EtherCAT Communication Expansion Card Instructions

1、install and set up

1、 Install

The EtherCAT expansion card is putted in the ES580 series drive card slot， Install the card when the drive power indicator is completely off.Shown in Figure 1-1：

Figure 1-1 EtherCAT

Mechanical and Electrical Installation Instructions:

1） Please make sure the drive is powered off before installation.

2） After removing the front cover of the driver and inserting the card (refer picture 1-1), lock it with the M3*8 screws in the box.

3） Ethernet RJ45 socket connection to the EtherCAT master,Its pin signal definition is consistent with the standard Ethernet pins,Both cross and straight cables are available.

4)To prevent interference, please use a qualified wire， keep a distance of more than 15CM from other control wires, motor wires and power wires,When staggered, please observe the principle of passing the wiring perpendicular to each other.

5)Please keep the indoor environment free of corrosive gas, liquid and dust.

Communication indicator

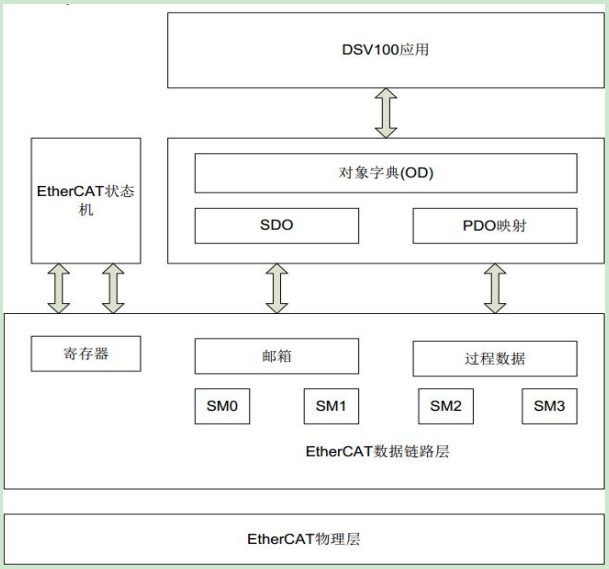
EtherCAT communication expansion card have 6 LED indicator：DL3、LED1、LED5、LED6、LED7

Indicator		status	meaning
DL3	bright	EtherCAT card Power normal	-

	off	EtherCAT card power abnormal	Check EtherCAT card installation and drive power up
LED1	bright	LN9252 works in OP mode,The master station and the slave station communicate normally read and write data。	-
	flash	LN9252 work in PREOP/SAFEOP mode	Confirm working mode,，Check if the drive supports the EtherCAT card and the 50.00 setup 1， Make sure the network port is connected correctly
	off	The LN9252 is not connected to the master orWork in Initial mode	Confirm whether the master station is connected normally, and confirm whether the network port is connected normally
LED5	bright	Normal	-
	off	The communication between the EtherCAT card and the main control board is abnormal	Setup 50.00 = 1，make sure that the drive supports EtherCAT cards
LED6	Bright	Normal	-
	off	There is a communication abnormality between the MCU and the LN9252	Confirm working mode，Confirm if the drive supports EtherCAT card and set 50.00 to 1, Ensure the network port connection is correct
LED7	idle	-	-
LED8	idle	-	-

Application layer protocol

1、 CoE Communication Protocol Model：CANOPEN over TtherCAT(CoE)



CoE working principle

EtherCAT The network included two parts：Data link layer and application layer.The data link

layer is mainly responsible for EtherCAT communication,The application layer embeds the CANopen communication protocol.

CoE include parameters,Application data and PDO mapping configuration information.

In order for SDO and PDO data to be correctly parsed on the EtherCAT data link layer,FMMU and Sync Manager need to be configured

EtherCAT status description

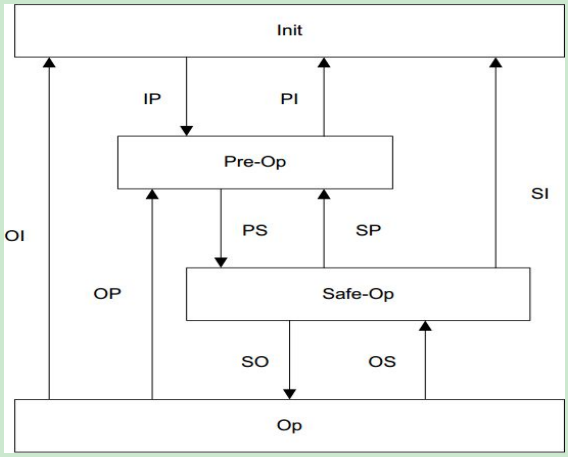
Synchronization management	configure	value	starting address
Sync Manager 0	assigned to receive SDO	512bytes	0x1000
Sync Manager 1	assigned to send SDO	512bytes	0x1400
Sync Manager 2	assigned to receive PDO	128bytes	0x1800
Sync Manager 3	assigned to send PDO	128bytes	0x1C00

2、 Slave configuration file

The EtherCAT slave information file (XML file) is read by the master，Used to build the master and slave configuration.

3、 EtherCAT State Machine

EtherCAT state machine is used to describe the state and change state of the slave application.State change is initiated by the master and the slave responds.



EtherCAT State Machine Flowchart

States	Discription
Init	SDO Communication cannot be used；PDO Communication cannot be used
Init to Pre-Op	The master data link layer address and synchronization management (SM) channel for SDO communication；The master station initializes the distributed clock (DC) synchronization information;Master request to jump to Pre-Op state；Master configuration application layer control register;Slave checks whether the mailbox has been initialized normally
Pre-Op	SDO Communication can be used；PDO 通Communication can be used

Pre-Op to Safe-Op	The master stationthe synchronization management (SM) channel for PDO communication and the FMMU channel;Master configures PDO mapping via SDO communication;Master request to jump to Safe-Op state;The slave checks that the PDO configuration and distributed clock (DC) are configured correctly.
Safe-Op	SDO Communication can use;Receive PDO communication can use,Send PDO communication cannot be used and is in safe state.
Safe-Op to Op	Master request to jump to Op state
Op	SDO communication can be used; PDO communication can be used

4、 PDO process data mapping

RXPDO1: Object Dictionary 1600h Configuration Map Objects，The first mapped word and the second mapped word are fixed

	first word	second word	third word	fourth word
RXPDO1 mapping object	Fieldbus Control Word Drive Parameters Index 0.01	Fieldbus reference 1 Drive parameter index 0.02	unlimited	unlimited

RXPDO2: object dictionary 1601h configure the mapping object
RXPDO3: object dictionary 1602h configure the mapping object
RXPDO4: object dictionary 1603h configure the mapping object

