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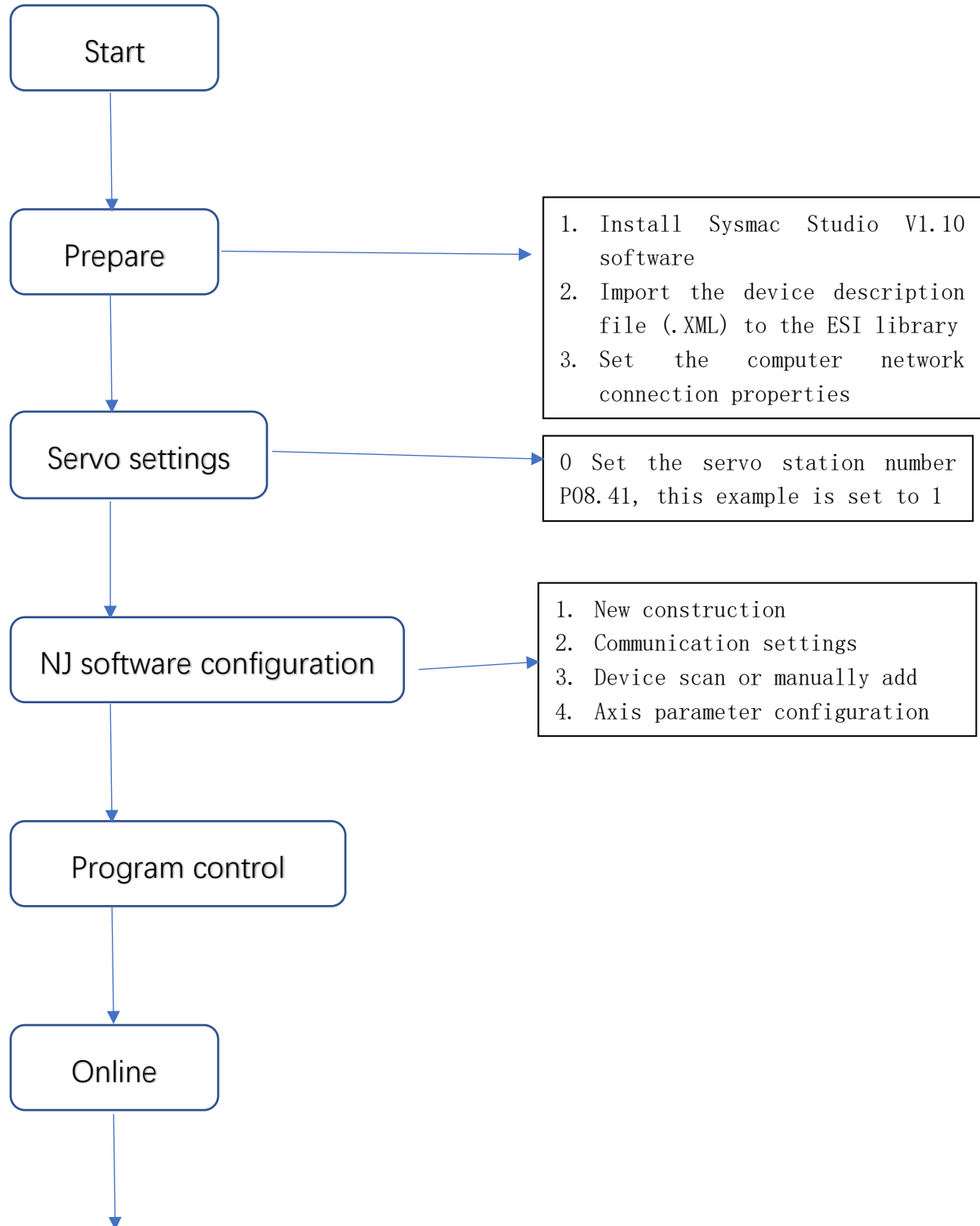
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---

# VC EtherCAT Servo Cooperate with Omron Master Station Operation Routine

● Operation main flow



---

Finish

---

# Configuration operation process:

## 11.2.1 Ready to work

1) To install the software of sysmac studio, it is recommended to install V1.10 and above.

Sysmac studio V1.03 and below cannot recognize third-party servers.

Sysmac studio V1.09 patch version, V 1.10 and above versions, no longer check whether the manufacturer ID in the xml is consistent with that in the program, it can match all VC EtherCAT xml files

For Sysmac studio software version 1.05~1.09, it is necessary to judge whether the three parameters of 1018h in the xml file are consistent with those in the program. Among the currently released versions, V1.1, V1.9, V2.1 and above can be used.

2) Import the device description file.

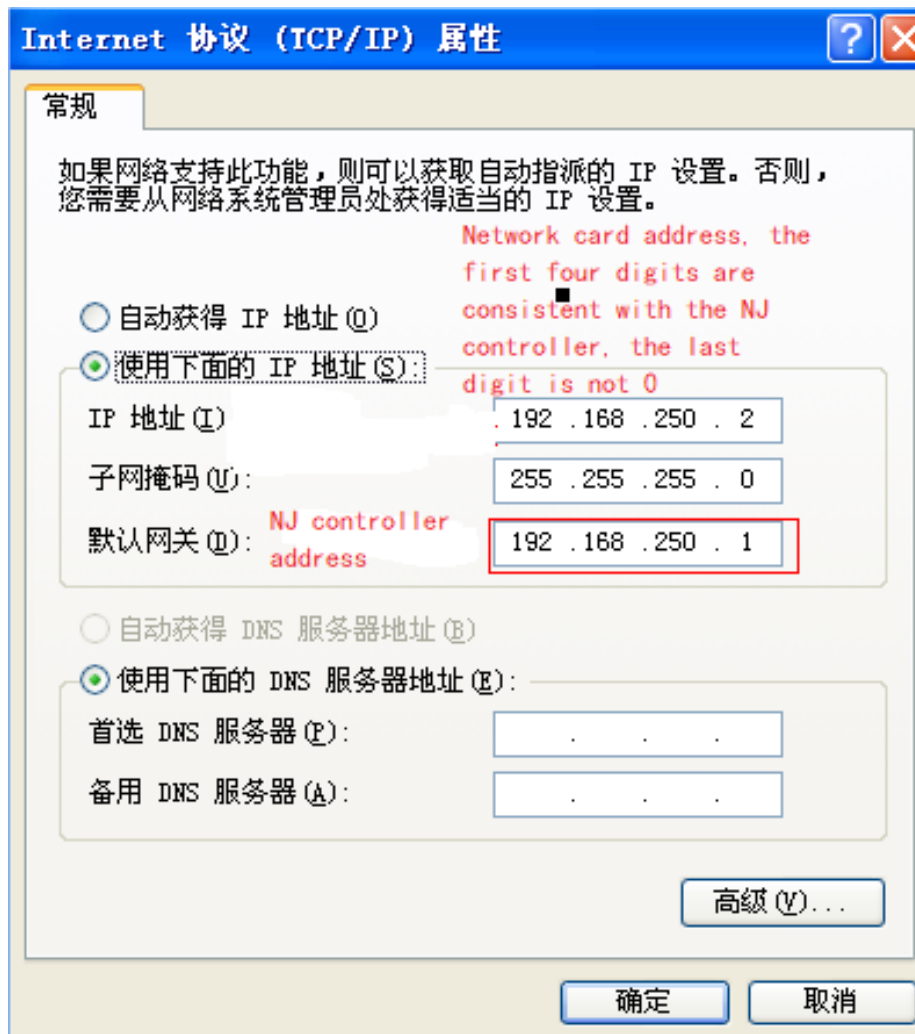
Use the device description file of "VECServeecat\_tensin.hex.xml" and above, the file placement path is as follows: OMRON\Sysmac Studio\IODeviceProfiles\EsiFiles\UserEsiFiles

When the xml file is placed in this path for the first time, the Sysmac studio software needs to be restarted.

3) Set the computer's network connection properties

If the computer and NJ controller choose USB direct connection, skip this step;

If the computer and NJ controller choose Ethernet to connect directly, set the TCP/IP properties of the computer, as shown in the figure below:



### 11.2.1 Servo parameter setting

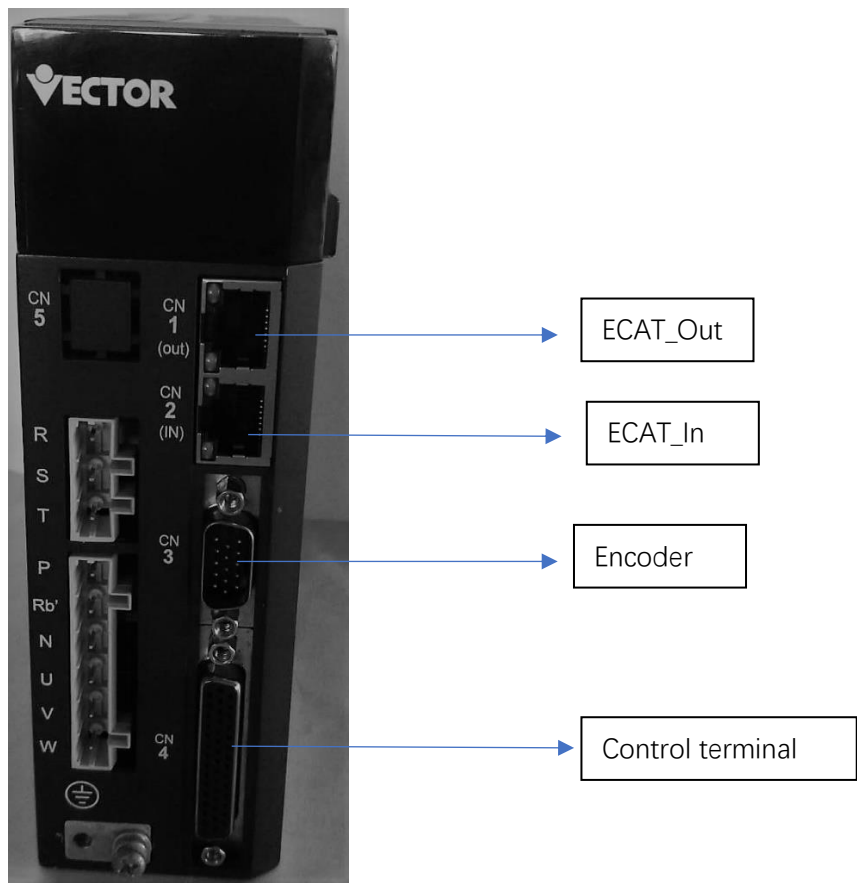
- 1) Servo parameter P08.41 sets the servo station number, this example is set to 1
- 2) Correspondence of digital input bits:

The functions of each bit of the 0X60FD digital input of the Omron controller are allocated as follows:

Bit	Signal	describe
0	Reverse overtravel switch	Each Bit reflects the current DI terminal logic of the drive; 0-Logic is invalid; 1- Logic is valid;
1	Forward overtravel switch	
2	Origin switch	

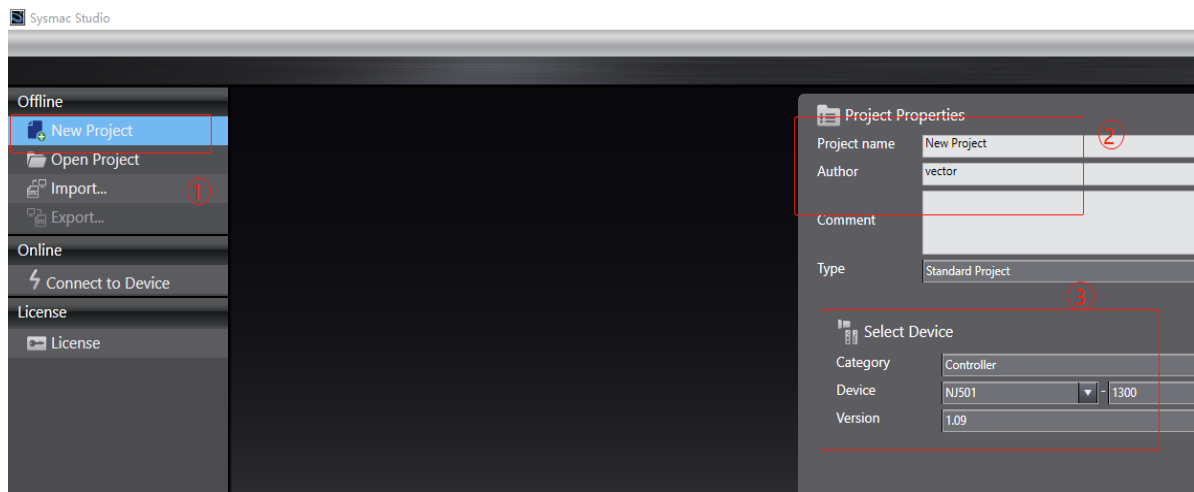
3-15	NA	In the process data configuration, please assign 60FD according to this table
16	Z signal	
17	Probe 1	
18	Probe 2	
25	DI emergency stop	
26-31	NA	

2) connect:



### 11.2.3 Omron NJ background software configuration

1) New Construction

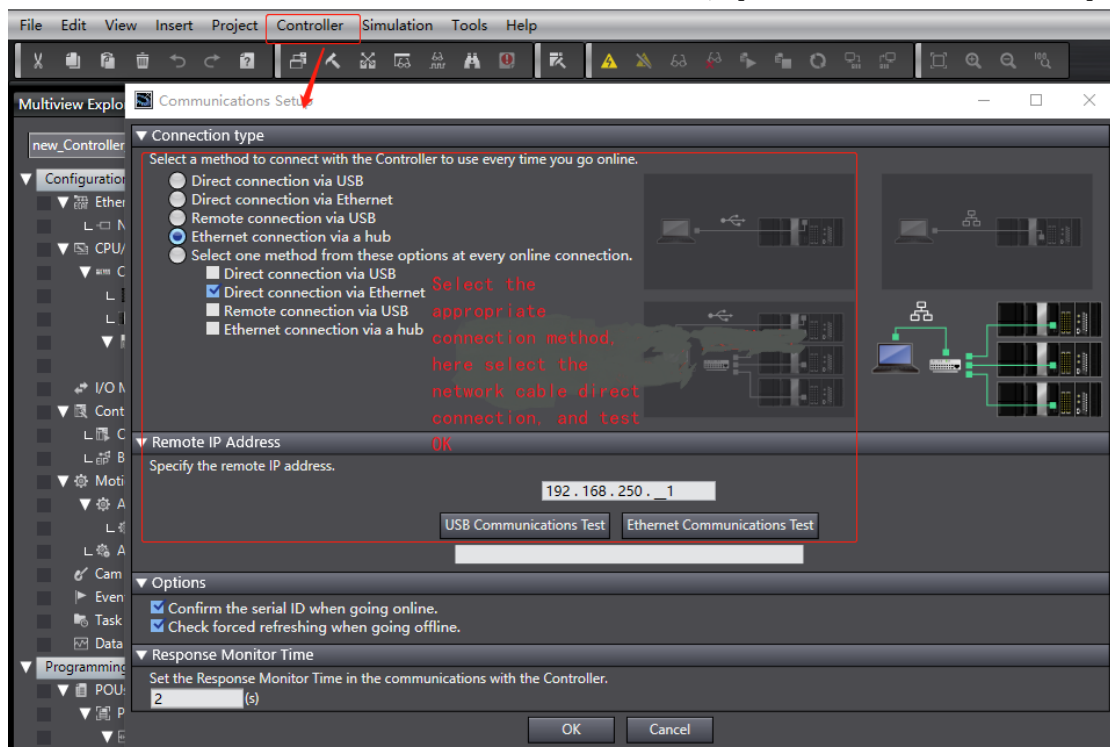


Equipment: Choose according to the actual NJ controller model

Version: New version 1.09 and above

## 2) Communication settings

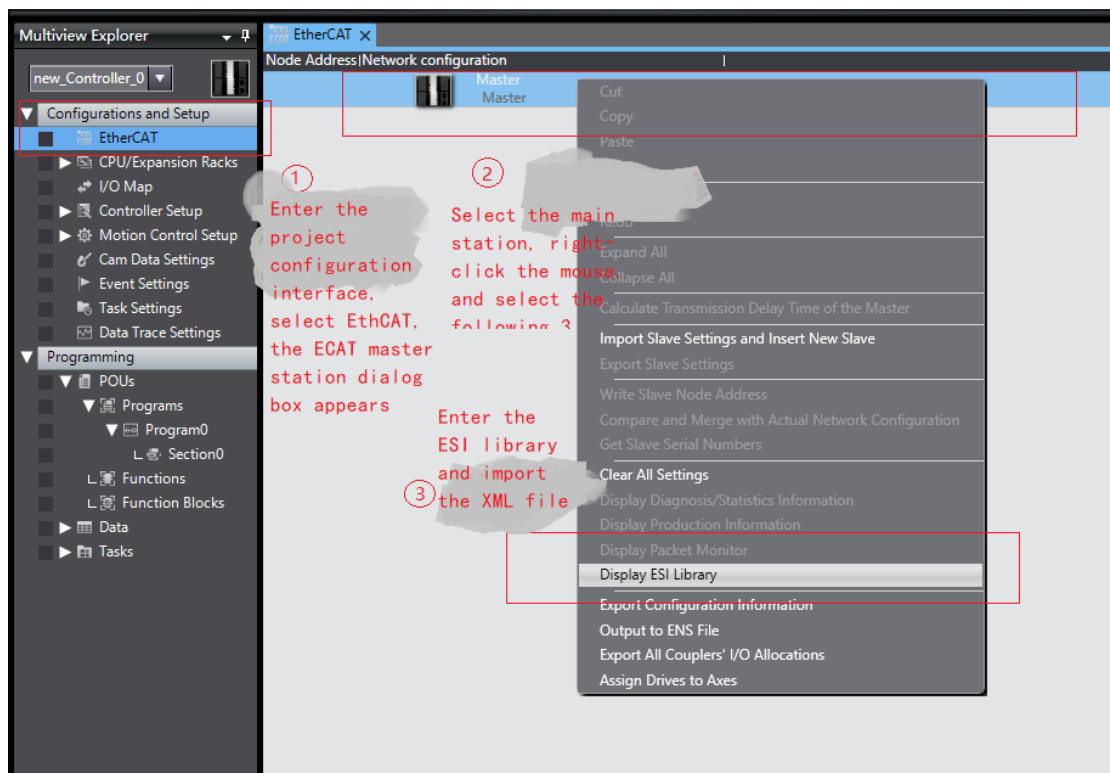
After entering the main interface, set the connection method between the computer and the NJ controller in "Controller"— "Communication Settings". Select "USB—Direct Connection", then directly proceed to "USB Communication Test", if the test is successful, proceed to the next step; Select "Ethernet—Direct connection", then set the IP address to the IP address controlled by NJ: 192.168.250.1, and then perform "Ethernet communication test". If the test is successful, proceed to the next step;



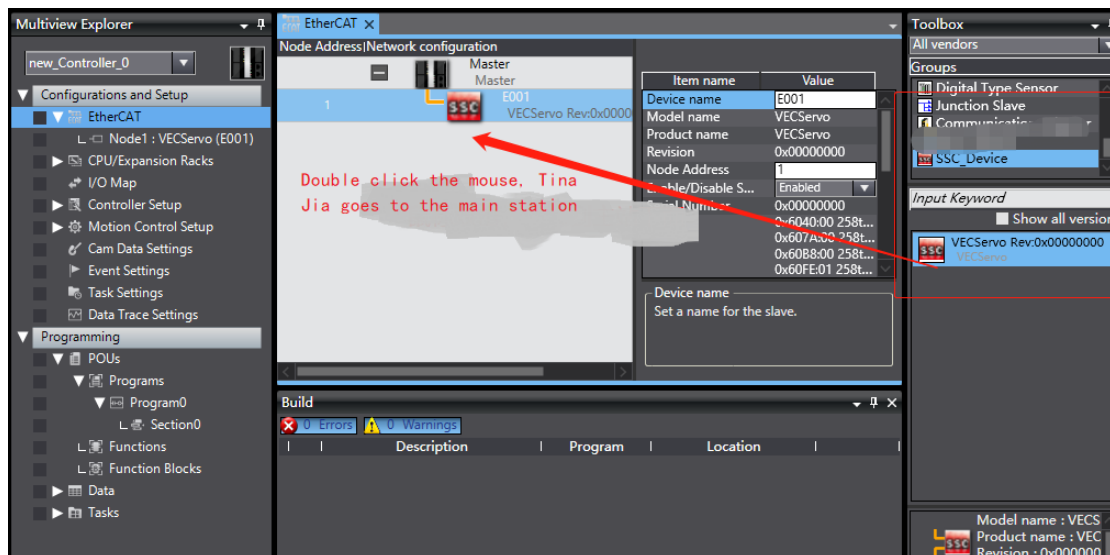
## 3) Add equipment

① Manually add, please follow this step to import the XML file before adding, if the file has already been imported when installing the software,

this step can be omitted



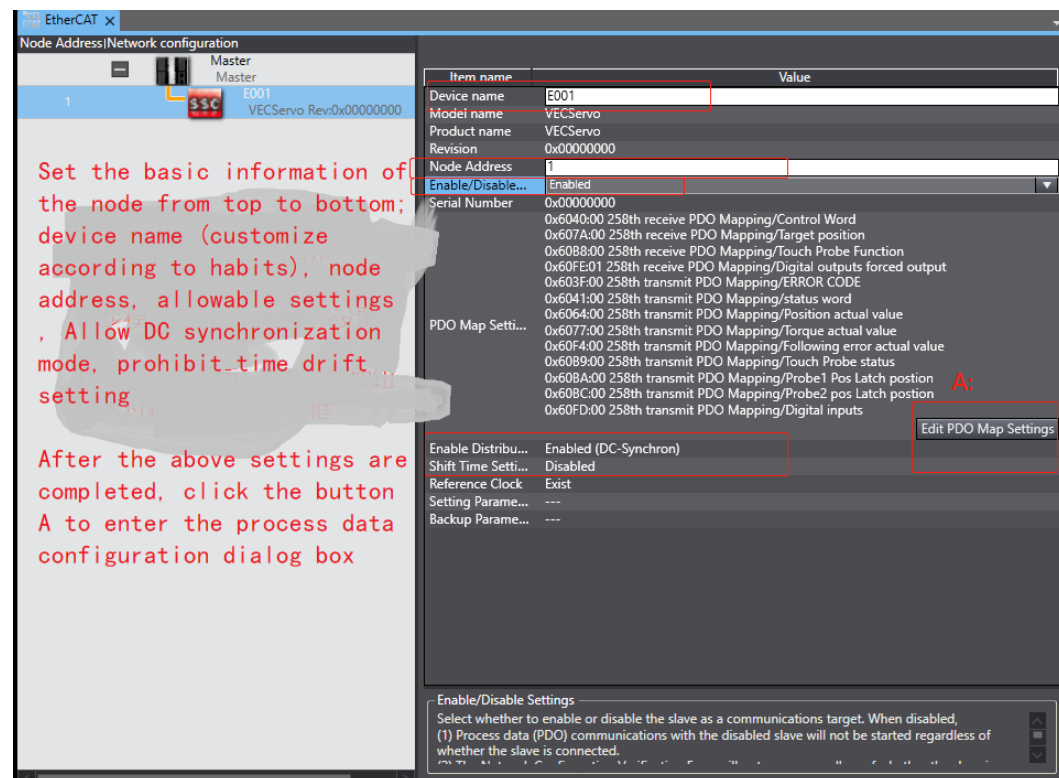
②After adding the XML file, close the software and reopen the software. The previously imported file will be automatically imported into the software as a device. VEC products can be found in the device components on the right.



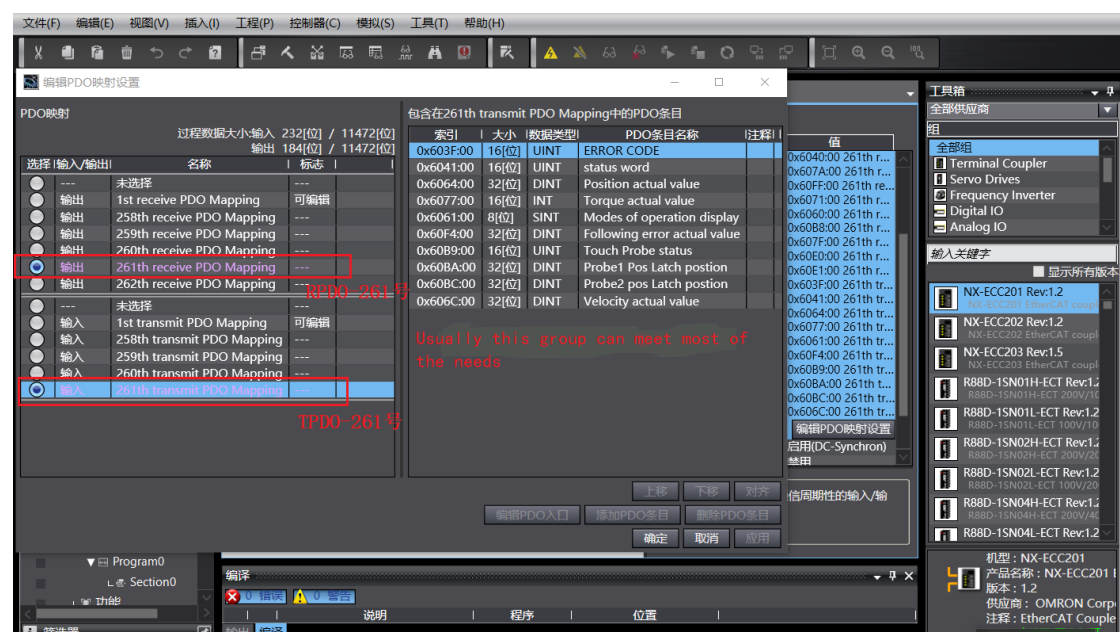
③Find "VECServo" from the equipment group on the right and click double-click, and all the version numbers of this component will be displayed in the version display column below. There is only one version. Double-click the component of this version, and the system will automatically add the component to the Master master. Below the station (a slave station appears under the master station), it means the addition is successful (if there is no related servo description file in the ESI library, the device cannot be found in the device group on the right, you need to follow the



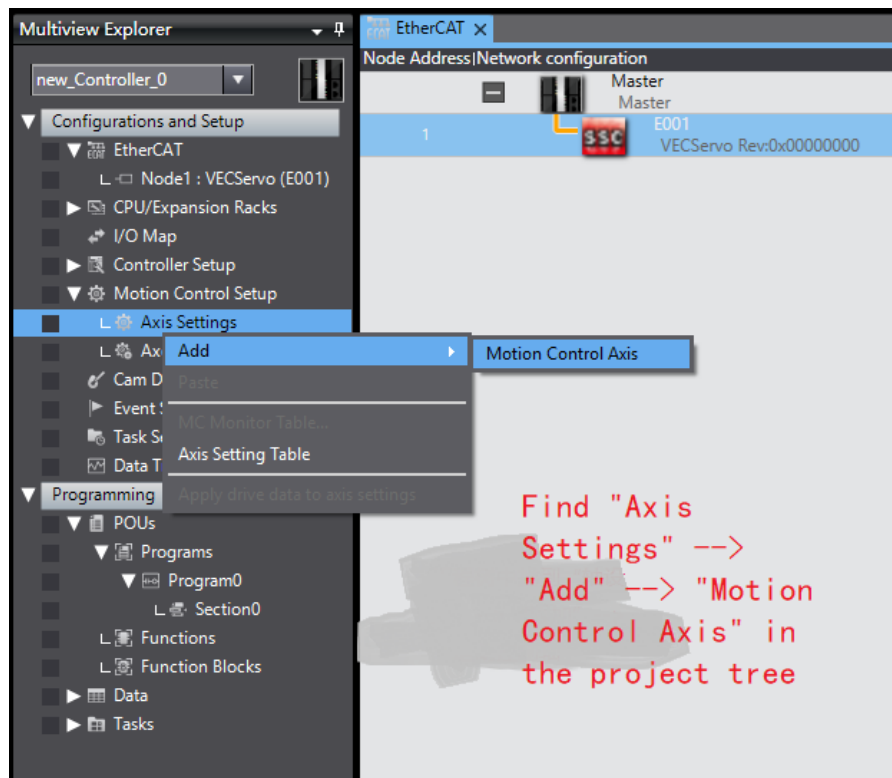
previous step ① after importing the XML file, and then proceed This step operates)  
 ④After the component is successfully added, you can configure the component node.  
 The figure below shows the configuration of the basic information of the node.



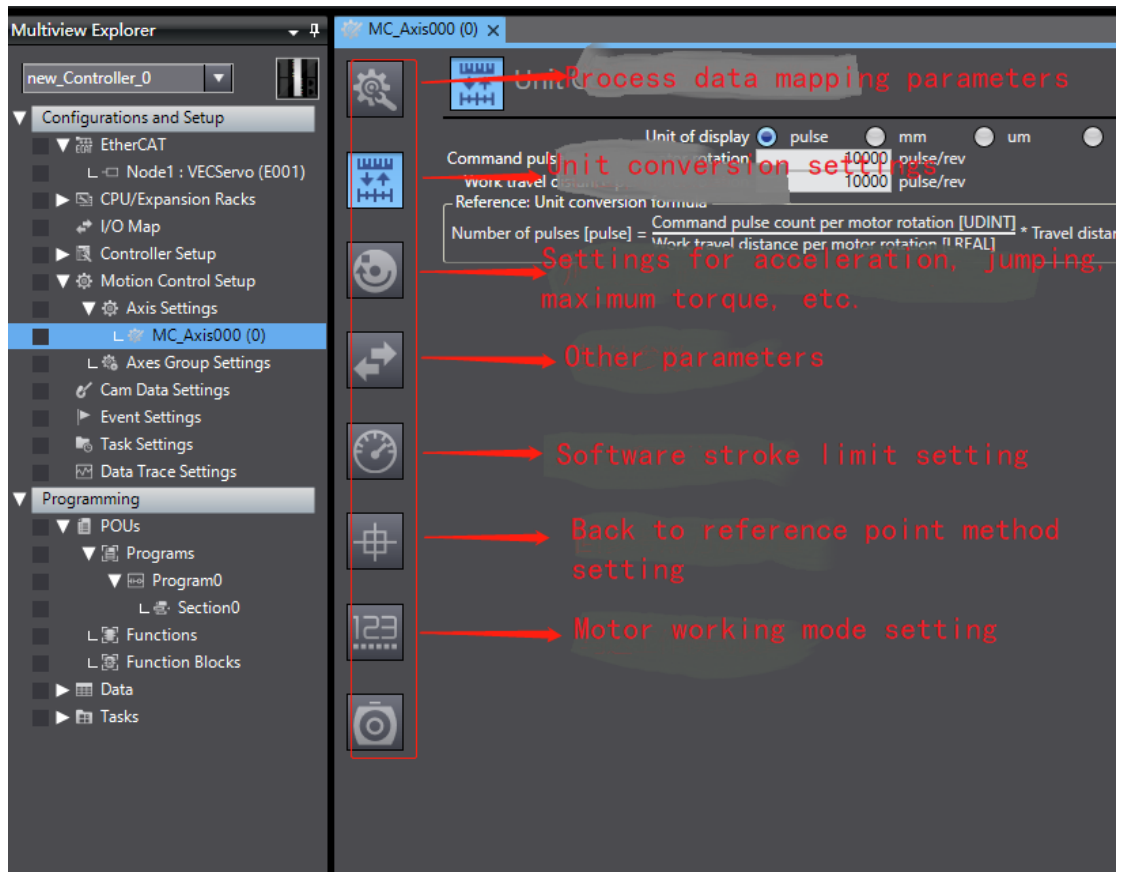
⑤Next, proceed to process data configuration, first click the "Edit PDO Map Settings" button at "A:" in the above figure with the mouse to enter the PDO mapping dialog box, and select a set of appropriate PDO mapping data according to the function of the component application and the working mode. , Click the "OK" button.



