INOVANCE

2021

MD500/MD290

EtherCAT communication

MD500-ECAT

INOVANCE TECHNOLOGY EUROPE

V1.0

TABLE OF CONTENTS

1 GENERAL DATA

Authors:	Raúl Sampé
Date:	19.01.2021
Hardware:	MD500, MD290, MD500-ECAT card
Software:	InoProShop v1.5.2, InoLoader v3.15
Info:	MD500 EtherCAT communication procedure

2 PURPOSE OF THIS DOCUMENT

The purpose of this document is to facilitate the commissioning of EtherCAT communications on the MD500/MD290 drives. To perform this procedure, an MD500/MD290 and an optional MD500-ECAT communications card are required.

If it is necessary to update the firmware, the PC Comms kit-02 and the InoLoader v3.15 software will also be used.

3 OVERVIEW

The MD500-ECAT card is an EtherCAT fieldbus adapter card, which can be used in the ultra-high speed I/O network. It is installed in the MD series AC drive to increase the communication efficiency and implement the AC drive networking function, which enables the AC drive to be a slave controlled by the fieldbus master station.

The MD500-ECAT card can be used on the MD series AC drives, such as MD500 and MD290.

NOTE MD series AC drives can only communicate with the MD500-ECAT card through the serial port (UART), and does **not support the CiA402 protocol**. Then the update rate of parameter used in the EtherCAT communication is limited to around 20ms.

5 INSTALLATION AND SETTINGS

5.1 INSTALLING THE MD500-ECAT CARD

The MD500-ECAT card is installed inside the MD500 series AC drive. Before installation, deenergize the AC drive and wait about 10 minutes until the charging indicator on the AC drive becomes off. Then, insert the MD500-ECAT card into the AC drive and fasten the screws to avoid damage caused by external signal cable tension on the signal socket between boards. Figure 1 shows the installation.

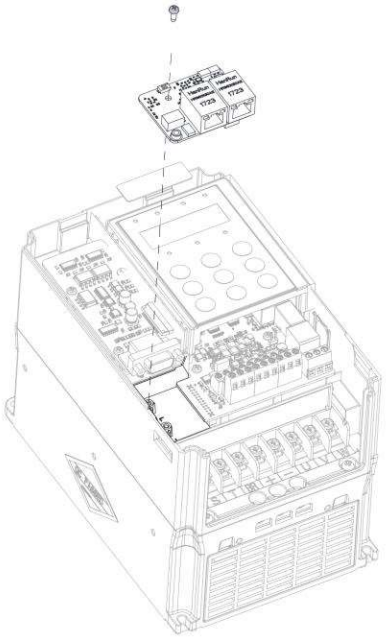


Figure 1 Installation of the MD500-ECAT card

Note that the ground terminals of both the MD500-ECAT card and AC drive must be connected properly, as shown in Figure 2.

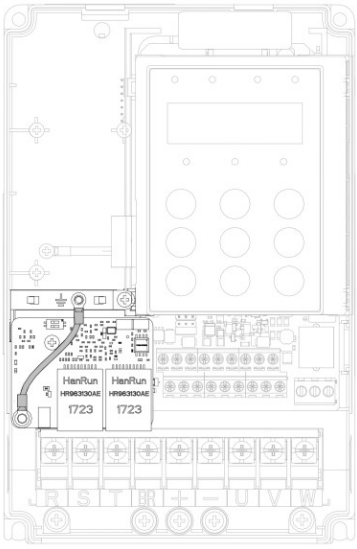


Figure 2. Ground terminal connection between the MD500-ECAT card and AC drive

5.2 HARDWARE LAYOUT

Figure 3 shows the hardware layout of the MD500-ECAT card. The pin header J7 on the back of the MD500-ECAT card is used to connect the AC drive. The MD500-ECAT card provides two network ports J4 and J6 for communication with the master station (or the previous slave station) and next slave station (if existing). For details about the hardware, see table 1.

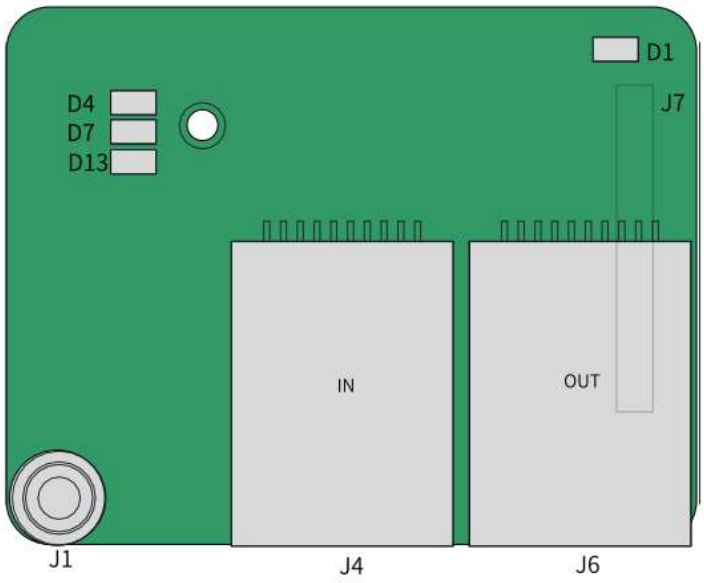
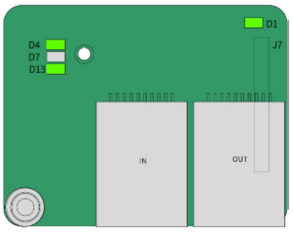


Table 1. Hardware description of the MD500-ECAT card

Symbol	Hardware Name	Function Description
J7	Pin header	Used to connect the AC drive.
J4 J6	Network port	Used for communication with the master station (or the previous slave station) and next slave station (if existing). The left one is used for input and the right one is for output.
J1	EMC ground terminal	Used to connect the EMC ground terminal of the AC drive.
D13	Power indicator (green)	Used to indicate the power status. On: power-on normal Off: power-on abnormal (Check whether the installation is correct.)
D1	AC drive communication status indicator (green)	See Table 2 Indicator description of the MD500-ECAT card.
D4	EtherCAT Interaction indicator (green)	
D7	ESC fault indicator (red)	

Table 2. Indicator description of the MD500-ECAT card

	Indicator	State Description	Solution
D1	Steady green	Normal	N/A
	Steady off	Abnormal communication with the AC drive	Set F0-28 to 1 and check whether the AC drive supports the MD500-ECAT card.
D4	Steady green	Working at OP state	N/A
	Flashing green	Working in PREOP/ SAFEOP mode	Check the configuration. Check whether the AC drive supports the MD500-ECAT card and whether F0-28 is set to 1. Check whether the network port is connected correctly.
	Steady OFF	Master station disconnected or working in Initial mode	Check whether the master station and network port are connected correctly.
D7	Steady OFF	Normal	N/A
	Steady on in red	ESC internal fault	Contact Inovance or the agent for technical support.



When the EtherCAT master controller is communicating with drive and drive is in the operational state the **D4, D13 and D1 leds must be ON**.

Led D1 becomes ON when parameter F0-28 is changed to 1 and the EtherCAT card acts as a bridge between EtherCAT network and AC drive.

6 COMMUNICATION CONFIGURATION

6.1 COMMUNICATION CONFIGURATION FOR THE MD500-ECAT CARD AND MD500/MD290 AC DRIVE

The following parameters must be set to enable normal communication between the MD500-ECAT card and MD500/MD290 series AC drive and to connect the MD500-ECAT card to the EtherCAT fieldbus network.

Parameter No.	Parameter Name	Setting Range	Value	Description
F0-02	Command source selection	0: Operating panel (keypad & display) (LED off) 1: Terminal I/O control (LED on) 2: Serial comms. (LED flashing)	**2**	Running command given through communication
F0-03	Main frequency reference setting channel selection	0: Digital setting F0-08 (pressing ▲ or ▼ can modify F0-08 easily, and the modified value won't be cleared even after power off) 1: Digital setting F0-08 (pressing ▲ or ▼ can modify F0-08 easily, but the modified value would be cleared after power off) 2: AI1 3: AI2 4: AI3 5: Pulse setting (DI5) 6: Multi-reference setting 7: Simple PLC 8: PID 9: Communication setting	**9**	Target frequency given through communication
F0-28	Serial port communication protocol	0: Modbus protocol 1: Communication card network bridge protocol	1	Select the special communication card network bridge for the serial communication protocol.
FD-02	Slave station alias	1 to 247	-	Alias of the EtherCAT slave station. Its default value is 1 (if the formal name of the slave station is used for communication, the setting of this parameter is not required).

6.2 DRIVE PARAMETERS MAPPING

This chapter specifies the correspondence method between the various AC drive paarameters and the EtherCAT object dictionary. We can simply and directly determine the relation between the parameters and the object dictionary by this method.

The parameter groups correspond to the indexes 0x2000 to 0x20FF of the EtherCAT object dictionary.

The correspondence method is as follows:

- Object dictionary index is the parameter group number plus 0x2000
- Object dictionary sub-index is the parameter number in the group plus 1.

Index → ***Group No. F0 + 0x2000***

Sub-index → ***Parameter number in the group + 1 (offset)***

For example, for drive parameter F0-03 (Main frequency source X selection) and communication address 0xF003, the corresponding object dictionary index and sub-index are 0x20F0 and 0x04, respectively.

The parameter groups of the MD500/MD290 series drive are divided into groups F0 to FF, A0 to AF, and U0 to UF. According to the preceding correspondence method, for parameter read/write operations, the relation between the parameter group numbers and the object dictionary indexes is as follows:

MD500/MD290 Parameter Group	EtherCAT Object Dictionary Index
F0–FE	0x20F0–0x20FE
A0–AC	0x20A0–0x20AC
U0–U3	0x2070–0x2073

NOTE Default PDO configuration

When the MD500-ECAT card is used, the **written PDO1 and PDO2** are mapped to U3-17 and U3-16, respectively. Therefore, the first item of RPDO must be U3-17; otherwise, the running will be abnormal. Besides, if the eight higher bits of U3-17 are written with any non-zero value, the AC drive will report a communication fault (Err16).

The default **read PDO1 and PDO2** are mapped to U0-68 and U0-69, respectively. Therefore, the first item of TPDO must be U0-68; otherwise, the running will be abnormal.

Parameters related to the control of the drive through communications:

Parameter No.	Parameter Name	Setting Range	Index	Sub-index
Communication control word parameters				
U3-16	Frequency setting	-Maximum frequency to +Maximum frequency 0.01 Hz	16#2073	16#11
U3-17	Control command	0001: Forward running 0002: Reverse running 0003: Forward jogging 0004: Reverse jogging 0005: Coast to stop 0006: Decelerate to stop 0007: Fault reset	16#2073	16#12
U3-18	DO control	BIT0: DO1 control BIT1: DO2 control BIT2: RELAY1 control BIT3: RELAY2 control BIT4: FMR output control BIT5: VDO1 BIT6: VDO2 BIT7: VDO3 BIT8: VDO4 BIT9: VDO5	16#2073	16#13
U3-19	AO1 control	0 to 7FFF corresponds to 0% to 100%.	16#2073	16#14
U3-20	AO2 control	0 to 7FFF corresponds to 0% to 100%.	16#2073	16#15
U3-21	FMP control	0 to 7FFF corresponds to 0% to 100%.	16#2073	16#16
U3-22	Reserved	Reserved	16#2073	16#17
U3-23	Speed control	-15000 rpm to +15000 rpm (The setting range is determined by the number of motor pole pairs and frequency setting range.)	16#2073	16#18
AC drive parameters (commonly-used)				
F0-10	Maximum frequency	50.00 Hz to 500.00 Hz	16#20F0	16#0B
F0-17	Acceleration time	0.00s to 650.00s (F0-19 = 2) 0.0s to 6500.0s (F0-19 = 1) 0s to 65000s (F0-19 = 0)	16#20F0	16#12
F0-18	Deceleration time	0.00s to 650.00s (F0-19 = 2) 0.0s to 6500.0s (F0-19 = 1) 0s to 65000s (F0-19 = 0)	16#20F0	16#13
F0-19	Acceleration/Deceleration timunit	0: 1s 1: 0.1s 2: 0.01s	16#20F0	16#14
F8-00	Jog running frequency	0.00 Hz to the maximum frequency	16#20F8	16#01
F8-01	Jog acceleration time	0.0s to 6500.0s	16#20F8	16#02
F8-02	Jog deceleration time	0.0s to 6500.0s	16#20F8	16#03
A0-03	Torque digital setting in torque control	-200.0% to +200.0%	16#20A0	16#04

A0-05	Forward maximum frequency in torque control	0.00 Hz to the maximum frequency	16#20A0	16#06
A0-06	Reverse maximum frequency in torque control	0.00 Hz to the maximum frequency	16#20A0	16#07
U0-06	Output torque (%)	-	16#2070	16#07
U0-07	DI state	-	16#2070	16#08
U0-08	DO state	-	16#2070	16#09
U0-24	Current speed	-	16#2070	16#19
U0-38	Encoder position	-	16#2070	16#27
2001H	DO control	-	16#2020	16#02
8000H	Current fault	-	16#2080	16#01

