_Power_1	MC_Power			
MC_Power_2	MC_Power			
H MC_Power_3	MC_Power			
MC_MoveAbsolute_0	MC_MoveAbsolute			~
¢		1		>
<pre>2 0: 3 MC_Power_0(Axis:= SM_Drive_GenericDSP402, Enable IN 4 MC_Power_1(Axis:= SM_Drive_GenericDSP402_1, Enable IN 5 MC_Power_2(Axis:= SM_Drive_GenericDSP402_2, Enable IN 6 MC_Power_3(Axis:= SM_Drive_GenericDSP402_3, Enable IN 7 IF MC_Power_0.Status INUE AND MC_Power_1.Status INUE 9 iStatus 1 := iStatus 1 +1; 8 MD_IF 1;</pre>	:= TRUE, bRegulat NE := TRUE, bRegul UE := TRUE, bRegul NE := TRUE, bRegul AND MC_Power_2.St	corOn TRUE := TR atorOn TRUE := atorOn TRUE := atorOn TRUE := catus TRUE AND	UE, bDriveStart TF TRUE, bDriveStart TRUE, bDriveStart TRUE, bDriveStart RKC_Power_3.Status	TRUE :=TRUE , ); TRUE :=TRUE , ) TRUE :=TRUE , ) TRUE :=TRUE , ) TRUE THEN
11 MC_MoveAbsolute_0(Axis:=SM_Drive_GenericDSP402, Exe 2 MC_MoveAbsolute_1(Axis:=SM_Drive_GenericDSP402, I, Ex 3 MC_MoveAbsolute_2(Axis:=SM_Drive_GenericDSP402, 2, Ex 4 MC_MoveAbsolute_3(Axis:=SM_Drive_GenericDSP402_3, Ex 4 MC_MoveAbsolute_3(Axis:=SM_Drive_GenericDSP40_3, Ex 4 MC_MOVEABSOLUTE_3, Ex 4 MC_MOVEABSOLUTE_3	cute TRUE := TRUE, ecute TRUE := TRUE, ecute TRUE := TRUE, ecute TRUE := TRUE,	Position 50 Position 5 Position 5 Position 5	:=50 , Veloci :=50 , Veloc :=50 , Veloc :=50 , Veloc Veloc	ty 3 := ity 3 :: ity 3 :: ity 3 ::
If MC_MoveAbsolute_0.Done FAISE AND MC_MoveAbsolute_1     MC_MoveAbsolute_0/Avist=SM_Drive_Generic	Done AND MC	MoveAbsolute_2	. Done HAUSE AND MC	MoveA 100 %

Step 9 Double-click **INVT\_DA200** from the device tree to view or set the current motor running parameters in the I/O mapping interface.

General	Find		Filter Show all			<ul> <li>Add FB for I</li> </ul>	O Channel → G	io to In	stance
Servo Function Code	Variable	Mapping	Channel	Address	Туре	Current Value	Prepared Value	Unit	Description
			Control Word	%QW64	UINT	0			Control Word
xpert Process Data	÷ *>		Target Position	%QD33	DINT	0			Target Position
	🛞 - 🍫		Target Velocity	%QD34	DINT	0			Target Velocity
rocess Data	÷-*>		Mode of Operation	%QB140	SINT	8			Mode of Operation
artup Parameters	🖷 - 🍫		Target torque	%QW71	INT	0			Target torque
	÷-~*>		Touch probe control	%QW72	UINT	0			Touch probe control
nline	🖷 - 🍫		Positive torque limit	%QW73	UINT	0			Positive torque limit
			Negtive torque limit	%QW74	UINT	0			Negtive torque limit
oE Online	🖷 - 🍫		Max profile velocity	%QD38	UDINT	0			Max profile velocity
herCAT I/O Manning	۰. ا		Status Word	%IW76	UINT	22096			Status Word
	🖷 - 🍫		Position Actual Value	%ID39	DINT	0			Position Actual Value
herCAT IEC Objects	۰. ا		Speed Actual Value	%ID40	DINT	0			Speed Actual Value
	🖷 - 🍫		Torque Actual Value	%IW82	INT	0			Torque Actual Value
atus	۰. *		Operation Mode Display	%IB166	SINT	8			Operation Mode Display
formation	🖷 - 🍫		Current Actual Value	%IW84	INT	0			Current Actual Value
	۰		Touch Probe Status	%IW85	UINT	0			Touch Probe Status
	🕸 - 🍫		Touch Probe Value	%ID43	DINT	0			Touch Probe Value
			Digital outputs	%ID44	UDINT	0			Digital outputs
	😟 🍫		Digital inputs	%ID45	UDINT	0			Digital inputs

Step 10 Select **Device** > **PLC Instructions**. Click the button at the lower right corner and select **plcload**. Then the CPU load rate of the current controller will be shown as follows.