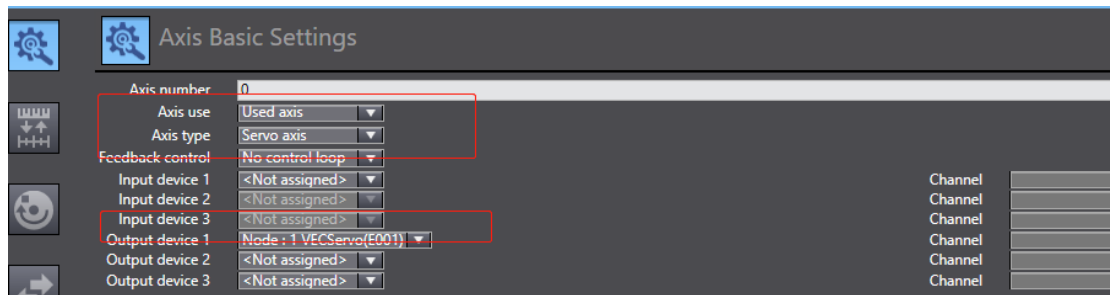
⑥ After the completion of step ⑤, the VEC component is officially hung under the master station as an IO device (at this time, it is only used as an ordinary IO device and cannot be used for motion control). Since the servo is usually used as a motion control device (axis), the next step is to configure the axis. Add a motion control axis as shown in the figure below. After adding, you can change the axis name according to the actual situation. Here, use the default axis name "MC\_Axis000"



⑦ After the new axis is created, double-click the new axis to set the axis parameters. The setting items are as follows.



a. Axis allocation.



b. Process data mapping. According to the PDO mapping object selected in "4) Parameter Configuration ① PDO Mapping Setting" above, assign output (controller to device) parameters and input parameters (device to controller) one by one. Note that the object name, node number, and index number must be Choose the right one. Each selected mapping object must be allocated correctly, otherwise an error will occur. 60FD must be mapped by bit, and must be mapped to be consistent with Omron's according to the following figure.

轴基本设置			
- 输出(控制器到设备)			
★ 1. Controlword	节点:1 VECServo(E001)	▼	6040h-00.0(261th rece
★ 3. Target position	节点:1 VECServo(E001)	▼	607Ah-00.0(261th rece
5. Target velocity	节点:1 VECServo(E001)	▼	60FFh-00.0(261th recei
7. Target torque	节点:1 VECServo(E001)	▼	6071h-00.0(261th rece
9. Max profile Velocity	节点:1 VECServo(E001)	▼	607Fh-00.0(261th rece
11. Modes of operation	节点:1 VECServo(E001)	▼	6060h-00.0(261th rece
15. Positive torque limit value	节点:1 VECServo(E001)	▼	60E0h-00.0(261th rece
16. Negative torque limit value	节点:1 VECServo(E001)	▼	60E1h-00.0(261th rece
21. Touch probe function	节点:1 VECServo(E001)	▼	60B8h-00.0(261th rece
44. Software Switch of Encoder's Input	<未分配>	▼	<未分配>
- 输入(设备到控制器)			
★ 22. Statusword	节点:1 VECServo(E001)	▼	6041h-00.0(261th tran
★ 23. Position actual value	节点:1 VECServo(E001)	▼	6064h-00.0(261th tran
24. Velocity actual value	节点:1 VECServo(E001)	▼	606Ch-00.0(261th tran
25. Torque actual value	节点:1 VECServo(E001)	▼	6077h-00.0(261th tran
27. Modes of operation display	节点:1 VECServo(E001)	▼	6061h-00.0(261th tran
40. Touch probe status	节点:1 VECServo(E001)	▼	60B9h-00.0(261th tran
41. Touch probe pos1 pos value	节点:1 VECServo(E001)	▼	60BAh-00.0(261th tran
42. Touch probe pos2 pos value	节点:1 VECServo(E001)	▼	60BCh-00.0(261th tran
43. Error code	节点:1 VECServo(E001)	▼	603Fh-00.0(261th tran
45. Status of Encoder's Input Slave	<未分配>	▼	<未分配>
46. Reference Position for csp	<未分配>	▼	<未分配>
- 数字输入			
28. Positive limit switch	节点:1 VECServo(E001)	▼	60F4h-00.1(261th tran
29. Negative limit switch	节点:1 VECServo(E001)	▼	60F4h-00.0(261th tran
30. Immediate Stop Input	节点:1 VECServo(E001)	▼	60F4h-00.25(261th tra
32. Encoder Phase Z Detection	节点:1 VECServo(E001)	▼	60F4h-00.16(261th tra
33. Home switch	节点:1 VECServo(E001)	▼	60F4h-00.2(261th tran
37. External Latch Input 1	节点:1 VECServo(E001)	▼	60F4h-00.17(261th tra
38. External Latch Input 2	节点:1 VECServo(E001)	▼	60F4h-00.18(261th tra

#### c. Unit conversion settings

According to the actual motor resolution, set the "command pulse number for one revolution of the motor" (for example, a 2500 line motor selects 10000 pulses per revolution). It needs to be set correctly, and the working stroke of one revolution of the motor can be kept as default. Actually it is similar to the electronic gear conversion done on the host computer, there is no need to set the conversion ratio inside the servo

EtherCAT
Section0 - Program0
MC\_Axis000 (0) x

Unit Conversion Settings

Unit of display
☐ pulse
☒ mm
☐ um
☐ nm
☐ degree
☐ inch

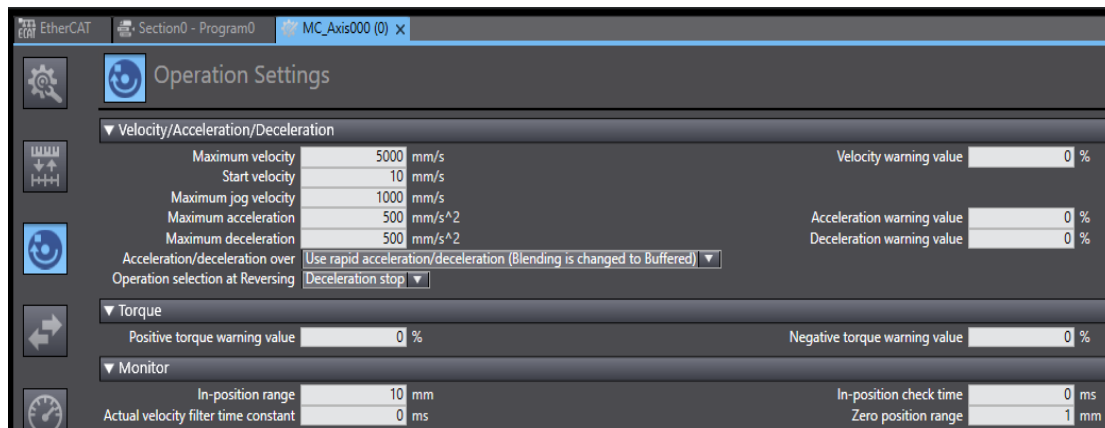
Command pulse count per motor rotation 10000 pulse/rev

Work travel distance per motor rotation 100 mm/rev

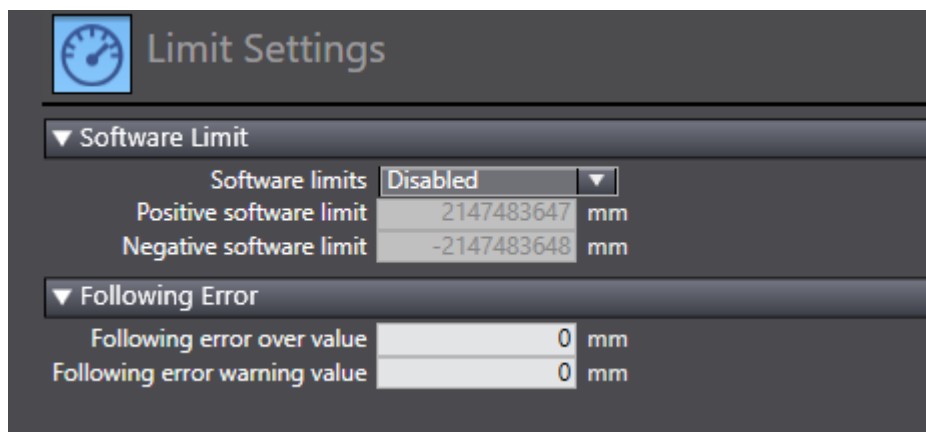
Reference: Unit conversion formula

$$\text{Number of pulses [pulse]} = \frac{\text{Command pulse count per motor rotation [UDINT]} \times \text{Travel distance [Unit of display]}}{\text{Work travel distance per motor rotation [LREAL]}}$$

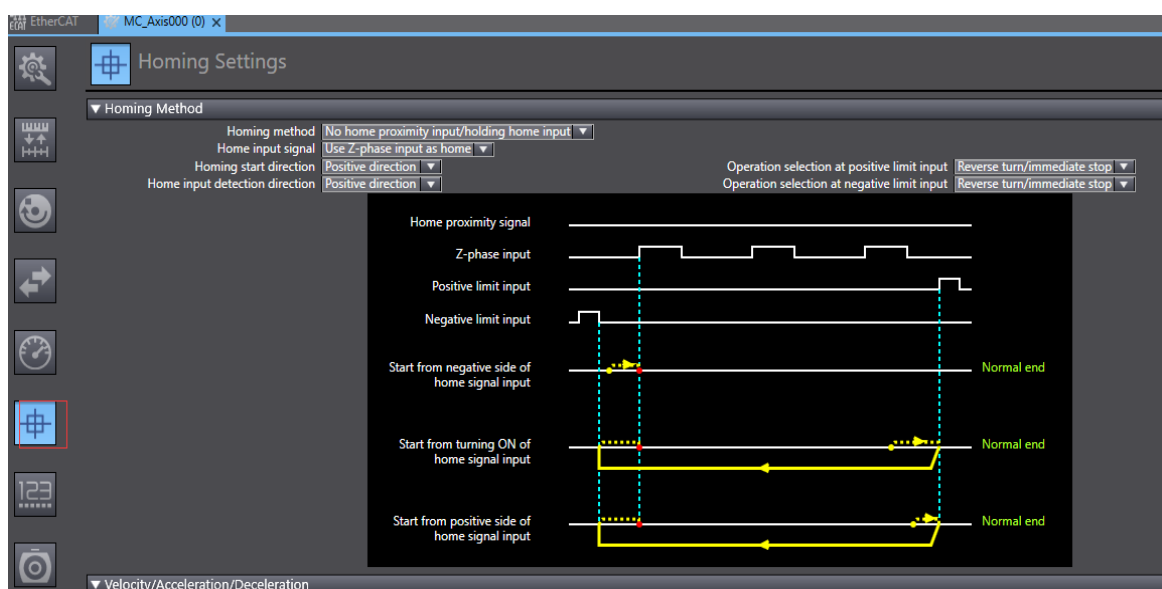
#### d. Acceleration/deceleration, jump, maximum torque, etc. settings



e. Software limit setting, software limit function can be selected, the software limit will take effect after using the host computer to return to the origin



f. Back to reference point method setting



Setting the origin return method requires special attention. It involves the cooperation of the servo and the upper computer function, please refer to the following table for setting

NJ software description servo corresponding function terminal configuration

Origin approach signal origin switch (nFn34) DI10

External origin input probe input 1 (default, no function number) DI8

Z phase signal input motor encoder Z phase signal N/A

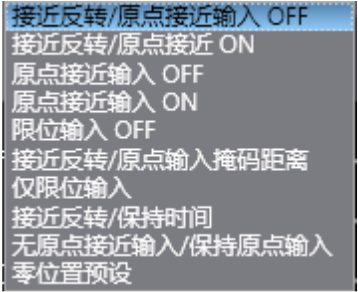
Positive limit input P-OT (nFn43) DI1

Negative limit input N-OT (nFn44) DI2

According to the actual mechanical conditions, select the homing mode of the host computer, and set the homing speed, acceleration, and origin offset.

Note: Z signal and external origin switch 2 choose 1, they will not be used at the same time

NJ software description	Servo corresponding function	Terminal configuration
The origin is close to the signal origin switch	(NFn34)	DI10
External origin input probe input 1	(Default, no function number)	DI8
Z phase signal input motor encoder	Z phase signal	N/A
Positive limit input P-OT	P-OT (nFn43)	DI1
Negative limit input	N-OT (nFn44)	DI2

	<p>Specify the return-to-origin action to be rewritten.</p> <p>0: Designated as nearby avoidance, near origin input OFF</p> <p>1: Designated as nearby avoidance, near origin input ON</p> <p>4: Designated as near origin input OFF</p> <p>5: Designated as near-origin input ON</p> <p>8: Designated as limit input OFF</p> <p>9: Designated as nearby avoidance, origin input shielding distance</p> <p>11: Only limit input</p> <p>12: Designated as nearby avoidance and contact time</p> <p>13: Designated as no near-origin input, touch-origin input</p> <p>14: Origin preset</p>
---	---

Origin proximity input OFF: refers to the origin search signal after encountering the falling edge of the origin proximity switch.

Origin proximity input ON: refers to the origin search signal when it encounters the rising edge of the origin proximity switch.

Nearby avoidance/approach reversal: that is, when the homing starts, the origin

approach signal is ON, and it runs in the reverse direction immediately after encountering the falling edge of the origin approach signal;

Origin input mask/shielding distance: After the host computer receives the origin search signal (such as the edge change of the origin approach signal), the origin signal is shielded within the set distance, and the origin signal is received after this distance;

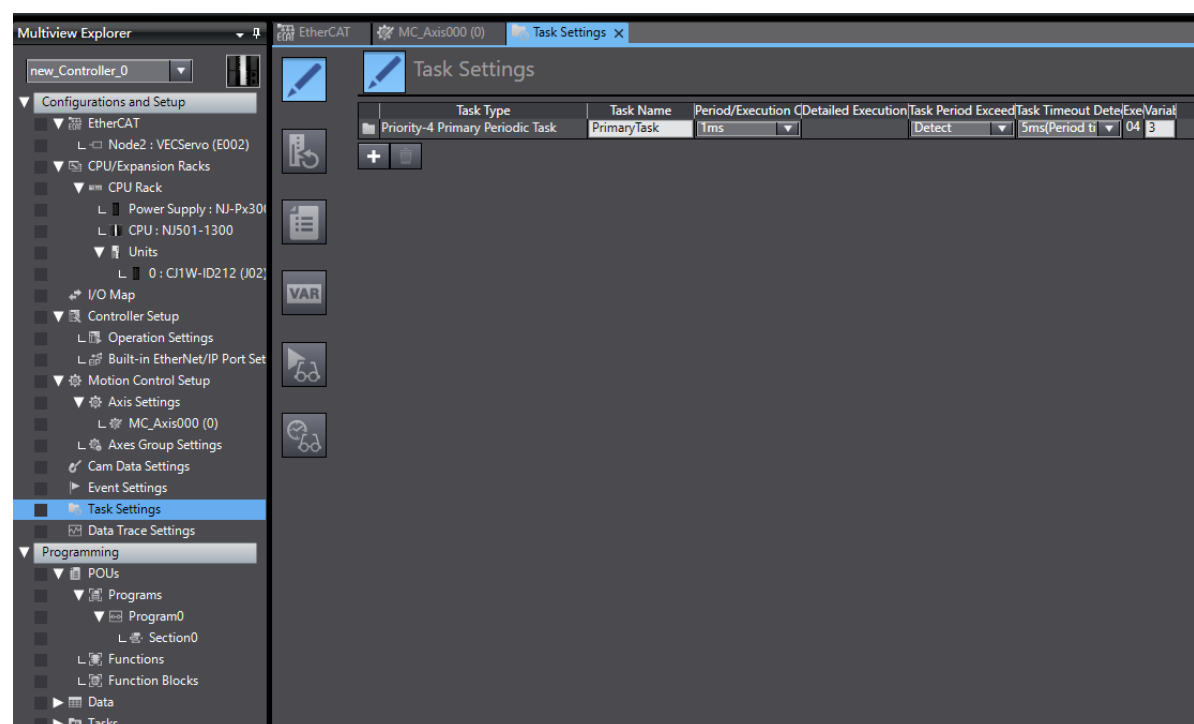
Hold time/contact time: After the host computer receives the origin search signal (such as the edge change of the origin approaching signal), the origin signal is shielded within the set time, and the origin signal is received after this period of time;

Zero position preset/origin preset: the current position is taken as the origin, the motor does not move, and the upper computer writes the origin offset into the position command/position feedback in the upper computer.

◆ Note:

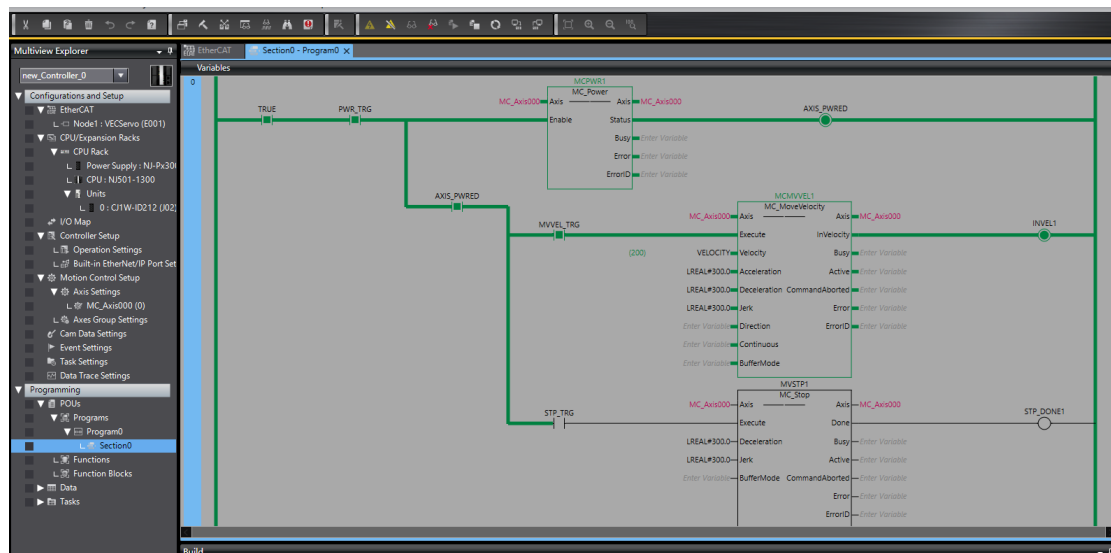
All homing methods are ultimately used to find the origin signal at low speed. If there is a high-speed running section, the origin signal will be shielded during the deceleration process from high speed to low speed.

⑦ After the above settings are completed, the added I/O slave device at this time has been formally associated with an axis that can be used for motion control. The user can use LD or ST instructions in the program to call the motion control module to control the device. The following describes the setting of the DC clock. The default clock is 1ms. In the offline state, you can change the synchronization clock (the cycle of the main fixed-period task) in the "Task Settings". In NJ, the name is "PDO Communication Cycle". , Re-power on and switch to online status, the changes will take effect.



#### 4) Program control


After the configuration is completed, the servo operation can be controlled by writing the PLC program. When using the "MC\_POWER" module, it is recommended to increase the axis servo status bit "MC\_Axis000.DrvStatus.Ready" to determine. Among them, MC\_Axis000 is the axis name to avoid the situation that when the PLC program runs first, but the communication has not been configured yet, the function module reports an error and cannot be enabled.




#### 5) Online operation

After all the settings and programming are completed, switch to the

online state and execute the download to the controller “”.

Use synchronization “”, Compare the difference between the current program and the program in the controller, and then decide whether to download to the

controller or upload from the controller according to needs “”, You can also leave it unchanged.

**NOTE** Regarding the mixed use of G5 series servos and third-party servos:



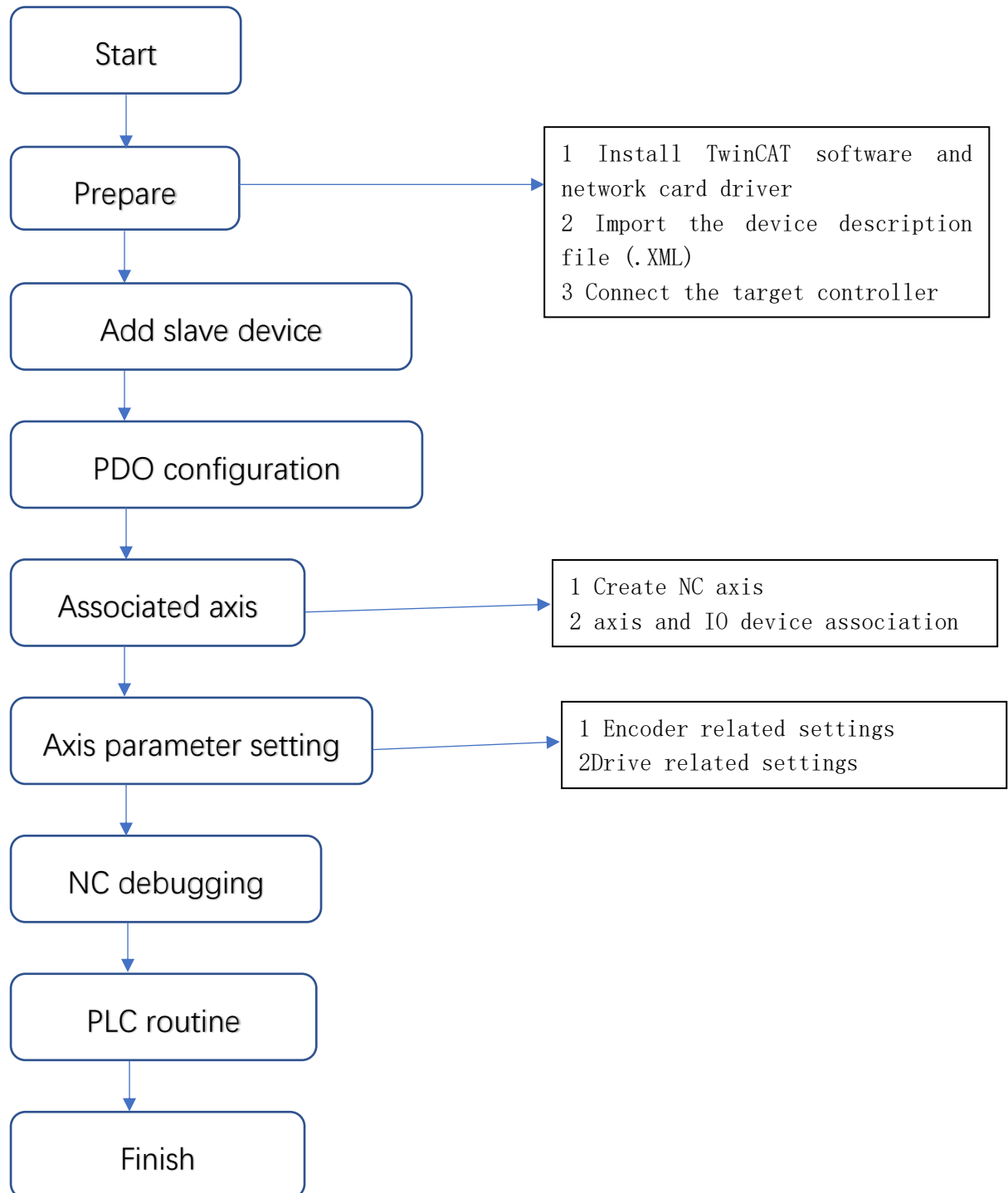
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According to user feedback, in the same network, regardless of the order of site address allocation, NJ will give priority to matching G5 series servos. After the G5 series servo network enters the operating state (Operation state), third-party servos will be configured.

---

# VC EtherCAT servo with Beckhoff TwinCAT master station operation routine

● Operation main flow



## 12.2.1 Installation and connection

### 1) Install TwinCAT software

The twinCAT software on Beckhoff's official website supports up to win7 32-bit system, but win7 64-bit system does not support it.

Windows xp system: It is recommended to install tcat\_2110\_2230

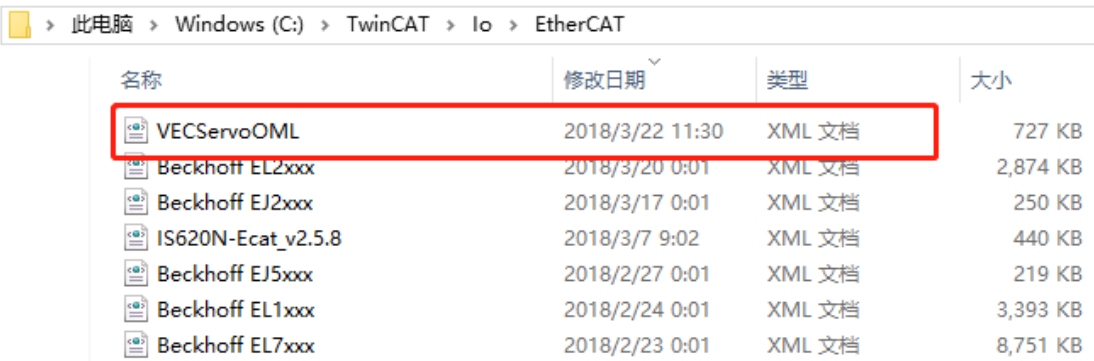
Windows 7 32-bit system: It is recommended to install tcat\_2110\_2248 and above

NOTE: Regarding the network card, you must choose a Fast Ethernet card with an intel chip. For the supported network card chip models, please refer to the announcement list on the Beckhoff official website (address link:

<https://infosys.beckhoff.com/english.php?content>

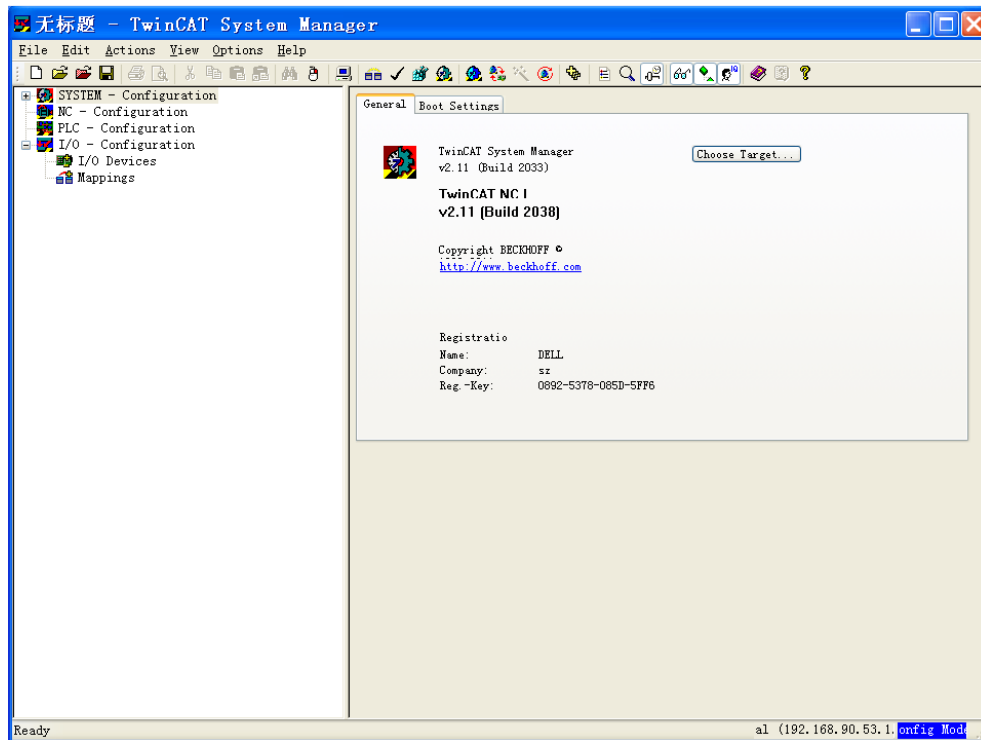
=../content/1033/tcsystemmanager/reference/ethercat/html/ethercat\_supnetworkcontroler.htm&id=). Other brands of network cards may not support EtherCAT operation.

### 2) Copy the EtherCAT configuration file (VECServoOML.XML) of the Vector E series servo to the TwinCAT installation directory: \TwinCAT\IO\EtherCAT.

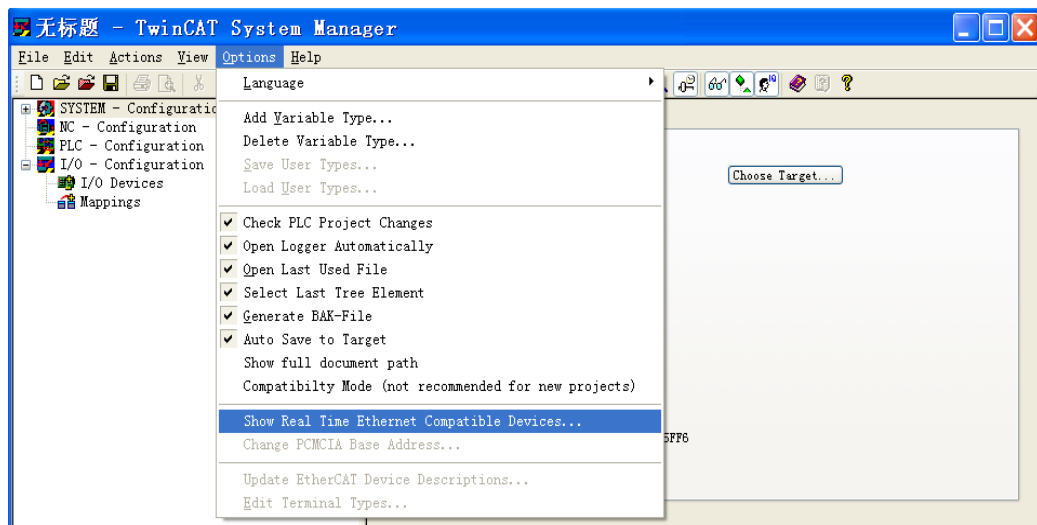


名称	修改日期	类型	大小
VECServoOML	2018/3/22 11:30	XML 文档	727 KB
Beckhoff EL2xxx	2018/3/20 0:01	XML 文档	2,874 KB
Beckhoff EJ2xxx	2018/3/17 0:01	XML 文档	250 KB
IS620N-Ecat_v2.5.8	2018/3/7 9:02	XML 文档	440 KB
Beckhoff EJ5xxx	2018/2/27 0:01	XML 文档	219 KB
Beckhoff EL1xxx	2018/2/24 0:01	XML 文档	3,393 KB
Beckhoff EL7xxx	2018/2/23 0:01	XML 文档	8,751 KB

### 3) Open TwinCAT system Manager software



### 3) Install TwinCAT network card driver

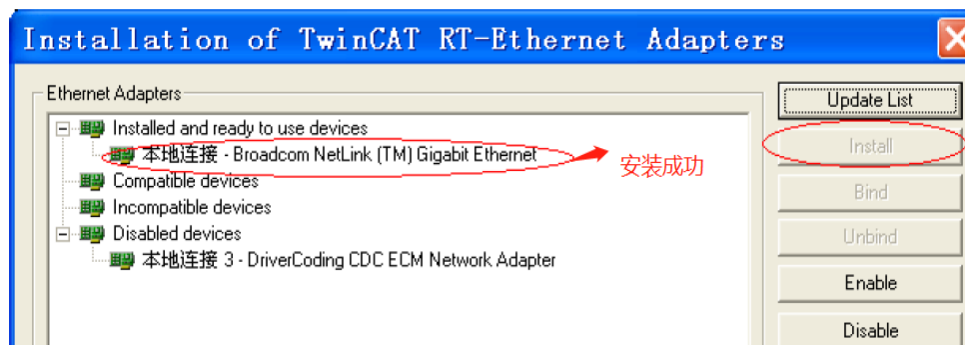


打开

In the above menu "Show Real Time Ethernet Compatible Devices...", the dialog box shown below will pop up, after selecting the local network card in the "Incompatible devices" column, click "install".