TXPDO1:object dictionary 1A00h configure the mapping object
TXPDO2:object dictionary 1A01h configure the mapping object
TXPDO3:object dictionary 1A02h configure the mapping object
TXPDO4:object dictionary 1A03h configure the mapping object

5、Synchronization management PDO

The exchange of EtherCAT data requires the assignment of PDOs to the Sync Manager channel.Establish the relationship between PDO and synchronization management by assigning 1C12h and 1C13h to the synchronization management PDO.PDO mapping objects (indexes 1600h to 1603h, 1A00h to 1A03h) and synchronization management PDO assignments Objects (index 1C12h and 1C13h) can only be written in Pre-Operation state.The PDO mapping configuration process is as follows:

(1) By setting subindex 0 of 1C12h and 1C13h to 0，Disable the PDO mapping configuration of the synchronization snap-in;

(2) Set PDO mapping objects: 1600h to 1603h, 1A00h to 1A03h

(3) Set the PDO mapping assignment of the sync snap-in: sub-index 1,2,3... of 1C12h and 1C13h;

(4) Enables PDO map assignment for the sync management unit by setting subindex 0 of 1C12h and 1C13h to 1

6、Network synchronization of distributed clocks

Distributed Clock allows all EtherCAT devices to use the same system clock,So as to control the synchronous execution of each device task.In the EtherCAT network, the clock of the first slave station with distributed clock function connected to the master station is used as the reference clock of the whole network,The remaining slaves and masters are synchronized with reference to the clock.

Free-Run: The operation cycle and communication cycle of each servo drive have nothing to do with the communication cycle of the master station

DC Mode：The servo drive is synchronized by the Sync0 event of the master.

CiA402 , Modification and feedback of operating parameters through manufacturer-specific parameters.Manufacturer-specific parameters 2000h-203Fh correspond to the drive's group 0-63 parameters.

7、 ES series drive-specific parameters

parameter address	Index	Sub-Index	Name	Type	Attr	Deff
00.00~00.30	2000	1	blank	U16	RW	
		2	Fieldbus control	U16	RW	
		3	Fieldbus reference1	U16	RW	
		4	Fieldbus reference2	U16	RW	
		5	Fieldbus status	U16	RO	
		6	Fieldbus actual value 1	U16	RO	
		7	Fieldbus actual value 2	U16	RO	
		8	Fieldbus module input 1	U16	RW	
		9	Fieldbus module input 2	U16	RW	
		…				
		19	Fieldbus module input12	U16	RW	
		20	Fieldbus module output 1	U16	RO	
		21	Fieldbus module	U16	RO	

			output2			
		31	Fieldbus module output12	U16	RO	

parameter address	Index	Sub-Index	Type 型	Attr
1.00	2001	1	U16 or S16	RO
1.01	2001	2	U16 or S16	RO
…				
1.10	2001	11	U16 or S16	RO
…				
2.00	2002	1	U16 or S16	RO
…				
10.00	200A	1	U16 or S16	RW
…				
63.00	203F	1	U16 or S16	RW

三、drive control

Fieldbus Control Word（Corresponding parameter address 06.05）

Fieldbus Control Word		
site	name	def
0	Stop	1 = stop
		0 = keep current state.
1	Start	1 = start
		0 = keep current state.
2	StopMode OFF2	1 = emergency stop mode
3	StopMode OFF3	1 = free stop mode
4	Local ctrl	1 = local control
5	StopMode ramp	1 = decelerate stop mode
6	StopMode coast	1 = free stop mode
7	Run enable	1 = Run enable 0 = run prohibited
8	Reset	0->1 reset fault
9	Jog1	1 = jog 1 start
10	Jog2	1 = jog 2 start
11	Remote	1 = remote control
12	Ramp in 0	1 = Ramp generator input 0
13	Ramp hold	1 = Ramp generator output unchanged
14	Ramp out 0	1 = Ramp generator input 0

15	Ext2 sel	1 = REV instruction

Fieldbus Status Word:

0	Ready	1：ready
1	Enabled	1 = Enabled
2	Modulating	1 = PWM signal output
3	Following ref	
4	EM OFF2	1 = Free stop mode
5	EM OFF3	1 = Emergency stop mode
5	Start inhibit	1 = Start inhibit.
6	Alarm	1 = Alarm
7	At setpoint	1 = output same as the setting
8	Torque limited	1 = Torque limited
9	Speed limited	1 = Speed limited
10	EXT2 active	1 = EXT2 active
11	Local ctrl	1 = Local ctrl
12	Zero speed	1 = 0 speed
13	Direction reverse	1 = Direction reverse。
14	Ramp out 0	1 = REV
15	Fault	1 = FAULT

四、Application example

1、Drive related settings

After the wiring ,Complete the setup of the drive（Set it to start at a given speed）,The

parameters to be set are as follows：

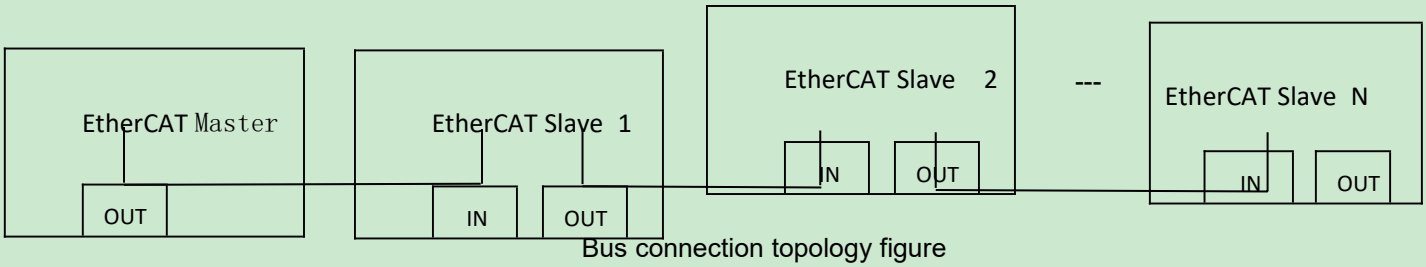
a) 10.00（Remote 1 start function）set to 5（Fieldbus）;
b) 11.02（Remote 1 Control Mode）set to 0（Speed）;
c) 21.00（Speed ref1 signal source）choose（Fieldbus reference 1）;
d) 24.00（Torque ref1 signal source）choose（Fieldbus reference 2）;
e) 50.00（Fieldbus enable）set to 1（enable）;
f) LOC/REM set REM (Remote control)

2、 EtherCAT card and EtherCAT Master station communication configuration instructions

EtherCAT card and ES580 After the drive realizes communication，Requires proper wiring with EtherCAT master,Set communication configuration，The communication between the EtherCAT card and the EtherCAT master can be realized,Drive networking function finished