Parameters related to communication monitoring

Parameter No.	Parameter Name	Units	Index	Sub-index
U0-00	Running frequency (Hz)	0.01 Hz	16#2070	16#01
U0-01	Frequency reference (Hz)	0.01 Hz	16#2070	16#02
U0-02	Bus voltage (V)	0.1 V	16#2070	16#03
U0-03	Output voltage (V)	1 V	16#2070	16#04
U0-04	Output current (A)	0.01 A	16#2070	16#05
U0-05	Output power (kW)	0.1 kW	16#2070	16#06
U0-06	Output torque (%)	0.1%	16#2070	16#07
U0-07	DI state	1	16#2070	16#08
U0-08	DO state	1	16#2070	16#09
U0-09	AI1 voltage (V)	0.01 V	16#2070	16#0A
U0-10	AI2 voltage (V)	0.01 V	16#2070	16#0B
U0-11	AI3 voltage (V)	0.01 V	16#2070	16#0C
U0-12	Count value	1	16#2070	16#0D
U0-13	Length value	1	16#2070	16#0E
U0-14	Load speed display	1	16#2070	16#0F
U0-15	PID reference	1	16#2070	16#10
U0-16	PID feedback	1	16#2070	16#11
U0-17	PLC stage	1	16#2070	16#12
U0-18	Pulse input reference (Hz	0.01 kHz	16#2070	16#13
U0-19	Feedback speed (Hz)	0.01 Hz	16#2070	16#14
U0-20	Remaining running time	0.1 min	16#2070	16#15
U0-21	AI1 voltage before correction	0.001 V	16#2070	16#16
U0-22	AI2 voltage before correction	0.001 V	16#2070	16#17
U0-23	AI3 voltage before correction	0.001 V	16#2070	16#18
U0-24	Linear speed	1 m/min	16#2070	16#19
U0-25	Current power-on time	1 min	16#2070	16#1A
U0-26	Current running time	0.1 min	16#2070	16#1B
U0-27	Pulse input frequency	1 Hz	16#2070	16#1C
U0-28	Communication reference	0.01%	16#2070	16#1D
U0-29	Encoder feedback speed	0.01 Hz	16#2070	16#1E
U0-30	Main frequency X display	0.01 Hz	16#2070	16#1F

U0-31	Auxiliary frequency Y display	0.01 Hz	16#2070	16#20
U0-32	Any memory address	1	16#2070	16#21
U0-33	Synchronous motor rotor position	0.1°	16#2070	16#22
U0-34	Motor temperature	1℃	16#2070	16#23
U0-35	Target torque (%)	0.1%	16#2070	16#24
U0-36	Resolver position	1	16#2070	16#25
U0-37	Power factor angle	0.1°	16#2070	16#26
U0-38	ABZ position	1	16#2070	16#27
U0-39	Target voltage upon V/f separation	1 V	16#2070	16#28
U0-40	Output voltage upon V/f separation	1 V	16#2070	16#29
U0-41	DI state display	1	16#2070	16#2A
U0-42	DO state display	1	16#2070	16#2B
U0-43	DI state display 1	1	16#2070	16#2C
U0-44	DI state display 2	1	16#2070	16#2D
U0-45	Fault information	1	16#2070	16#2E
U0-58	Z signal counting	1	16#2070	16#3B
U0-59	Rated frequency (%)	0.01%	16#2070	16#3C
U0-60	Running frequency (%)	0.01%	16#2070	16#3D
U0-61	AC drive state	1	16#2070	16#3E
U0-62	Current fault code	1	16#2070	16#3F
U0-63	Data sent by master during point-point communication	0.01%	16#2070	16#40
U0-64	Data sent by slave during point-point communication	0.01%	16#2070	16#41
U0-65	Torque upper limit	0.1%	16#2070	16#42
U0-66	Expansion card model	100: CANopen 200: PROFIBUS-DP 300: CANlink 400: PROFINET 500: EtherCAT	16#2070	16#43
U0-67	Expansion card version	0.01	16#2070	16#44
U0-68	AC drive state	1	16#2070	16#45
U0-69	Running frequency (Hz)	0.01 Hz	16#2070	16#46
U0-70	Motor speed	1 rpm	16#2070	16#47
U0-71	Output current	0.1 A	16#2070	16#48
U0-80	EtherCAT slave station name	1	16#2070	16#51
U0-81	EtherCAT slave site alias	1	16#2070	16#52
U0-82	EtherCAT ESM transmission error code	1	16#2070	16#53
U0-83	EtherCAT XML file version	0.01	16#2070	16#54
U0-84	EtherCAT synchronization loss times	1	16#2070	16#55
U0-85	Maximum EtherCAT port 0 invalid frames and errors per unit time	1	16#2070	16#56

U0-86	Maximum EtherCAT port 1 invalid frames and errors per unit time	1	16#2070	16#57
U0-87	Maximum EtherCAT port forwarding errors per unit time	1	16#2070	16#58
U0-88	Maximum EtherCAT data frame processing unit errors per unit Time	1	16#2070	16#59
U0-89	Maximum EtherCAT port link losses per unit time	1	16#2070	16#5A

6.3 AC DRIVE FAULT INFORMATION

Parameter 8000H provides the AC drive error information. The following table shows the description of the errors:

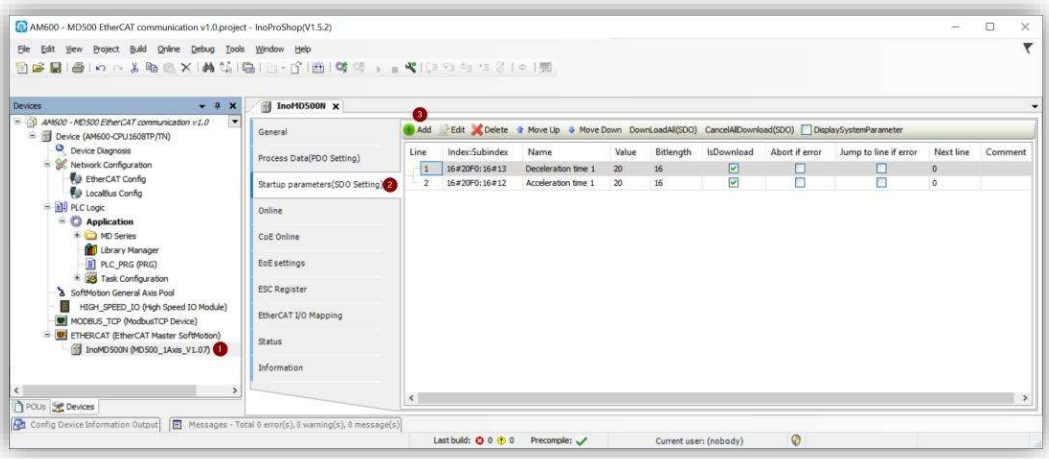
Fault ID	Description
2	Overcurrent during acceleration
3	Overcurrent during deceleration
4	Overcurrent at constant speed
5	Overvoltage during acceleration
6	Overvoltage during deceleration
7	Overvoltage at constant speed
8	Pre-charge resistor fault
9	Undervoltage
10	AC drive overload
11	Motor overload
12	Input phase loss
13	Output phase loss
14	IGBT overheat
15	External fault
16	Communication fault
17	Contactor fault
18	Current detection fault
19	Motor auto-tuning fault
20	Encoder fault
21	EEPROM read-write fault
23	Short circuit to ground
26	Accumulative running time reached
27	User-defined fault 1
28	User-defined fault 2
29	Accumulative power-on time reached
30	Load loss
31	PID feedback lost during running
40	Pulse-by-pulse current limit fault
41	Motor switchover fault during running
42	Speed error
43	Motor overspeed
45	Motor overtemperature
61	Braking unit overload
62	Short-circuit of braking circuit
90	Incorrect setting of PPR of the encoder
91	Not connecting the encoder
92	Initial position error
94	Speed feedback error

6.4 SET RETAIN VALUES BY SDOS

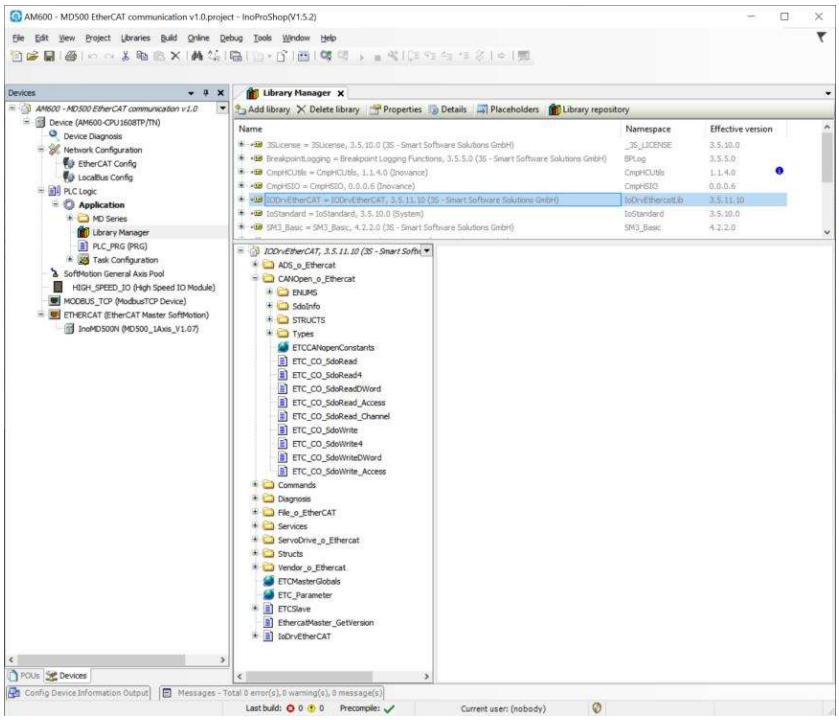
Communication via PDOs modifies the values of the drive's RAM memory parameters. These changes are not saved in the drive's EEPROM memory.

To be able to modify the values of the parameters of the non-volatile memory of the drive, it is necessary to carry out communication through SDOs. All parameters modified with asynchronous communication via SDOs are stored in the non-volatile memory of the drive."

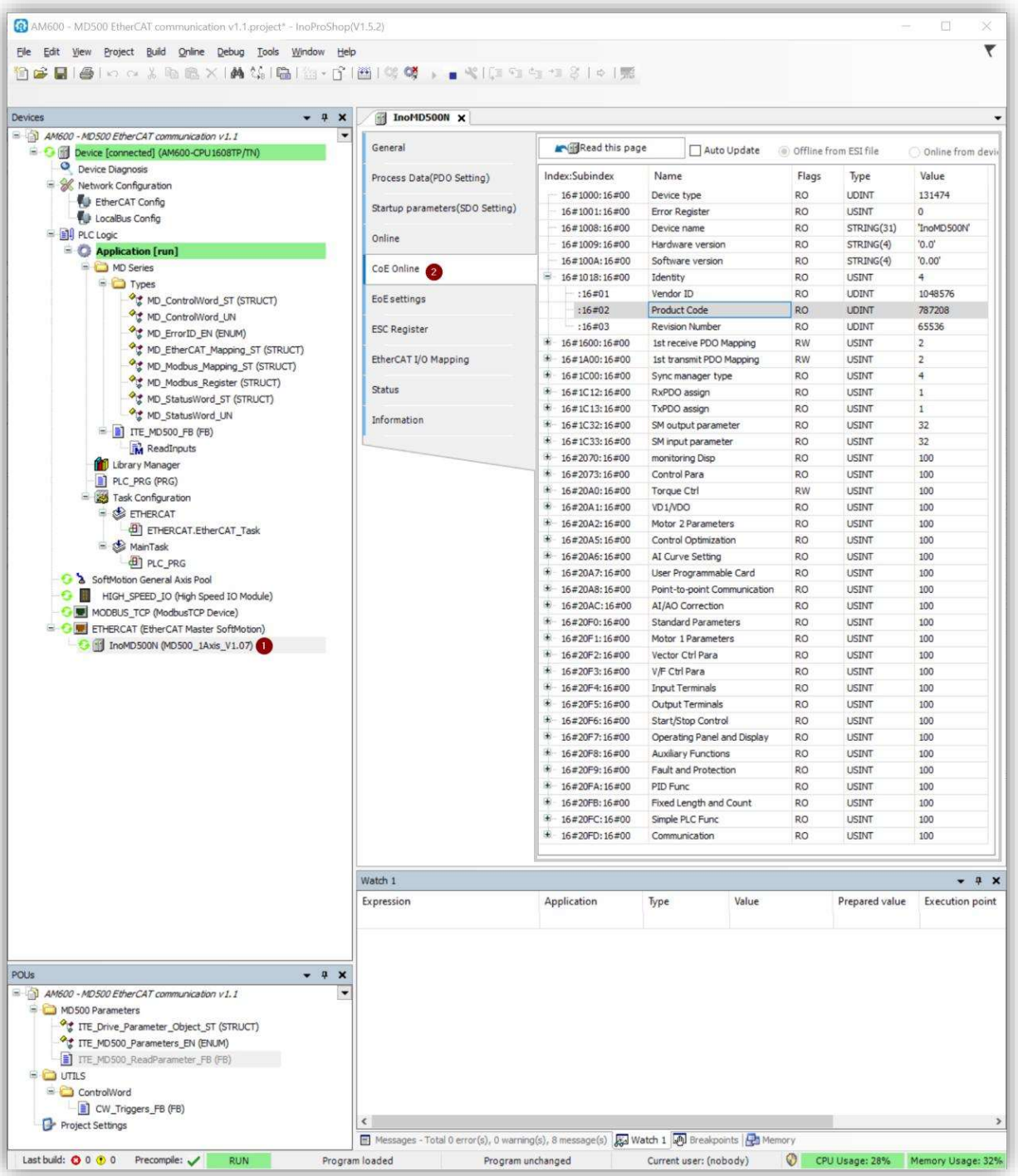
There are two ways to communicate through SDOs, when the EtherCAT network is started with the configuration of the "Startup Parameters" or through the communication functions provided by the controller's programming language. The following image shows the configuration of the "Startup Parameters" with InoProShop. Every time the PLC starts, it transfers all the configured SDOs to the drive.