After the installation is complete, the installed network card appears in the "Installed and ready to use devices" column as shown below (try to choose a 100M network card with intel chips, other chips may cause unsuccessful installation or unstable problems)

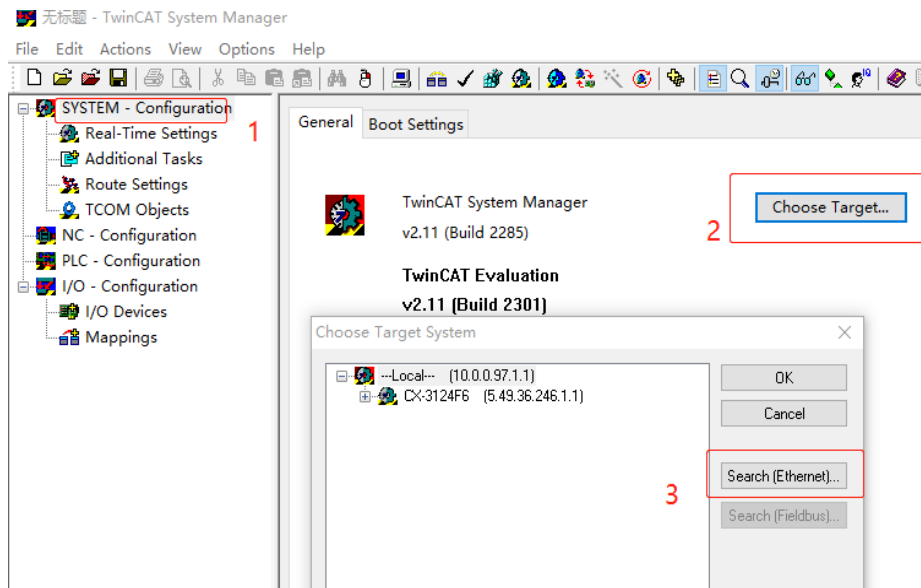


#### 4) Connect the target controller

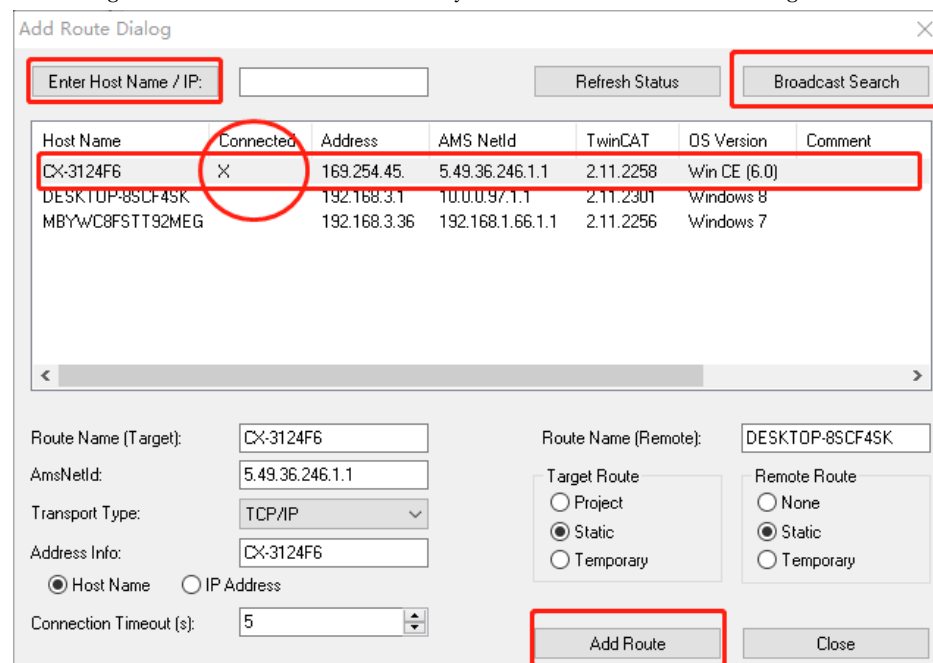
If the target controller is the local machine, you can omit this step and go directly to the next step "Search and add devices"; if the target controller is not the local machine, you need to perform the following steps (take Beckhoff CX5020 as an example)

(1) The default IP address of Beckhoff CX5020 is: 169.254.XX, and the subnet mask is 255.255.0.0, so you need to set the computer's IP and the controller to the same network segment (the mask is the same, the last two digits of the IP are set Different)

(2) Enter the target controller search interface according to the operation below



(1) You can enter the target controller name or determined IP through the input box on the right of "Enter Host Name/IP" for direct search, or use "Broadcast Search" for broadcast search. After the search is successful, click the "Add Route" button, and the dialog that appears Enter the user name and password in the box (the user name of the XP/WIN7 system is Administrator, the password is 1, and the WinCE password is blank), and then "Connected" in the target controller information bar will display "X" to indicate that the target controller path has been added successfully. Close the dialog The box returns to step (2), select the target controller and click "OK". So far, the steps of establishing the actual connection between the computer and the controller are completed. The process of connecting to the target controller is to easily add slave devices through online scanning later

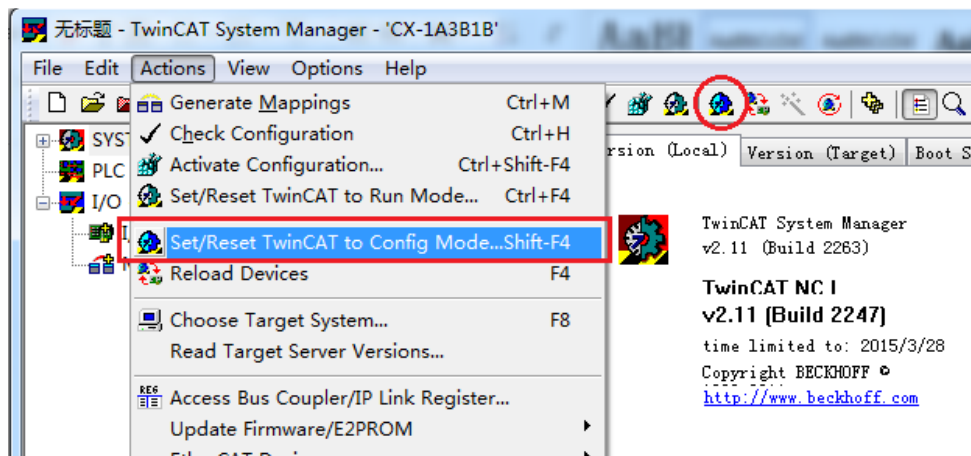


Through the status display in the status bar in the figure below, you can observe the actual connection of the target controller

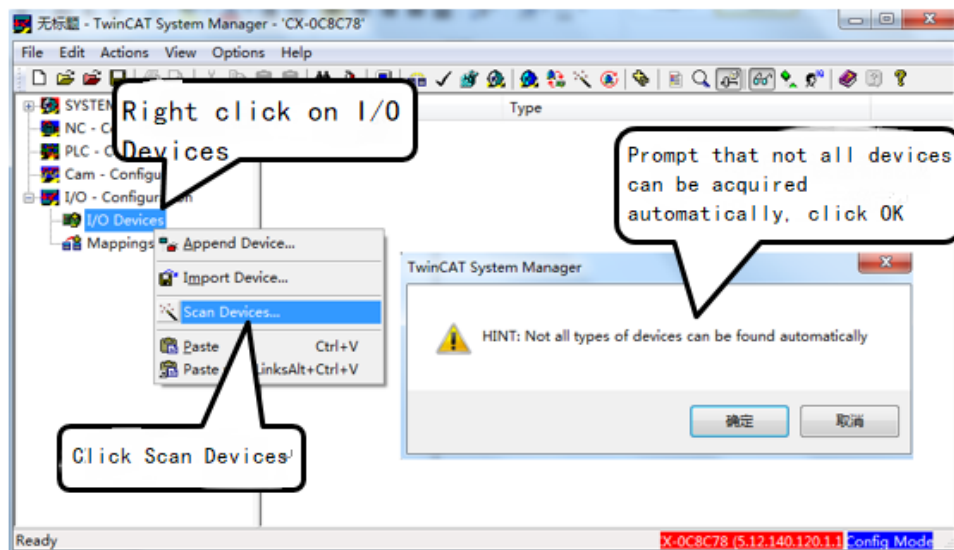
<u>RTime 10%</u>	The current target control is running
<u>Config Mode</u>	The current target control is configured
<u>Timeout</u>	The target controller is not connected

### 12.2.2 Add slave devices online

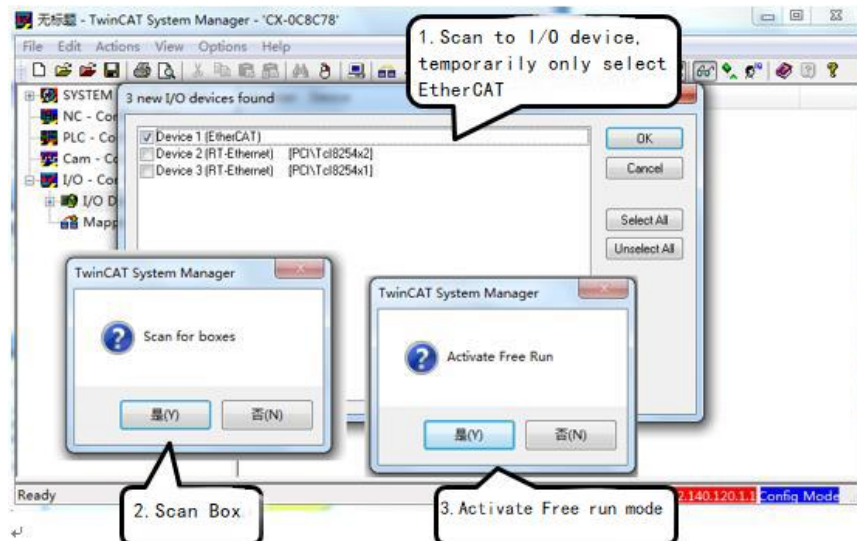
1) Operate as shown below to switch the controller state to configuration mode



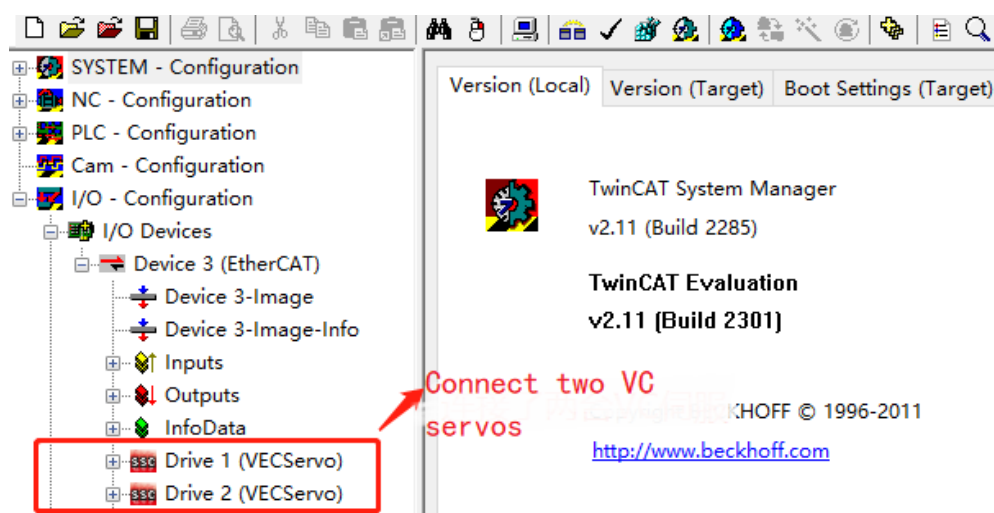
2) Select the scanning device in I/O Device to perform automatic scanning



3) The prompt window during the scanning process is as follows, the user can decide whether to activate the "Free Run" operating mode according to their needs. For servo control, basically it runs in the "DC synchronization" mode, so you can select "no"



4) After the scan is successful, expand the I/O Device tree structure, at the bottom layer, you can see all local and remote I/O modules and devices



### 12.2.3 PDO configuration

1) After the slave exhibition is added, we need to configure each slave node to send and receive PDO process data. The configuration content is selected according to the actual application of the slave. A total of 6 groups are defined for receiving and 5 groups for sending, including 0x1600 and 0x1A00. For variable mapping, the user can freely combine the configuration content. Others are fixed mappings and cannot be changed. For specific options, please refer to the introduction of the PDO mapping section of the servo manual. All servo nodes need to be configured one by one according to the following figure.



**All mappable PDO groups**

Index	Size	Name	Flags	SI
0x1A00	22.0	1st transmit PDO Mapping		3
0x1B01	28.0	258th transmit PDO Mapping	F	
0x1B02	25.0	259th transmit PDO Mapping	F	
0x1B03	29.0	260th transmit PDO Mapping	F	
0x1B04	29.0	261th transmit PDO Mapping	F	
0x1600	12.0	1st receive PDO Mapping		2
0x1701	12.0	258th receive PDO Mapping	F	
0x1702	19.0	259th receive PDO Mapping	F	
0x1703	17.0	260th receive PDO Mapping	F	
0x1704	23.0	261th receive PDO Mapping	F	
0x1705	19.0	262th receive PDO Mapping	F	

**Group details**

Index	Size	Offs	Name	Type
0x6040	2.0	0.0	Controlword	UINT
0x607A	4.0	2.0	Target position	DINT
0x60B8	2.0	6.0	Touch probe function	UINT
0x60FF	4.0	8.0	Target velocity	DINT

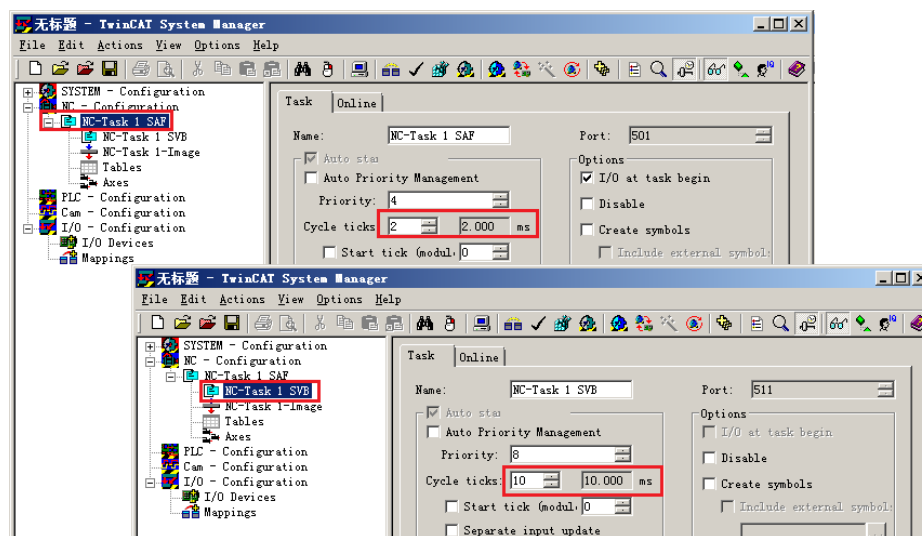
2) Through the toolbar “” Activate the configuration and click “” Run, you can perform some simple operations and view the status of the node and other parameters through the following figure

## 12.2.4 Associated NC axis

1) Right-click NC-Configuration, Append Task:

2) Edit the task name and click OK to directly use the default name.

### 3) Configure NC Task

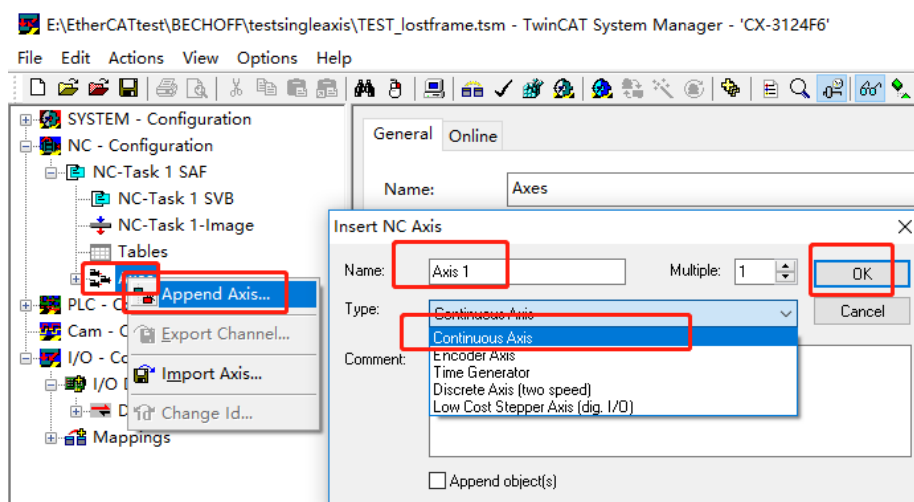


There are two NC tasks,

One is the SAF task, the default period is 2ms. This is the interval of interpolation during trajectory planning, the cycle of position loop calculation, and the cycle of data mapping between TwinCAT NC and TwinCAT IO. If it is synchronous mapping, then it is the EtherCAT communication cycle where the servo drive is located.

The other is the SVB task, the default period is 10ms. This is the cycle of data mapping between PLC and NC:

### 4) Add an axis as shown in the figure below. After the Axis is created, the type cannot be modified.



Continuous: The default type, continuous axis. NC can continuously obtain the state of the axis and control its precise positioning or other actions. Choose this type without special instructions. Encoder Axis: Encoder axis. NC can only read the position, but cannot control the movement of the axis. This kind of axis may be PLC controlled, it may be controlled by other systems, or it may

be manual. Usually this kind of shaft is used as the main shaft of the two-axis linkage, and the slave shaft follows it for gear or cam coupling.

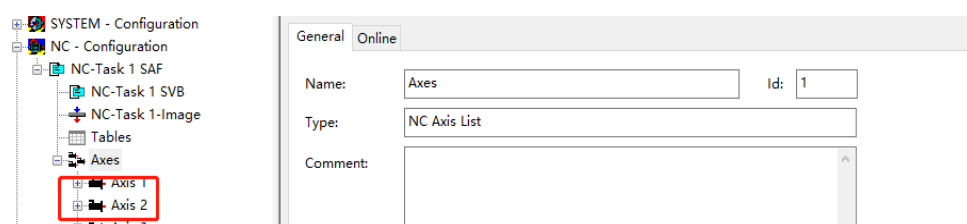
Multiple: The number of added axes, all types of axes (including NC I, Fifo, Kinematics, etc. Channels) cannot exceed 255 in total.

Time Generator: The time axis does not need to be enabled and cannot be stopped. It will always move at a constant speed of 1mm/s. But you can use the button Set Actual Position in Function or use MC\_SetActualPosition in the PLC program to set the current position. In practical applications, the time axis is often used as the main axis, and the actual axis follows it as an electronic gear (Gear) or cam movement (Camming).

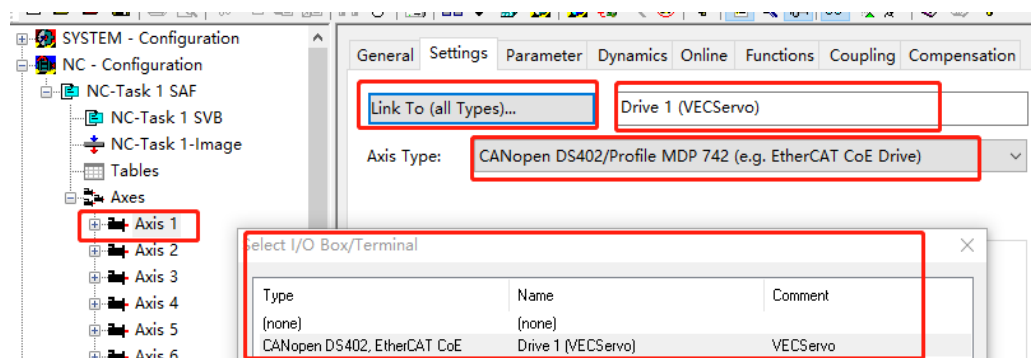
Discrete Axis (Two Speed): Not commonly used.

Low Cost Stepper Axis (dig I/O): Not commonly used.

5) After the axis is added, the following figure



6) Connect or associate the NC axis with the scanned I/O device (if it is a virtual axis, it does not need to be associated)



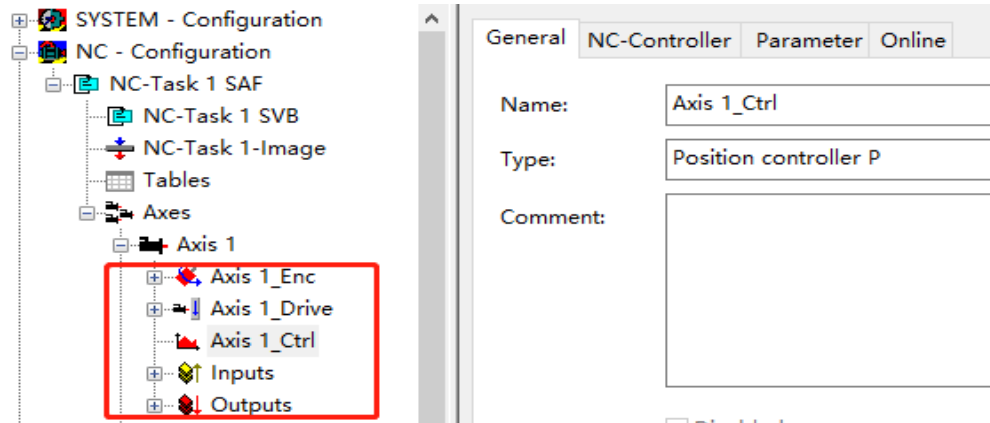
## 12.2.5 Axis parameter setting

1) Axis parameter settings, mainly encoder (Enc), drive (Drive), PID (Ctrl) controller settings.

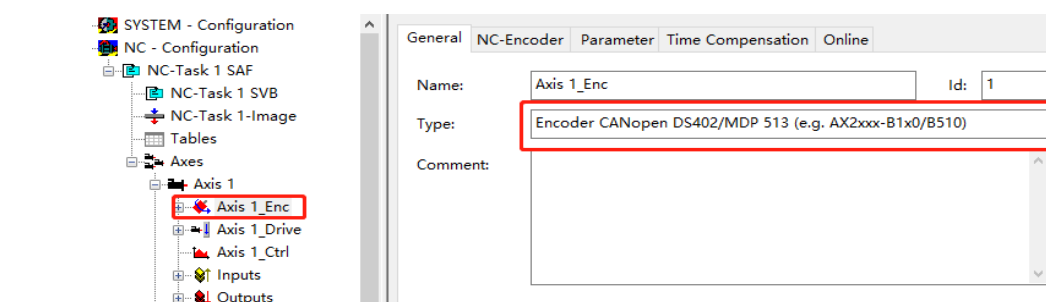
Enc is to set the parameters of the encoder, the most important is the pulse equivalent of the encoder (Scaling Factor).

Drive is to set the drive parameters, especially when the position loop is processed in the NC, the parameters here must be set.

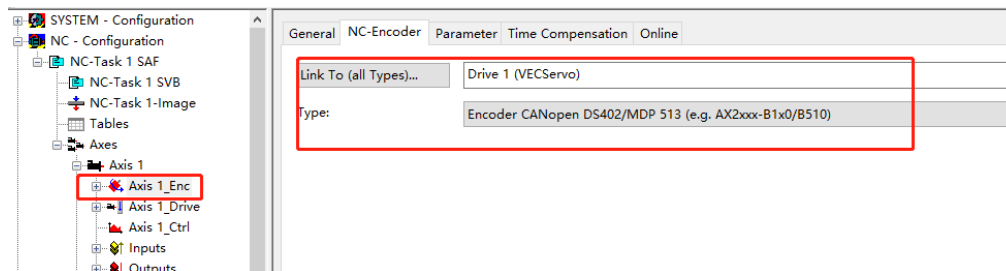
Ctrl is to set the PID parameters of the position loop. If the position loop is processed in the servo drive, this parameter is invalid.



### (1) General



### (2) NC-Encoder settings, select the type in the red box



### (3) Parameter

#### Encoder Evaluation

**Invert Encoder Counting Direction:** The encoder counting direction is reversed, and the default is False. If you want the motor to rotate forward and the position feedback value is reduced, you need to set it to True. At the same time, reverse the motor polarity (Invert Motor Polarity on the Parameter page of Drive under Axis item).

**Scaling Factor:** The distance corresponding to the encoder pulse of each position feedback. For example, if the motor rotates 10,000 pulses per revolution, and the motor rotates one revolution corresponds to 60mm, the Scaling Factor should be  $60/10000=0.006$  mm/Inc.

**Tip:** For no-load debugging, it is customary to set one circle to 60mm, so that the speed of 1mm/s is equivalent to 1 circle/min. Because the rated speed unit of the motor is rpm, it is more intuitive to use rpm as the speed unit during debugging.

**Position Bias:** The offset between the origin of the device and the zero

position of the encoder. After the mechanical installation is fixed, this value will not change. When using an absolute encoder, there is no need to search for parameters every time, just use this offset to calculate the device origin.

Because the position of a multi-turn absolute encoder is unchanged each time it is powered on, and the position of a single-turn absolute encoder is a Modulo value each time it is powered on.

Modular Factor: Modular length. Usually refers to the distance of Axis movement in a process cycle, the default value is 360. For example, the rotation spindle positioning action, the current position is 30 degrees, to be positioned to 60 degrees, the motor can rotate forward 30 degrees, or it can rotate 390 degrees, and eventually reach the same point. If the action is not repeated within a fixed length, this parameter can be ignored.

Encoder Mask: Encoder mask, related to the number of bits of the position variable, usually 32 bits, that is, the maximum is 0xFFFFFFFF.

Encoder Sub Mask: Encoder Sub Mask, which is related to the maximum feedback value. For example, for a 16-bit incremental encoder, it will become 0 if the positive direction exceeds 65535. At this time, NC will deal with the zero-crossing problem, knowing that the position is increasing steadily, instead of There is really a reverse mutation. At this time, Sub Mask should be set to 0x0000FFFF.

Parameter	Value
<b>Encoder Evaluation:</b>	
Invert Encoder Counting Direction	FALSE
Scaling Factor	0.006
Position Bias	0.0
Modulo Factor (e.g. 360.0°)	60.0
Tolerance Window for Modulo Start	0.0
Encoder Mask (maximum encoder value)	0xFFFFFFFF
Encoder Sub Mask (absolute range maximum value)	0x0000FFFF
Reference System	'INCREMENTAL'
<b>Limit Switches:</b>	
Soft Position Limit Minimum Monitoring	FALSE
Minimum Position	0.0
Soft Position Limit Maximum Monitoring	FALSE
Maximum Position	0.0
<b>Filter:</b>	
Filter Time for Actual Position (P-T1)	0.0
Filter Time for Actual Velocity (P-T1)	0.01
Filter Time for Actual Acceleration (P-T1)	0.1
<b>Homing:</b>	
Invert Direction for Calibration Cam Search	FALSE
Invert Direction for Sync Impuls Search	TRUE
Calibration Value	0.0
Reference Mode	'Hardware Sync'
<b>Other Settings:</b>	
Encoder Mode	'POSVELO'
Position Correction	FALSE
Filter Time Position Correction (P-T1)	0.0

Reference System: Reference point coordinate system:

General   NC-Encoder   <b>Parameter</b>   Sercos   Time Compensation   Online				
	Parameter	Value	T	Unit
-	Encoder Evaluation:			
	Invert Encoder Counting Direction	TRUE	B	
	Scaling Factor	0.000343322753906	F	mm/INC
	Position Bias	0.0	F	mm
	Modulo Factor (e.g. 360.0°)	360.0	F	mm
	Tolerance Window for Modulo Start	0.0	F	mm
	Encoder Mask (maximum encoder value)	0xFFFFFFFF		
	Encoder Sub Mask (absolute range maximum value)	0x000FFFFF		
	Reference System	'INCREMENTAL'		
-	Limit Switches:			
	Soft Position Limit Minimum Monitoring	'INCREMENTAL (singleturn absolute)	B	
	Minimum Position	'ABSOLUTE (with single overflow)'	F	mm
	Soft Position Limit Maximum Monitoring	'ABSOLUTE (modulo)'	B	
	Maximum Position	0.0	F	mm

The three parameters of Encoder Mask, Encoder SubMask and Reference System are combined to determine the "rule of converting the position feedback variable value into the actual position of the NC axis", and the Scaling Factor determines the conversion ratio. Under normal circumstances, these three parameters do not need to be set. After selecting the encoder type, the NC has determined their values. But after understanding the role of these parameters, you can do some flexible processing yourself according to the characteristics of the project.

Homing:

Invert Direction for Calibration Cam: Whether to move in the negative direction and find the origin.

Invert Direction for Sync Impulse Search: After finding the origin, whether to move in the negative direction to find the sync pulse.

Calibration Value: Reference point position. Usually this value is given in the PLC program, and it does not affect whether it is set here or not.

Reference Mode: Seek reference mode. The homing mode with action selects 'MC\_DefaultHoming', 'bCalibrationCam1' is the reference origin signal, when this signal comes (rising or falling edge, set in the shaft encoder parameters), detect the Z phase signal or detect probe 1 Signal to set the origin.

Other Settings:

Encoder Mode: Encoder mode, there are the following three options,

Pos: The encoder is only used to calculate the position. It is used when the position loop is in the drive.

PosVelo: The encoder is only used to calculate position and speed, and is used when the position loop is in TwinCAT NC.

PosVeloAcc: Choose when TwinCAT NC uses encoders to determine position, velocity and acceleration.

Time Compensation

Time compensation refers to dead zone compensation, which is often caused by sampling delay and is related to the NC cycle. Usually, you don't need to set it, and you can

add this compensation when the accuracy is particularly high.

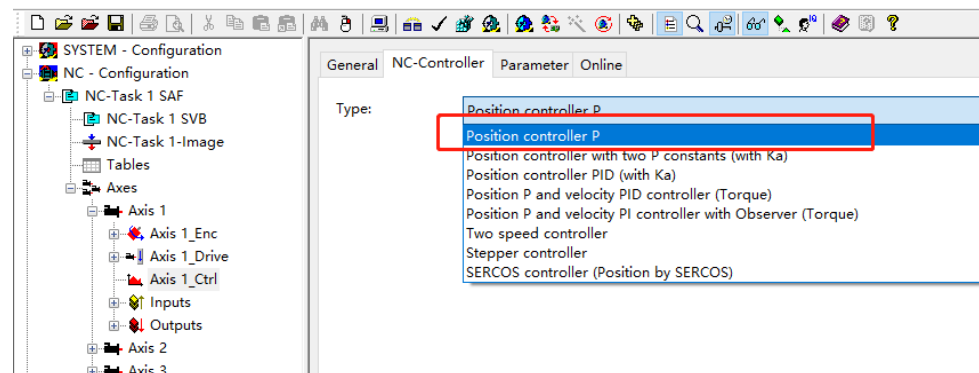
Online:

Monitoring page, no need to set

2) Drive settings

Generally, do not need to be set

3) Ctrl control parameter setting



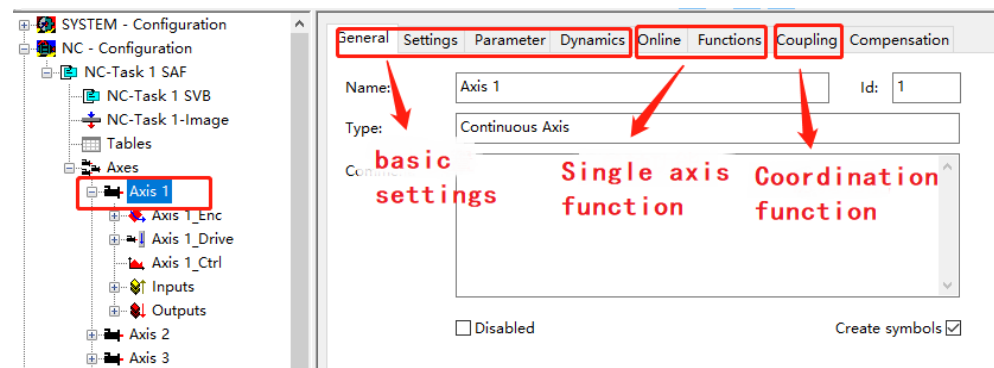
Position ring: drive Speed loop: drive	Drive: position mode	The default Position Controller P can be used, but the actual P value does not work.
Position ring: TwinCAT NC Speed loop: drive	Drive: Speed mode	Usually you can use the default Position Controller P, you can adjust the P value to change the response speed. Change the double P or PID only under special circumstances

Note: The speed loop can also be completed by TwinCAT NC, sending the target torque to the drive every cycle. But in fact, such use will greatly increase the load on the CPU and network, and few projects will use it in this way.