2.1、Topology of EtherCAT

Topologies supported by EtherCAT include bus, star, tree, etc.combinations of various topologies，The bus type connection topology is shown in the following figure



Bus connection topology figure

2.2、PDO area data

The data in the PDO area realizes the real-time change and reading of the drive data by the master station and the periodic data interaction.The communication address of the data is directly configured by the drive.

a） Fieldbus control word, fieldbus reference 1,fieldbus reference 2

B)Fieldbus Status Word

c） Function parameters between drive and EtherCAT master,Monitoring parameter data real-time interaction

PDO process data mainly completes the periodic data interaction between the master station and the drive,data as below

The master sends the PDO area (0x1600)			
Fixed RPDO			Variable RPDO
Fieldbus Control Word	Fieldbus reference 1	Fieldbus reference 2	Real-time change of function parameters
RPDO1	RPDO2	RPDO3	RPDO3~ RPDO10
Master station receives PDO （0x1A00）			
Fieldbus Status Word	Real-time reading of parameters		
TPDO1	TPDO2~ TPDO10		

3、 Operation case of EtherCAT card with Beckhoff controller

Take Beckhoff's TwinCAT master as an example，Describe the simple configuration and use process of the EtherCAT card。

Note: About the network card,Must choose 100M Ethernet card with intel chip.

1） Risk of EtherCAT operation.

TwinCAT installation

Windows xp：recommended to install tcat_2110_2230

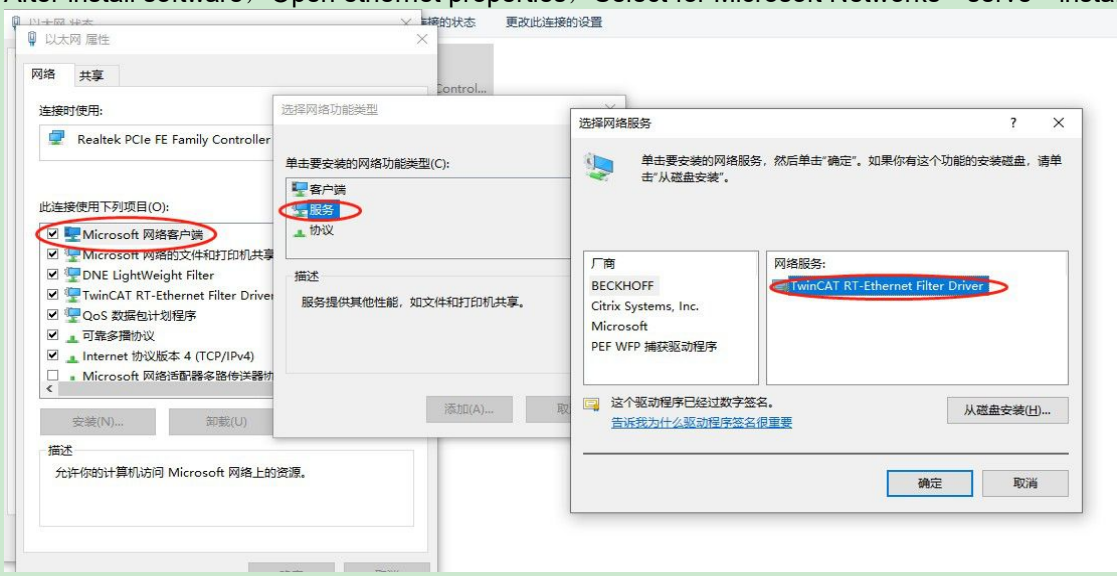
Windows 7 32：recommended to tcat_2110_2248

2） EtherCAT document（ES580_1Axis_V1.06.xml）copy to twinCAT .

TwinCAT2：TwinCAT\IO\EtherCAT。

TwinCAT3 content：TwinCAT\3.1\config\IO\EtherCAT。

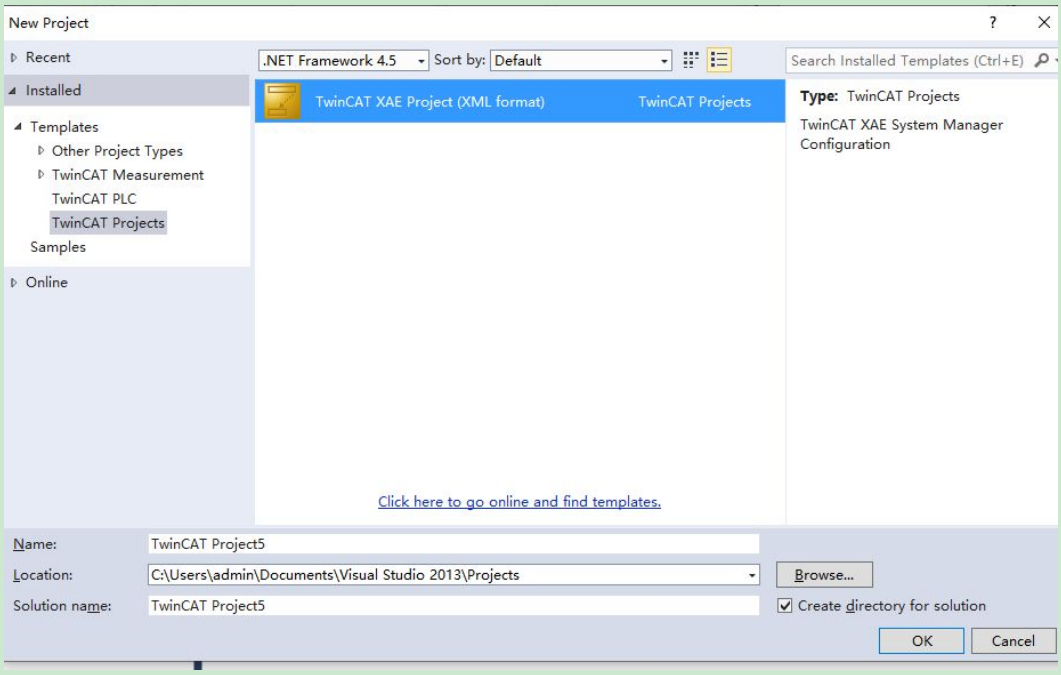
After install software，Open ethernet properties，Select for Microsoft Networks—serve—installation agreement