Library Manager 🛛 👔 D	evice 🗙 👔 PLC_PRG 🛛 🖗 POU 🏹 Auto scan	•
Communication Settings	plcload	
Applications	PLC load average: 7%	
Backup and Restore	CoreID: 0	
Filer	PLC Core load: 7%	
Log		
PLC Settings		
PLC Shell		
Users and Groups		
Access Rights		
Symbol Rights		
IEC Objects		
Task Deployment		
Status		
Information		
	l pidoad	
Messages - Total 0 error(s), 0 warning(s	), 1 message(s)	<b>-</b> ₽ X

To observe the operation of the motor shaft in an intuitive way and track the actual position of the shaft, create a new trace. Right-click **Application** and select **Add Object** > **Trace**. Set the task attribute to **EtherCAT\_Task**, and add **PLC\_PRG.MC\_Power\_0.Axis.fActPosition** and

**PLC\_PRG.MC\_Power\_0.Axis.fActVelocity** variables in **Trace**. Adjust the display properties of the coordinates appropriately to track the actual position and actual speed of the motor.



## A.3 Example of CANopen Communication Configuration between the Controller and DA200 Series Servo

By writing a small program, you can implement CANopen communication to connect DA200 series servo drive. The operation steps are as follows:





Step 2 Click Tools > Device Repository, and then click Install. Locate and click the device profile INVT\_DA200\_CANopen.eds to open it. At this time, DA200 CANopen device profile is added successfully.

ation	System Repository			~	Edit Location
	(D:\Program Files\Invtmatic Studio\InvtmaticStudioRepository\D	evices)			
talled de	vice descriptions				
ring for a	fulltext search Vendor: <all vendors=""></all>			$\sim$	Install
lame		Vendor	Version	10	Uninstall
	CMMP-AS-C2-3A-M3 SoftMotion	Festo	4.8.0.0	I	Export
	CMMP-AS-C20-11A-P3 SoftMotion	Festo	4.8.0.0	I	Export
	CMMP-AS-C5-11A-P3-M0 SoftMotion	Festo	4.8.0.0	I	
	CMMP-AS-C5-11A-P3-M3 SoftMotion	Festo	4.8.0.0	I	
	CMMP-AS-C5-3A-M0 SoftMotion	Festo	4.8.0.0	I	
	CMMP-AS-C5-3A-M3 SoftMotion	Festo	4.8.0.0	I	
	DA200 Drive	INVT	Revision = 16 #00000 104, FileVersion = 1, 1		
	DA300 and DA180 Drive	INVT	Revision = 16 #00000070, FileVersion = 1, 1	,	
	1 DIS-2 SoftMotion	Metronix GmbH	4.4.0.0	ć	
	1 EC-TX105	INVT	Revision=16#00000000, FileVersion=1.1, File=EC-TX105.eds	,	
	ECOSTEP200 SoftMotion	Jenaer Antriebstechnik GmbH	4.6.1.0	ć	Dataile
	ECOVARIO 114/214/414 SoftMotion	Jenaer Antriebstechnik GmbH	4.6.1.0	I	Decons.
	I EMCA-EC-67CO(DS402)	Festo	4.8.0.0	I	
	IBDCAN CMZ CANopen node SoftMotion	CMZ Sistemi Elettronici	4.4.0.0	I	
	IBDCAN CMZ CANopen node SoftMotion Encoder	CMZ Sistemi Elettronici	4.4.0.0	I	
	IBMDCAN Bonfiglioli Vectron MDS GmbH SoftMotion	Bonfiglioli Vectron MDS GmbH	4.6.0.0	I ~	
				>	
• C:\	Users\Administrator\Desktop\UNVT_DA200_CANopen_V2.60.eds				
• • • C:\	Users/Administrator/Desktop\JNVT_DA200_CANopen_V2.60.eds Device "DA200 Drive" installed to device repository.				
1 C:\	Users\Administrator\Desktop\UNVT_DA200_CANopen_V2.60.eds Device "DA200 Drive" installed to device repository.				
•• ① C:\	Users'Administrator'/Desktop/UNIT_DA200_CANopen_V2.60.eds Device "DA200 Drive" installed to device repository.				
••• ① C:\	Users\Administrator\Deaktop\UNIT_DA200_CANopen_V2.60.eds Device "DA200 Drive" installed to device repository.				
••• • C:\	Uters/Administrator/Deaktop/UWIT_DA200_CANopen_1/2.60.eds Device "DA200 Drive" installed to device repository.				
<b>0</b> C:\   <b>0</b>	Users (Administrator (Desktop (UNT_DA200_CANopen_V2.60.eds Device "DA200 Drive" installed to device repository.				
0 C:\   0	Users/Administrator/Deaktop/UWIT_DA200_CANopen_1/2.60.eds Device "DA200 Drive" installed to device repository.				
- O C:\ O	Users/Administrator/Deaktop/UVIT_DA200_CANopen_V2.60.eds Device "DA200 Drive" installed to device repository.				
- ① C:\	Users/Administrator/Deaktop/UNIT_DA200_CANopen_V2.60.eds Device "DA200 Drive" installed to device repository.				
- 0 C:\ 0	Liters/Administrator/Deaktop/UWIT_DA200_CANopen_1/2.60.eds Device "DA200 Drive" installed to device repository.				
- 0 C:\ 0	Users/Administrator/Deaktop/UNIT_DA200_CANopen_V2.60.eds Device TDA200 Drive <sup>®</sup> installed to device repository.				
- O C:\ O	Users/Administrator/Deaktop/UNIT_DA200_CANopen_1/2.60.eds Device "DA200 Drive" installed to device repository.				
<b>0</b> C:\ <b>0</b>	Leers Vadministrator (Desktop (UVIT_DA200_CANopen_1/2.60.eds Device "DA200 Drive" installed to device repository.				