## 12.2.6 Commissioning of TwinCAT NC axis

The debugging and parameter setting of the TwinCAT NC axis are often carried out alternately, and the parameters are determined and modified during the debugging. The debugging of the project is divided into two parts: one is the debugging of the logic action, and the other is the debugging of the servo axis. The former can be carried out on the virtual axis, and the latter can be carried out in the NC debugging interface of the System Manager without the PLC program. After the logic actions and dynamic characteristics of the servo axis have been debugged, the PLC program can be used to control the servo axis actions (when debugging on the NC interface, please switch the PLC program to Stop mode or do it when you have not associated the PLC program. If it is associated with a PLC program for axis control and it is already in RUN mode, it will affect your use of the NC debugging interface). The following

describes how to debug the servo axis in System Manager.



## 1) General

**Name:** The name of the axis, writable.

**Type:** The category of the axis, which is determined when the axis is created, and cannot be modified here.

**Id:** The serial number of the axis, which is numbered in the order of creation and cannot be modified.

**Create symbols:** Select this option, and the external program (e.g. scope view) can access the parameters of the NC axis through the variable name.

**Disable:** Select this option and the NC axis will stop running.。

## 2) Settings

For Unit and Display settings, try to use the default values to avoid confusion caused by the unit mismatch of speed, displacement, and acceleration. If the hardware is not connected (not associated with the actual IO device), this page does not need to be set.

**Axis Type:** Because the protocol layer is CanOpen DS402, CanOpen DS402/ProfileMDP742 should be selected at this time

"Link to", the system will pop up the matching hardware, select the target axis, and press "OK".

## 3) Parameter

Axis debugging interface sets the parameters of the axis. After the setting is completed, you need to click the "Download" button to make the new parameter values effective. Some parameters can be modified at any time, such as Dynamic, and some parameters cannot be modified in the Enable state, such as Scaling Factor. Save the file and reactivate the configuration, and all modifications will take effect.

**Velocity:** Speed parameter

**Reference Velocity:** parameter speed, that is, the speed at the maximum value (32767) of the speed variable of Drive. The unit is mm/s.

**Maximum Velocity:** Maximum velocity. When debugging or PLC control axis action, the target velocity should not exceed this value, and should be slightly lower than the reference velocity, usually set to about 95% of the reference velocity.

**Manual Velocity (Fast/Slow):** The speed of the standard fast mode and standard slow mode when Jog is inching.



Calibration Velocity (Towards/off PLC Cam): The speed when going to the reference point and leaving the parameter point when seeking a reference.

JogIncrement (Forward/Backward): The displacement step of forward jog and reverse jog.

General Settings Parameter Dynamics Online Functions Coupling Compensation		
Parameter	Value	
- Velocities:		
Reference Velocity	16800.0	
Maximum Velocity	8000.0	
Manual Velocity (Fast)	300.0	
Manual Velocity (Slow)	100.0	
Calibration Velocity (towards plc cam)	30.0	
Calibration Velocity (off plc cam)	30.0	
Jog Increment (Forward)	5.0	
Jog Increment (Backward)	5.0	

Limit Switches: Soft limit parameter

General Settings Parameter Dynamics Online Functions Coupling Compensation			
Parameter	Value	U...	
+ Velocities:			
+ Dynamics:			
- Limit Switches:			
Soft Position Limit Minimum Monitoring	FALSE		
Minimum Position	0.0		mm
Soft Position Limit Maximum Monitoring	FALSE		
Maximum Position	0.0		mm

False: The soft limit function is disabled by default;


Minimum / Maximum Position: Minimum position and maximum position. The action stops when it exceeds, and NC reports an error.

Monitoring: Monitoring function settings

General Settings Parameter Dynamics Online Functions Coupling Compensation		
Parameter	Value	
- Monitoring:		
Position Lag Monitoring	TRUE	
Maximum Position Lag Value	5.0	
Maximum Position Lag Filter Time	0.02	
Position Range Monitoring	TRUE	
Position Range Window	5.0	
Target Position Monitoring	TRUE	
Target Position Window	2.0	
Target Position Monitoring Time	0.02	
In-Target Alarm	FALSE	
In-Target Timeout	5.0	
Motion Monitoring	FALSE	
Motion Monitoring Window	5.0	
Motion Monitoring Time	0.1	

Position Lag Monitoring: Following error monitoring, when it is True, monitoring is allowed, if the following error exceeds


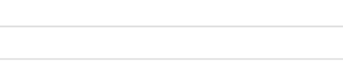
Maximum Position Lag Value, NC reported an error. Following error (also known as Following Error) can be monitored online in the Lag Distance shown in the figure below during debugging.

Functions		Coupling		Compensation	
General	Settings	Parameter	Dynamics	Online	
		0.0000		Setpoint [mm]	
Lag Distance [mm]		Actual Velocity: [mm/s]		Setpoint [mm/s]	
0.0000 (0.000, 0.000)		0.0000		0.0000	
Override: [%]		Total / Control [%]		Error:	
0.0000 %		0.00 / 0.00 %		0 (0x0)	
<b>Status (log.)</b> <input type="checkbox"/> Ready <input type="checkbox"/> Calibrated <input type="checkbox"/> Has Job <input checked="" type="checkbox"/> NOT Moving <input type="checkbox"/> Moving Fw <input type="checkbox"/> Moving Bw		<b>Status (phys.)</b> <input type="checkbox"/> Coupled Mode <input type="checkbox"/> In Target Pos. <input type="checkbox"/> In Pos. Range		<b>Enabling</b> <input type="checkbox"/> Controller: <input type="button" value="Set"/> <input type="checkbox"/> Feed Fw <input type="checkbox"/> Feed Bw	
Controller Kv-Factor: [mm/s/mm]		Reference Velocity: [mm/s]			
10		16800			
Target Position: [mm]		Target Velocity: [mm/s]			
0		0			

Position Lag Monitoring is True by default. If the virtual axis is used for testing or PID debugging is not performed, this function can be temporarily disabled. If the NC has a Following Error alarm, you need to adjust the Kv-Factor in the above figure, or the dynamic characteristics (acceleration/deceleration) of the Dynamics page.

Position Range Monitor and Target Position Monitor: Enable the position range and target position monitoring functions. Once the actual position enters the setting range, the corresponding NC mark will be set. During debugging, the status (phys.) of the flag can be displayed from the status (phys.) in the above figure.

#### 4) Dynamic

General	Settings	Parameter	Dynamics	Online	Functions	Coupling	Compensation
<input type="radio"/> Indirect by Acceleration Time							
Maximum Velocity (V max):		2000		mm/s			
Acceleration Time:		2		s			
Deceleration Time:		<input checked="" type="checkbox"/> as above 2		s			
		smooth		stiff			
Acceleration Characteristic:		<input type="range"/>					
Deceleration Characteristic:		<input type="range"/>					
a (t):							
v (t):							
<input checked="" type="radio"/> Direct							
Acceleration:		1500		mm/s <sup>2</sup>			
Deceleration:		<input checked="" type="checkbox"/> as above 1500		mm/s <sup>2</sup>			
Jerk:		2250		mm/s <sup>3</sup>			
				<input type="button" value="Download"/> <input type="button" value="Upload"/>			

There are two ways to set the dynamic characteristics of the NC axis: one is to set the time from the acceleration to the specified speed, and the other is to

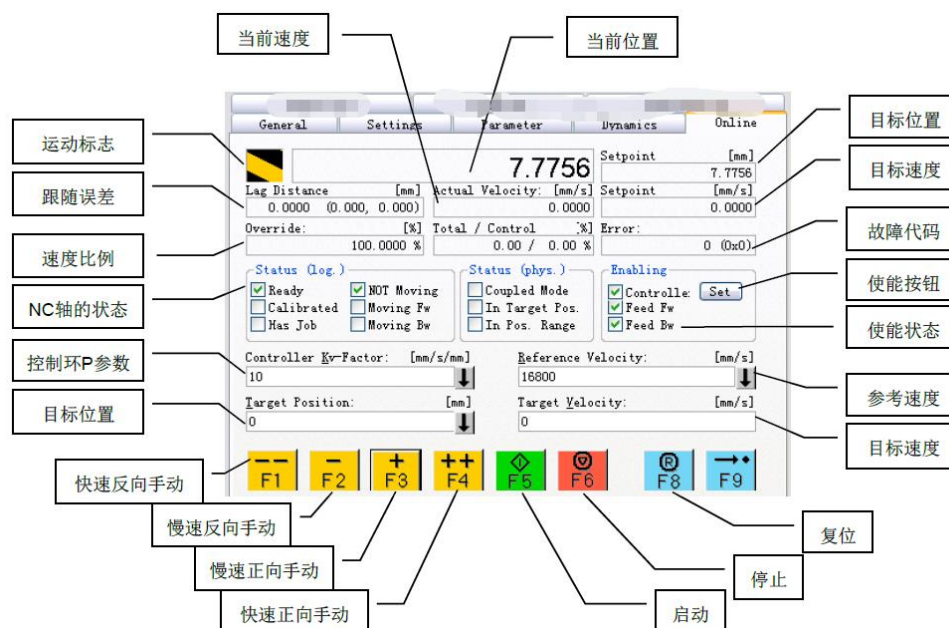
directly input the acceleration value. The author's experience believes that the method of setting the acceleration time is relatively intuitive and easy to modify.

In addition to setting the acceleration, you can also set the jerk. There are also two methods available: one is to pull the slider of the  $a(t)$  and  $v(t)$  characteristic curves, and the other is to directly input the Jerk value. The author's experience believes that the method of pulling the slider is relatively intuitive. The farther to the right, the faster the jerk and the greater the impact when the mechanism moves. On the contrary, the smoother the action of the mechanism.

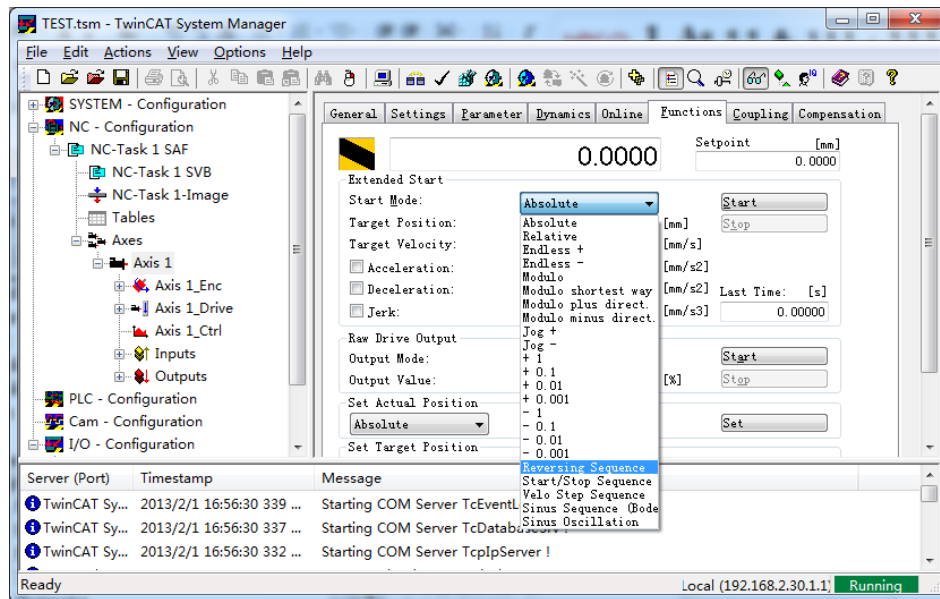
The dynamic characteristics should match the inertia of the motor, the inertia of the load, and the rated torque. Under the premise that the mechanical and electrical characteristics can be achieved, and the process permits, the shorter the acceleration time, the faster the speed of the entire system and the higher the production efficiency.

## 5) Online (Test jog)

This is the debugging page, which is only available when the current configuration file is consistent with the actual configuration file of the target system and the target system is in the Running mode. Therefore, after configuring the NC axis, it should be saved, and then log in to the target system and activate the configuration, and switch to operation



## 6) Functions (Test single axis motion)



This is the function debugging page. After enabling Axis on the Online page and the jog is normal, test the single-axis specified action on this page. Test whether the positioning of the axis is accurate to verify whether the pulse equivalent setting of the encoder is correct. Usually, Relative is used to let the motor go one circle, or let the mechanism go a specified distance. To adjust the PID parameters of the NC or drive, Reversing Sequence is usually used to make the motor forward and reverse. With the Scope View software of the electronic oscilloscope, the speed and position waveforms of different PID parameters can be continuously observed. Optimize the PID parameters, so that the speed fluctuation is small, and the position does not overshoot.

## 7) Coupling

General Settings Parameter Dynamics Online Functions **Coupling** Compensation

874591.3860 Setpoint Pos.: m] 874591.3860

Master/Slave Coupling

Master Axis: Axis 4 Couple

Coupling Mode: Flying Saw (Velo) Decouple

Coupling Factor: Linear Change Factor

Parameter 2: Flying Saw (Velo) Stop

Slope Angle: Flying Saw (Pos)

Parameter 4: Cyclic Change RAMP

Table Id: Const Surf.Velo RAMP

Interpolation Type: Linear

Slave Offset: 0 ☒ Absolute

Master Offset: 0 ☒ Absolute

On the function debugging page, after enabling Axis on the Online page and the jog is normal, test the dual-axis linkage on this page. By selecting Coupling Mode, you can choose electronic cam or electronic gear coupling. If you choose the cam mode, you also need to fill in the cam number in the Table Id box. If gear is selected, enter the gear ratio in Coupling Factor.

After clicking Coupling, the value of Setpoint in the upper right corner turns red, which indicates that the axis is in the coupled slave state at this time and cannot perform positioning, constant speed and other actions, nor can it set the current position or search parameters.

## 8) Compensation

凸轮进给补偿示例 - TwinCAT System Manager

File Edit Actions View Options Help

General Settings Parameter Dynamics Online Functions **Compensation**

0.0000 Setpoint [mm] 0.0000

Distance Compensation

Compensation Mode: Velo Red. Additive Start

Max. Acceleration Boost: Velo Red. Limited [mm/s<sup>2</sup>] Stop

Max. Deceleration Boost: Velo Red. Limited [mm/s<sup>2</sup>]

Max. Boost Velocity: Length Red. Lim. [mm/s]

Process Velocity: Acc. Red. Additive [mm/s]

Compensation Delta: 0 [mm]

Compensation Range: 0 [mm]

Function debugging page, after testing that the specified action of each axis is normal on the Function page, test the position compensation here.

System Manager

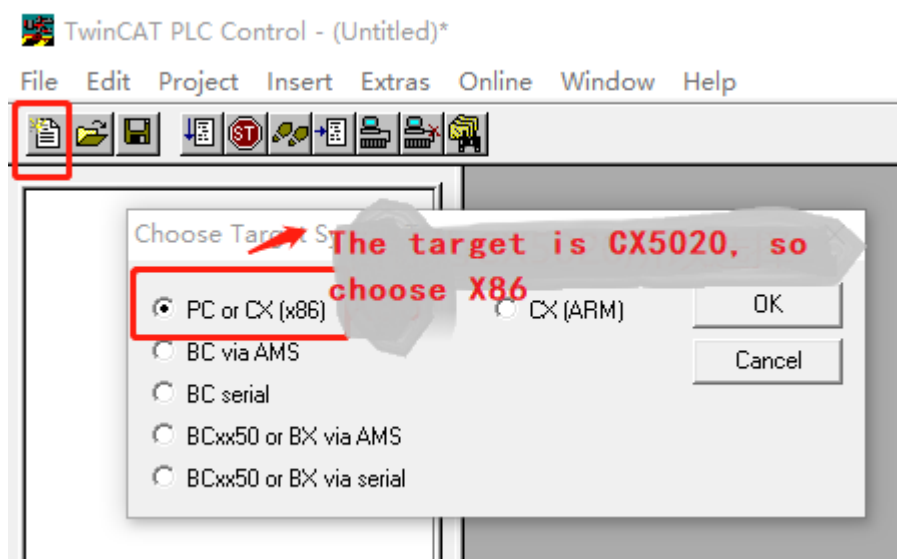
MC\_MoveSuperImposedExt

Compensation Mode	Mode
Velo Red Additive	SUPERPOSITIONMODE_VELOREDUCTION_ADDITIVEMOTION
Velo Red Limited	SUPERPOSITIONMODE_VELOREDUCTION_LIMITEDMOTION
Length Red Additive	SUPERPOSITIONMODE_LENGTHREDUCTION_ADDITIVEMOTION
Length Red Limited	SUPERPOSITIONMODE_LENGTHREDUCTION_LIMITEDMOTION
Acc Red Limited	
Acc Red Limited	
Compensation Delta	Distance
Max Boost Velocity	VelocityDiff
Max Acceleration Boost	Acceleration
Max Deceleration Boost	Deceleration
	Jerk
Process Velocity	VelocityProcess
Compensation Range	Length

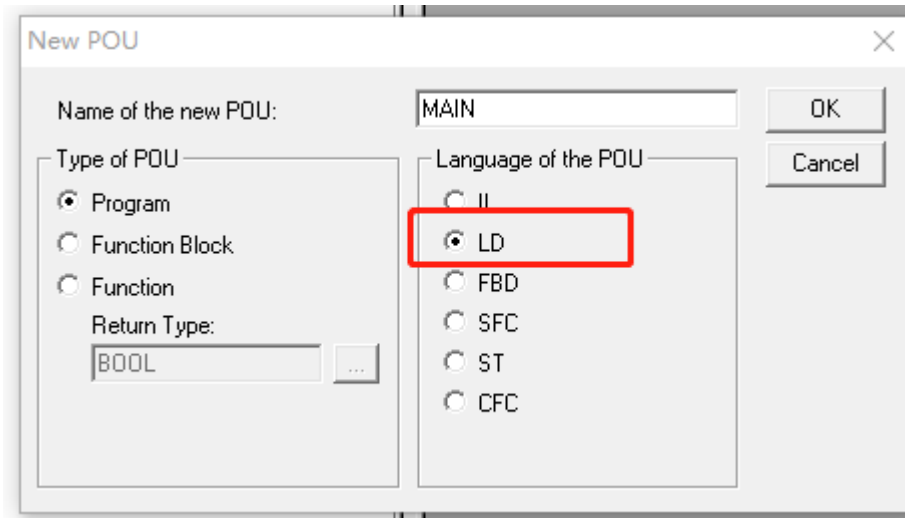
Note: After enabling, you can pass 5), 6), 7), and 8) to test each function separately.

## 12.2.6 PLC as NC control routine

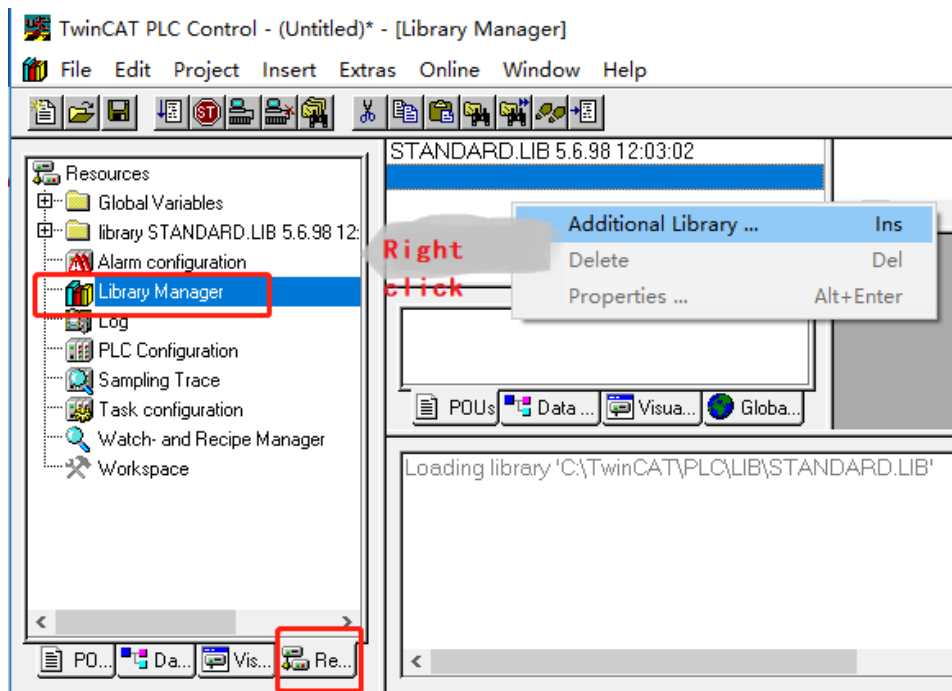
1) Open the "TwinCAT PLC Control" software, select the controller type, and create a new project,



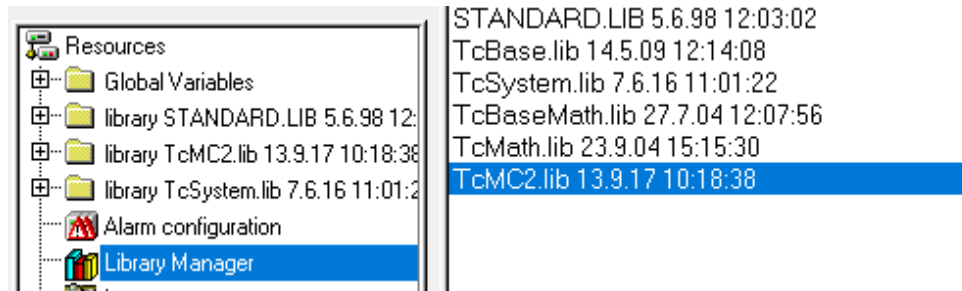
2) Select the programming language, here select LD



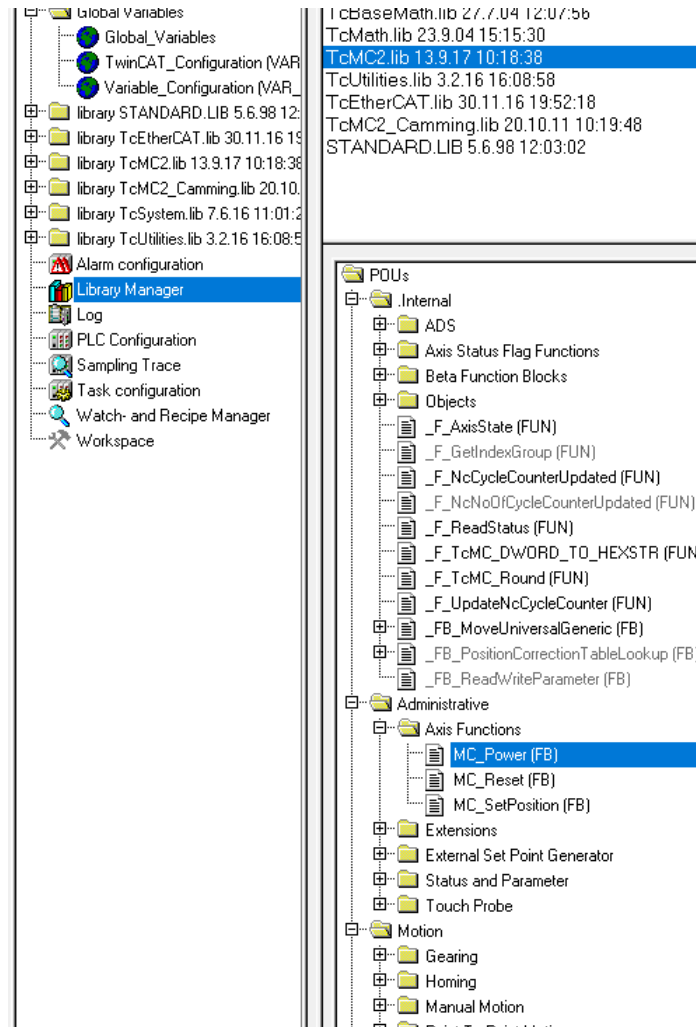
3) Add motion control function library "TcMc2.lib"



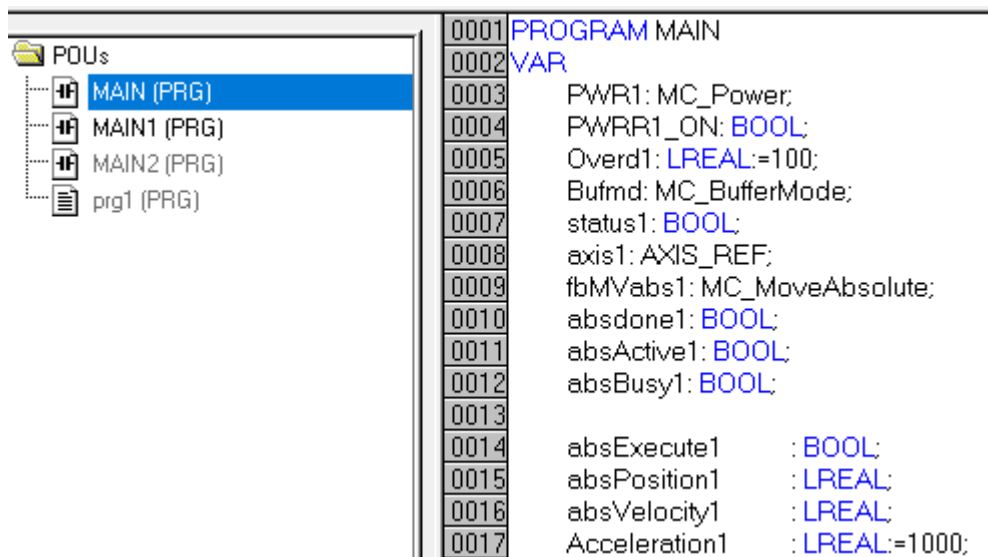
After adding, it will be displayed as follows



4) Write the PLC control program, call the motion control module through the library, and press the F1 key to enable the instruction help

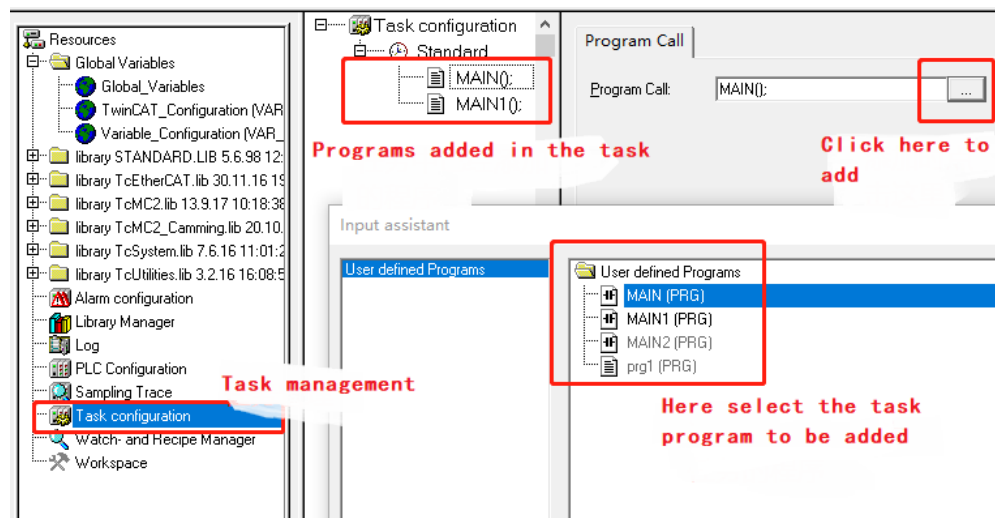


5) Create a program through POU

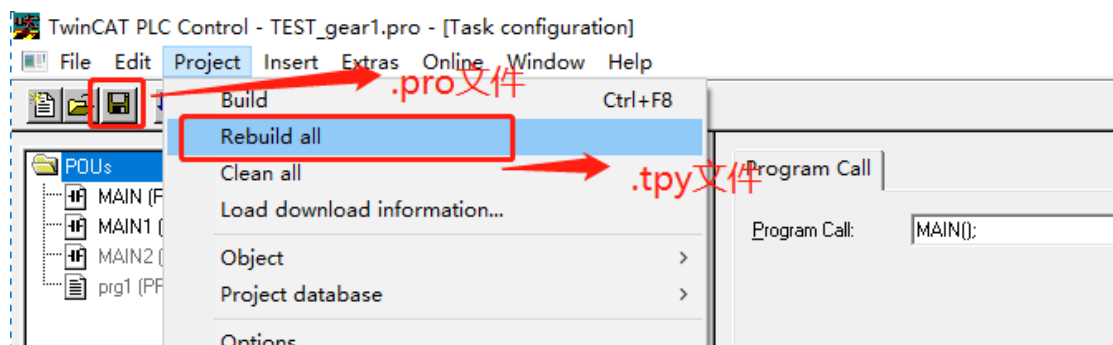




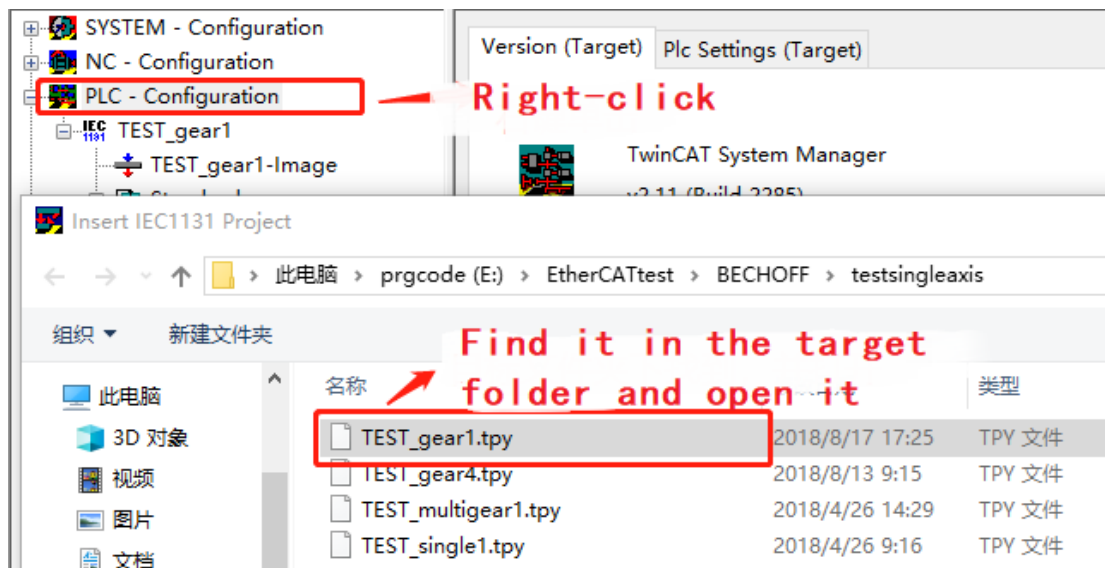
6) Add the written program as a task to the task configuration area. Programs that are not added to the task will not be downloaded to the controller after being compiled. The controller only runs the added task