With the libraries provided by the InoDriveShop it is possible to read / write drive parameters from the PLC program code:



Another option to modify the drive parameters is with the InoProShop tool that allows access to all the SDOs of the object dictionary:



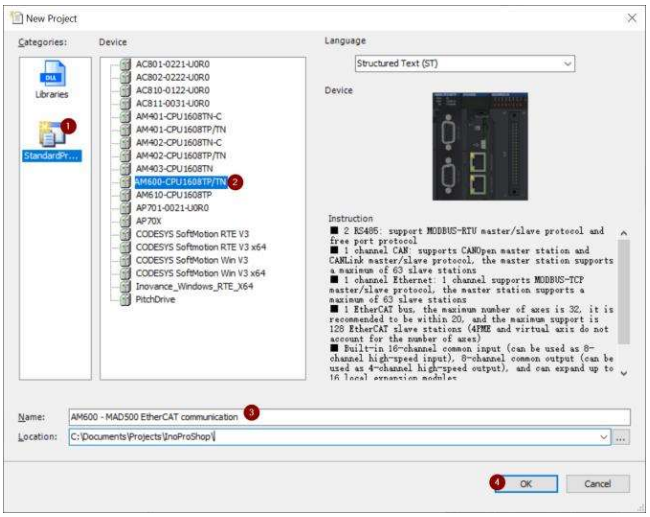
7 PROJECT EXAMPLES

7.1 INOPROSHOP PROJECT (INOVANCE'S AM/AC SERIES CONTROLLERS)

The AM600 master station is used as an example to describe how to use the MD500-ECAT card with the master station.

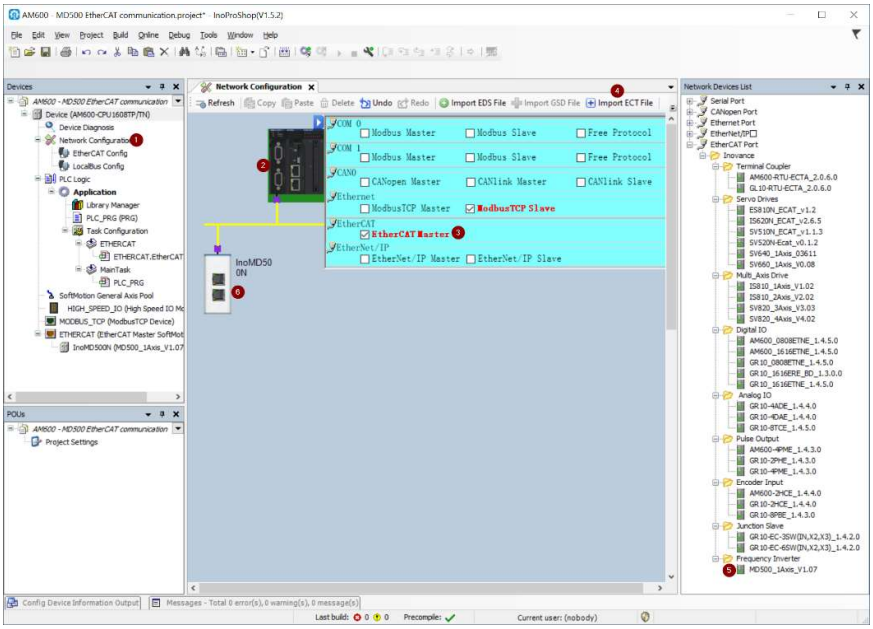
1) Start the software, and create an AM600 project.

Select AM600-CPU1608TP, as shown in the following figure.



2) Add the MD500 AC drive slave station.

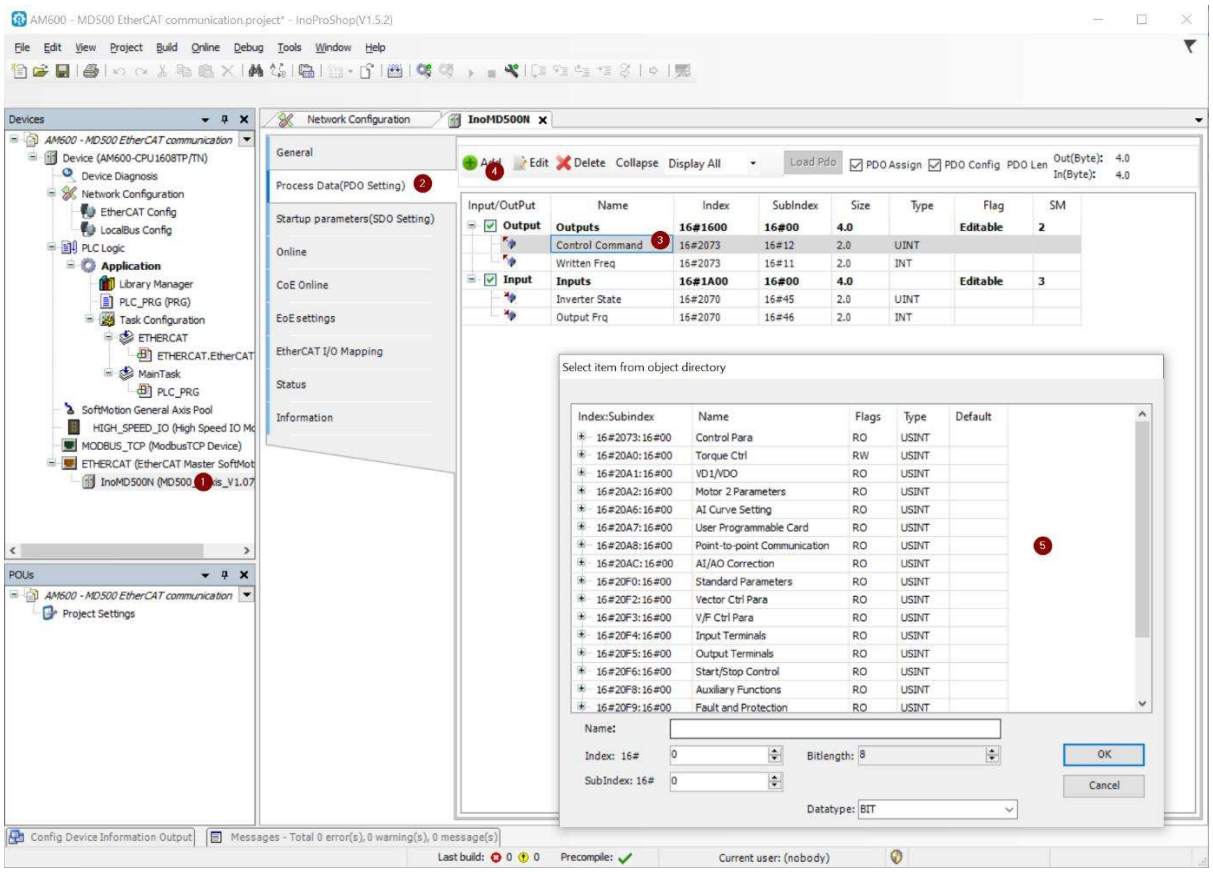
1. Open the network configuration.
2. Select CPU.
3. Enable EtherCAT Master.
4. Import the EtherCAT configuration file of MD500. If any configuration file of other version exists, delete the existing configuration file before importing a new one.
5. Drag the device in the network device list.
6. Add the AC drive slave station, as shown in the following figure.



3) Configure PDO parameters.

1. Select EtherCAT Slave.
2. Open PDO Setting tab.
3. Select Input/Output PDOs.
4. Click on Add button.
5. Select the required PDO and add to PDO settings list.

Control Command and Inverter State of the RPDO cannot be changed and they must be set as the first items. Otherwise, the running will be abnormal.



7.2 BECKHOFF'S CONTROLLER

Beckhoff's TwinCAT master station is used as an example to describe the configuration of the MD500-ECAT card.

NOTE: The 100M Ethernet network adapter with Intel chip must be used. Other network adapters may not support EtherCAT.

1. Install TwinCAT.

   Windows XP system: **tcat_2110_2230** is recommended.

   Windows 7 32-bit system: **tcat_2110_2248** is recommended.

2. Copy the EtherCAT configuration file (MD500_1Axis_V1.03.xml.XML) of MD500 to the

   TwinCAT installation directory.

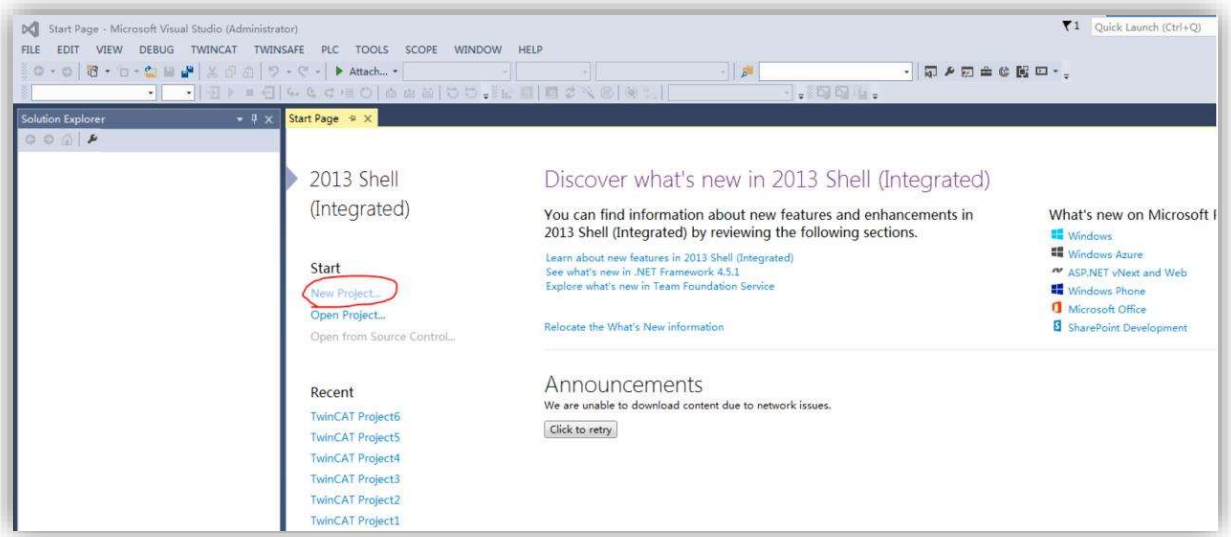
   TwinCAT2 directory: **TwinCAT\IO\EtherCAT**

   TwinCAT3 directory: **TwinCAT\3.1\config\IO\EtherCAT**

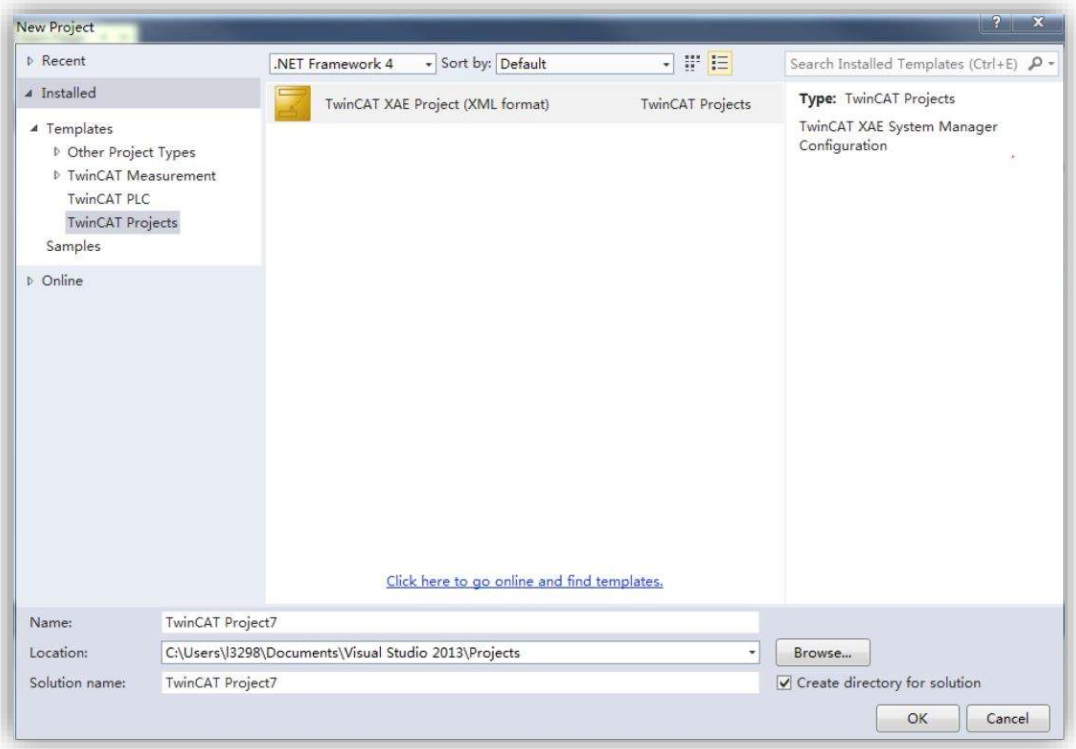
   TwinCAT3 is used as an example in the following section. The operation steps for TwinCAT2 are similar.