Step 3 Double-click **ExtCard** in the device tree and enter the Settings interface. There is no device option by default. Select CANopen to automatically add CANbus and CANopen\_Manager to the left device tree.



Step 4 Right-click **CANopen\_Manager** in the device tree, select **Add Device**, and then select the CANopen remote device and **DA200 Drive**. Click **Add Device** in the lower right corner to add DA200 CANopen drive.

e EtherCAT_Master_SoftMotion_1										
Action										
Append device O Insert device O Plug de	evice Ol	Jpdate device								
ring for a fulltext search	Vendor	<all vendors=""></all>								
	Veed		Manatan	Description						
ame	vendo	or	version	Description						
E CANIng										
But Enercal										
But Master	20.0-	ant Caffringer Call Hans Carbo	0.5.15.00	Ether CAT Marshar						
EtherCAT Master	35 - 50	art Software Solutions Gribh	3.5.15.30	EtherCAT Master Cofficient						
EtherCAT Master Softworter	35 - SII	art Software Solutions Gribh	3.5.15.0	EtherCAT Master SoftMotion	•					
EtherCAT Master SoftMotion	35 - Sm	art Software Solutions GmbH	3.5.15.30	EtherCAT Master SoftMotion						
EtherCAT Master SoftMotion	35 - SM	art Software Solutions GMDH	3.5.16.30	EtherCAT Master SoftMotion						
Ethernet Adapter										
Etherivet/IP					♣ ← EtherNet/IP					
Im HomesBuilding Automation										
Die and the second second										
Hodbus										
Imit Modbus     Profibus										
❀ - ■■14 Modbus ❀ - ### Profibus ❀ - ### Profinet IO										
Modbus     Modbus     mii Profibus     mii Profinet IO     S sercos										
Image Modbus     I										
In Modbus     In Modbus										
In Modbus     In Modbus     In Internet     Internet     S sercos										
If Modbus     If Modbus     If Profibus     If Profinet IO     S serces  Group by category Display all versions (fr	or experts o	only) 📋 Display outdated ve	trsions							
	or experts o	inly) 🗌 Display outdated ve	ersions							
In Modbus     Im Profibus     Im Profibus     Im Profinet IO     S sercos     Group by category     Display all versions (fr     Name: EtherCAT Master SoftMotion     Vendor: SS - Smart SoftWare Solutions Gmi	or experts o	only) 🗌 Display outdated ve	ersions							
If Modbus     If Modbus     If Profiles     If Profiles     If Profiles     If Profiles     If Display all versions(fr     Name: EtherCAT Master SoftWotion     Vendora: S-Isnart SoftWotion     Vendora: S-Isnart SoftWotion     Vendora: S-Isnart SoftWotion     Vendora: Data	or experts o	inly) 🔲 Display outdated ve	ersions							
Image: A model of the second sec	or experts o	only) 🗌 Display outdated ve	ersions							
Group by category Display all versions (fr Mame: EtherCAT Master SoftMotion Version: 3: 5.15.30 Order Number: Description: EtherCAT Master SoftMotion	or experts c	only) 🗌 Display outdated vé	rrsions							
In Modbus     Im Profiles     Im Profiles     Im Profiles     Im Profiles     Im Profiles     Im International Internatio I	br experts c	nly) 🗌 Display outdated ve	rrsions							
If Modbus     If Modbus     If Profiles     If Profiles     If Second Seco	br experts o	inly) 🔲 Display outdated v	rsions							