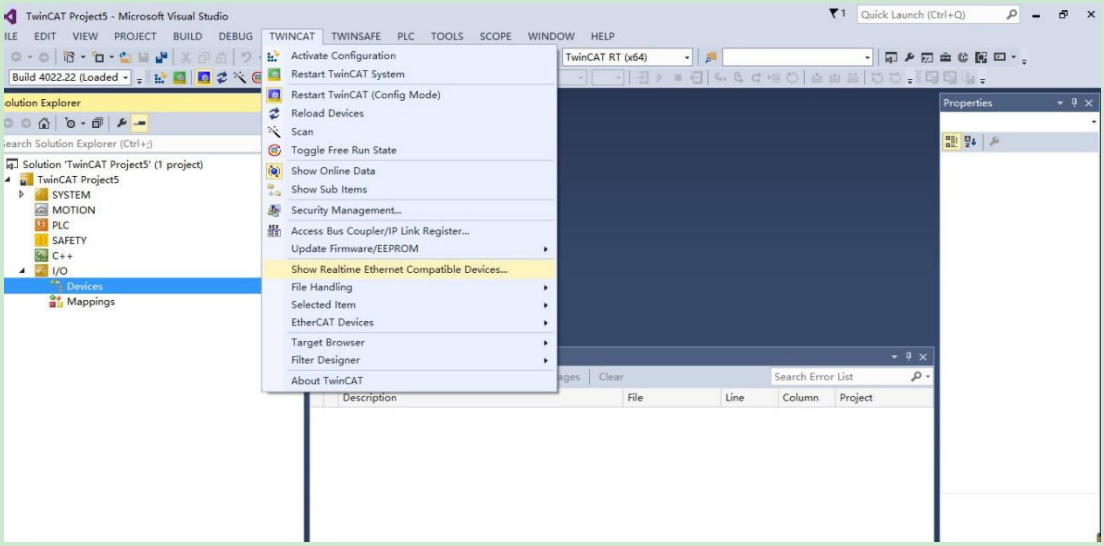
The following description is based on TwinCAT3，TwinCAT2 operation similar with TwinCAT3.

3） Open TwinCAT，start page，click“New Project”。

Click OK，Creat new project



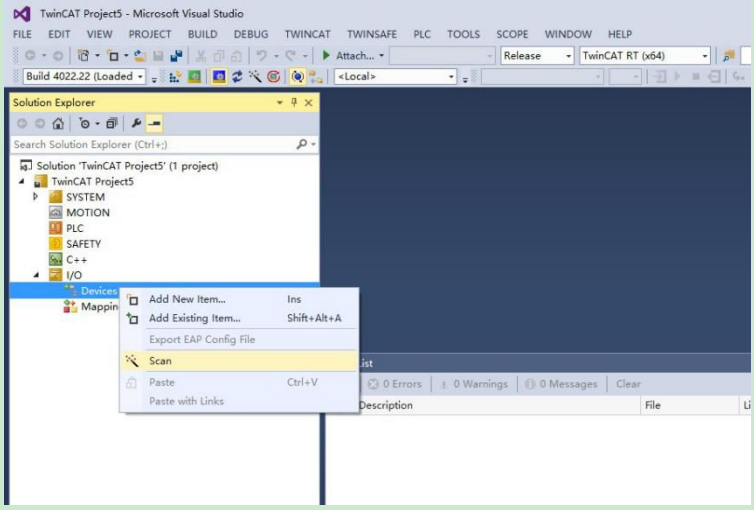
4） Install TwinCAT NIC drive

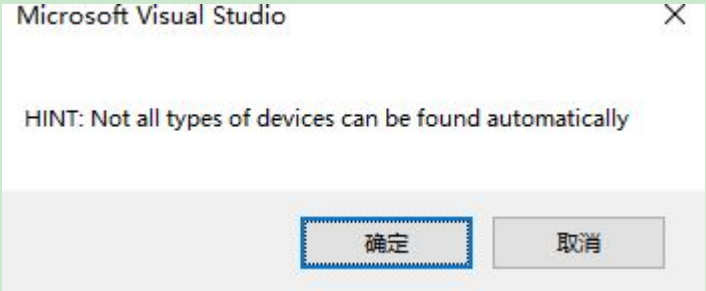


Open menu“Show Real Time Ethernet Compatible Devices”，Jump out of the following dialog，Incompatble devices”choose local website，click install。After installation“Instaled and ready to use devices ”The installed network card appears

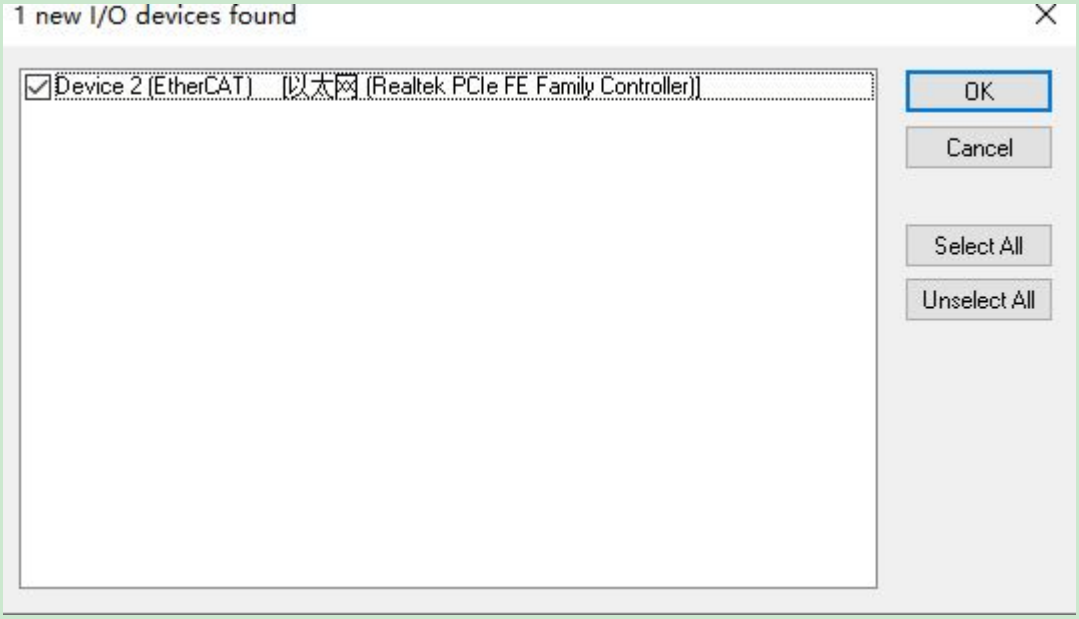
5） Device Search

After creating a new project page，Start searching for devices，right click Device，clickScan，