3. Start TwinCAT.

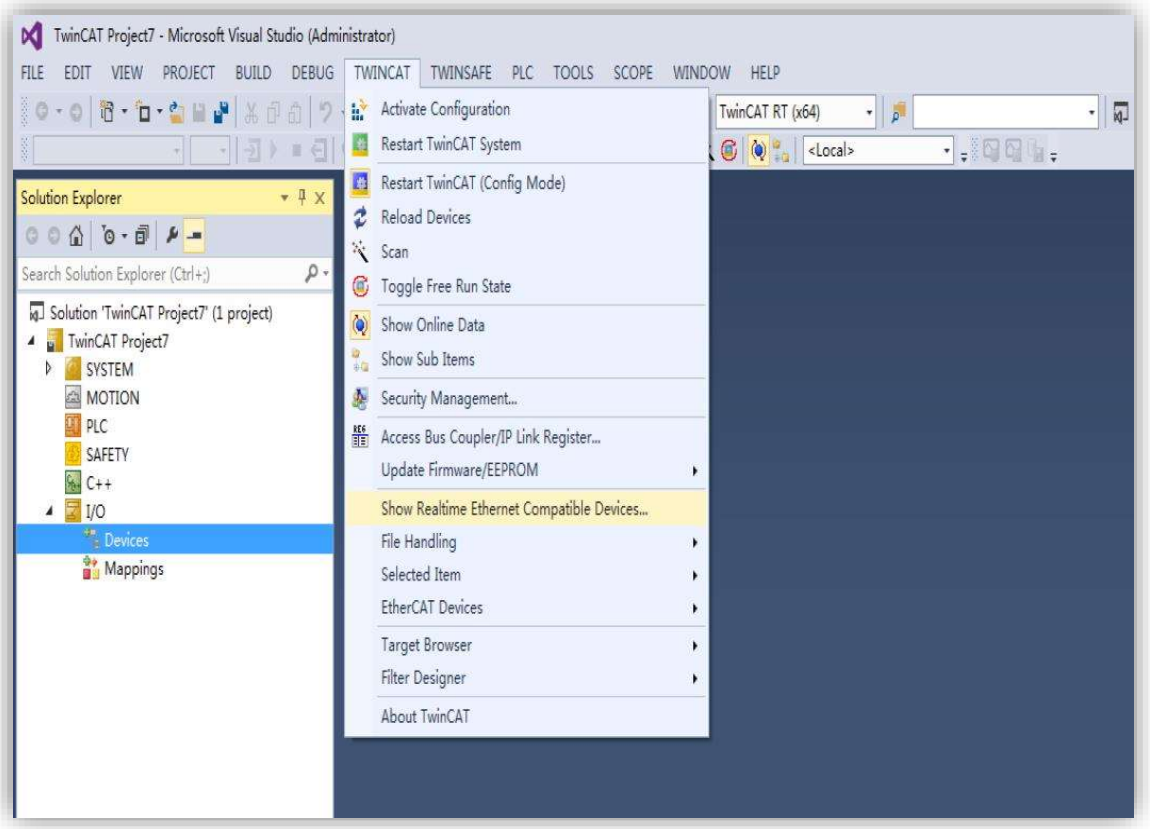
   Click **New Project** to create a project.



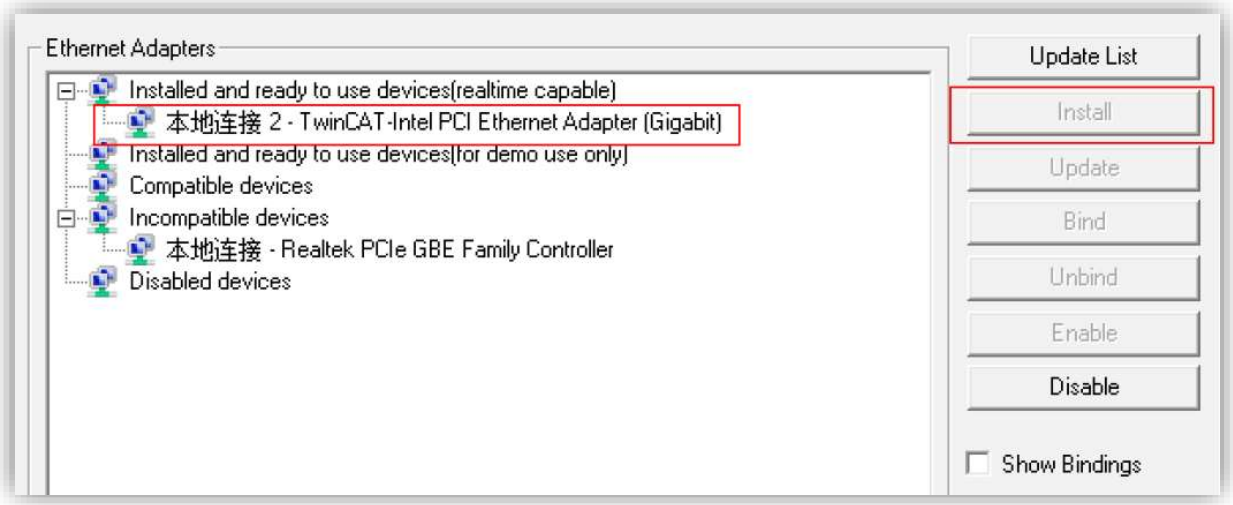
Select TwinCAT XAE Project and click **OK**.



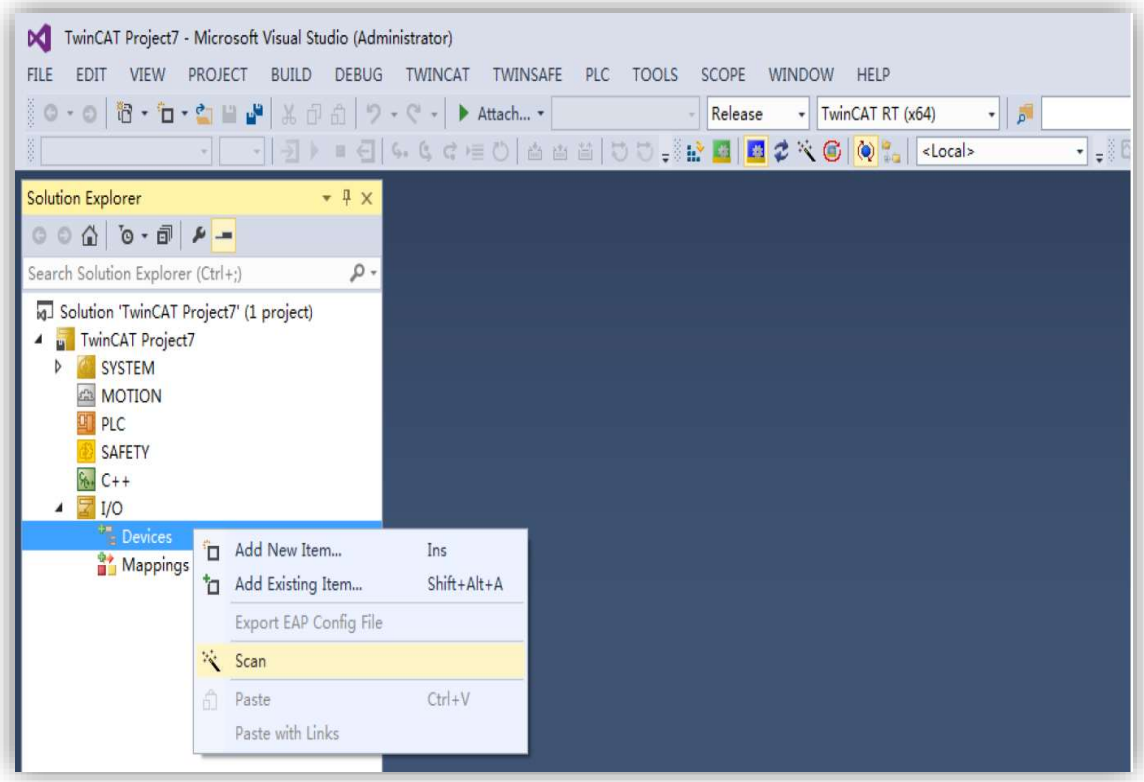
4. Install the TwinCAT network adapter driver.



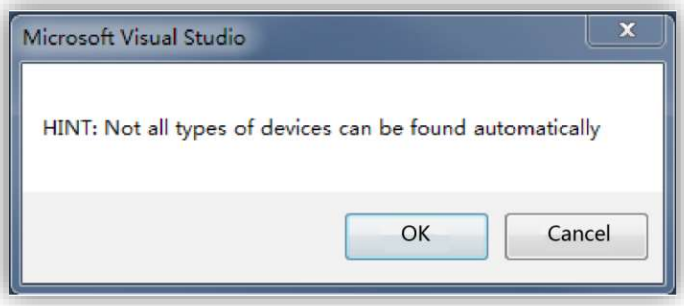
Choose **TWINCAT > Show Real Time Ethernet Compatible Devices**…. In the displayed dialog box, select the local network adapter in **Incompatible devices**, and click **Install**. After installation, the installed network adapter is displayed in **Installed and ready to use devices**.



5. Search for devices.
   Create a project, right-click Device, and then click Scan to search for devices, as shown in the following figure.



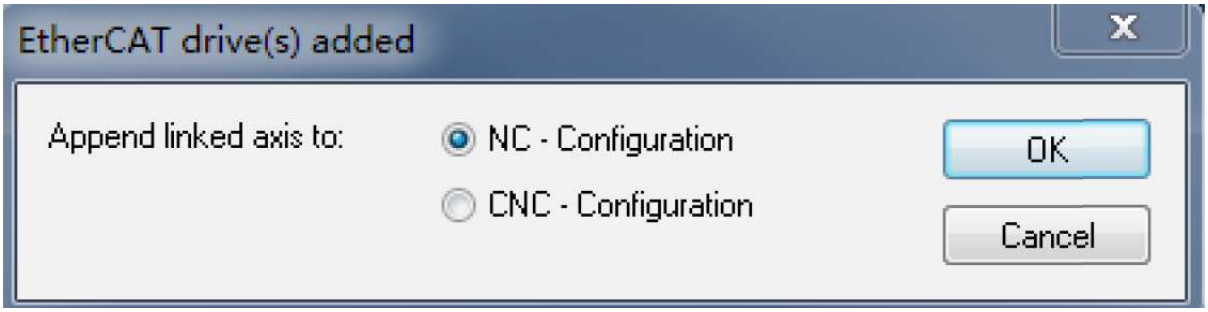
The following message appears. Click **OK**.



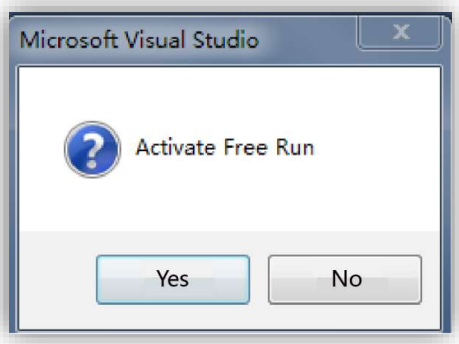
Select EtherCAT device and click **OK**.

Click **Yes**.