Modbus     Modbus	br experts o	only) 📄 Display outdated ve	rsions							
ITH Modbus     ITH Modbus     ITH Profibus     ITH Profibus     ITH Profibus     ITH Profibus     ITH Profibus     ITH Profibus     Ither CAT Master SoftMotion     Vendor: 3S - Smart Software Solutions Gm     Categories: Master     Version: 5: 515:30     Order Number:     Description: EtherCAT Master SoftMotion	br experts o	only) 🗌 Display outdated ve	rsions			100				
In Modbus     Im Profibus     Im Profibus     Im Profinet IO     S sercos      Group by category Display all versions (fr     Name: EtherCAT Master SoftMotion     Vendor: 3S - Smart SoftMotion     Vendor: 3S - Smart SoftMotion     Vendor: SS - Smart SoftMotion     Vendor: SS - Smart SoftMotion     Description: EtherCAT Master SoftMotion  pend selected device as last child of vice	or experts o bH 	inly) Display outdated ve	rsions			100	**			
Modbus     Modbus	br experts o bH 	hile this window is open.)	rrsions			100	**			
ITI Modbus     ITI Modbus     ITI Profibus     ITI Profibus     ITI Profibus     ITI Profinet IO     ITI Display all versions (fr     Iname: EtherCAT Master SoftMotion     Vendor: 3S - Smart Software Solutions Gmt     Categories: Master     Version: 3.5.15.30     Order Number:     Description: EtherCAT Master SoftMotion  pend selected device as last child of vice     (You can select another target node in the r	br experts o bH 	hile this window is open.)	arsions							

- Step 5 On the "CANbus" overview interface, the baud rate configuration needs to be consistent with DA200 CANopen servo (DA200 P4.02); on the "DA200\_Drive" overview interface, the node ID configuration needs to be consistent with DA200 CANopen servo (DA200 P4.05).
- Step 6 After completing the physical connection of the device, download the program and log in to the device. Then, you can see that the CANopen connection to DA200 is successful.



#### **∠**Note:

- If high real-time performance is required for data, the CAN bus load rate should be less than 30% to avoid a small delay in data transmission and reception caused by bus contention.
- For CAN buses with synchronization requirements, the window length setting value in the bus synchronization message should be slightly smaller than the cycle value.

SYNC	
🕑 Enable SYNC produci	ing
COB ID (Hex) 16#	80
Cycle period (µs)	60000
Window length (µs)	58000
Enable SYNC consum	ing

- The cycle time of the CANopen task should be slightly longer than the actual execution time of the task.
- To ensure that the master can monitor the slave normally, check the Heartbeat Enable option in the slave.

DA200_Drive X	
General	General
PDOs	
SDOs	Enable expert settings
Log	Enable SYNC producing
CANopen I/O Mapping	Guarding
CANopen IEC Objects	Enable nodeguarding     Image: Constraint of the second seco
Status	Life time factor 0 + Heartbeat consuming (1/1 active)
Information	✓ Emergency (EMCY) ▷ TIME
	Enable emergency (EMCY)
	COB ID \$NODEID+16#80
	A Checks at Startup
	Check vendor ID Check product number Check revision number