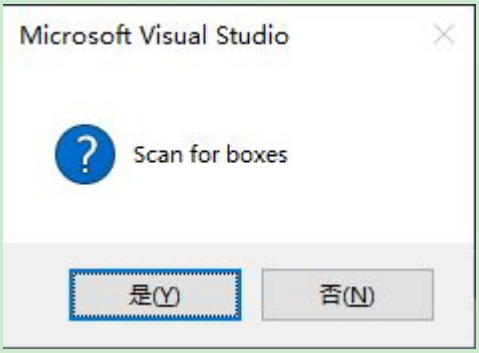




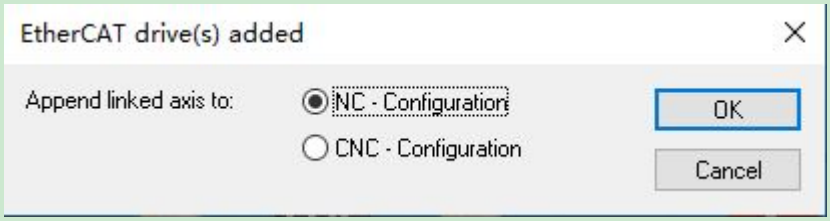
click“OK”。



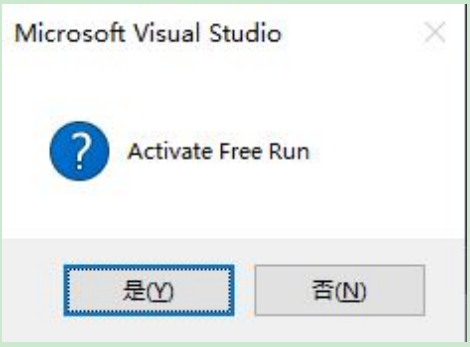
Click yes

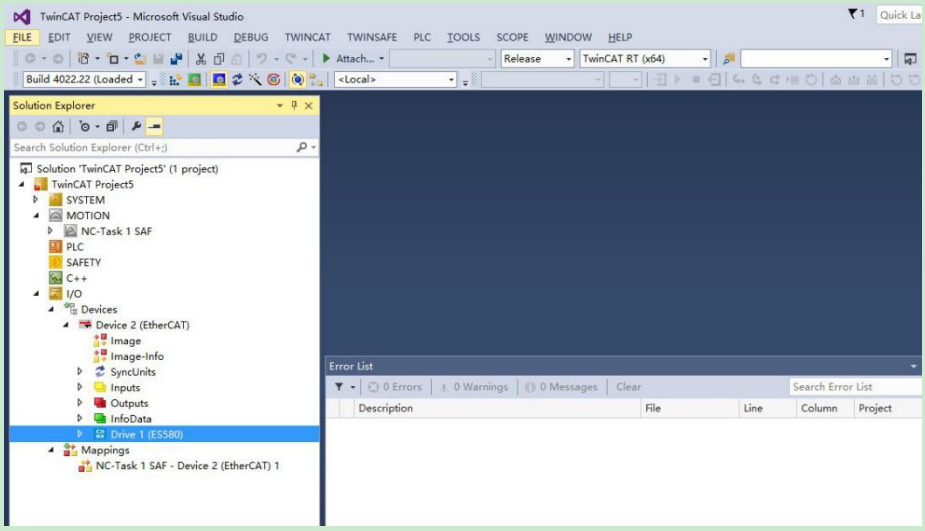


click“OK”。



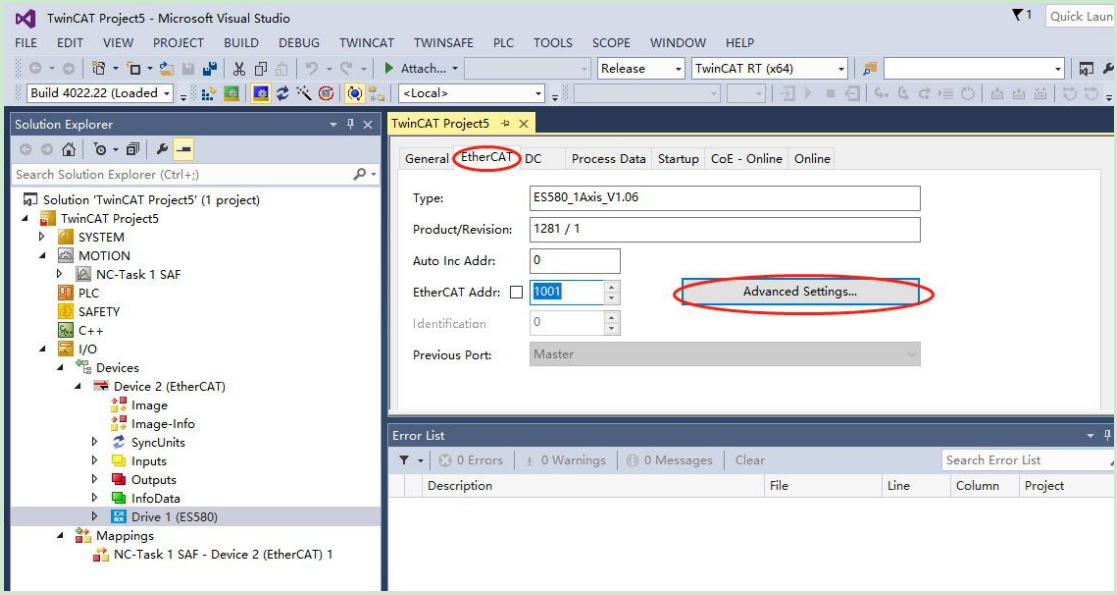
The device has been searched here,as below