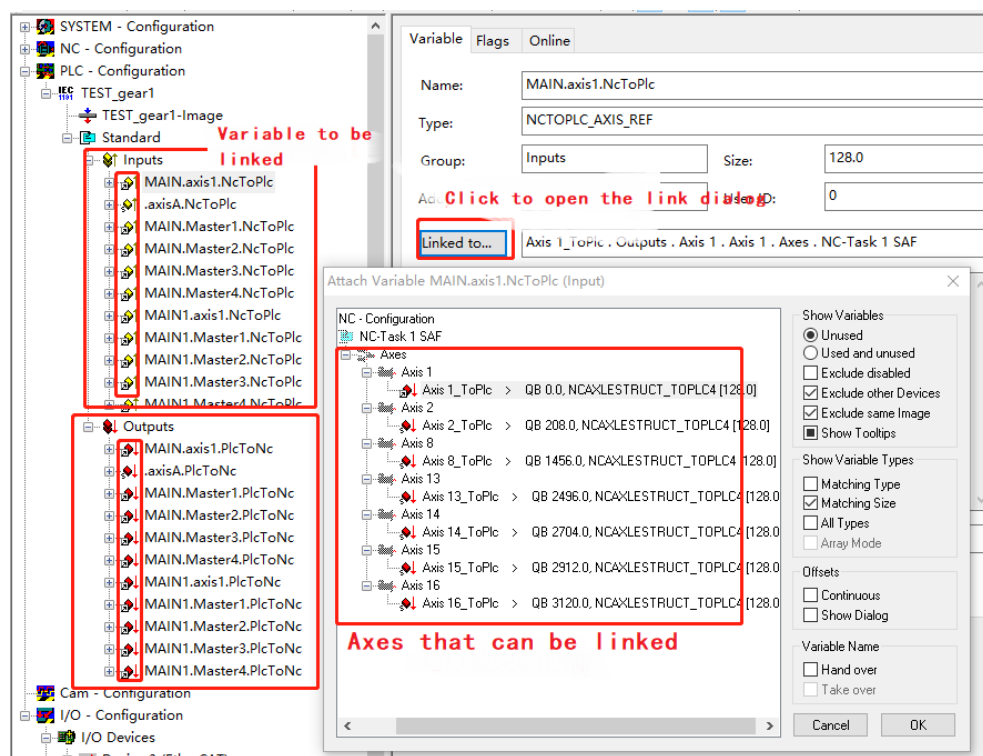
7) Save and compile the program. After compiling, a .tpy file will be generated for TwinCATsystemManager to call



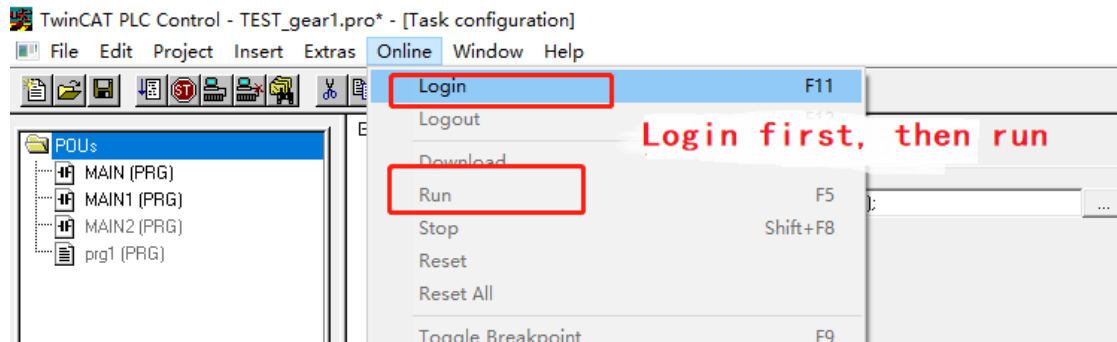
8) Return to the TwinCAT system Manager software interface to call the .tpy file generated above



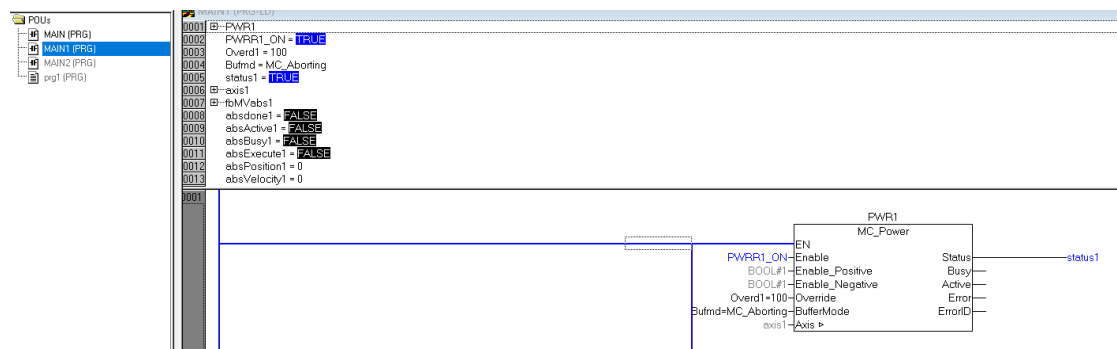
9) Open the structure of the imported file, and associate the input and output parts with the corresponding NC axis. After the association, an arrow pointing to the upper right corner will appear as a mark



10) Save and activate the configuration, switch to DC mode to run, and then return to the "TwinCAT PLC Control" software, open the program for online monitoring and operation



Ctrl+F7更新写入值

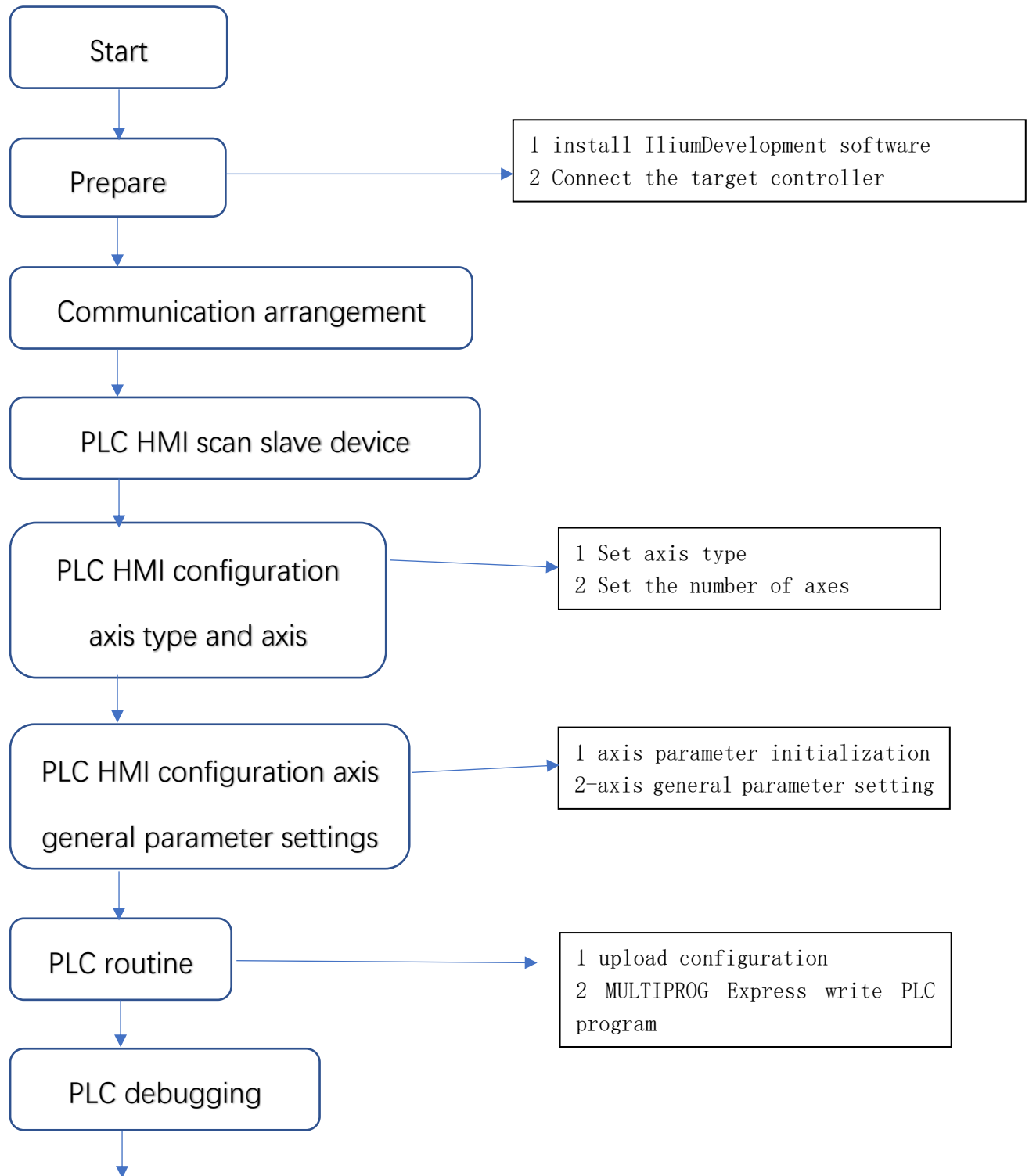


11) The entire configuration process is introduced

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# VC EtherCAT Servo Cooperate with ISAC Master Station Operation Routine

●Operation main flow

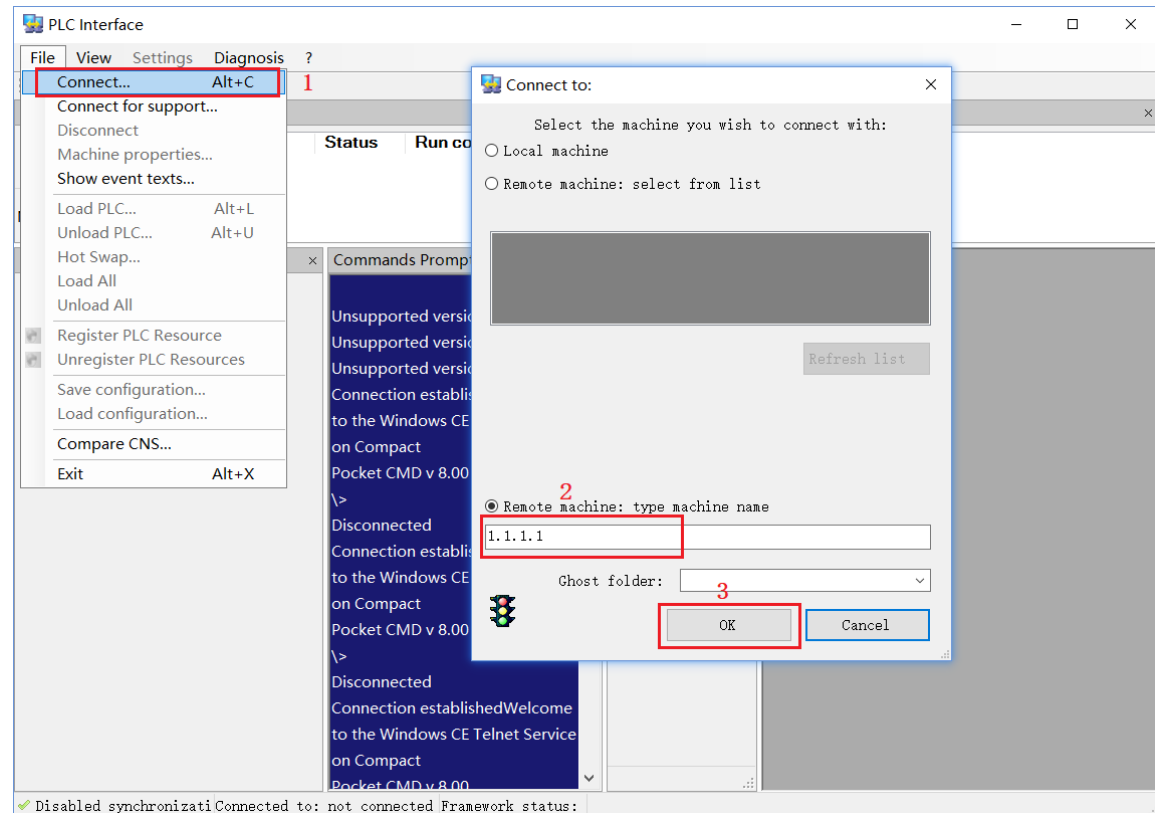


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Finish

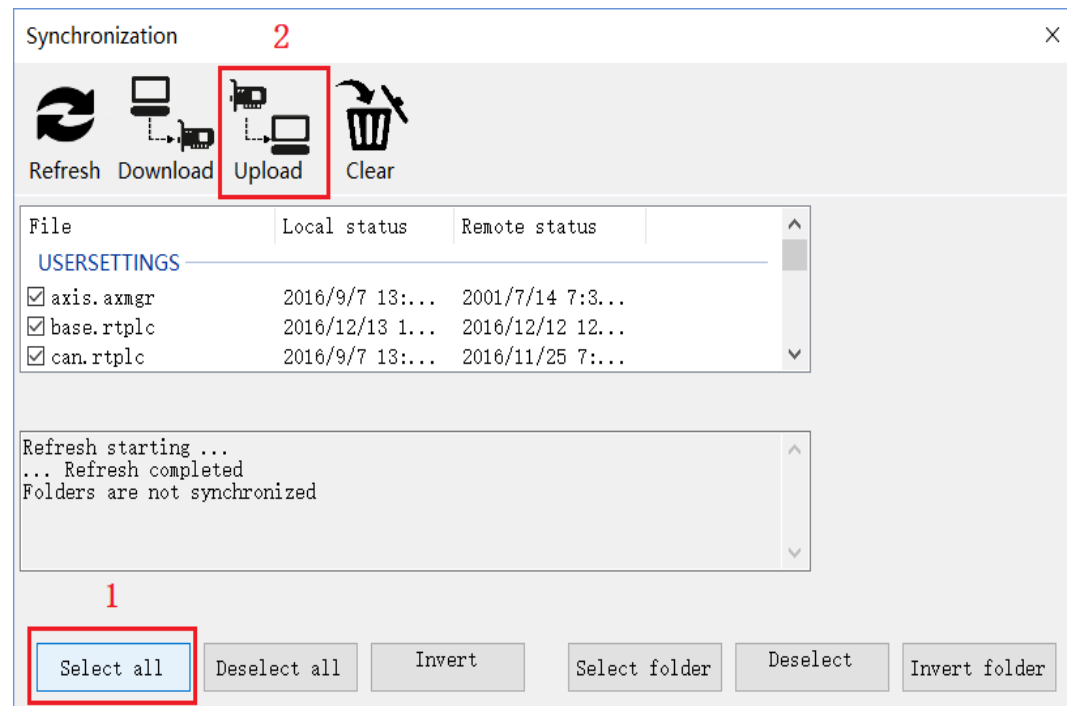
## EtherCAT communication configuration and axis configuration::

1. After connecting the Ilium controller (the controller is connected to two VECServo in this configuration case), open the RTPLC configuration tool through "Start -> ISAC -> RTPLC -> PLC HMI", and click "File -> Connect to ", select Remote machine: type machine name, set the IP address (the default address of the controller is 1.1.1.1, at the same time, the computer's IP address should be in the same segment as this address, that is, 1.1.1.x))



After clicking OK, the Synchronization dialog box pops up, select "Select all", then select Upload to upload the current configuration of the motion controller to the PC, and click Close

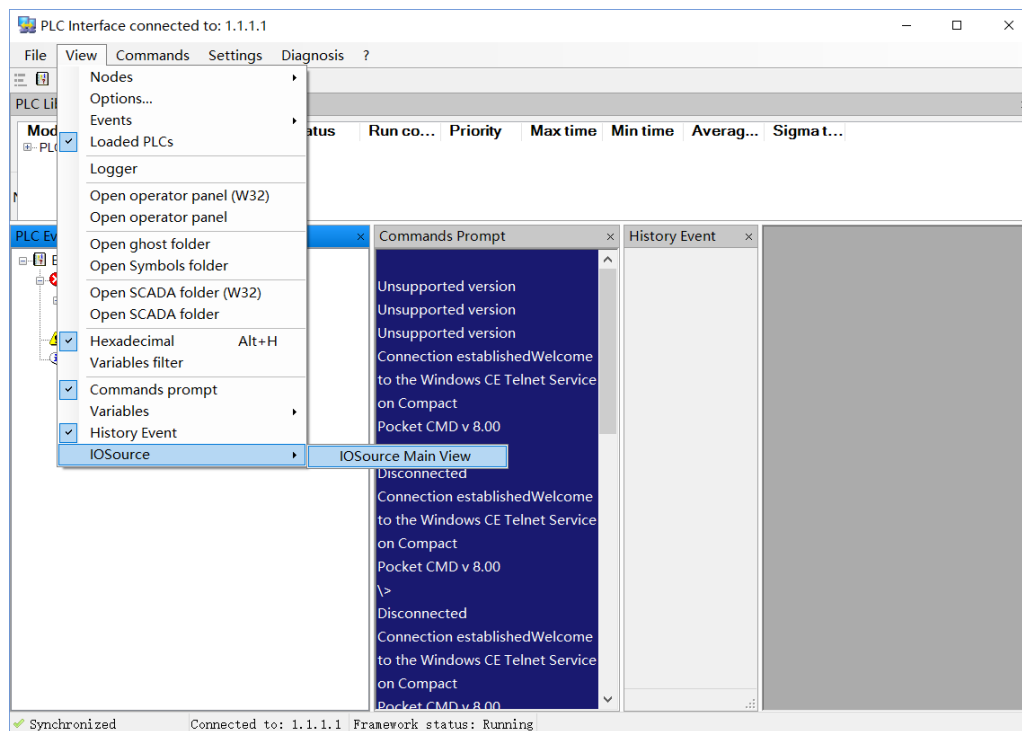
when finished;



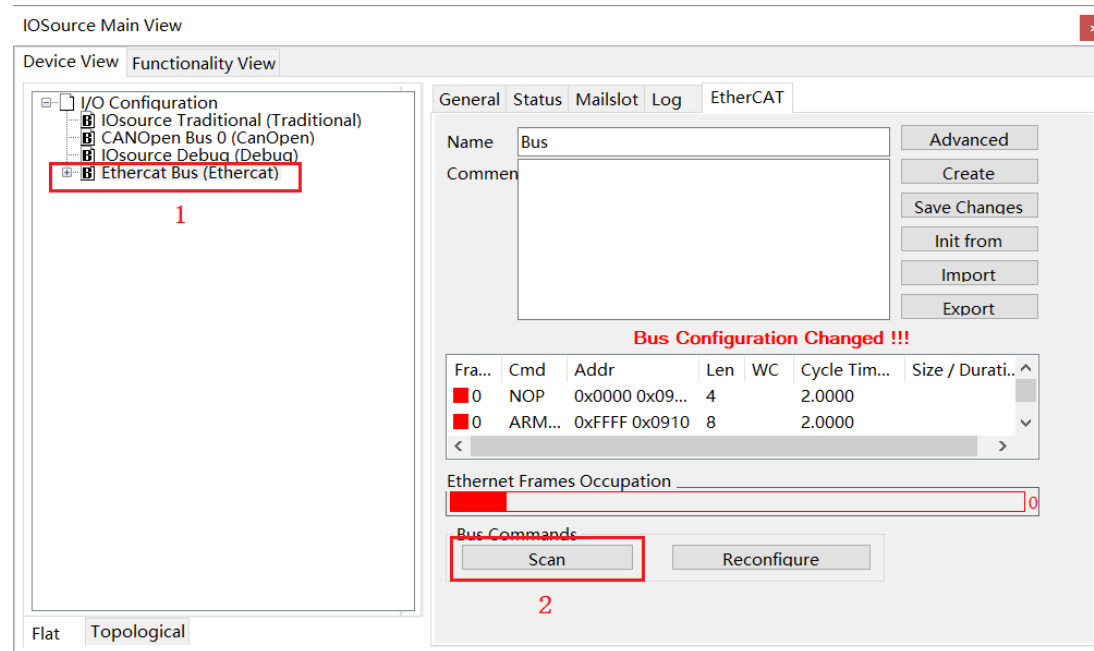
2. Before configuring the EtherCAT network, you need to place the description file (XML file) of the connected device in the following folder: C:\isac\exe\ios\Ethercat

3. The configuration process of EtherCAT is as follows:

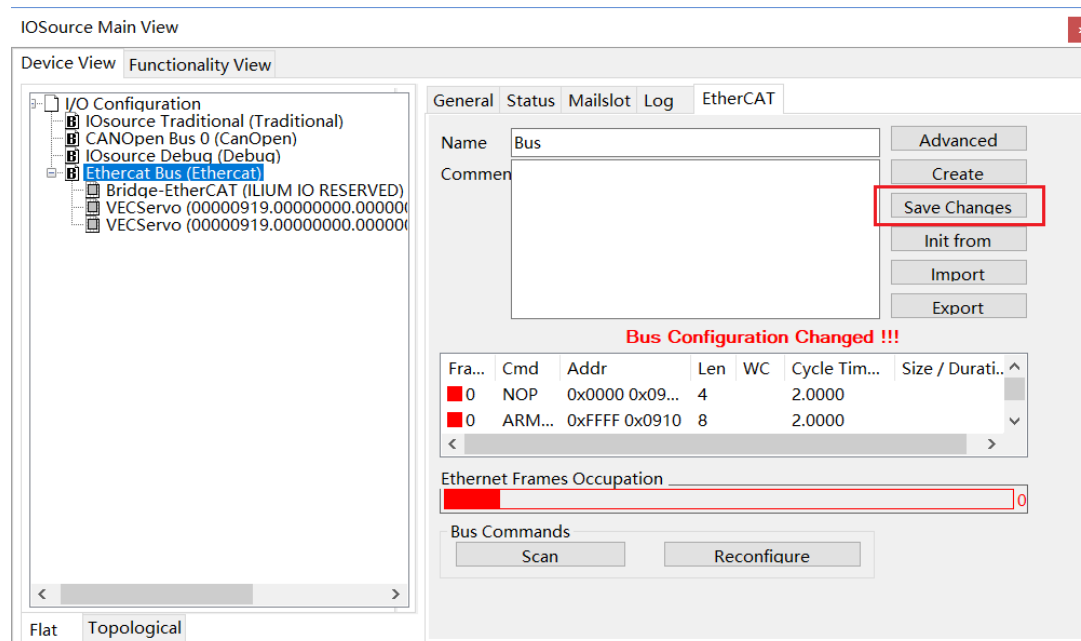
1) Open the IO configuration window through PLC HMI -> View -> IoSource -> IoSource Main Viewer



2) Click Ethercat Bus in the DeviceView window on the left, then open the EtherCAT tab in the right window, and click the Scan button;

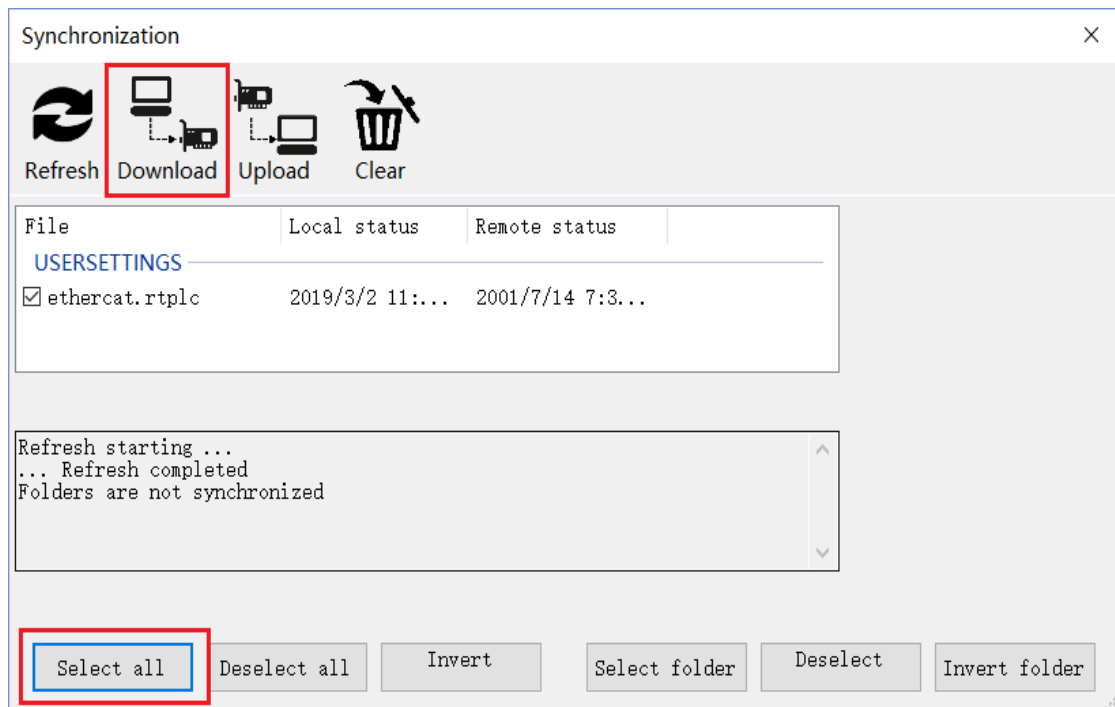


3) After the online scan is completed, there will be a red font prompting that the configuration information has been changed, and the Save Changes button is activated. At this time, the scanned slave devices are listed under the EtherCAT Bus node on the left (connected in this configuration case) Two VEC servo). Save the configuration information in a local file by clicking the Save Changes button.

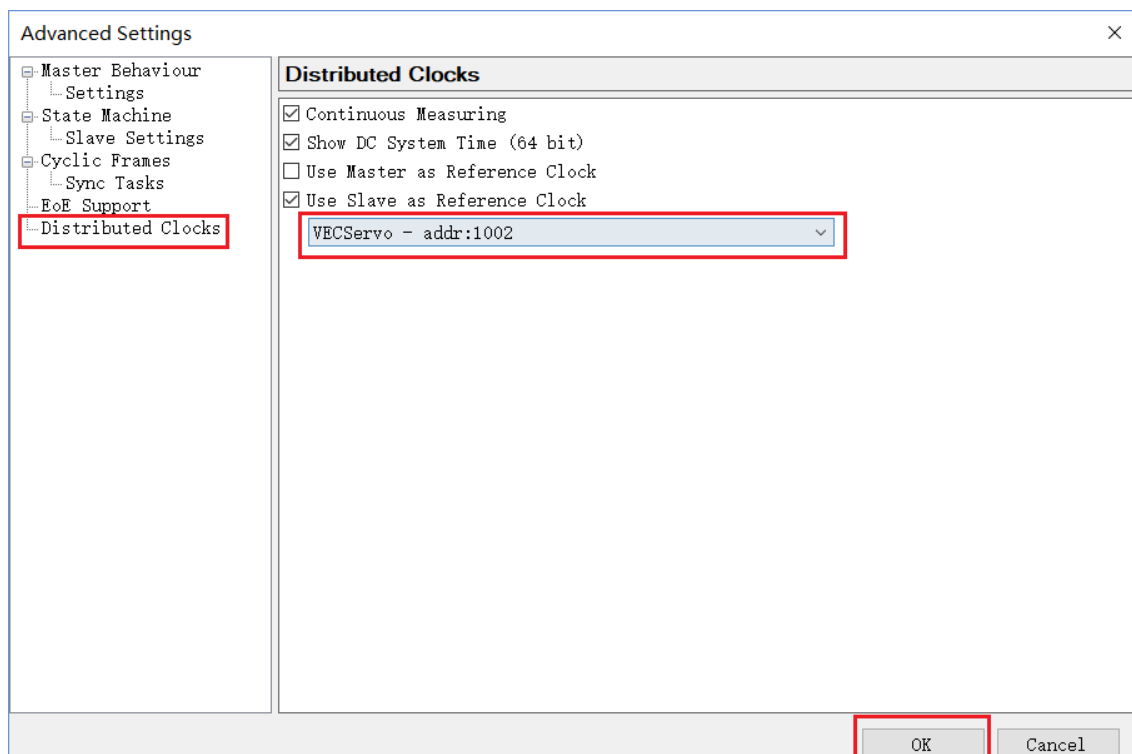


4) In the pop-up Synchronization dialog box, select "Select all", then select Download to download the current scan configuration to the controller (after the configuration is completed, when the window pops up, select Download);





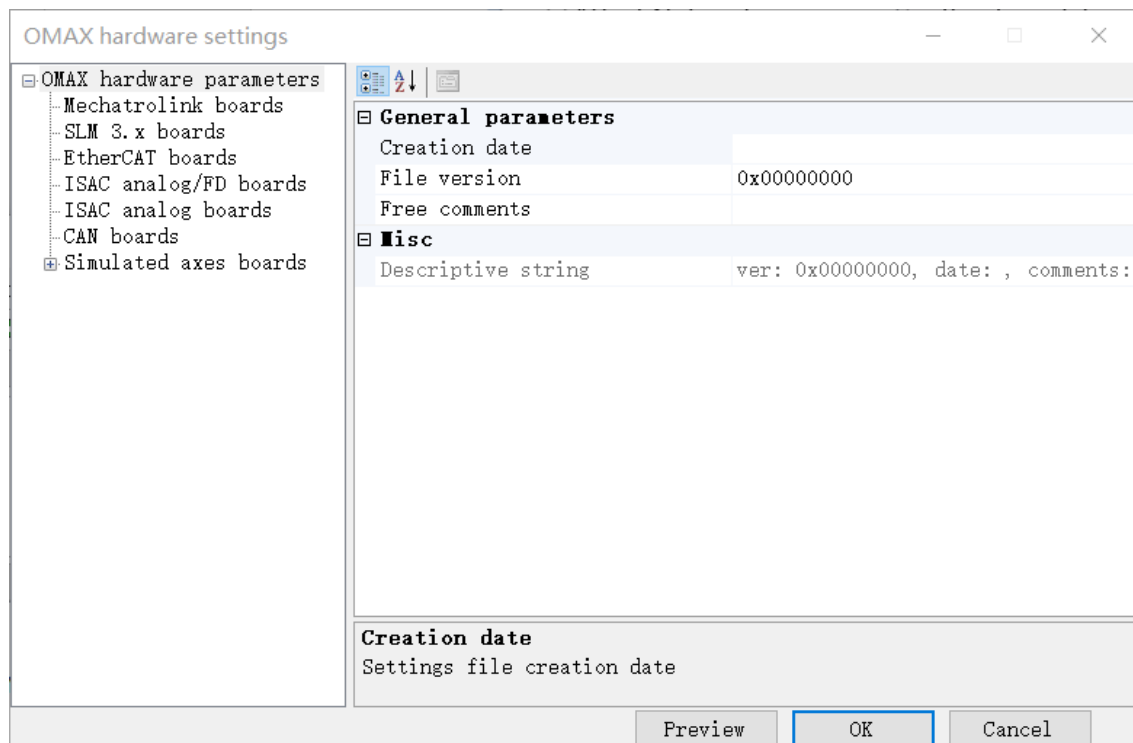
5) Click the Advanced Settings button to enter the advanced settings, select VECServo-addr:1002 (the closest servo to the controller) in Distributed Clorks, as the distributed clock reference, click OK;