# **Appendix B SMC\_ERROR Description**

Error	Module	ENUM Variable	Description
0	All function blocks		No error
0	All function blocks	SMC_NO_ENROR	
1	DriveInterface		example sercos ring has broken
2	DriveInterface	SMC DI AXIS ERROR	Axis error
			Position output within the
10	DriveInterface	SMC_DI_SWLIMITS_EXCEEDED	allowed range (SWLimit)
11	DriveInterface	SMC_DI_HWLIMITS_EXCEEDED	Hardware end switch is active.
13	DriveInterface	SMC_DI_HALT_OR_QUICKSTOP_ NOT_SUPPORTED	Drive status Halt or Quickstop is not supported.
14	DriveInterface	SMC_DI_VOLTAGE_DISABLED	The drive is not enabled.
15	DriveInterface	SMC_DI_IRREGULAR_ACTPOSITI ON	Current position given from the drive seems to be irregular. Check the communication
16	DriveInterface	SMC_DI_POSITIONLAGERROR	Position lag error. Difference between set and current position exceeds the given limit
20	All motion generating function blocks	SMC_REGULATOR_OR_START_N OT_SET	The controller is not enabled or the brake is applied
21	Axis in wrong controller mode	SMC_WRONG_CONTROLLER_MO DE	Axis in wrong control mode
30	DriveInterface	SMC_FB_WASNT_CALLED_DURIN G_MOTION	The module created by motion control is not called before the motion is completed
31	All function blocks	SMC_AXIS_IS_NO_AXIS_REF	The given AXIS_REF variable is not of the type AXIS_REF
32	Axis in wrong controller mode	SMC_AXIS_REF_CHANGED_DURI NG_OPERATION	AXIS_REF variables have been changed while the modules being activated
33	DriveInterface	SMC_FB_ACTIVE_AXIS_DIABLED	The axis is not activated while moving (MC_Power.bRegulatorOn)
34	All motion generating function blocks	SMC_AXIS_NOT_READY_FOR_MO TION	Axis in its current state cannot execute a motion instruction
40	VirtualDrive	SMC_VD_MAX_VELOCITY_EXCEED ED	Maximum velocity (fMaxVelocity) exceeded
41	VirtualDrive	SMC_VD_MAX_ACCELERATION_E XCEEDED	Maximum acceleration (fMaxAcceleration) exceeded
42	VirtualDrive	SMC_VD_MAX_DECELERATION_E XCEEDED	Maximum deceleration (fMaxDeceleration) exceeded

Error Number	Module	ENUM Variable	Description
50	SMC_Homing	SMC_3SH_INVALID_VELACC_VAL UES	Invalid velocity or acceleration values
51	SMC_Homing	SMC_3SH_MODE_NEEDS_HWLIMI T	Mode requests use of limit switches for safety reasons
70	SMC_SetControllerM ode	SMC_SCM_NOT_SUPPORTED	Mode not supported
71	SMC_SetControllerM ode	SMC_SCM_AXIS_IN_WRONG_STA TE	The controller mode cannot be changed in the current state
75	SMC_SetTorque	SMC_ST_WRONG_CONTROLLER_ MODE	The axis is under the wrong controller mode
80	SMC_ResetAxisGrou p	SMC_RAG_ERROR_DURING_STAR TUP	Error occurs when the axis group is activated
90	SMC_ChangeGearin gRatio	SMC_CGR_ZERO_VALUES	Invalid values
91	SMC_ChangeGearin gRatio	SMC_CGR_DRIVE_POWERED	The gear ratio parameters of the drive cannot be modified when it is under control
92	SMC_ChangeGearin gRatio	SMC_CGR_INVALID_POSPERIOD	Invalid position period (≤ 0)
110	MC_Power	SMC_P_FTASKCYCLE_EMPTY	Axis contains no information in the scan cycle (fTaskCycle=0)
120	MC_Reset	SMC_R_NO_ERROR_TO_RESET	Axis reset without error
121	MC Reset	SMC R DRIVE DOESNT ANSWER	Axis does not perform error-reset
122	MC_Reset	SMC_R_ERROR_NOT_RESETTABL	Error could not be reset
123	MC_Reset	SMC_R_DRIVE_DOESNT_ANSWER	Communication with the axis did not work
130	MC_ReadParameter, MC_ReadBoolParam eter	 SMC_RP_PARAM_UNKNOWN	Parameter number unknown
131	MC_ReadParameter, MC_ReadBoolParam eter	SMC_RP_REQUESTING_ERROR	Error during parameter transmission to the drive. See error number in the Programming Manual ReadDriveParameter (SM_DriveBasic.lib)
140	MC_WriteParameter, MC_WriteBoolParam eter	SMC_WP_PARAM_INVALID	Parameter number unknown or writing not allowed
141	MC_WriteParameter, MC_WriteBoolParam eter	SMC_WP_SENDING_ERROR	See error number in the Programming Manual WriteDriveParameter (Drive_Basic.lib)
170	MC_Home	SMC_H_AXIS_WASNT_STANDSTIL L	Axis has not been in standstill state
171	MC_Home	SMC_H_AXIS_DIDNT_START_HO MING	Error at start of homing action
172	MC Home	SMC H AXIS DIDNT ANSWER	Communication error