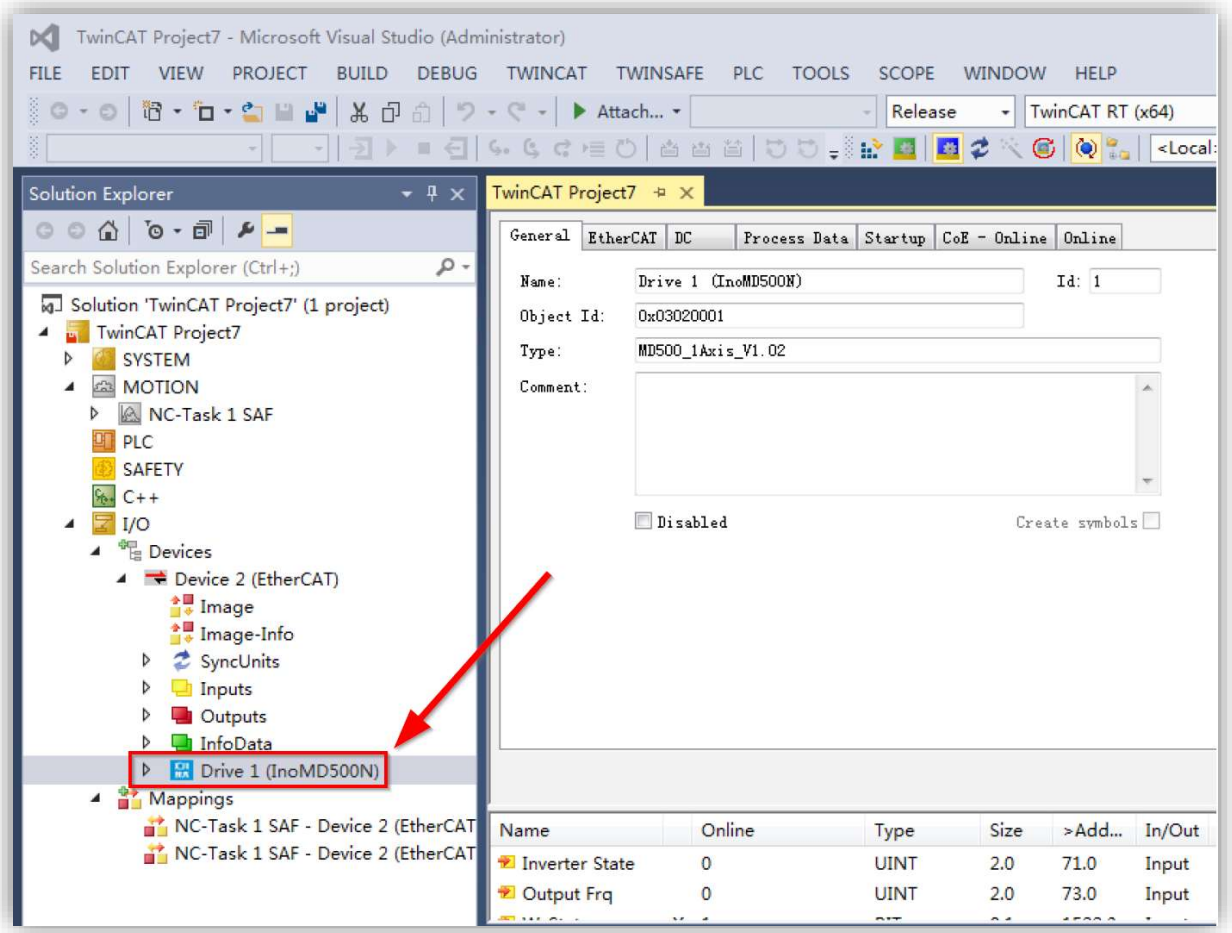
Select NC configuration and click **OK**.



Click **No**.

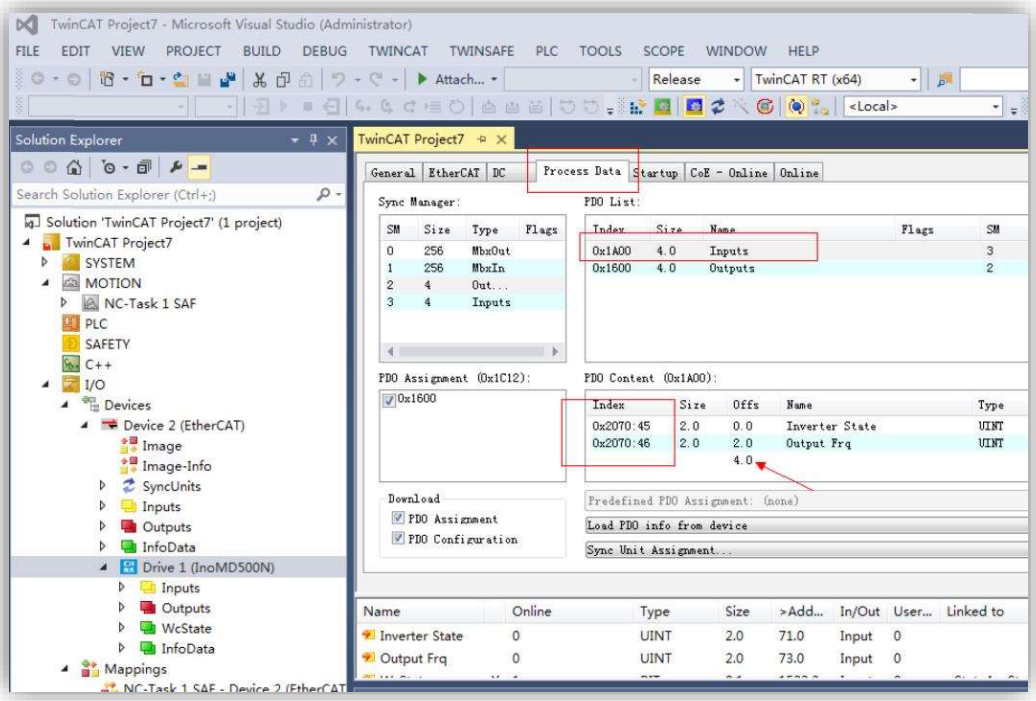


Now the equipment search is complete, as shown in the following figure:

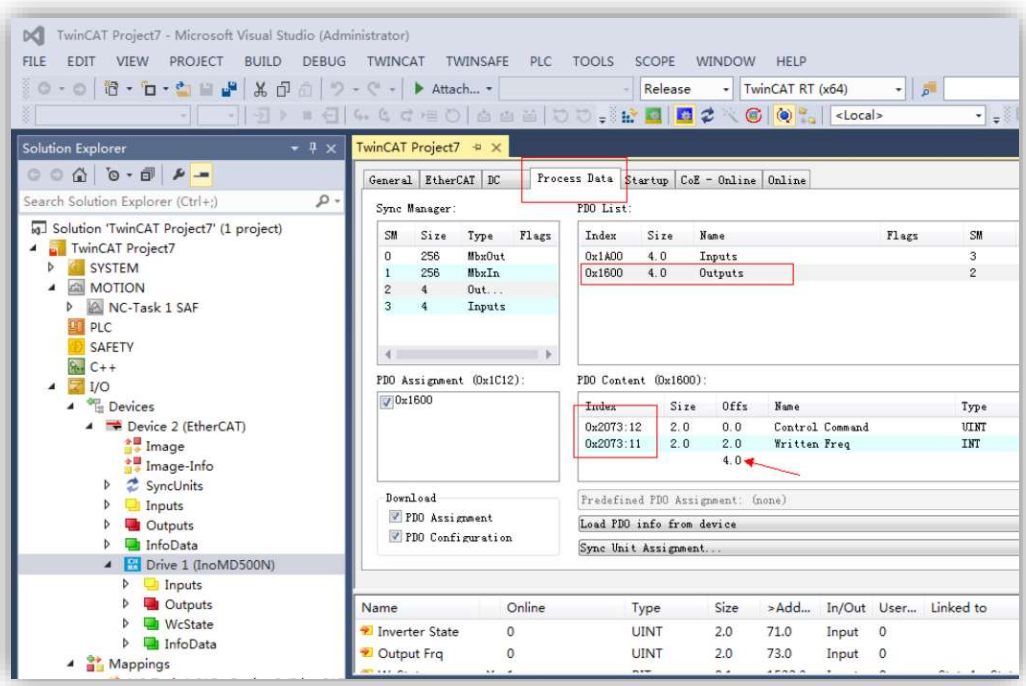


7.2.1 CONFIGURE PDO PARAMETERS.

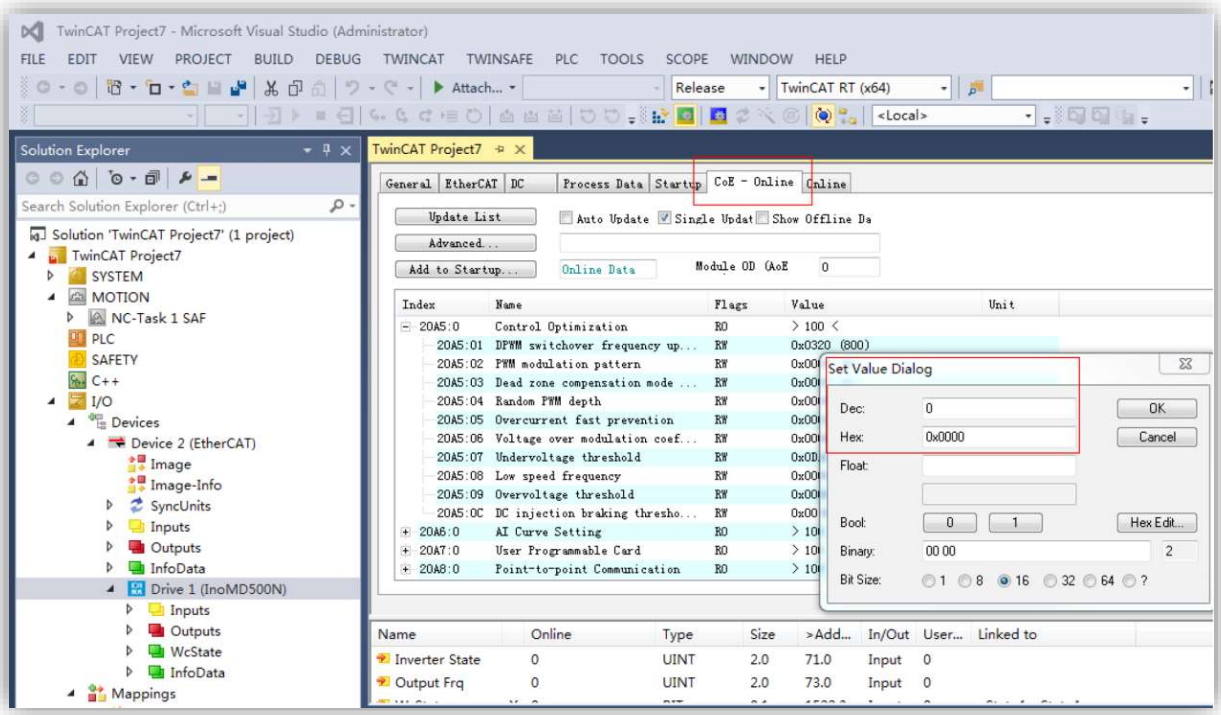
1. Configure TPDO.
   Select 0x1A00 when configuring TPDO. The first two items are set to TPDO by default and cannot be changed. Right click at the position indicated by the red arrow in the following figure to add the TPDO mapping as required.



2. Configure RPDO.
   Select 0x1600 when configuring RPDO. The first two items are set to RPDO by default and cannot be changed. Right click at the position indicated by the red arrow in the following figure to add the RPDO mapping as required.

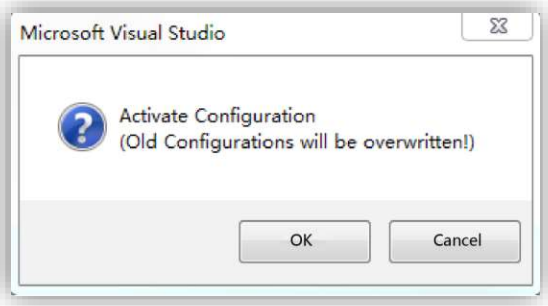


3. View the SDO data list.
   After the OP state is activated, you can view real-time data in the SDO data list or double-click the object dictionary to modify the SDO data.