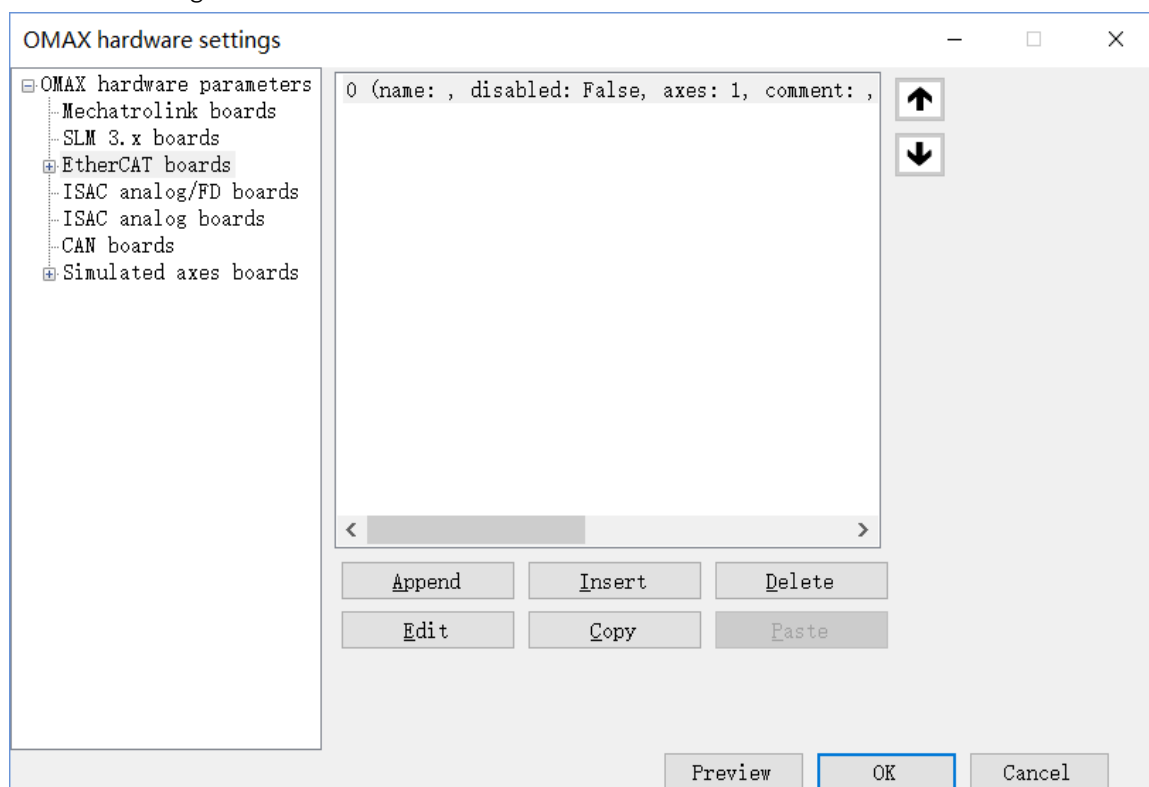
点 Click Save Changes in the EtherCAT tab to save the settings;

4. Axis parameters and axis type configuration (in this example, two EtherCAT axes and two virtual axes are configured)

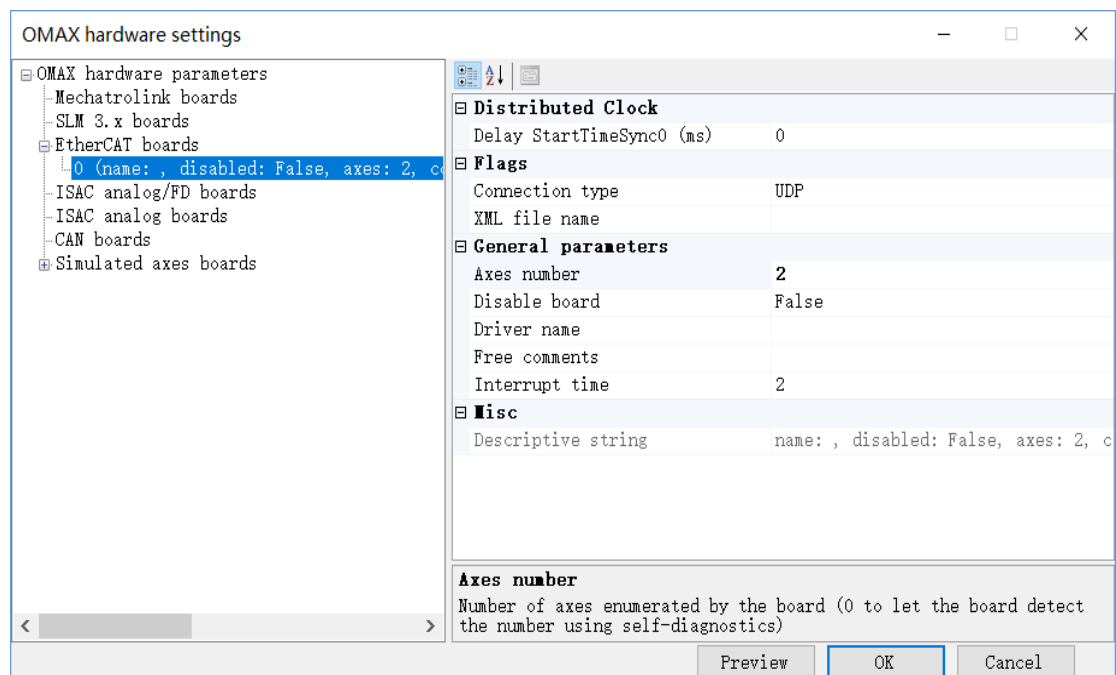
1). You can open the OMAX hardware settings window through the menu bar "Settings -> OMAX optional module -> Hardware service axmgr..." to configure the protocol to be used and the total number of axes.



2) Select EtherCAT boards, and add an EtherCAT spindle configuration via the Append button in the right window.



3) Configure the communication cycle of the EtherCAT master station and the number of axes supported.



Mainly modify the following parameters, and keep the default values for other parameters:  
Axes number: The number of EtherCAT connected axes. In this example, there are two EtherCAT axes, so it is set to 2.

Disableboard: Whether to disable this parameter configuration. If this parameter is set to True, it is disabled, and if it is set to False, it is not disabled. Set to False in this example.

Interrupt time: EtherCAT communication scan cycle, in ms, set the communication cycle to 2ms here.

Add two virtual axis interfaces to Simulated axes boards in the same way as above, and then click OK;

## 5. Axis allocation and initialization of axis configuration parameters

After configuring the number of axes used in the system, you can add the axes to the corresponding channels before they can be accessed. In this example, take a channel as an example:

1). Open the channel configuration window through the menu Settings -> OMAX optional module -> Axis Module (OMAX)...

☐ Enable PLC interpolator

Speed unit: u / min
 NOTE: "u" stands for the current unit of movement (metres or

Acceleration unit: u / min \* sec

Channel: 0
Add
Remove channel

Channel properties

Name: ch0

Omax channel type: PlcOpen mc part1

☐ Automatically enable axes at block beginning

☐ Automatically disable axes at block end

Ratio between channel cycle and axes: 1

.CAMM files to load:

Axis ...	Axis Type
0	EtherCAT
1	EtherCAT
2	Simulated
3	Simulated

Init from
Apply
Reset

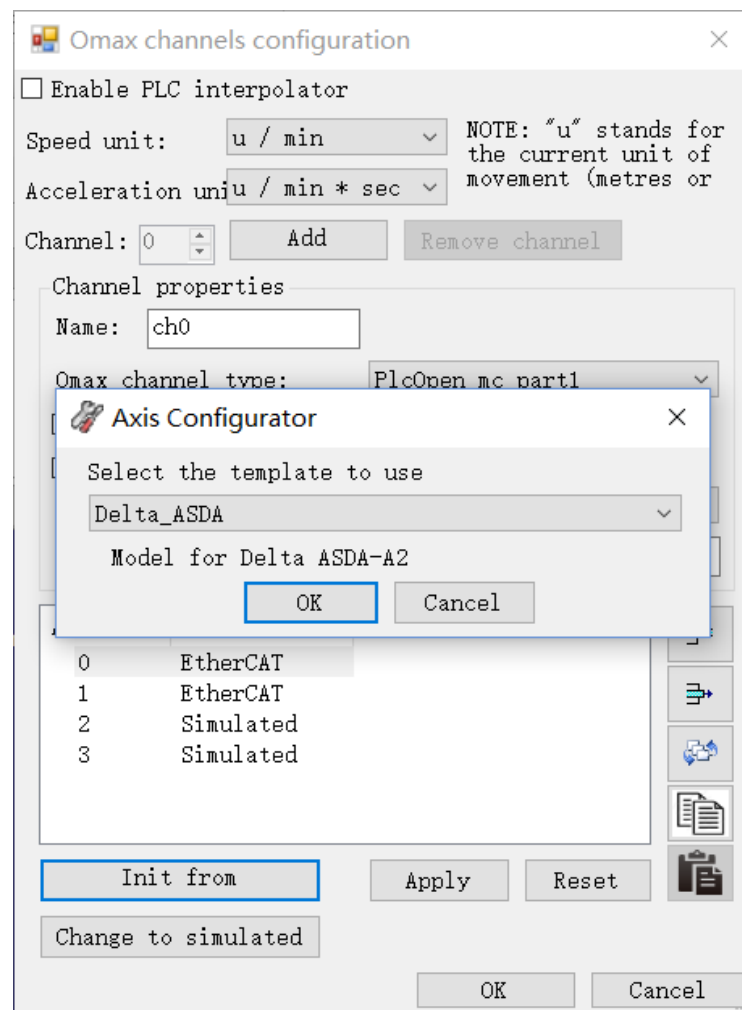
Change to simulated

OK
Cancel

When the number of axes currently added has not reached the set total number of axes,

you can click the button Add axis, or via button Delete the selected axis. Configure parameters through the parameter template: For axis general parameters, you can select the axis and then click the Init from button to select the corresponding template to configure the parameters of the current axis, so that only a few parameters need to be

modified (here, VECServo selects the initialized template as Delta\_ASDA);

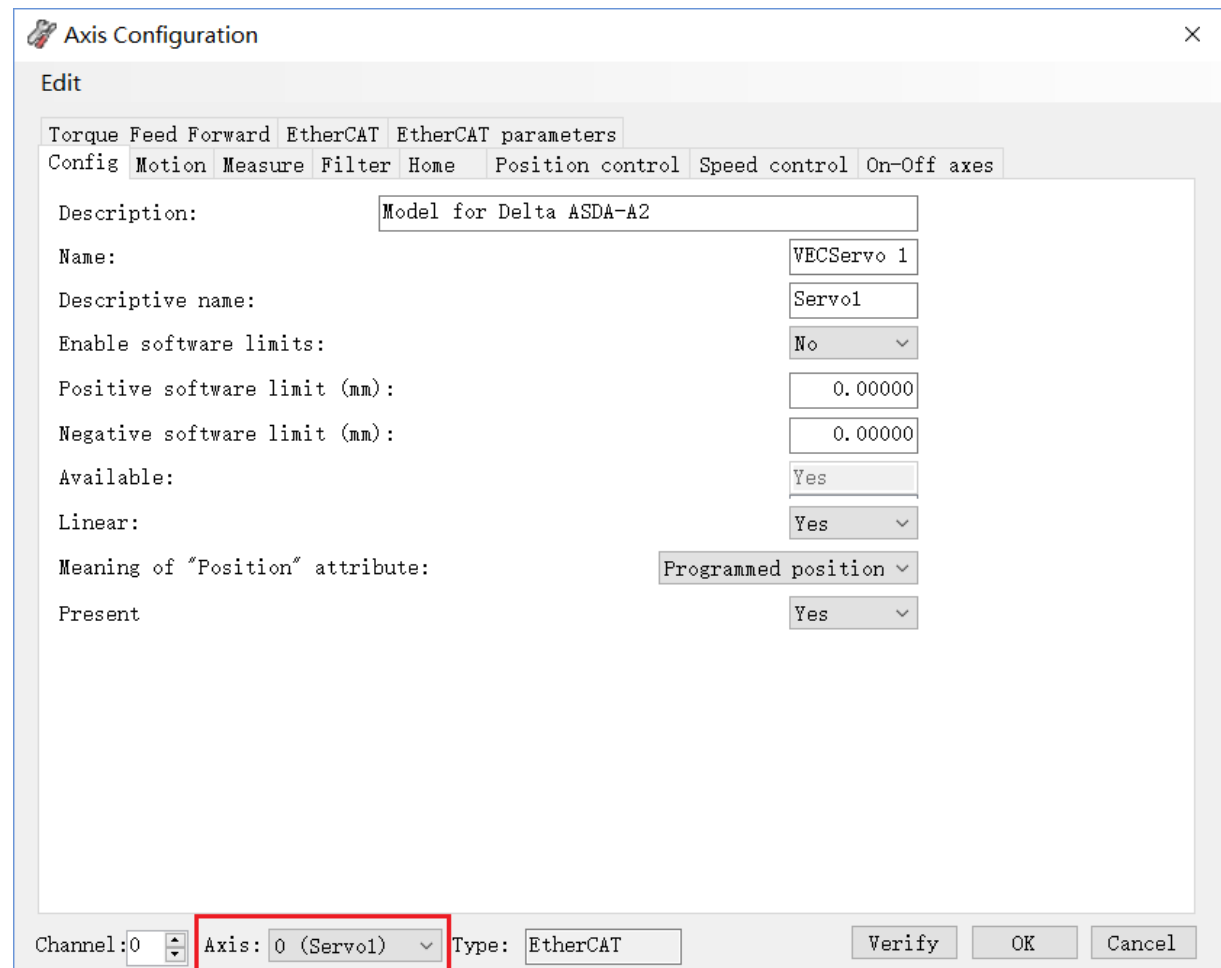


After all the axis parameters are initialized, click the Apply button to apply the loaded parameters, and click OK to keep exiting.

## 6. Axis general parameter setting

Open the Axis Configuration window through the menu bar "Settings -> OMAX optional module -> Axis service axmgr..." to configure the general parameters of the axis.

Config:



The screenshot shows the 'Axis Configuration' window with the 'Edit' tab selected. The window has a menu bar with 'Torque', 'Feed Forward', 'EtherCAT', and 'EtherCAT parameters'. Below the menu bar are tabs for 'Config', 'Motion', 'Measure', 'Filter', 'Home', 'Position control', 'Speed control', and 'On-Off axes'. The 'Config' tab is active, showing the following parameters:

Parameter	Value
Description:	Model for Delta ASDA-A2
Name:	VECServo 1
Descriptive name:	Servo1
Enable software limits:	No
Positive software limit (mm):	0.00000
Negative software limit (mm):	0.00000
Available:	Yes
Linear:	Yes
Meaning of "Position" attribute:	Programmed position
Present	Yes

At the bottom of the window, there are three fields: 'Channel: 0', 'Axis: 0 (Servo1)' (highlighted with a red box), and 'Type: EtherCAT'. To the right of these fields are three buttons: 'Verify', 'OK', and 'Cancel'.

- Description: just a text description of the current axis, just add it as needed;
- Descriptive name: axis name, which can be added as required, but the PAC system accesses each control axis according to the axis number;
- Enable software limits: enable software limits. Yes: Enable the software limit, and the Positive software limit and Negative software limit settings are valid; No: Disable the software limit, and the Positive software limit and Negative software limit settings are invalid.
- Positive software limit(mm): If the software limit is enabled, this parameter is used to set the positive software limit value. If the software limit is not enabled, this parameter is invalid.
- Negative software limit(mm): If the software limit is enabled, this parameter is used to set the negative software limit value. If the software limit is not enabled, this parameter is invalid.

- **Linear:** Set whether the axis is a linear axis or an analog-digital axis. If it is set as an analog-digital axis, select No here, and set the system's analog-digital axis function to enable through parameter 1011 in the PLC logic;
- **Meaning of Position attribute:** indicates whether the position of the axis is set to the command position or the actual position of the feedback;
- **Present:** used to set whether the axis is available. If it is set to No, the axis is no longer controlled by the motion command. Usually during simulation test, in order to avoid the CNC sending an alarm and entering the holding state due to unconnected motor or servo failure, etc., this parameter can be set to No, but it needs to be set to Yes under normal motion control conditions.

Measure:

The screenshot shows the 'Axis Configuration' dialog box with the 'Measure' tab selected. The dialog has a title bar with a close button (X). Below the title bar is a tabbed interface with tabs: Torque, Feed Forward, EtherCAT, EtherCAT parameters, Config, Motion, Measure (selected), Filter, Home, Position control, Speed control, and On-Off axes. The 'Measure' tab contains the following settings:

- Transducer type: incremental (dropdown)
- Save axis position: No (dropdown)
- Monitor transducer alarm: No (dropdown)
- User units per motor revolution (mm): 60.00000 (text input)
- Max position for round axis (mm) (ignored for linear axis): 360.00000 (text input)
- Encoder lines per motor revolution (counts divided by 4): 2500 (text input)
- Invert count (analog only): No (dropdown)
- Offset of absolute transducer (mm): 0.00000 (text input)
- Position delay (no of cycles) : 0 (text input)
- Encoder Ratio (Cycles Pulse Motor / Cycles Pulse Encoder): 0 (text input)
- Bit Depth: 0 (text input)

Below these settings is a 'Settings' button. At the bottom of the dialog, there are fields for 'Channel: 0' (dropdown), 'Axis: 0 (Servo1)' (dropdown), and 'Type: EtherCAT' (text input). To the right of these fields are three buttons: 'Verify', 'OK', and 'Cancel'.

- **Transducer type:** Set the encoder type. The supported types are: incremental, single-turn absolute, multi-turn absolute, and no transducer.
  - ✓ Incremental (incremental): The zero point needs to be searched every time it is started.
  - ✓ Single-turn absolute: It can determine the angle within a circle.
  - ✓ Multi-turn absolute: In addition to determining the angle within one lap, it can also determine the number of laps.
  - ✓ No transducer: open loop output control without encoder feedback to the controller.

- 
- **Save axis position:** If it is set to Yes, the CNC will save the axis position data and the homing flag in the power-down retention area. The position data can be loaded at the next startup, and the homing flag will be set at the same time. When the encoder alarms, then The homing flag will be cleared. This function is mainly used to simulate an absolute encoder axis. When the device is not running, the axis will be locked. If the servo used does not support the brake function, it must be set to No here;
  - **Monitor transducer alarm:** used to monitor the status of the encoder hardware function. This function depends on the servo function used. Some servos support this function, and some servos do not support this function. If the servo does not support this function, this function should be disabled.
  - **User units per motor revolution:** motion equivalent, which means the distance (mm) that the motor moves in one revolution.
  - **Max position for module axis:** Indicates the maximum angle or position of the motor rotation. When the maximum angle or position is reached, it will go to the starting point 0, which is only used for the module axis, usually set to 360.
  - **Encoder lines per motor revolution:** the number of encoder lines. The number of encoder lines is different from the number of pulses generated by one rotation of the encoder. Generally, moving one grating slot corresponds to 4 encoder pulses. This parameter is usually set according to the parameters of the motor or the encoder actually used.
    - ✓ SLM axis is set to 16384.
    - ✓ Mechatrolink bus axis is set to the number of pulses.
    - ✓ Set other encoder types as

"The number of pulses required for one revolution of the motor/4".

(The two VECServo motors connected here are both 2500-line incremental motors)

- **Invert count:** Set the counting direction of encoder feedback signal. For some axes (such as analog control and other types of axes), when changing the direction of motor rotation, you need to change the counting direction of the encoder AB phase through this parameter at the same time. For the axis controlled by digital quantity, this parameter can be ignored. Because this parameter mainly sets the A and B phase counting direction of the encoder.
- **Offset of absolution transducer:** The position offset of the absolute encoder. For example, the current absolute position of the axis is 1000, and the offset value is set to 900, the displayed axis position is 100.
- **Position delay:** The number of delay cycles for the controller to read the position information. The unit is the axis interpolation cycle of the motion controller. It will be affected by multiple factors:
  - ✓ When the system performs pulse + direction control, there will be a difference of 1 cycle between the pulse command sent each time and the position information read.
  - ✓ When the EtherCAT transit bridge is used for pulse control, the delay will be affected by the DC time of the EtherCAT bus, so the delay period is 3.



- 
- ✓ If a bus-type servo is connected, the actual position of the axis from the servo to the controller has to go through many transmission links of the communication protocol, especially when using the EtherCAT or Mechatrolink bus, each position command sent may require the servo to run for several cycles, so At this time, the delay can be set to 4-5. Sometimes the value is not an integer, so it can only be partially compensated.
  - ✓ If the following error of the axis is calculated and controlled by the servo drive, the delay will be meaningless. But if it is calculated by the controller, this value needs to be set, but in this case, the calculated error value does not represent the actual error value of the axis, but will be added to the instantaneous speed of the axis for compensation.
  - ✓ If the position closed loop is realized by the controller, the PID adjustment is actually not accurate. Although the following error value can be controlled within a reasonable range, the frequent adjustment of the instantaneous speed will cause certain vibration or vibration when the speed changes. There are problems such as speed crossing, so this method is not recommended when the communication cycle is relatively long.
  - ✓ Servo is used to realize the position loop. In this case, sometimes the following error value is relatively large due to the following performance problems of the servo, so the error threshold needs to be set larger in the CNC.
  - ✓ The reasonable setting range is 0-8. When it is set to 0, it means no delay, but it depends on the processing of the following error and the performance of the servo.
- **Encoder Ratio:** Indicates the ratio of the number of pulses sent by the controller to the number of feedback pulses received by the encoder. For example, when controlling a stepper motor, the number of control pulses is calculated according to the number of steps, but the feedback encoder may have different resolutions. If it is set to 0, it means "Ratio=1". If it is greater than 1, it means that the number of pulses sent is greater than the number of feedback pulses received. If it is less than 1, the opposite is true. Note: If the set value is too large, the number of pulses collected and the number of pulses output by the interpolation calculation may be seriously inconsistent and a warning message of 1034 may be reported during the CNC homing process.

Motion:

Axis Configuration

Edit

Torque Feed Forward EtherCAT EtherCAT parameters  
Config Motion Measure Filter Home Position control Speed control On-Off axes

Maximum speed (mm/sec):	3000.00000
Nominal acceleration (mm/sec <sup>2</sup> ):	15000.00000
Nominal deceleration (mm/sec <sup>2</sup> ):	15000.00000
Jerk for independent axis (mm/sec <sup>3</sup> ):	15000.00000
Positioning time (ms):	0
Position threshold (um):	0.00000
Backlash compensation (um):	0.00000
Deceleration asynthote:	
Feed forward (%):	100
Invert direction:	No

Channel: 0 Axis: 0 (Servo1) Type: EtherCAT

Verify OK Cancel

- **Maximum speed:** Indicates the maximum speed that a single axis can reach. The unit of the previous parameter is mm/sec, which is the speed value after user equivalent conversion. Do not exceed the actual rated speed of the motor when setting it;
- **Nominal acceleration:** The maximum acceleration value supported by the mechanical structure of the axis or the motor indicates the maximum speed value that can be reached in one second when a single axis is moving rapidly.
- **Nominal deceleration:** The mechanical structure of the axis or the maximum deceleration value that the motor can support. If this parameter is set to 0, it means that the deceleration value and the acceleration value are the same. This value can be set to a value different from the acceleration. If the motor and the machine are connected with high elasticity (such as belt drive), usually set the acceleration value to a higher value to reach the target position quickly, and set the deceleration to a lower value to reduce Small error, this situation is more obvious when pushing the axis control, because the inertia may cause the object to separate from the control axis at the end of the movement, which causes the object to exceed the range of motion, but the axis is at the target position of the control.
- **Jerk for independent axis:** Set the jerk value of a single axis (Jerk).
- **Positioning time(ms)和 Position threshold(um):** These two parameters are used to confirm whether the axis has reached the target position after the movement. If the difference between the actual position of the axis and the theoretical value is within the

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range set by the Position threshold and lasts for the Positioning time, the CNC considers that the axis has reached the target position of the current command and can continue to execute the next step. A motion control instruction. Otherwise, CNC has been waiting for the end of the movement. If one of these two values is set to 0, the function is disabled.

Notice:

1. If the axis has no encoder feedback, such as stepper motor open-loop control, this function must be disabled.

2. If the axis does not need to compensate for the following error, such as pulse + direction control, you can set a reasonable value according to the magnitude of the following error.

3. In general, if you want to activate this function, it is recommended to set the Position threshold between 100 and 200, and the Positioning time between 10 and 50.

- **Backlash compensation(um):** Backlash compensation. It is generally used to compensate the error caused by the gap of the mechanical transmission structure (such as the lead screw) when the shaft is reciprocating. The unit is um. If the gap to be compensated is 0.1mm, you need to enter 100.
- **Feed forward:** Feed forward ratio. If it is set to 0, it is 100%, and if the value is greater than 100, it is limited to 100%. For speed feed forward (VFF) enabled, the usual value is 100. For Mechatrolink axis, it cannot exceed 80%. This parameter is synchronized with PN109. For EtherCAT axis, this parameter will be linked to the F.F. parameter of the servo. If VFF is not enabled or under position mode control, this parameter has no practical meaning.
- **Invert direction:** Set the direction of movement of the axis. If it is set to No, the motor moves clockwise to perform incremental motion, if the value is set to Yes, the motor moves counterclockwise to achieve incremental motion.

EtherCAT:

The configuration window needs to be opened after the EtherCAT bus configuration is completed. You need to map the axis configured by the control system to the connected axis device, open the EtherCAT tab, as shown in the figure below, set the Logical address to the logical address of the EtherCAT device , And then click the Read configuration button;

**Axis Configuration**

Edit

Config Motion Measure Filter Home Position control Speed control On-Off axes Torque Feed Forward EtherCAT EtherCAT parameters

Logical address: 1002 Slot Index: 0

Read configuration

Homing  
Homing mode: DSP402 HM  
Command code for searching marker clockwise: 33  
Command code for searching marker counter-clockwise: 34

Modes of operation  
Default mode: 8  
Mode for IP: 8 Mode for VL: 2  
Mode for PV: 9 Mode for HM: 6

Multipliers  
Current position: 1.00000  
Target: 1.00000  
Speed: 0.00047  
Acceleration: 1.00000  
Following Error: 1.00000

Operations  
On reconnection: Pass to OP  
On leaving alarm: Pass to OP  
If sent to idle: No operation

Slot properties  
SDO offset: 0x0

Channel: 0 Axis: 0 (Servo1) Type: EtherCAT

Verify OK Cancel

Ensure the logical address of the EtherCAT device and the corresponding axis number, and then click the Read file button to automatically establish the PDO mapping, and finally click OK.

**Read EtherCAT configuration**

Node address: 1002 Slot Index: 0

Configuration file: C:\ProgramData\ISAC\RTPLC\ui\ghostmachines\1.1.1.1\USERSETTINGS\ecat.xml

Device name: Device (VECServo)

Mode of operation: IP with Cyclic Synchronous Position Mode (CSPM)

Offsets (input)  
Status word: 2 - 0x6041:0, Status word  
Current position: 4 - 0x6064:0, Current position  
Current position error: 10 - 0x60F4:0, Current position error  
Current velocity: (no mapping)  
Current torque: 8 - 0x6077:0, Current torque  
Latch1 value pos edge: 16 - 0x60BA:0, Latch1 value  
Latch1 value neg edge: (no mapping)  
Latch2 value pos edge: 20 - 0x60BC:0, Latch1 value  
Latch2 value neg edge: (no mapping)  
Digital inputs: 24 - 0x60FD:0, Digital inputs  
Mode of operation display: (no mapping)  
Error Code: 0 - 0x603F:0, Error code  
Status latch: 14 - 0x60B9:0, Status Latch

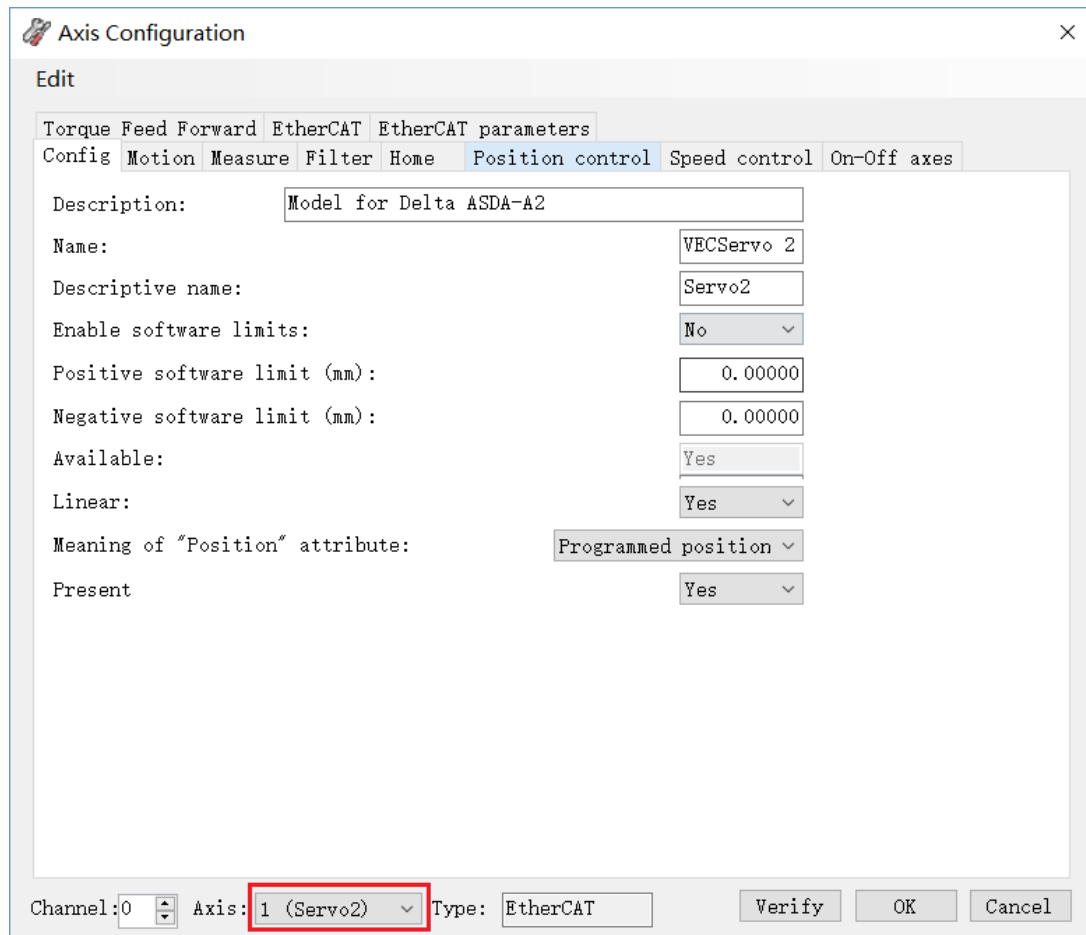
Offsets (output)  
Control word: 0 - 0x6040:0, Control word  
Target: 2 - 0x607A:0, Target position  
Velocity offset: (no mapping)  
Torque offset: (no mapping)  
Digital outputs: 8 - 0x60FE:1, unrecognized (Physical outputs)  
Mode of operation: (no mapping)  
Control latch: 6 - 0x60B8:0, Control latch

Slot properties  
SDO offset: 0x0

File read: address 1002 found, slot 0 found

OK Cancel

After configuring Axis0, switch to another axis, and then follow the Axis0 configuration steps to complete the axis's general parameter configuration;



The image shows a software window titled "Axis Configuration" with a close button (X) in the top right corner. The window has a tabbed interface with the following tabs: Torque, Feed Forward, EtherCAT, EtherCAT parameters, Config, Motion, Measure, Filter, Home, Position control (selected), Speed control, and On-Off axes. The "Position control" tab is active, displaying the following configuration fields:

- Description: Model for Delta ASDA-A2
- Name: VECSServo 2
- Descriptive name: Servo2
- Enable software limits: No (dropdown)
- Positive software limit (mm): 0.00000
- Negative software limit (mm): 0.00000
- Available: Yes (dropdown)
- Linear: Yes (dropdown)
- Meaning of "Position" attribute: Programmed position (dropdown)
- Present: Yes (dropdown)

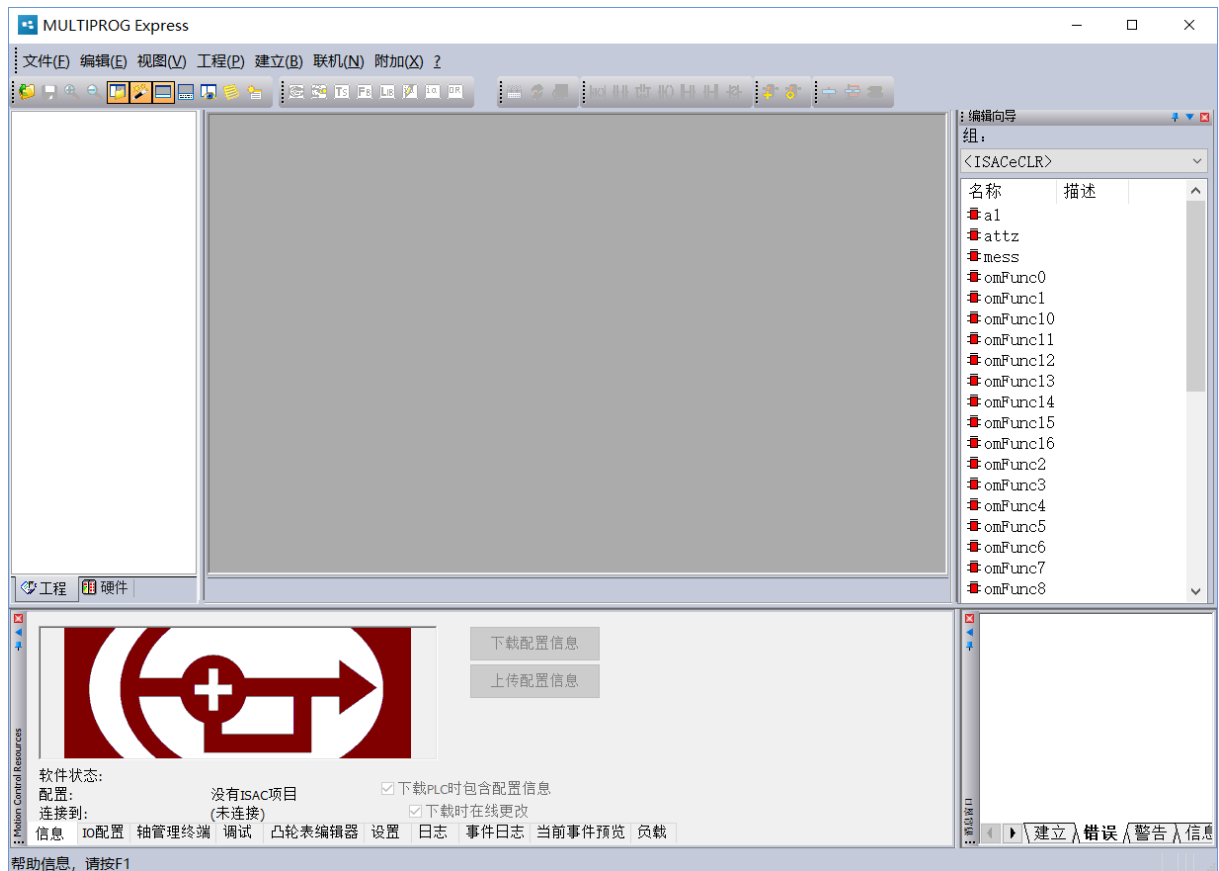
At the bottom of the dialog, there are three fields: "Channel: 0" (dropdown), "Axis: 1 (Servo2)" (dropdown, highlighted with a red rectangle), and "Type: EtherCAT" (text field). To the right of these fields are three buttons: "Verify", "OK", and "Cancel".