Error Number	Module	ENUM Variable	Description
173	MC_Home	SMC_H_ERROR_WHEN_STOPPIN G	Error at stop after homing. Check whether deceleration is set
180	MC_Stop	SMC_MS_UNKNOWN_STOPPING_ ERROR	Unknown error at stop
181	MC_Stop	SMC_MS_INVALID_ACCDEC_VALU ES	Invalid velocity or acceleration values
182	MC_Stop	SMC_MS_DIRECTION_NOT_APPLI CABLE	Direction=shortest not applicable
183	MC_Stop	SMC_MS_AXIS_IN_ERRORSTOP	Drive is in errorstop status. Stop cannot be executed
184	MC_Stop	SMC_BLOCKING_MC_STOP_WAS NT_CALLED	An instance of MC_Stop with multiple calls
201	MC_MoveAbsolute	SMC_MA_INVALID_VELACC_VALU ES	Invalid velocity or acceleration values
202	MC_MoveAbsolute	SMC_MA_INVALID_DIRECTION	Direction error
226	MC_MoveRelative	SMC_MR_INVALID_VELACC_VALU	Invalid velocity or acceleration values
227	MC MoveRelative	SMC MR INVALID DIRECTION	Direction error
251	MC_MoveAdditive	SMC_MAD_INVALID_VELACC_VAL	Invalid velocity or acceleration
252	MC MoveAdditive	SMC MAD INVALID DIRECTION	Direction error
202	MC MoveSuperImpo	SMC_MSL_INVALID_VELACC_VALU	Invalid velocity or acceleration
276	sed	ES	values
277	MC_MoveSuperImpo sed	SMC_MSI_INVALID_DIRECTION	Direction error
301	MC_MoveVelocity	SMC_MV_INVALID_ACCDEC_VALU ES	Invalid velocity or acceleration values
302	MC_MoveVelocity	SMC_MV_DIRECTION_NOT_APPLI CABLE	Direction=shortest/fastest not applicable
325	MC_PositionProfile	SMC_PP_ARRAYSIZE	Erroneous array size
326	MC_PositionProfile	SMC_PP_STEP0MS	Step time = t#0ms
350	MC_VelocityProfile	SMC_VP_ARRAYSIZE	Erroneous array size
351	MC_VelocityProfile	SMC_VP_STEP0MS	Step time = t#0ms
375	MC_AccelerationPro file	SMC_AP_ARRAYSIZE	Erroneous array size
376	MC_AccelerationPro file	SMC_AP_STEP0MS	Step time = t#0ms
400	MC_TouchProbe	SMC_TP_TRIGGEROCCUPIED	Trigger already active
401	MC_TouchProbe	SMC_TP_COULDNT_SET_WINDO	Drive interface does not support the window function
402	MC_TouchProbe	SMC_TP_COMM_ERROR	Communication error
410	MC_AbortTrigger	SMC_AT_TRIGGERNOTOCCUPIED	Trigger already de-allocated
	SMC_MoveContinuo	SMC_MCR_INVALID_VELACC_VAL	Invalid velocity or acceleration
426	usRelative	UES	values
427	SMC_MoveContinuo usRelative	SMC_MCR_INVALID_DIRECTION	Direction error
451	SMC_MoveContinuo	SMC_MCA_INVALID_VELACC_VAL	Invalid velocity or acceleration