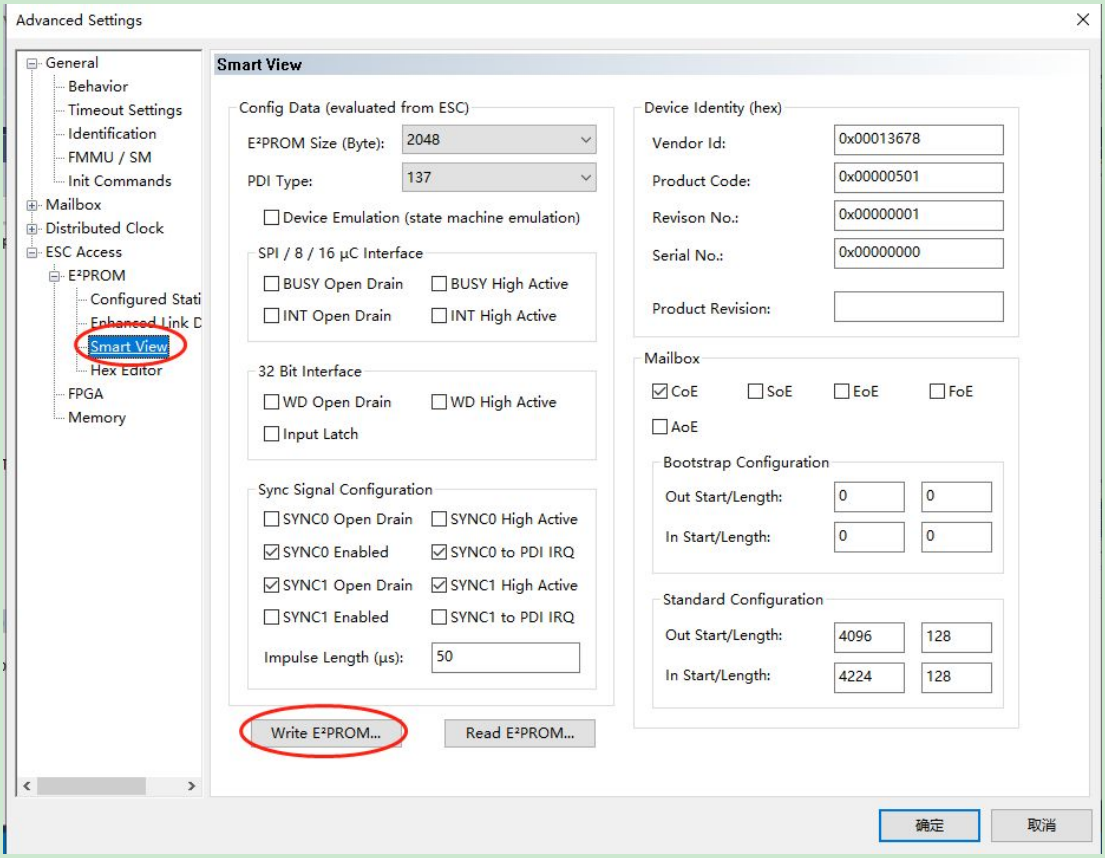


6） Downloadxml documet

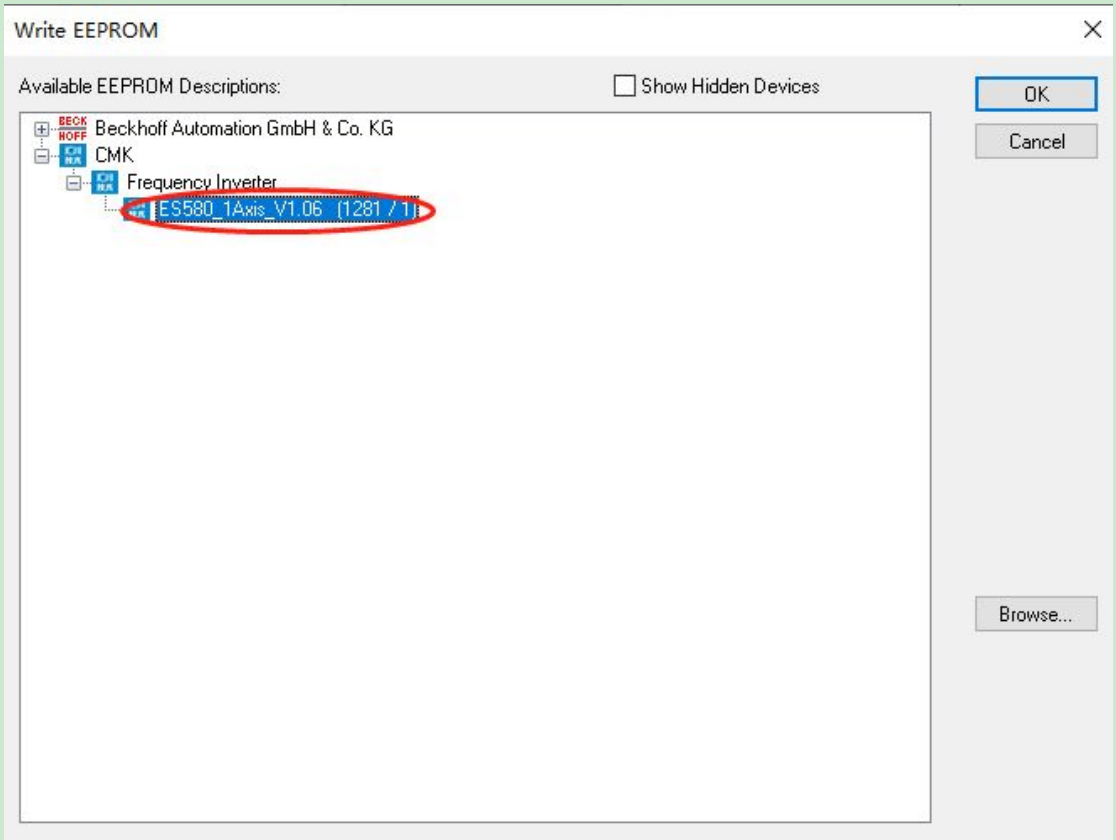
Enter EtherCA and click Advanced Settings



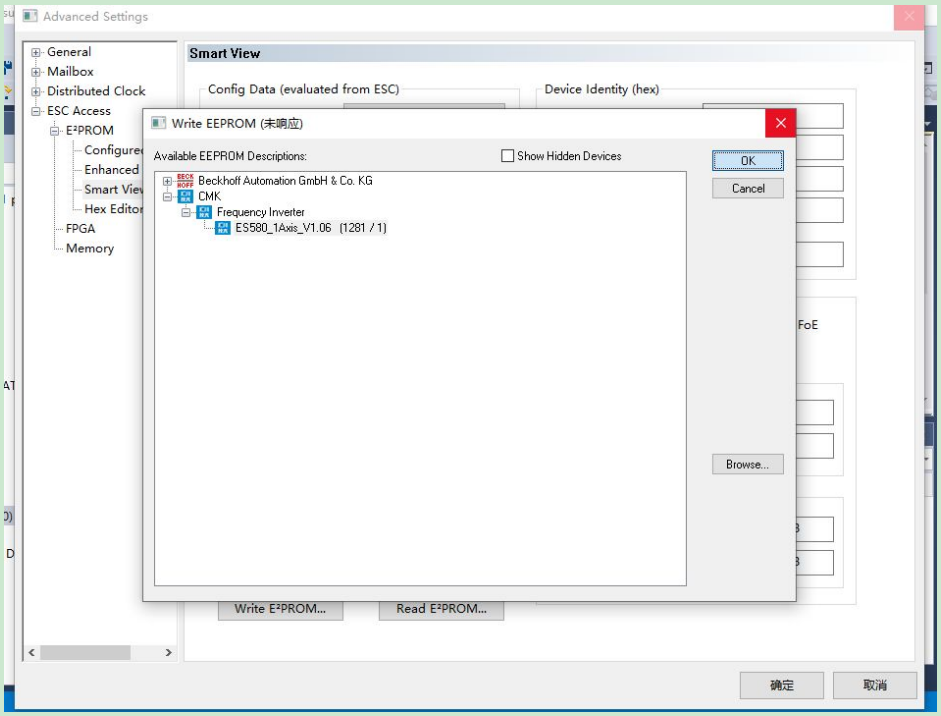
Choose ESC Access—E2PROM—Smart View，click Write E2PROM