Follow the above steps to complete the configuration of all axes, click OK to save and download;

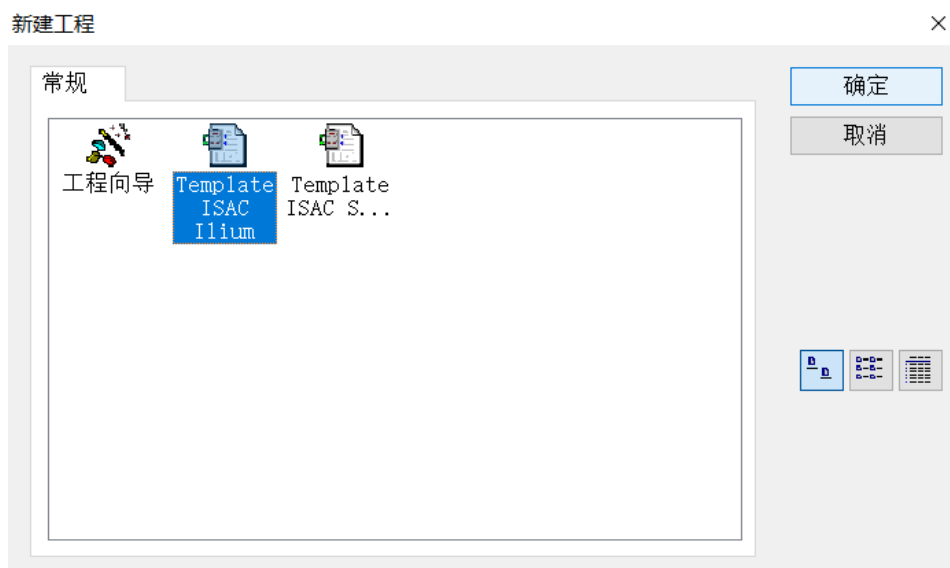
**Note:** The modification of all functions or parameter configuration through the configuration tool will take effect after restarting the system.

## Build a project quickly:

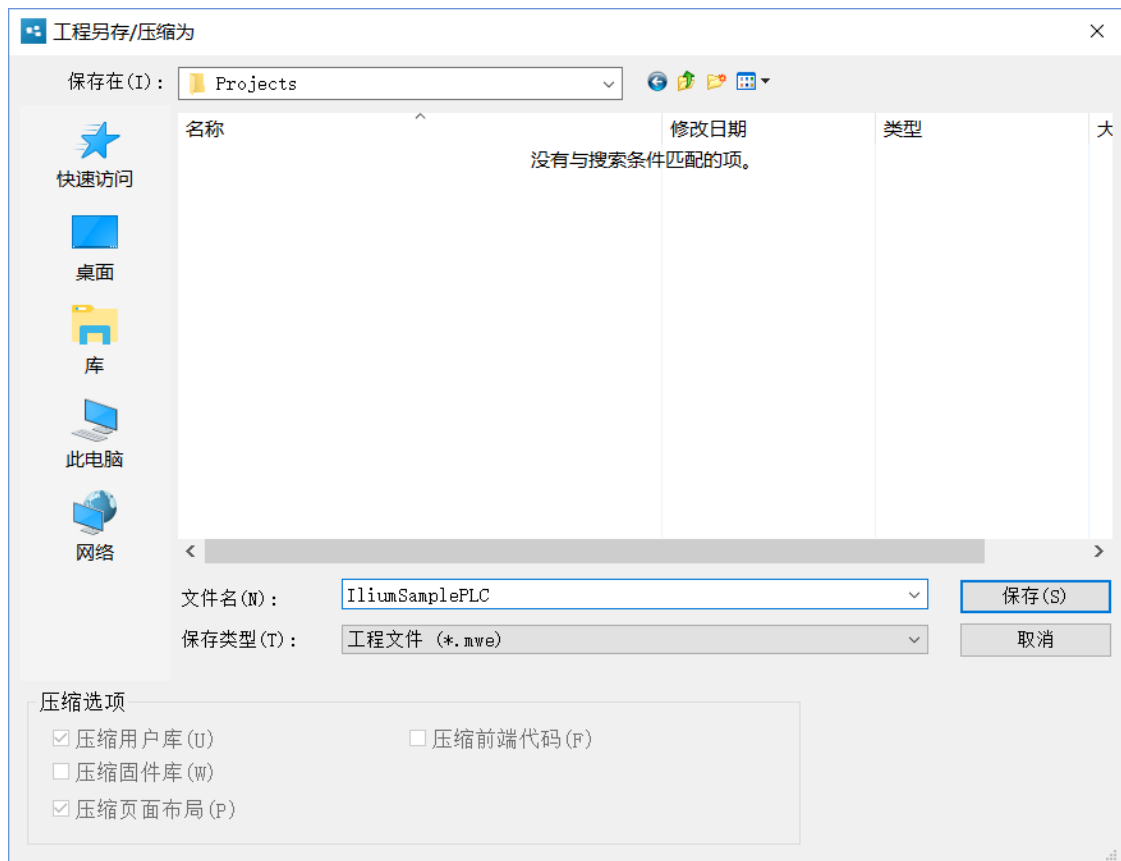
1. Open the MULTIPROG Express software, the interface is as shown in the figure below:



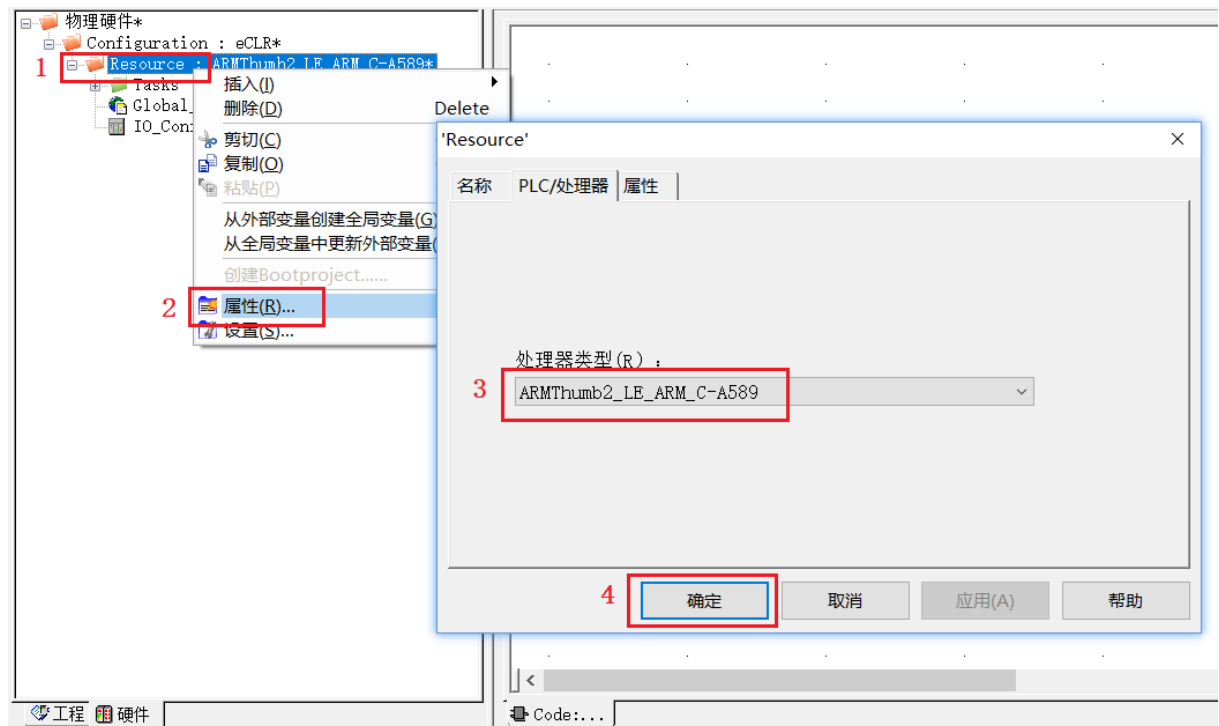
2. Open the "New Project" window through "File" >> "New Project" or through the icon in the toolbar, as shown below:



3. Double-click the "Template ISAC Ilium" template to create a new function, but the newly created project is saved in a temporary file and needs to be saved as another folder. In the default project path saved as MULTIPROG, the name is IliumSamplePLC;



4. Modify the resource type to match the currently used CPU type. Right-click the "Resource" node in the project tree, select "Properties", the following window will pop up:



In the software structure of IEC61131-3, the resource is equivalent to a CPU. After the

software is installed, the following types are explained here:

ARMThumb2_LE_ARM_C-A589	For CortexA9+WEC2013 embedded platform
I486_LE_MSC12	For X86 platform

Because we currently use the CortexA9+WEC2013 embedded platform, here we choose the resource type as ARMThumb2\_LE\_ARM\_C-A589, click OK;

5. If after confirming, if the following prompt pops up, click OK;

版本处理 (Configuration.Resource)

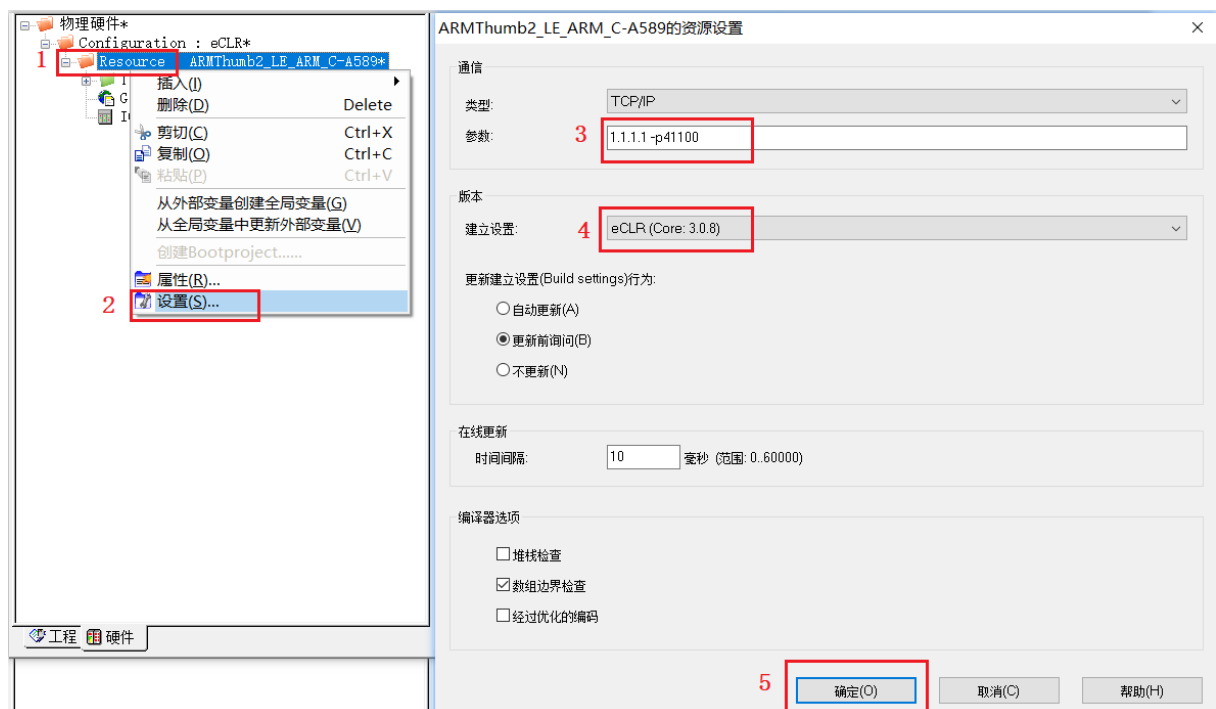
×



这个编程系统不支持所配置的建立设置(build settings)"eCLR (Core: 3.0.8)". 请检查资源设置对话框中的资源设置!

确定

6. Right-click the "Resource" node in the project tree and select "Settings". A setting window will pop up. In the setting window, the communication parameters are set to "1.1.1.1-p41100" (in this example, the IP address of the controller is 1.1.1.1), at the same time, set the computer's IP address to "1.1.1.X" (the controller must be in the same IP segment as the PC's network IP, otherwise it will not be able to connect), and the version creation setting drop-down box Just select the bottom one, as shown below;



PC 的 IP 地址:





7、After the above parameter configuration is correct, you can open the project control window through "Online -> Project Control" in the toolbar;



If the communication is successful, the status information will be displayed in the pop-up engineering control dialog box (if running is not displayed, click cold start);

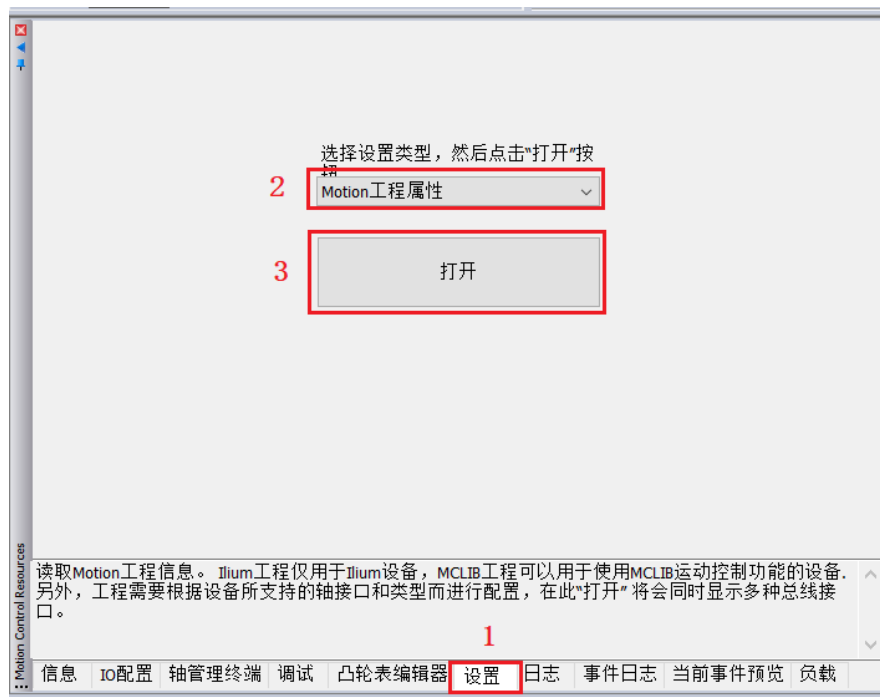


Click the "More" button in the dialog control of the project control, and select the option "Permanently reside as a boot project" in the pop-up "Download Options" dialog box. Then close.

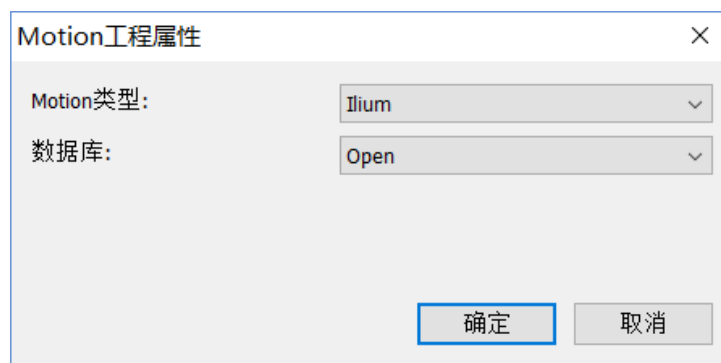
8、Upload system configuration: To upload configuration information, you need to open the "View -> Motion Control Resources" window, as shown in the figure below;



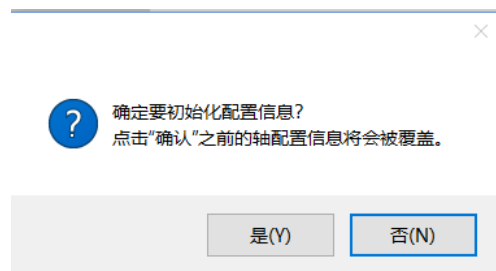
Project parameter initialization: Open Motion Control Resources >> Settings >> Motion project properties;



Click ok;



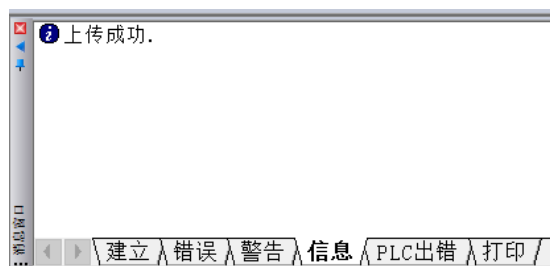
Click "Yes" in the pop-up dialog box.



Upload system parameters: If the parameters have been configured in the running system, upload the parameters before each download, and then compile to ensure the unity of the configuration parameters: Open the "Project Control Dialog Box" in MULTIPROG to establish online communication ,As shown below;



Click the "Upload Configuration Information" button to upload the parameters, and after the upload is successful, the connection will be automatically re-established;



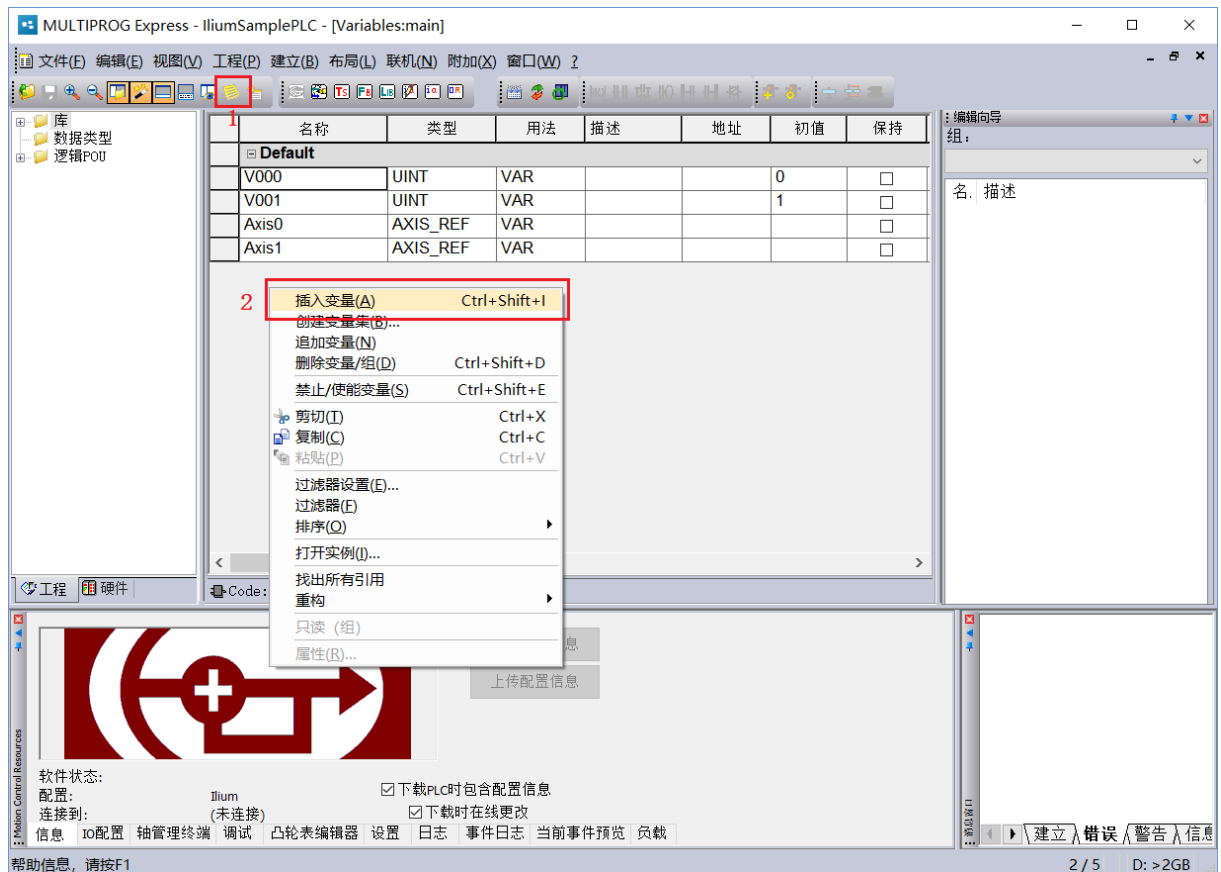
Recompile using uploaded parameters.

## Create a simple program:

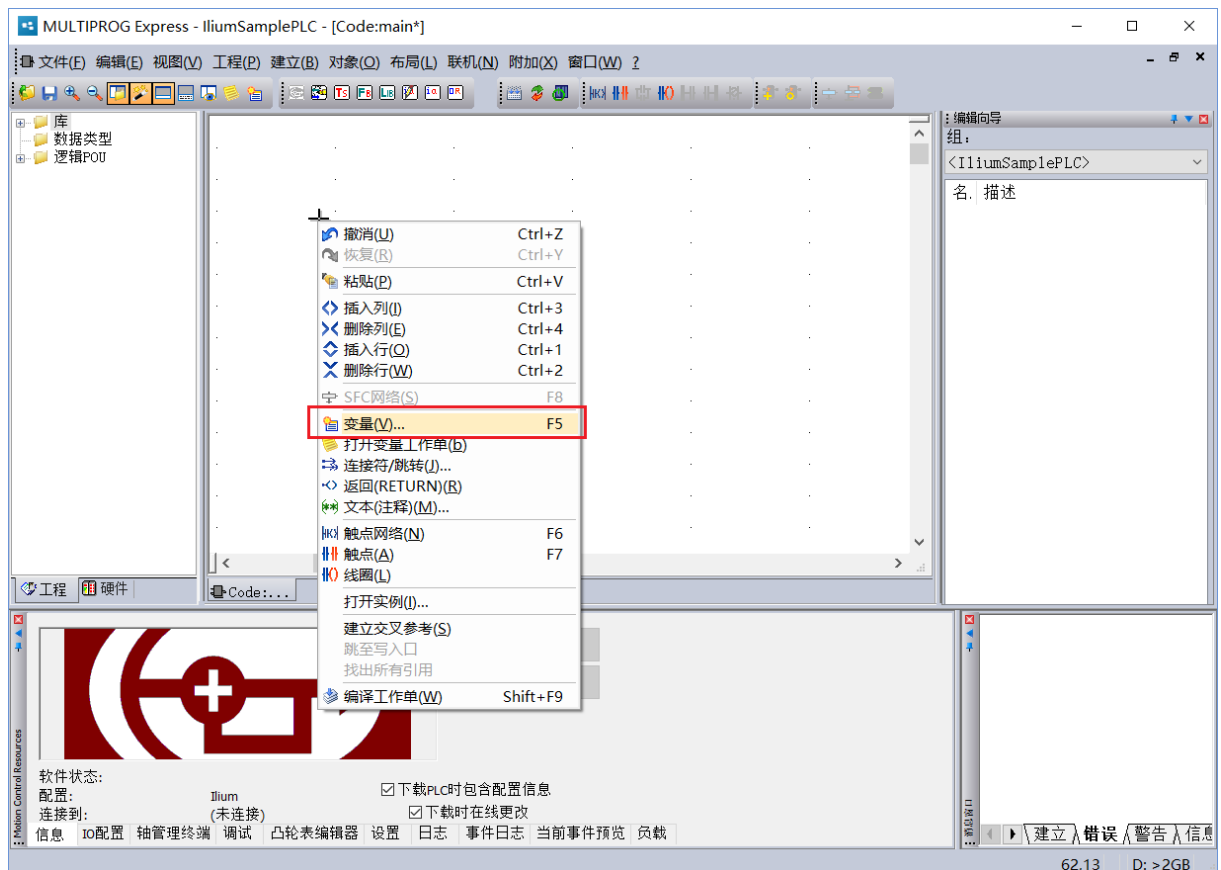
After the configuration information is uploaded successfully, you can start to write the PLC program. In the above case, we configured the communication parameters and axis parameters of the two servo axes. Here we directly use the established configuration to directly write a simple PLC program. The program functions include: axis enable, speed operation, electronic gear operation, and Stop; right-click the blank space in the programming interface and click variables, as shown in the figure below:

(1) New variable:

a. Open the variable worksheet, right-click the blank space, click Insert Variable, and insert 4 variables respectively. The variable name, type and initial value settings are as shown in the figure below;



b. Right-click the blank area of the program editing interface and add V000 and V001 to the program, as shown in the figure below:



c. Right-click the blank area of the program editing interface, and create two new variables: Axis0.AxisNo, Axis1.AxisNo, the properties are shown in the figure below, add them to the program, and then assign the values of V000 and V001 to Axis0.AxisNo and Axis1 respectively. AxisNo is shown in the figure below:

The screenshot shows the 'Variable Properties' dialog box for the variable 'Axis0.AxisNo'. The 'Name (N):' field contains 'Axis0.AxisNo'. The 'Data Type (D):' is set to 'AXIS\_REF'. The 'Usage (U):' is set to 'VAR'. The 'Initial Value (I):' field is empty. The 'I/O Address (S):' field is empty. The 'Description (E):' field is empty. The 'Define Scope' section has 'Local (L)' selected. The 'Local Variable Group (v):' is set to 'Default'. The 'Global Variable Group (A):' section shows a tree view with 'Physical Hardware' expanded, containing 'Configuration', 'Resource', and 'System Variables'. The 'Show all variables in the workbench (W)' checkbox is checked. The 'PDD', 'OPC', and 'Hidden (X)' checkboxes are unchecked. The 'Initial value as default value' checkbox is unchecked. The 'Confirm', 'Cancel', and 'Help (H)' buttons are on the right.

变量属性

名称(N):  
Axis0.AxisNo

数据类型(D):  
AXIS\_REF

用法(U):  
VAR ☐ RETAIN

初值(I):

I/O地址(S):

描述(E):

☐ PDD ☐ OPC ☐ 隐藏(X)  
☐ 初值作为默认值.

定义范围  
☒ 局部(L) ☐ 全局(G)

局部变量组(v):  
Default

全局变量组(A):  
物理硬件  
Configuration  
Resource  
System Variables

☒ 显示工作单的所有变量(W)

确定 取消 帮助(H)

The screenshot shows the 'Variable Properties' dialog box for the variable 'Axis1.AxisNo'. The 'Name (N):' field contains 'Axis1.AxisNo'. The 'Data Type (D):' is set to 'AXIS\_REF'. The 'Usage (U):' is set to 'VAR'. The 'Initial Value (I):' field is empty. The 'I/O Address (S):' field is empty. The 'Description (E):' field is empty. The 'Define Scope' section has 'Local (L)' selected. The 'Local Variable Group (v):' is set to 'Default'. The 'Global Variable Group (A):' section shows a tree view with 'Physical Hardware' expanded, containing 'Configuration', 'Resource', and 'System Variables'. The 'Show all variables in the workbench (W)' checkbox is checked. The 'PDD', 'OPC', and 'Hidden (X)' checkboxes are unchecked. The 'Initial value as default value' checkbox is unchecked. The 'Confirm', 'Cancel', and 'Help (H)' buttons are on the right.

变量属性

名称(N):  
Axis1.AxisNo

数据类型(D):  
AXIS\_REF

用法(U):  
VAR ☐ RETAIN

初值(I):

I/O地址(S):

描述(E):

☐ PDD ☐ OPC ☐ 隐藏(X)  
☐ 初值作为默认值.