Error Number	Module	ENUM Variable	Description
	usAbsolute	UES	values
452	SMC_MoveContinuo usAbsolute	SMC_MCA_INVALID_DIRECTION	Direction error
453	SMC_MoveContinuo usAbsolute	SMC_MCA_DIRECTION_NOT_APP	Direction=fastest not applicable
600	SMC_CamRegister	SMC_CR_NO_TAPPETS_IN_CAM	Cam does not contain any tappets
601	SMC_CamRegister	SMC_CR_TOO_MANY_TAPPETS	Tappet group ID exceeds MAX_NUM_TAPPETS
602	SMC_CamRegister	SMC_CR_MORE_THAN_32_ACCES SES	More than 32 accesses in one CAM_REF
625	MC_CamIN	SMC_CI_NO_CAM_SELECTED	No cam selected
626	MC_CamIN	SMC_CI_MASTER_OUT_OF_SCAL E	Master axis out of valid range
627	MC_CamIN	SMC_CI_RAMPIN_NEEDS_VELACC _VALUES	Velocity and acceleration values must be specified for ramp_in function
628	MC_CamIN	SMC_CI_SCALING_INCORRECT	Scaling variables fEditor/TableMasterMin/Max are not correct
640	SMC_CAMBounds, SMC_CamBounds_P os	SMC_CB_NOT_IMPLEMENTED	Function block for the given cam format is not implemented
675	MC_GearIn	SMC_GI_RATIO_DENOM	RatioDenominator=0
676	MC_GearIn	SMC_GI_INVALID_ACC	Acceleration invalid
677	MC_GearIn	SMC_GI_INVALID_DEC	Deceleration invalid
725	MC_Phase	SMC_PH_INVALID_VELACCDEC	Velocity and acceleration/deceleration values invalid
726	MC_Phase	SMC_PH_ROTARYAXIS_PERIOD0	Rotation axis with fPositionPeriod = 0
750	All modules using MC_CAM_REF as input	SMC_NO_CAM_REF_TYPE	Type of given cam is not MC_CAM_REF
751	MC_CamTableSelect	SMC_CAM_TABLE_DOES_NOT_C OVER_MASTER_SCALE	Master axis area (xStart and xEnd) from CamTable is not covered by curve data
775	MC_GearInPos	SMC_GIP_MASTER_DIRECTION_C HANGE	During coupling of slave axis, master axis has changed direction of rotation
800	SMC_BacklashComp ensation	SMC_BC_BL_TOO_BIG	Gear backlash fBacklash too large (> position period/2)
1000	CNC function blocks which are supervising the licensing	SMC_NO_LICENSE	Target is not licensed for CNC
1001	SMC_Interpolator	SMC_INT_VEL_ZERO	Path cannot be processed because set velocity = 0

Error Number	Module	ENUM Variable	Description
1002	SMC_Interpolator	SMC_INT_NO_STOP_AT_END	Last object of path has Vel_End>0
1003	SMC_Interpolator	SMC_INT_DATA_UNDERRUN	Warning: GEOINFO List processed in DataIn but end of list not reached Reason: EndOfList of the queue in DataIn not be set or SMC_Interpolator faster than path generating function blocks
1004	SMC_Interpolator	SMC_INT_VEL_NONZERO_AT_ST OP	Velocity at Stop > 0
1005	SMC_Interpolator	SMC_INT_TOO_MANY_RECURSIO	Too many SMC_Interpolator recursions. SoftMotion error
1006	SMC_Interpolator	SMC_INT_NO_CHECKVELOCITIES	Input-OutQueueDataIn is not the last processed function block of SMC_CHeckVelocities
1007	SMC_Interpolator	SMC_INT_PATH_EXCEEDED	Internal/numeric error
1008	SMC_Interpolator	SMC_INT_VEL_ACC_DEC_ZERO	Velocity and acceleration / deceleration is null or too low
1009	SMC_Interpolator	SMC_INT_DWIPOTIME_ZERO	FB called with dwIpoTime = 0
1050	SMC_Interpolator2D ir	SMC_INT2DIR_BUFFER_TOO_SM ALL	Data buffer too small
1051	SMC_Interpolator2D ir	SMC_INT2DIR_PATH_FITS_NOT_I N_QUEUE	Path does not go completely in queue
1100	SMC_CheckVelocitie s	SMC_CV_ACC_DEC_VEL_NONPOS ITIVE	Velocity and acceleration/deceleration values non-positive
1120	SMC_Controlaxisbyp os	SMC_CA_INVALID_ACCDEC_VALU ES	Values of fGapVelocity / fGapAcceleration / fGapDeceleration non-positive
1200	SMC_NCDecoder	SMC_DEC_ACC_TOO_LITTLE	Acceleration value not allowed
1201	SMC_NCDecoder	SMC_DEC_RET_TOO_LITTLE	Deceleration value not allowed
1202	SMC_NCDecoder	SMC_DEC_OUTQUEUE_RAN_EMP TY	Data underrun. Queue has been read and is empty
1203	SMC_NCDecoder	SMC_DEC_JUMP_TO_UNKNOWN _LINE	Jump to line cannot be executed because line number is unknown
1204	SMC_NCDecoder	SMC_DEC_INVALID_SYNTAX	Syntax invalid
1205	SMC_NCDecoder	SMC_DEC_3DMODE_OBJECT_NO T_SUPPORTED	Objects are not supported in 3D mode
1300	SMC_GCodeViewer	SMC_GCV_BUFFER_TOO_SMALL	Buffer too small
1301	SMC_GCodeViewer	SMC_GCV_BUFFER_WRONG_TYP E	Buffer elements have wrong types
1302	SMC_GCodeViewer	SMC_GCV_UNKNOWN_IPO_LINE	Current line of the Interpolator could not be found
1500	All function blocks using SMC_CNC_REF	SMC_NO_CNC_REF_TYPE	Given CNC program is not of the SMC_CNC_REF type
1501	All function blocks using	SMC_NO_OUTQUEUE_TYPE	Given OutQueue is not of the SMC_OUTQUEUE type