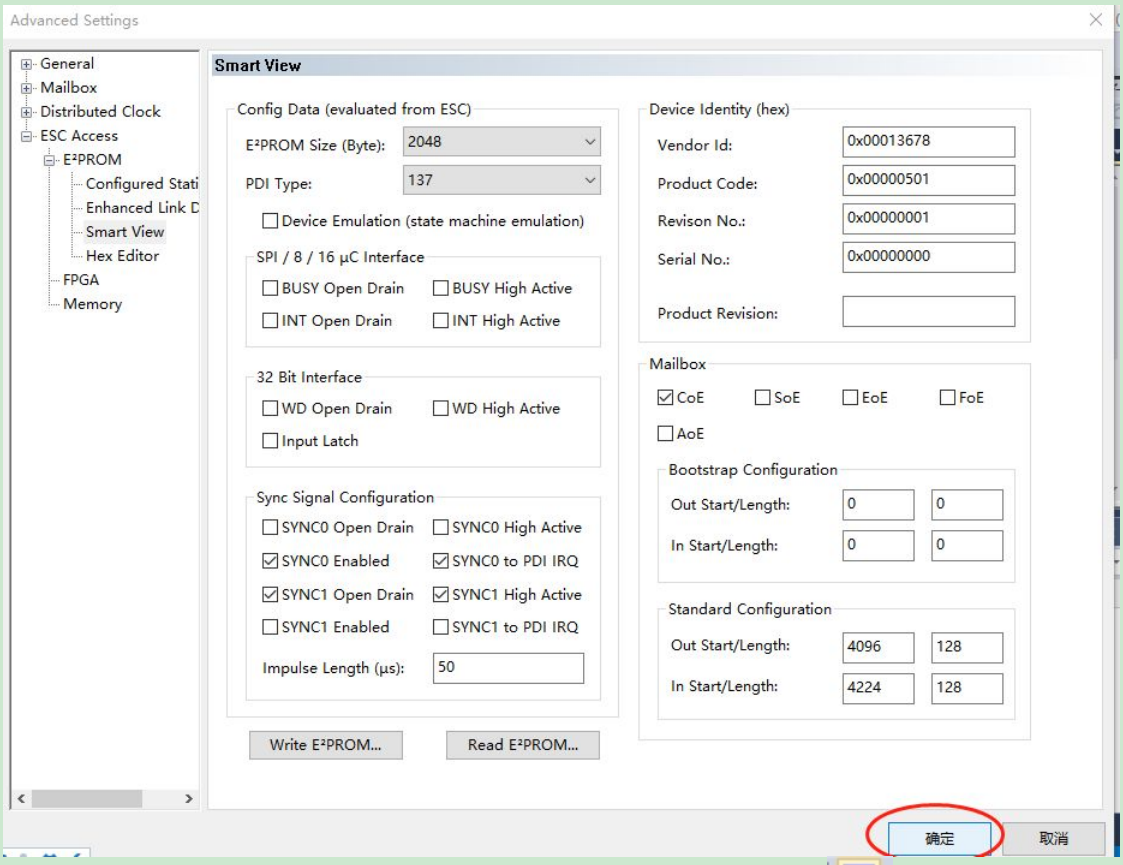


choose ES580_1Axis_V1.06 and click OK

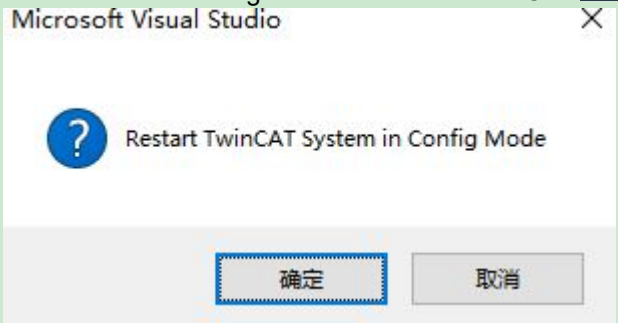


After the download is complete, click OK to exit the download interface

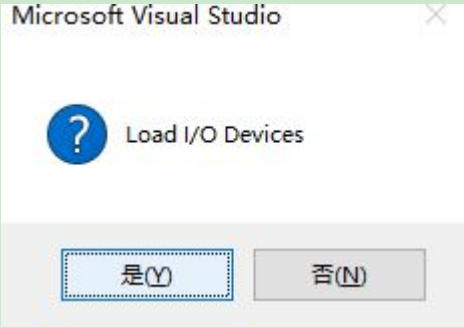




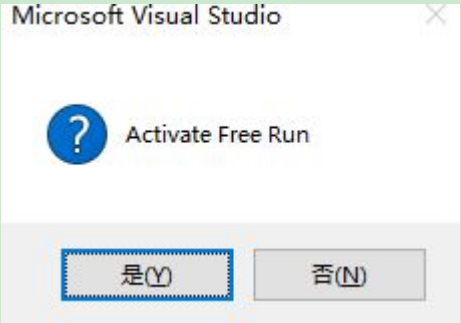
Restart Restart configuration mode and run Click  ,