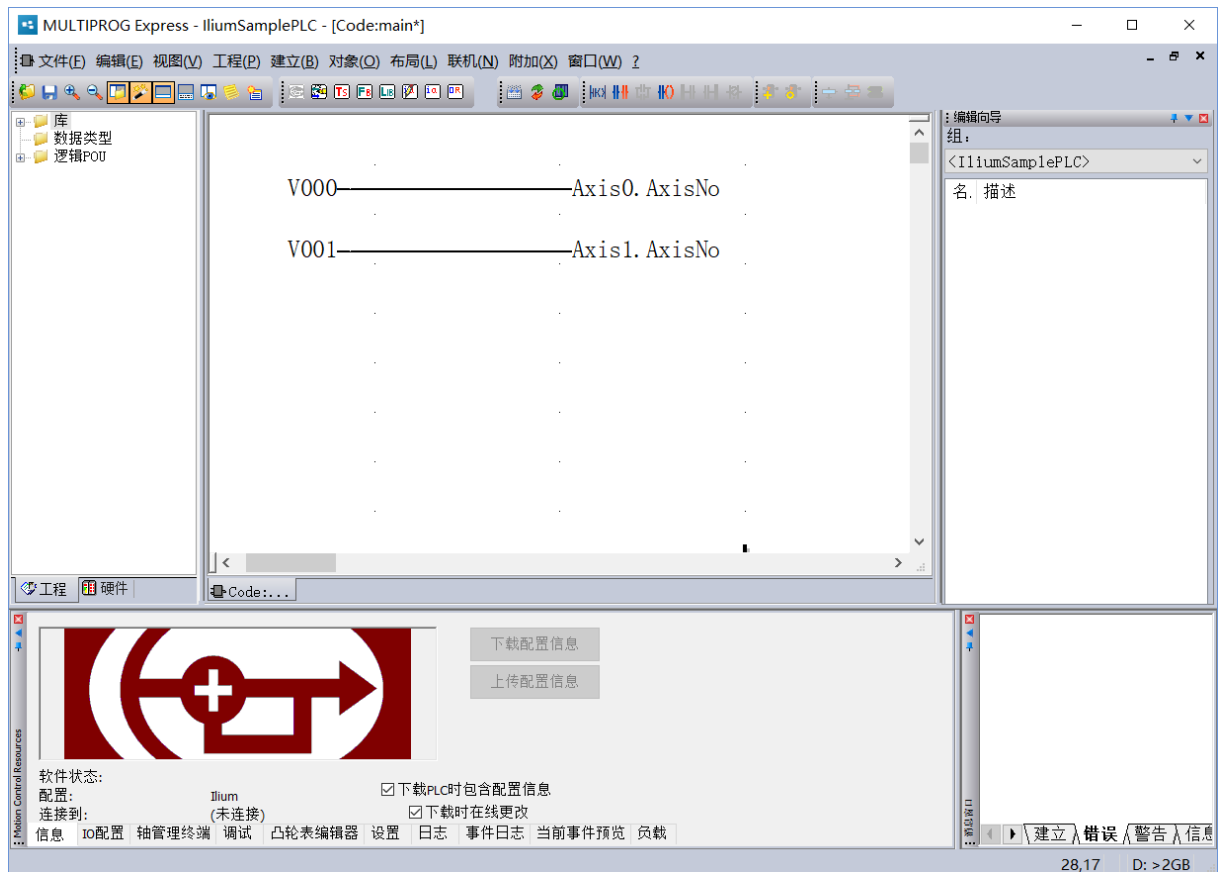
定义范围  
☒ 局部(L) ☐ 全局(G)

局部变量组(v):  
Default

全局变量组(A):  
物理硬件  
Configuration  
Resource  
System Variables

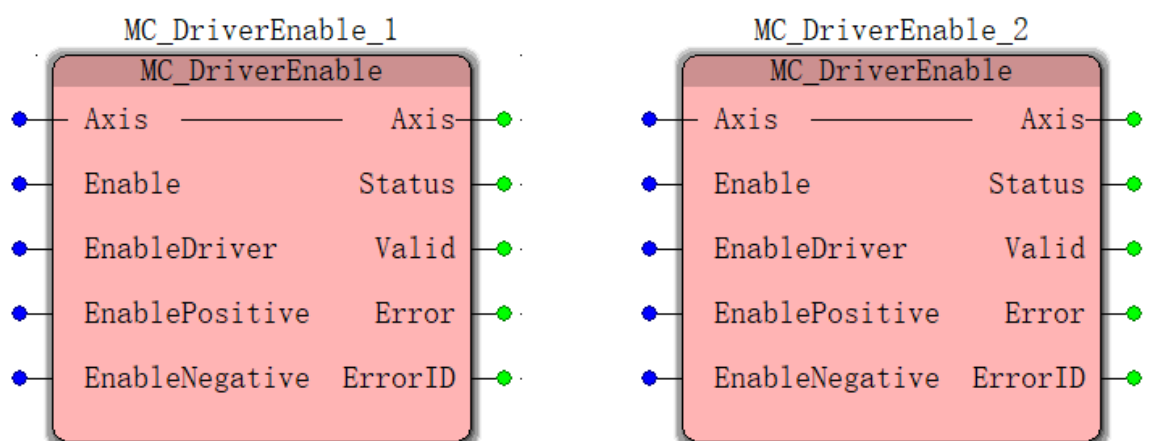
☒ 显示工作单的所有变量(W)

确定 取消 帮助(H)



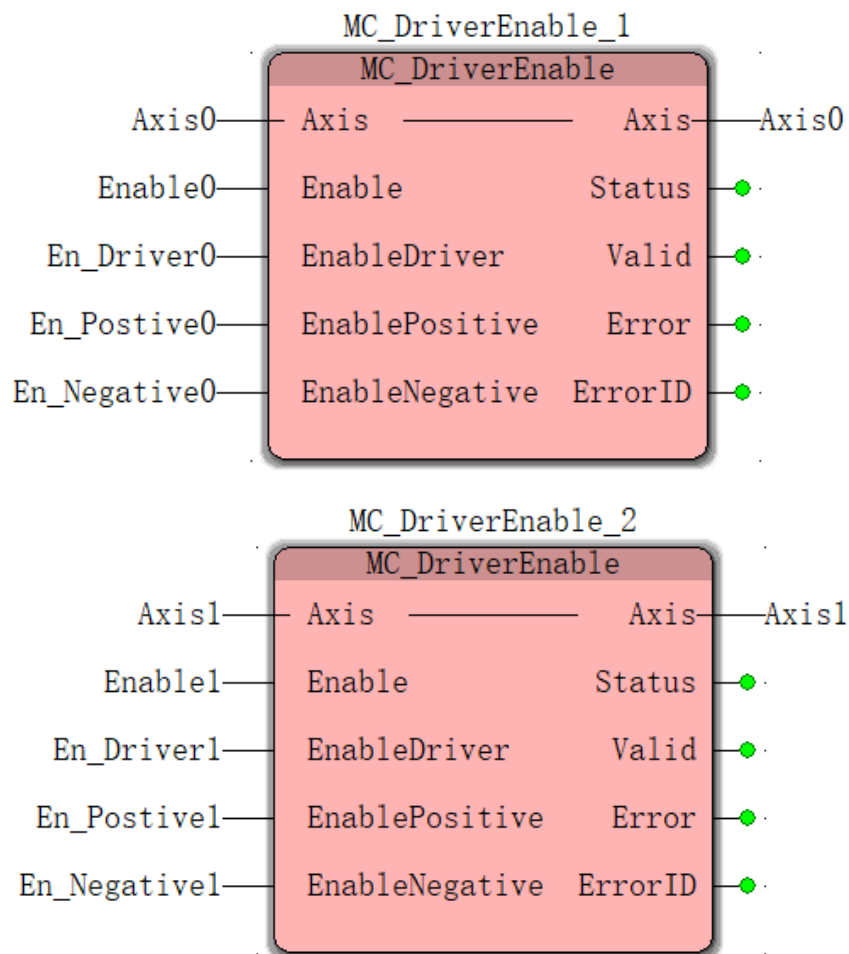
## (2) Insert function block instruction

a. In the programming wizard window, find the MC instruction library, insert two enable modules, MC\_DriverEnable, hold down the left mouse button and drag to the programming interface, and then let go. At this time, the properties of the module will pop up. You need to name the module, generally keep it The default is OK, click "OK", as shown in the figure below:



Double-click the module input pin (blue dot), and the "variable attribute" box will pop up to define the variable name, data type, usage, initial value, etc.; (the user can just

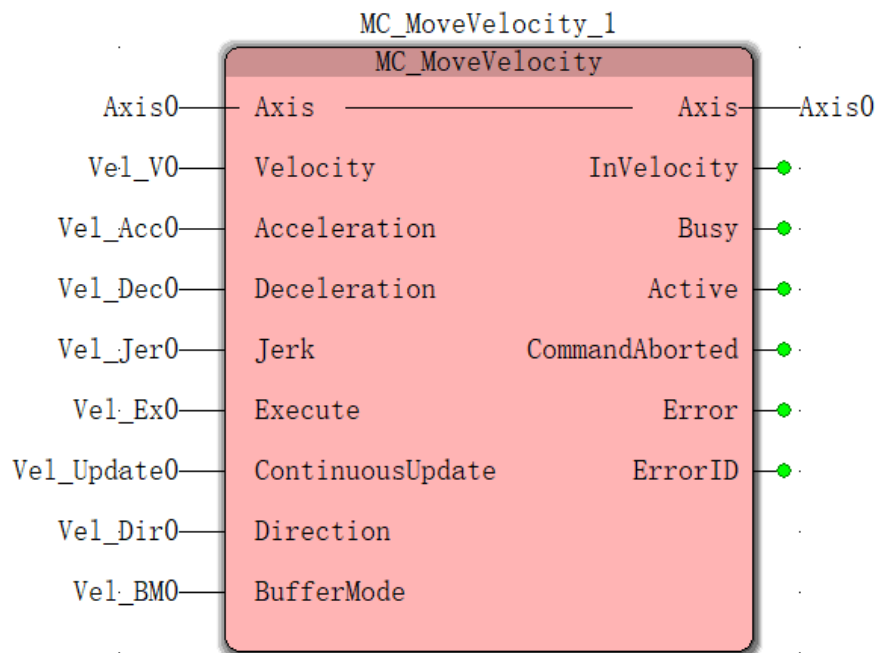
fill in the axis parameters and introduce the parameters that cannot be defaulted. Yes, please refer to 6.2.3.1.3), as shown in the figure below:



variable name	type of data	Initial value
Axis0	AXIS_REF	0
Enable0	BOOL	1
En_Driver0	BOOL	0
En_Postive0	BOOL	1
En_Negative0	BOOL	1
Axis1	AXIS_REF	1
Enable1	BOOL	1
En_Driver1	BOOL	0
En_Postive1	BOOL	1
En_Negative1	BOOL	1

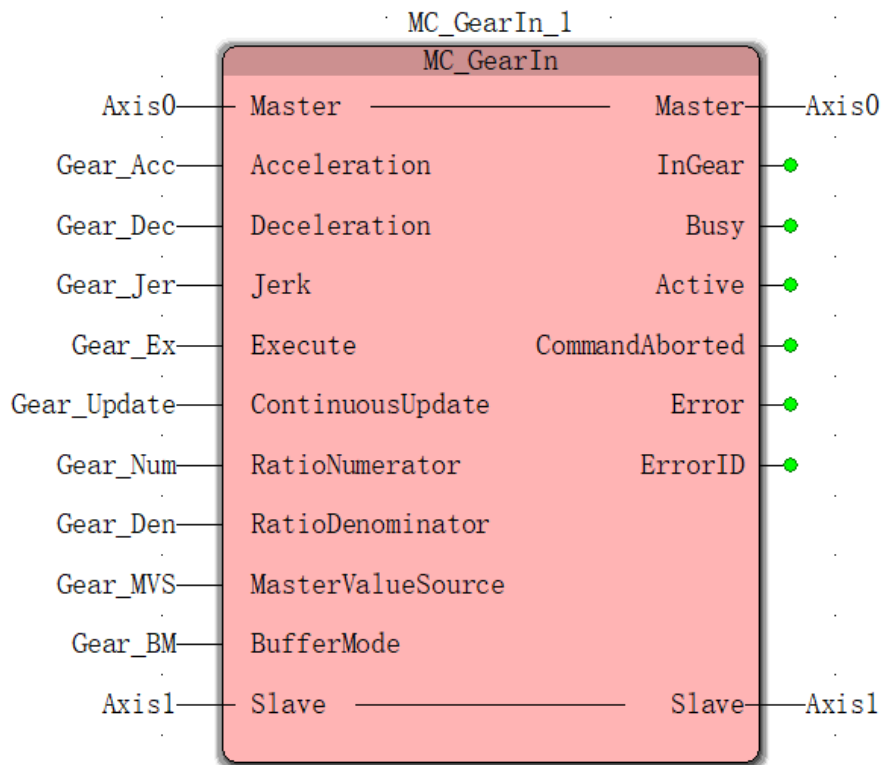
b. In the same way, insert the speed module **MC\_MoveVelocity** from the MC instruction library, enter the variables, and click "OK", as shown in the figure below:





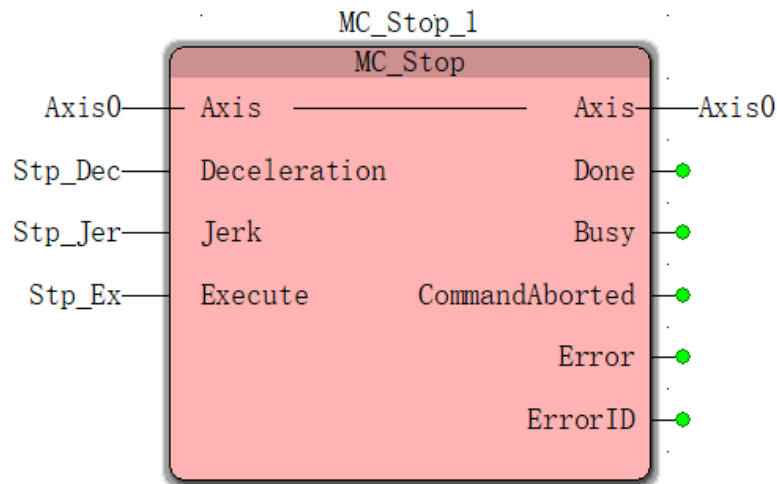
variable name	type of data	Initial value
Axis0	AXIS_REF	0
Vel_V0	LREAL	500.0
Vel_Acc0	LREAL	1000.0
Vel_Dec0	LREAL	1000.0
Vel_Jer0	LREAL	10000.0
Vel_Ex0	BOOL	0
Vel_Update0	BOOL	0
Vel_Dir0	INT	1
Vel_BM0	INT	0

c. In the same way, insert the electronic gear module MC\_GearIn from the MC instruction library, enter the variables, and click "OK", as shown in the figure below:



variable name	type of data	Initial value
Axis0	AXIS_REF	0
Gear_Acc	LREAL	1000.0
Gear_Dec	LREAL	1000.0
Gear_Jer	LREAL	10000.0
Gear_Ex	BOOL	0
Gear_Update	BOOL	0
Gear_Num	INT	1
Gear_Den	UINT	2
Gear_MVS	INT	0
Gear_BM	INT	0
Axis1	AXIS_REF	1

d. Using the same method, insert the stop module MC\_Stop from the MC instruction library, enter the variables, and click "OK", as shown in the figure below:



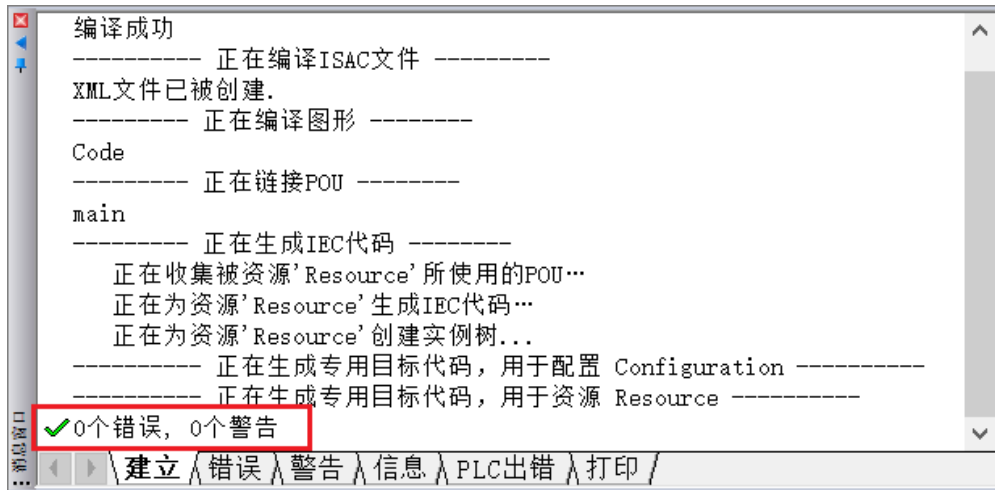
variable name	type of data	Initial value
Axis0	AXIS_REF	0
Stp_Dec	LREAL	1000.0
Stp_Jer	LREAL	10000.0
Stp_Ex	BOOL	0

At this point, the program is established.

## PLC program downloading and debugging

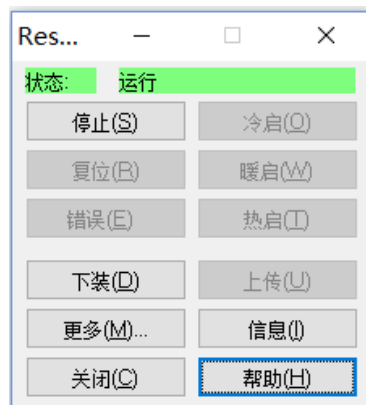
### (1) Program compilation and production

After the program is edited, click the menu "Create -> Make", or click the button on the toolbar. After there is no error prompt in the information status area, proceed to the next step of downloading the program. If there is a prompt, double-click the "under the message area" "Error" prompt, the software automatically jumps to the wrong place, click "Make" after the modification is completed, until there is no error prompt in the information status area;

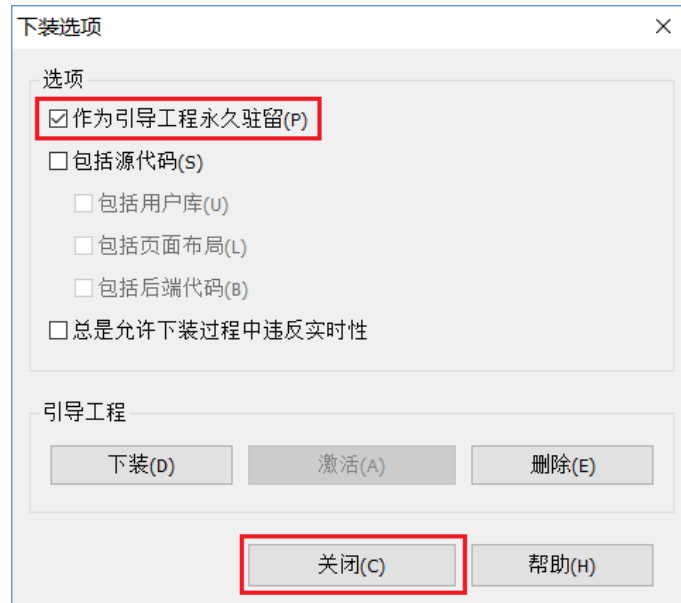


### (2) Download the program

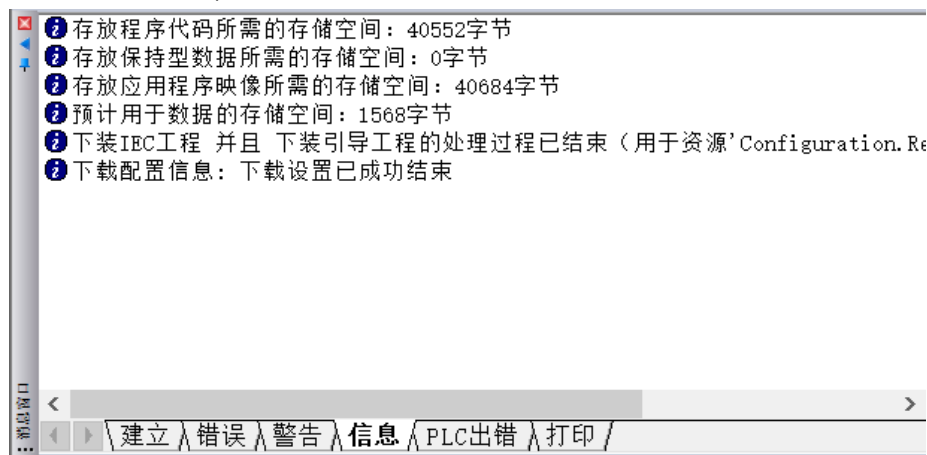
After the program is made, click the menu "Online -> Project Debugging" to open the project control dialog window, as shown in the figure below;



Click More, in the pop-up download options, check "As a boot project permanent residence", click Close;



Then click "Stop -> Reset -> Download" in the project control dialog box in turn, and wait for the download to complete;




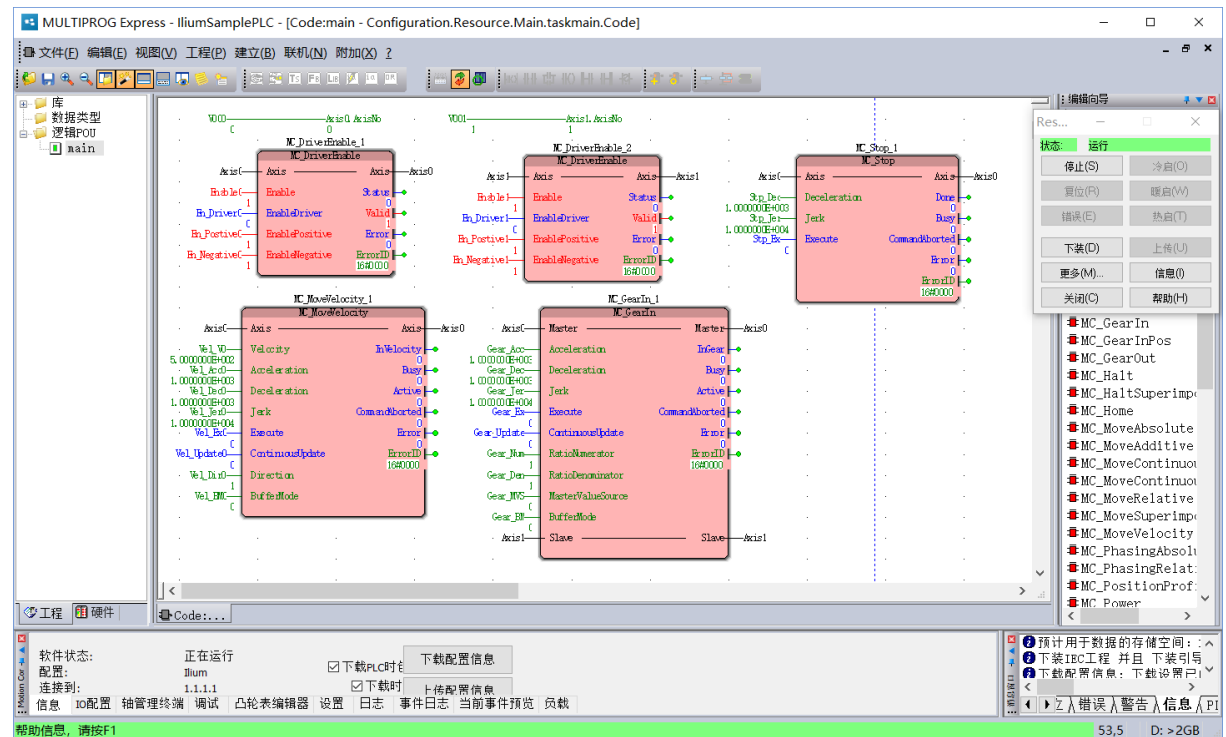
After the message window "shows that the download setting has been successfully completed", click the cold start to run the program, and the status display will change to "running".



### (3) Program debugging

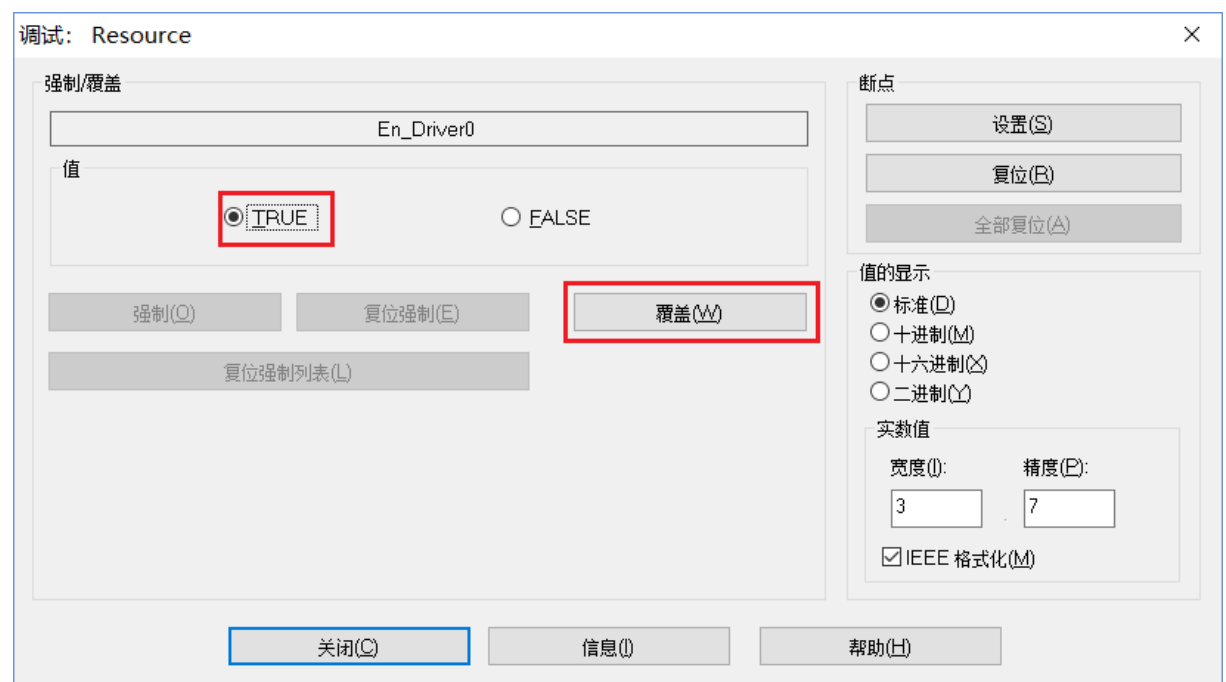
Under the premise that the status displayed in the project control dialog box is running, click

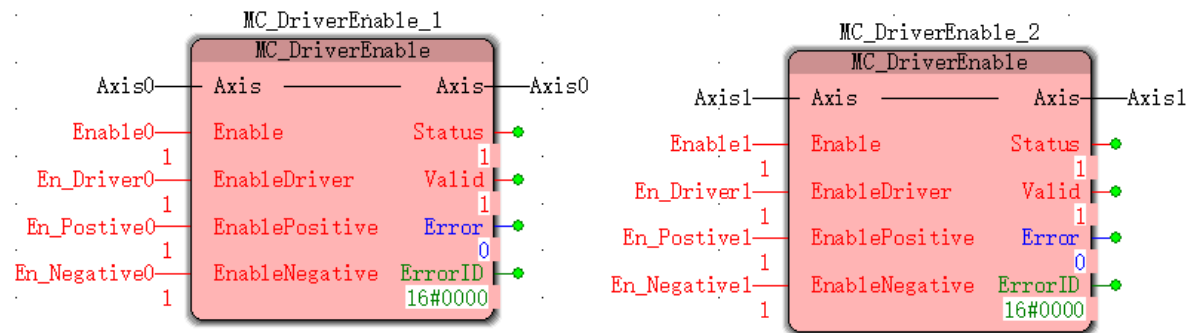
the menu "Online -> Debug", or click the debug button on the toolbar , Open the program monitoring and debugging, as shown in the figure below;



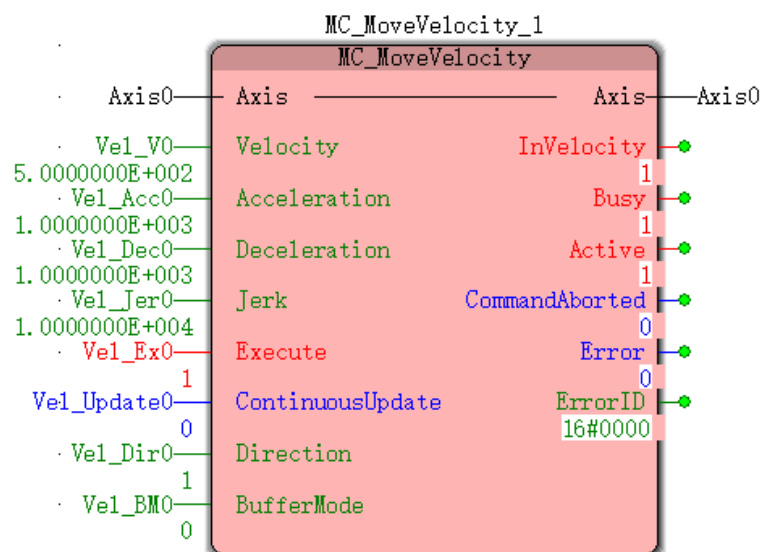
Action steps:

a. First enable the servo before starting, double-click the MC\_DriverEnable blue input points "En\_Driver0", "En\_Driver1", and set the value to Ture (when it needs to be turned off, the value is set to False), click to overwrite, "En\_Driver0", "En\_Driver1" "Will change from False to Ture, as shown in the figure below;

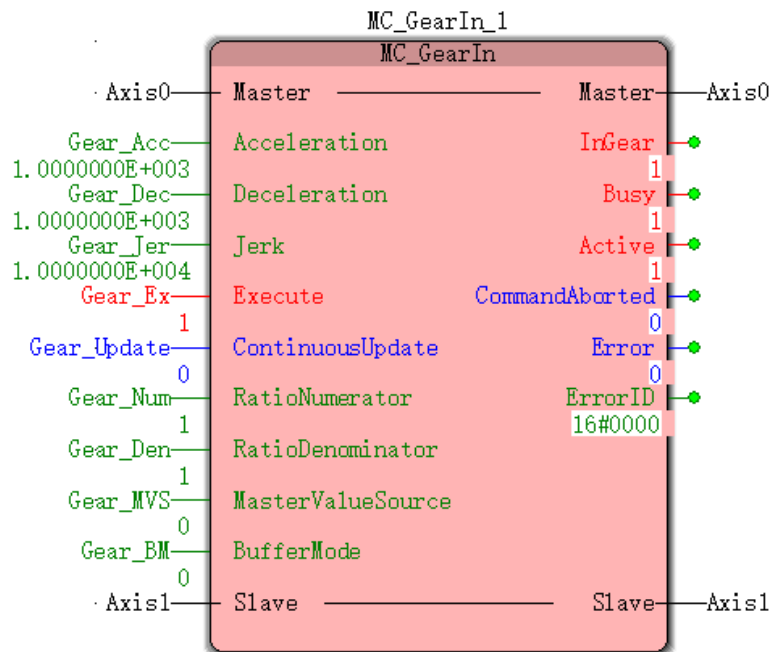




b. After the servo is enabled, set the "Vel\_Ex" of the MC\_MoveVelocity\_1 module to Ture, trigger the speed command of axis 0, and axis 0 will start to run according to the set speed parameters, as shown in the figure below;



c. After the axis 0 is started, set the "Gear\_Ex" of the MC\_GearIn\_1 module to Ture, trigger the electronic gear coupling command, and axis 1 will follow the main shaft to move the electronic gear according to the set electronic gear ratio and speed parameters, as shown in the following figure;



d. When the movement is stopped, set the "Stp\_Ex" of the MC\_Stop\_1 module to Ture, trigger the stop command, axis 0 will decelerate to a stop according to the set deceleration parameters, and axis 1 will follow the axis 0 to go the electronic gear, so axis 1 will also Follow the spindle to decelerate and stop, as shown in the figure below;