Error Number	Module	ENUM Variable	Description
	SMC_OUTQUEUE		
1600	CNC function blocks	SMC_3D_MODE_NOT_SUPPORTE D	Function block only works with 2D paths
2000	SMC_ReadNCFile	SMC_RNCF_FILE_DOESNT_EXIST	File does not exist
2001	SMC_ReadNCFile	SMC_RNCF_NO_BUFFER	No buffer allocated
2002	SMC_ReadNCFile	SMC_RNCF_BUFFER_TOO_SMALL	Buffer too small
2003	SMC_ReadNCFile	SMC_RNCF_DATA_UNDERRUN	Data underrun. Buffer has been read and is empty
2004	SMC_ReadNCFile	SMC_RNCF_VAR_COULDNT_BE_R EPLACED	Placeholder variable could not be replaced
2005	SMC_ReadNCFile	SMC_RNCF_NOT_VARLIST	Input pvl does not point to a SMC_VARLIST object
2050	SMC_ReadNCQueue	SMC_RNCQ_FILE_DOESNT_EXIST	File could not be opened
2051	SMC_ReadNCQueue	SMC_RNCQ_NO_BUFFER	No buffer defined
2052	SMC_ReadNCQueue	SMC_RNCQ_BUFFER_TOO_SMAL	Buffer too small
2053	SMC_ReadNCQueue	SMC_RNCQ_UNEXPECTED_EOF	Unexpected end of file
2100	SMC_AxisDiagnostic Log	SMC_ADL_FILE_CANNOT_BE_OP ENED	File could not be opened
2101	SMC_AxisDiagnostic Log	SMC_ADL_BUFFER_OVERRUN	Buffer overrun. WriteToFile must be called more frequently
2200	SMC_ReadCAM	SMC_RCAM_FILE_DOESNT_EXIST	File could not be opened
2201	SMC_ReadCAM	SMC_RCAM_TOO_MUCH_DATA	Saved cam too big
2202	SMC_ReadCAM	SMC_RCAM_WRONG_COMPILE_T YPE	Wrong compilation mode
2203	SMC_ReadCAM	SMC_RCAM_WRONG_VERSION	Wrong file version
2204	SMC_ReadCAM	SMC_RCAM_UNEXPECTED_EOF	Unexpected end of file
3001	SMC_WriteDrivePara msToFile	SMC_WDPF_CHANNEL_OCCUPIE	SMC_WDPF_TIMEOUT_PREPARIN G_LIST
3002	SMC_WriteDrivePara msToFile	SMC_WDPF_CANNOT_CREATE_FI LE	File could not be created
3003	SMC_WriteDrivePara msToFile	SMC_WDPF_ERROR_WHEN_READ ING_PARAMS	Error at reading the parameters
3004	SMC_WriteDrivePara msToFile	SMC_WDPF_TIMEOUT_PREPARIN G_LIST	Timeout during preparing the parameter list
5000	SMC_Encoder	SMC_ENC_DENOM_ZERO	Nominator of the conversion factor dwRatioTechUnitsDenom of the Encoder reference is 0
5001	SMC_Encoder	SMC_ENC_AXISUSEDBYOTHERFB	Other module trying to process motion on the Encoder axis
5002	DriveInterface	SMC_ENC_FILTER_DEPTH_INVALI	Filter depth invalid

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