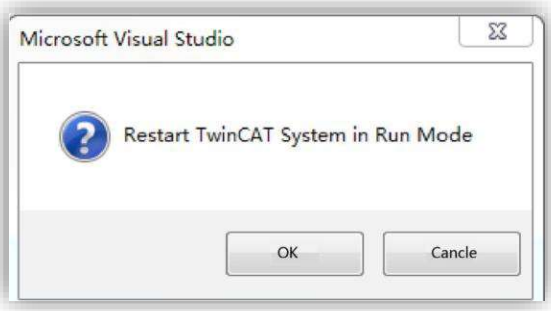


4. Activate the configuration and switch over to the running mode.

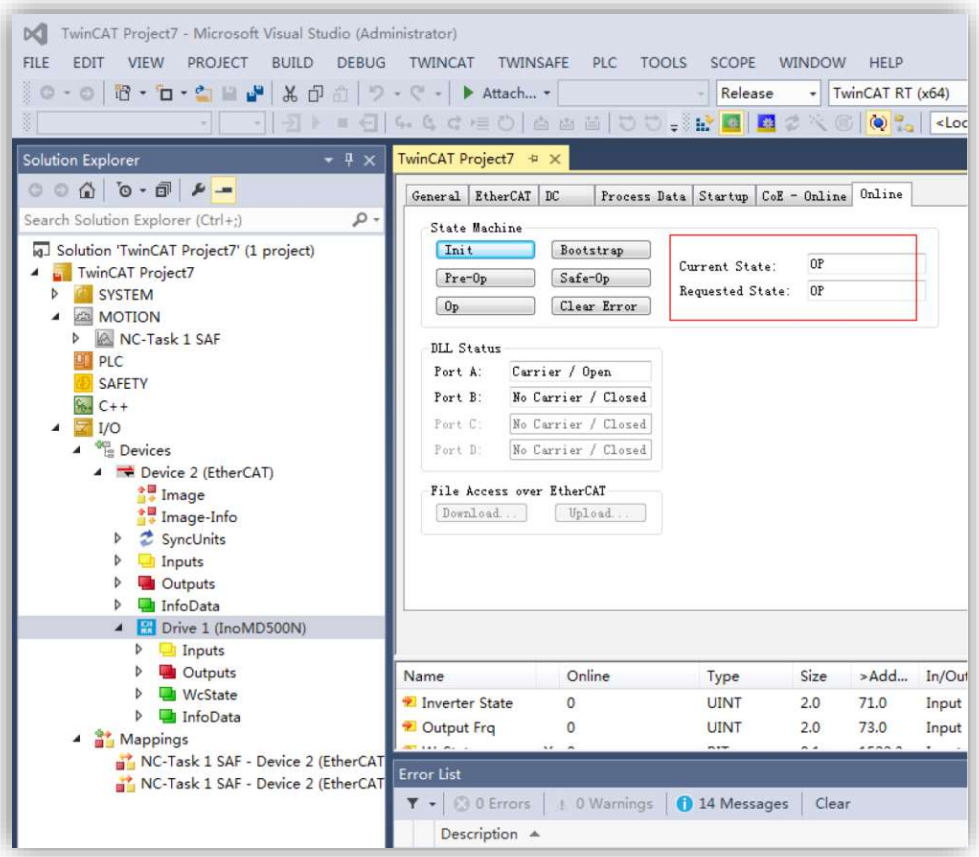
   Click  . The following dialog box is displayed.



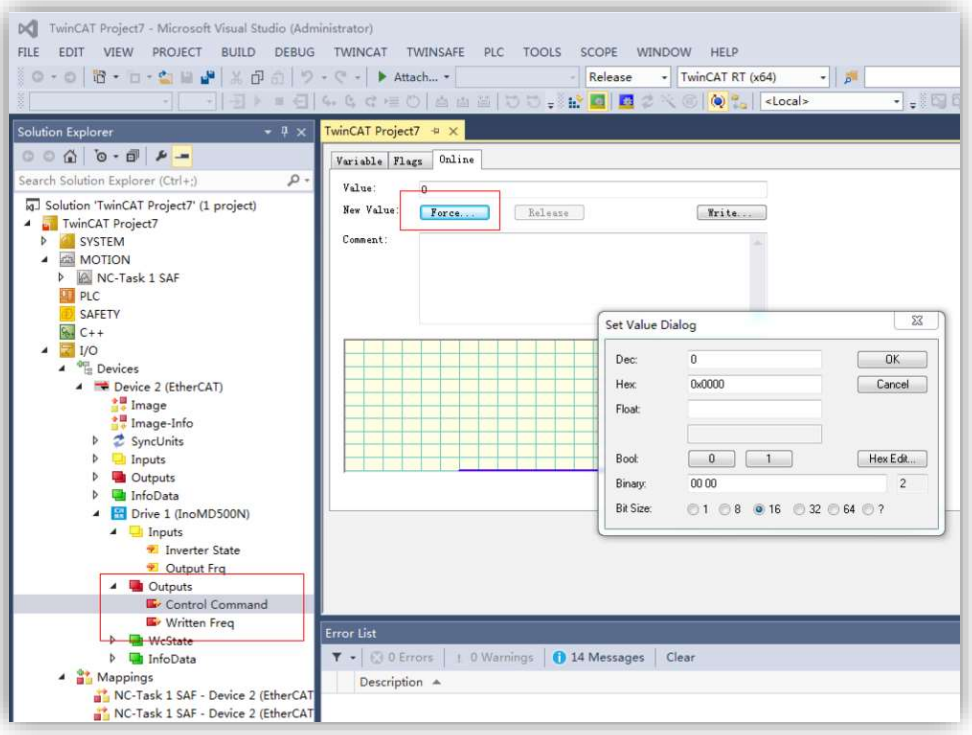
   Click **OK**.



Click OK to enter the OP state.



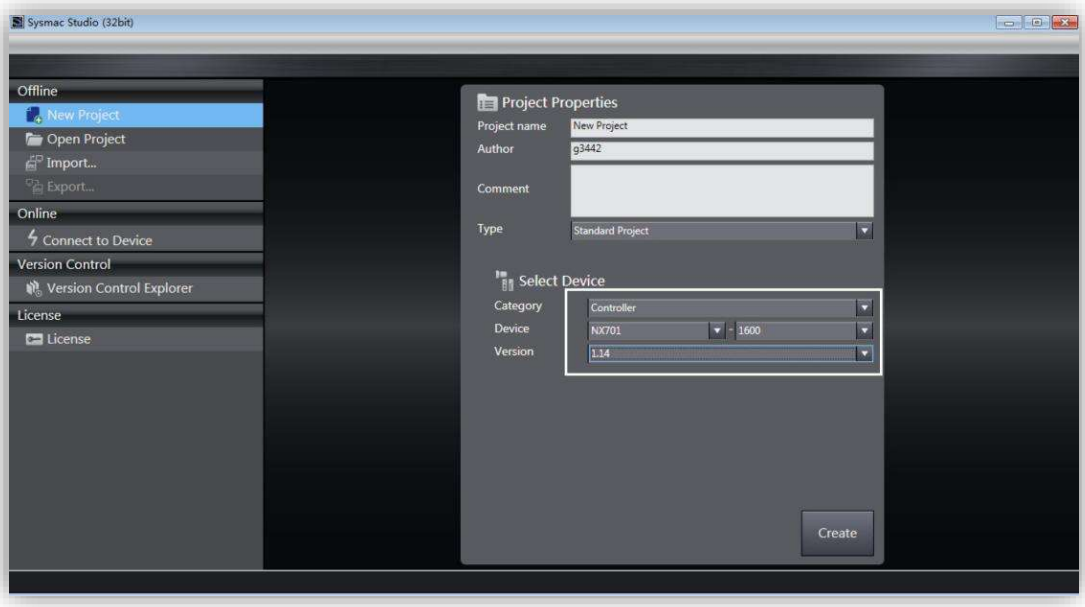
5. Control the AC drive through PDO.
   Write corresponding values through the configured RPDO to control the AC drive.



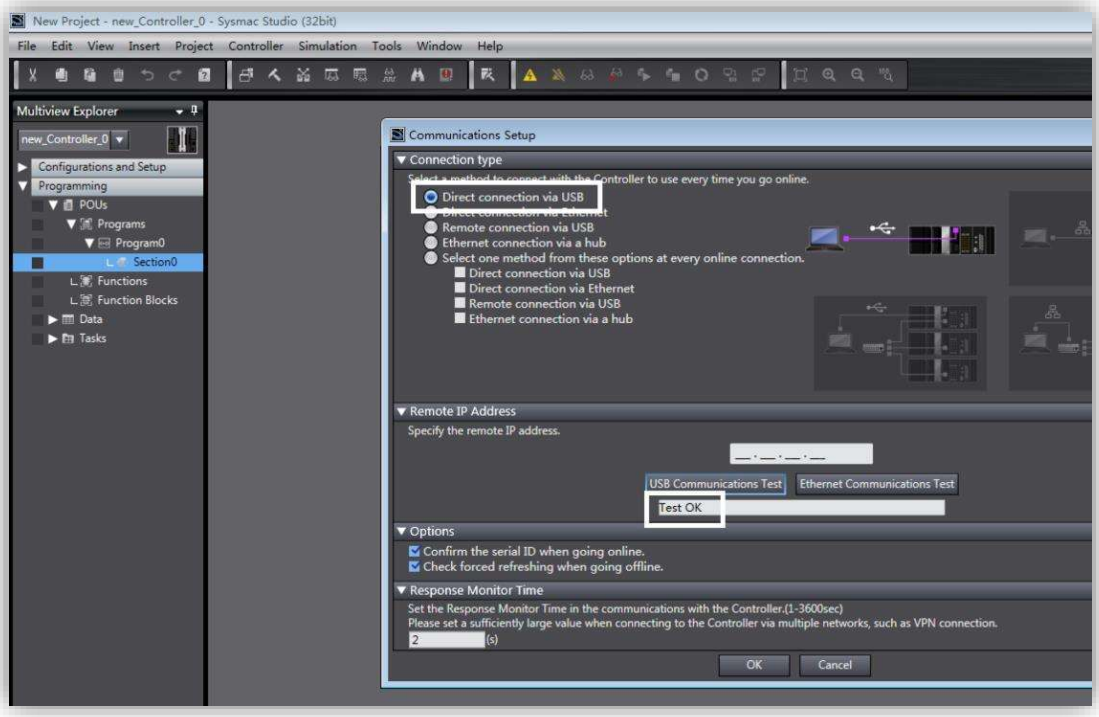
7.3 OMRON'S MASTER STATION

Omron's NX701 master station is used as an example to describe how to use the MD500-ECAT card with the MD500 AC drive.

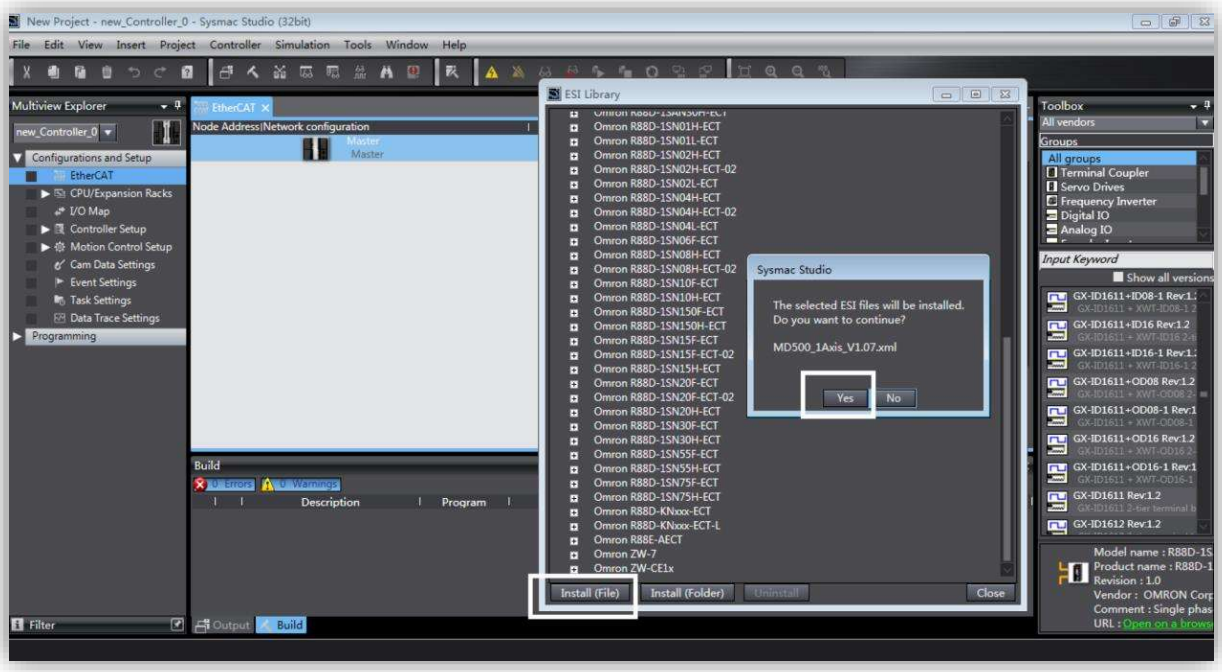
1. Create a project.
   Device: Set it according to the actual controller model.
   Version: 1.09 or later version. NX701-1600 only supports 1.10 or later version.



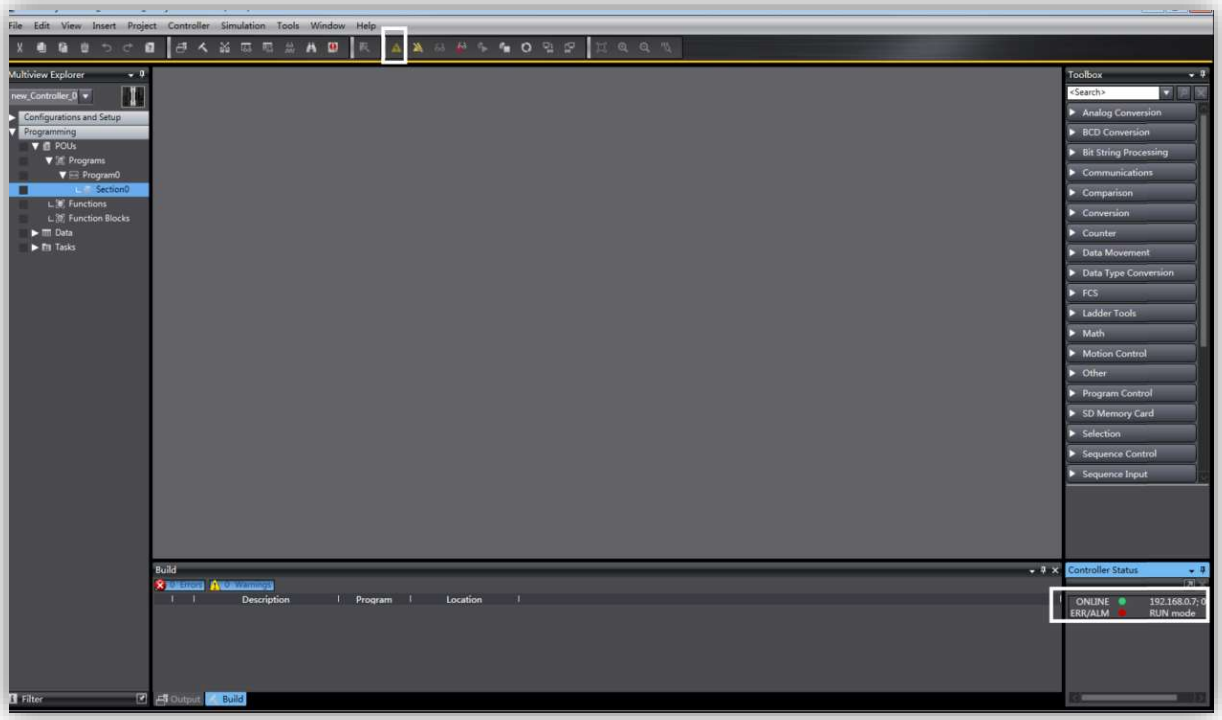
2. Perform communication settings.
   Enter the main interface and choose **Controller > Communications Setup** to set the control mode for the computer and controller.
   Select **Direct connection via USB**. Go to next step if the test is successful.



3. Import the XML configuration file.
   Double-click **EtherCAT** on the left navigation pane, and then select and right-click on the master device. In the displayed **ESI Library** dialog box, click **Install (File)**, and select the XML configuration file of the MD500_ECAT card to import the XML file.

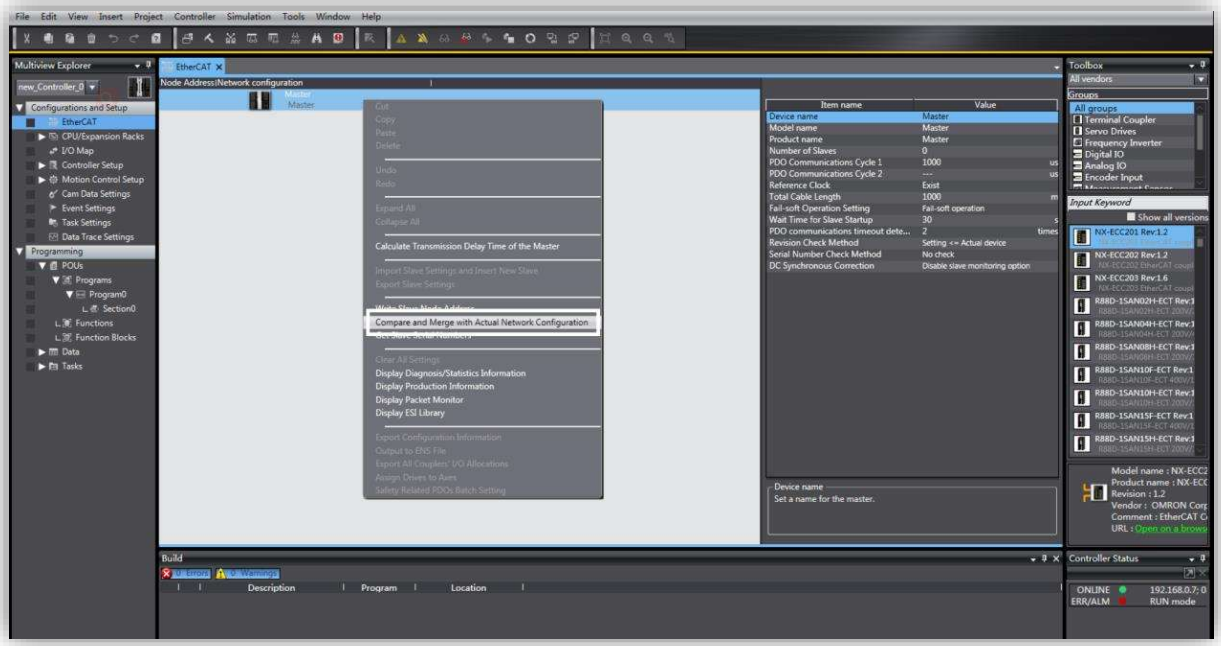


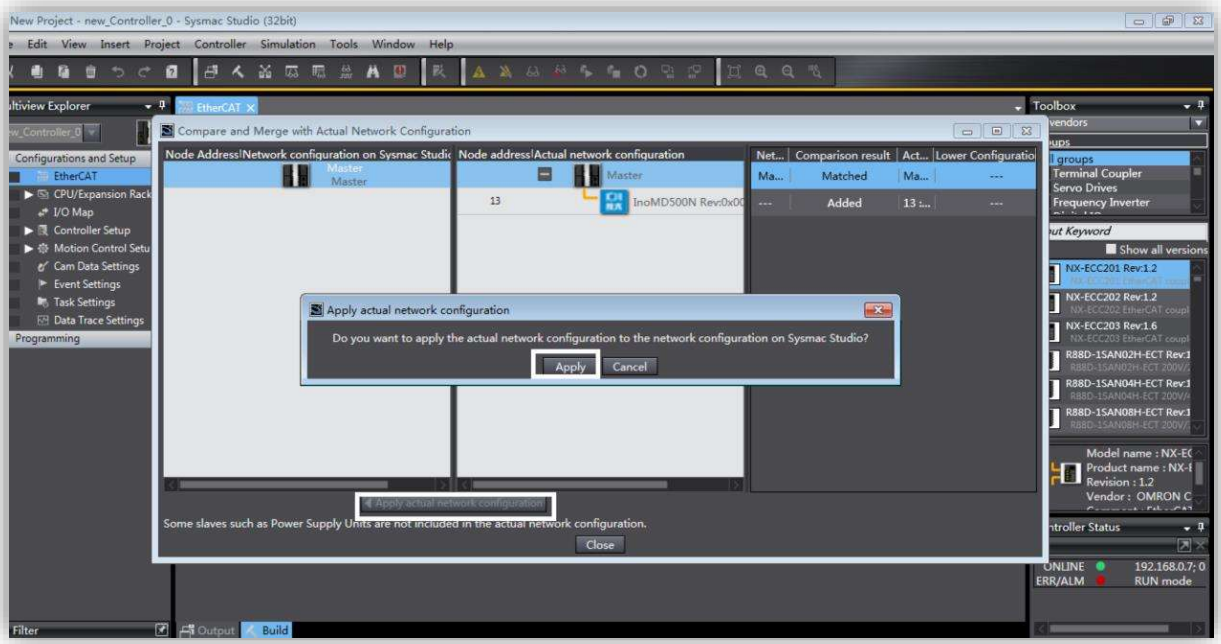
4. Scan the devices.
   Switch the controller to the online running mode.
   Observe the controller status in the lower right corner: online, running mode.

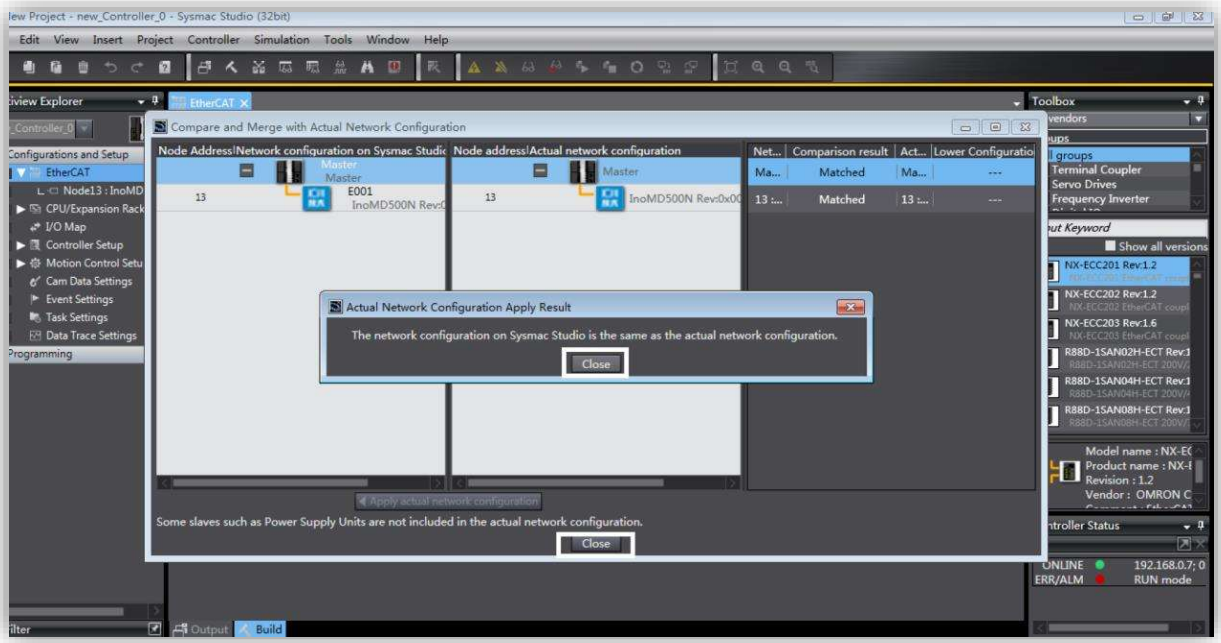


Scan the device and add the slave station. Choose **Configurations and Setup > EtherCAT** on the left navigation pane. Right click on the master device, and then select **Compare and merge with Actual Network Configuration** to have the controller automatically scan all slave stations in the network (a fault will be reported if any station number is 0). After the scanning is complete, click **Apply actual network configuration** in the displayed dialog box. Now, the added slave can be viewed on the main interface.

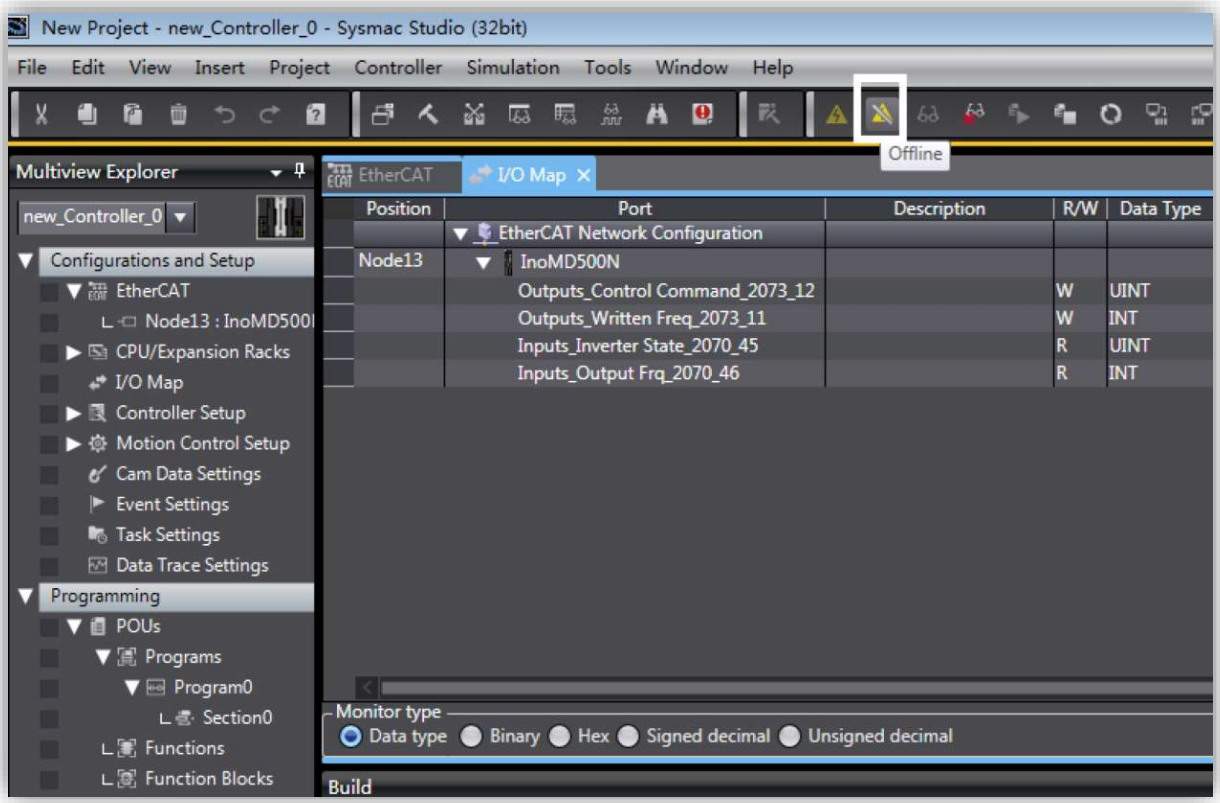
NOTE : For the MD500-ECAT card, the station alias can be modified through the parameter Fd-02 or the software tool of the master station (the AC drive software must be updated to the version required in "3.1 Communication Configuration for the MD500-ECAT Card and MD500 AC Drive"). The modified station alias takes effect upon next power-on.



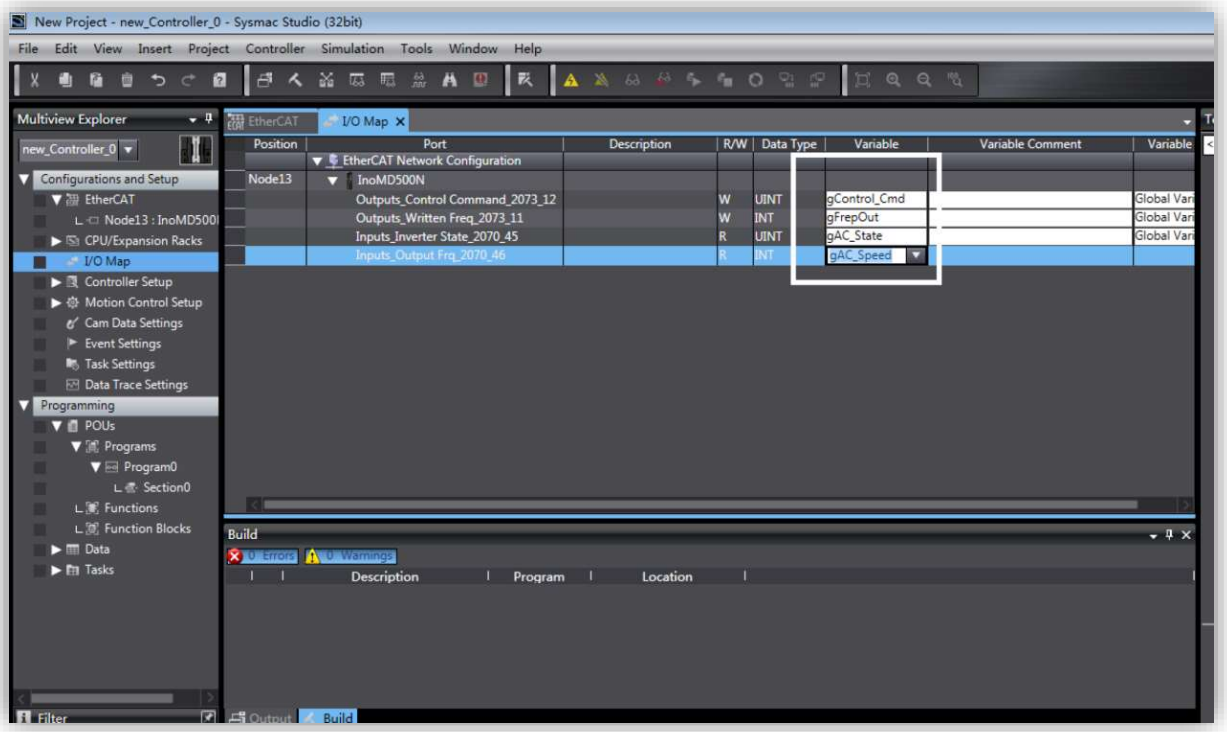




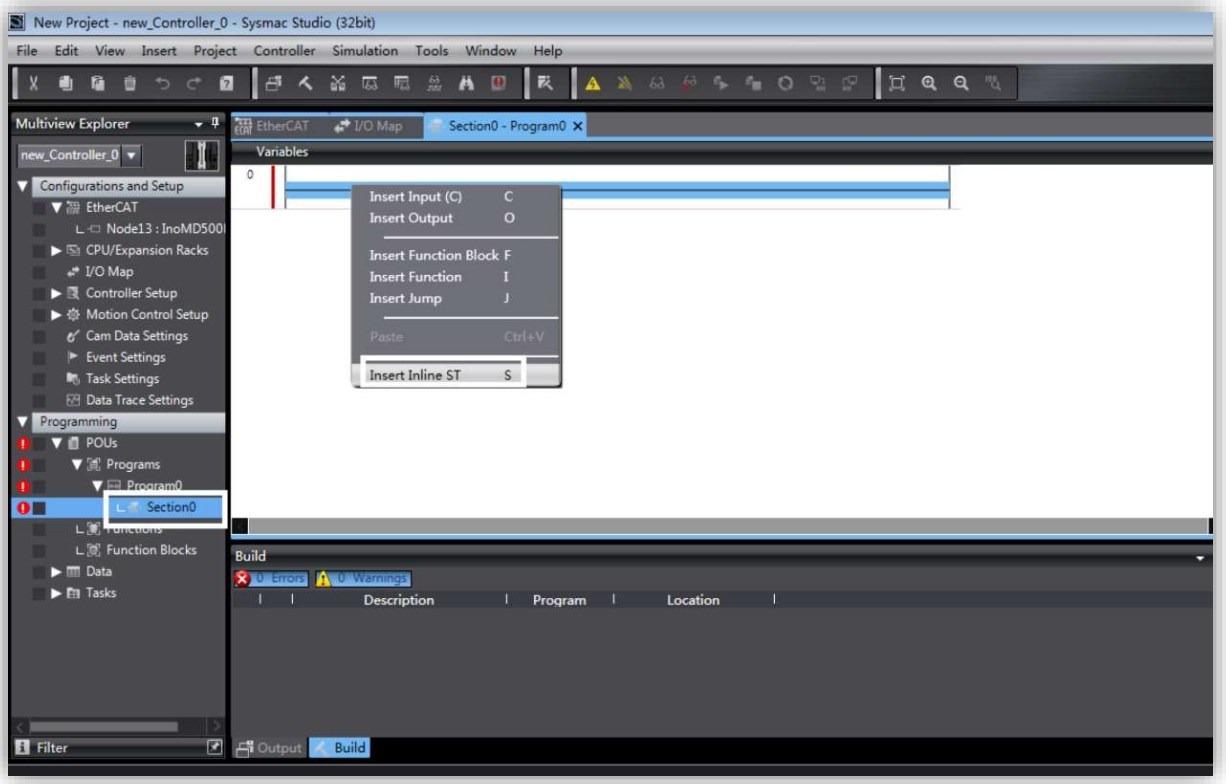
5. Set the parameters.
   Switch the controller to the offline mode.

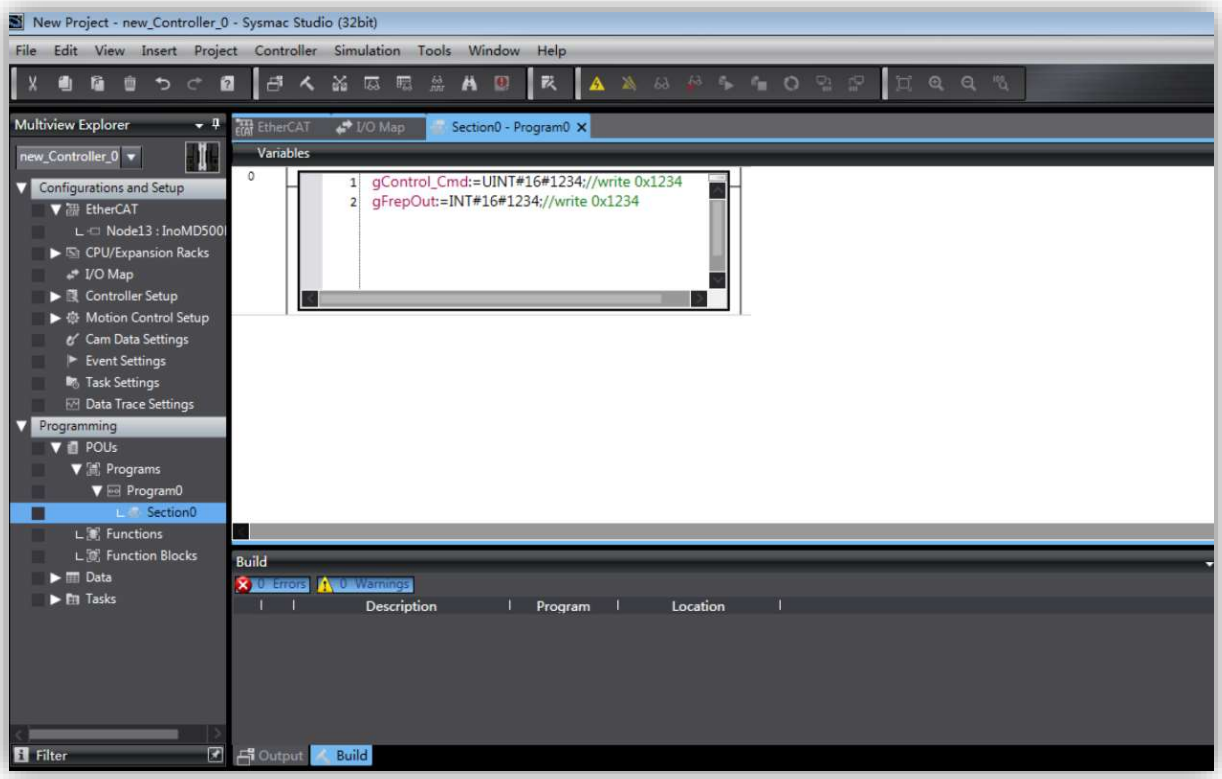


Set the PDO mapping (I/O mapping distribution).

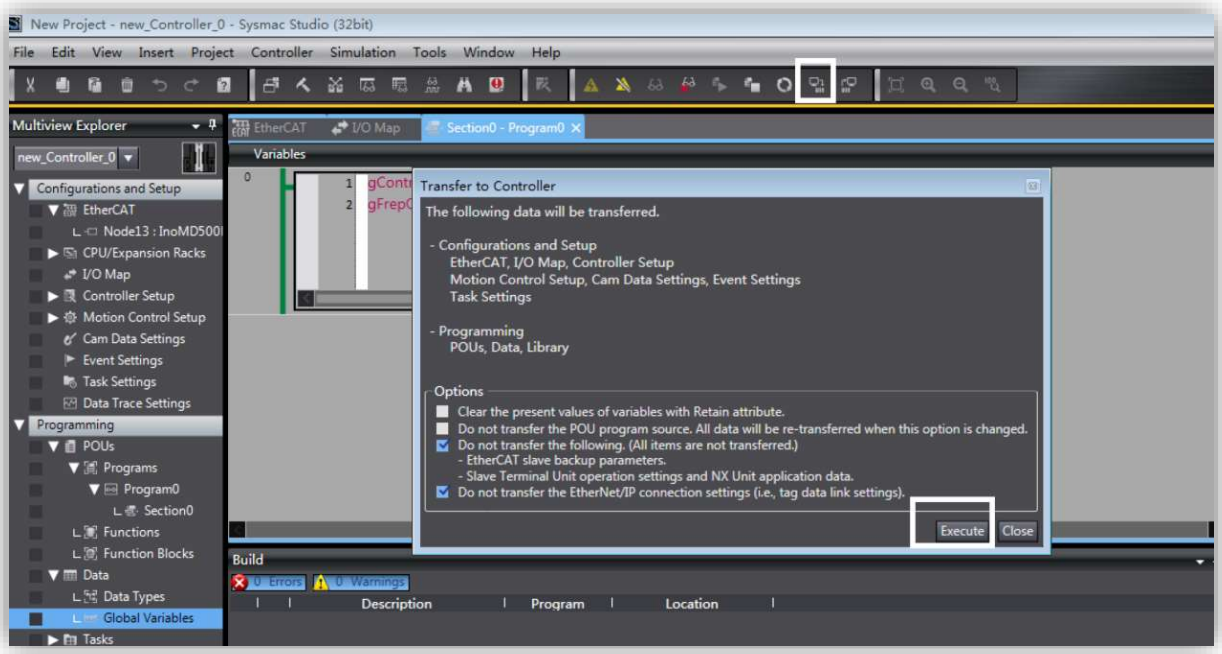


6. Edit the PLC program.





7. Download the program to the controller.
   After all the setting and programming are complete, switch over to the online state, and download the program to the controller.



8 SPECIFICATIONS ETHERCAT EXTENSION CARD

	MD500 & MD290
	 MD500 EtherCAT card
Material Code	01040113
Model	MD500-ECAT
Dimensions (mm)	52.5(W) x 41(H) x 16(D)
Cycle time	20 ms
Jitter	Not tested
Max. distance cable	< 100 m
Power supply	Internal
Size	All
Distributed Clocks	Available
EtherCAT Slave .xml	Available
Beckhoff description	Available
Max. period of DC synchronization	< 100 ms 64bit
Usable older firmware drive	U76.60_L77.60_000.00_400.00 Parameter from drive F7-10 = U76.60 / F7-11=L77.60 F7-15 = 000.00 / F7-16 = 400.00
Connection	Crossover & straight
Communication protocol	N/S
CoE motion profile	N/A
Fix RPDO	2
Fix TPDO	2
Configurable RPDO in the drive	10
Configurable TPDO in the drive	10
Emergency information	N/A
SDO request	Available
SDO response	Available
Remote TxPDO sending request	N/A
Remote RxPDO send request	N/A
SDO information	N/A