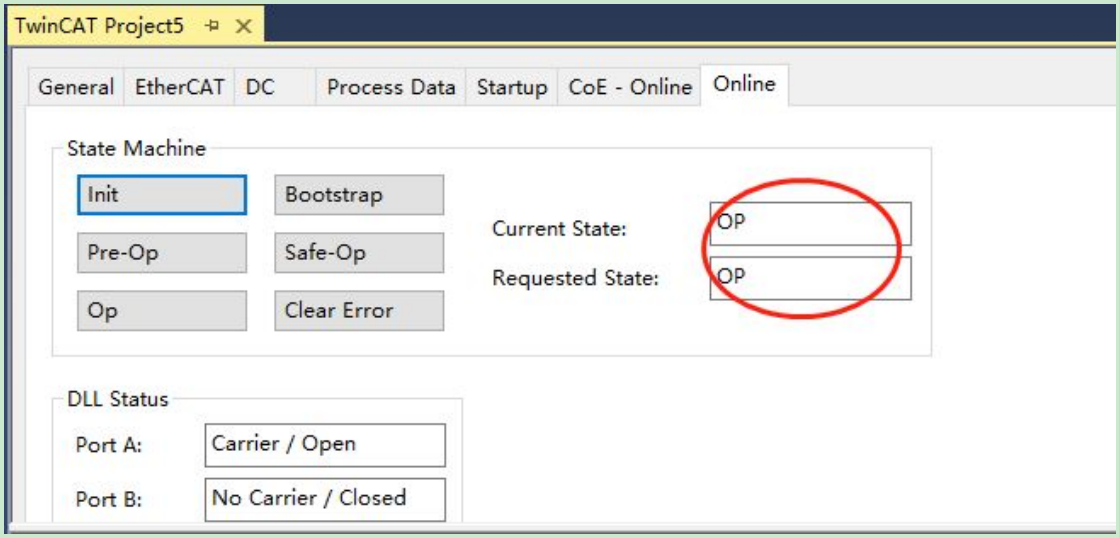
Click“sure”。



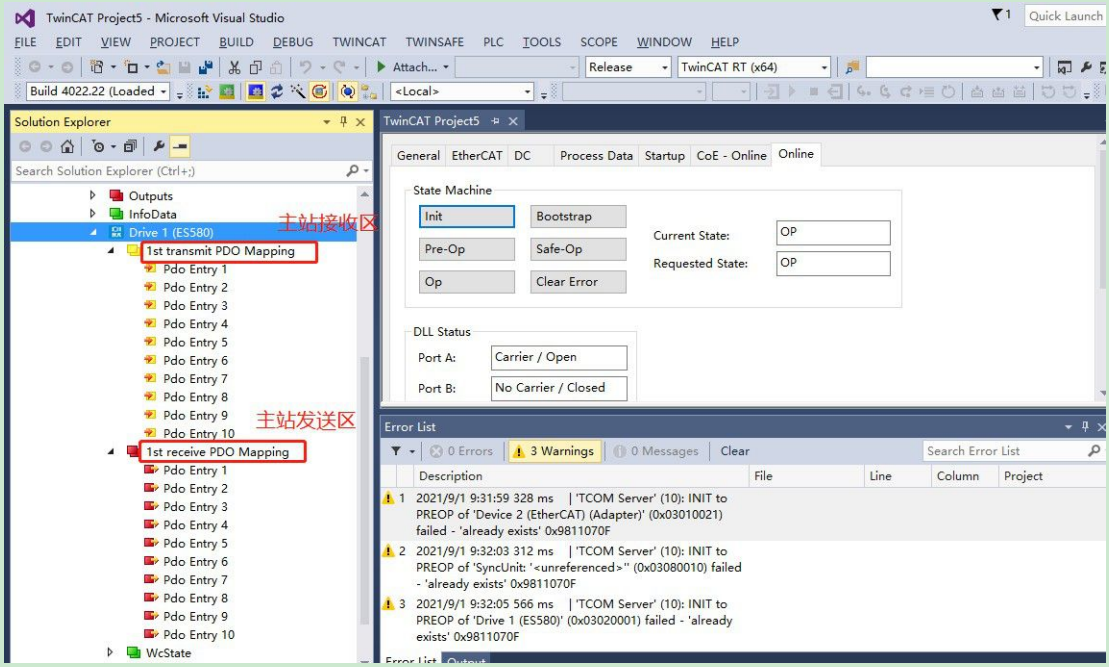
Click“yes”，load device.



Click“yes”，running equipment，Enter the following OP state

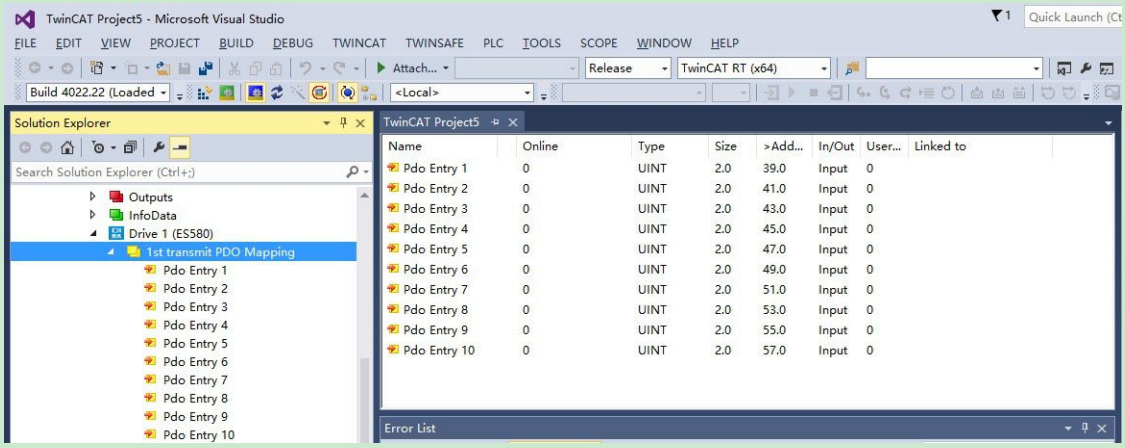


7） Monitor drives by configuring PDOs

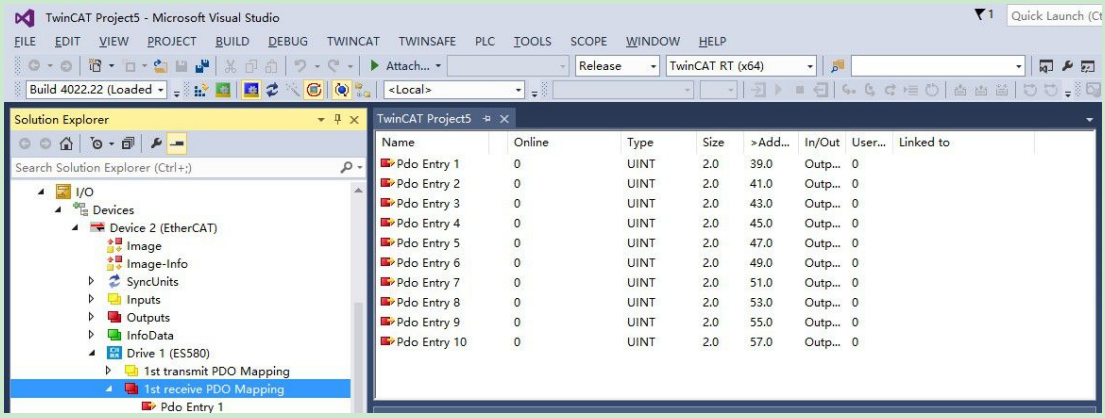


Master station receiving area：Receive drive data and monitor drive status in real time，PDO1 is the fieldbus status word is fixed without configuration，PDO2—PDO10 require the user to manually set the mapping parameters in the drive parameter group 50.03—50.12

（50.09 Can not be mapped, need to set the next parameter）。



Master sending area: send data to control the drive，PDO1 is the fieldbus control word，PDO2 is the fieldbus reference 1，PDO3 is fieldbus reference 2，These three are fixed PDOs without configuration，PDO4—PDO10 require the user to manually set the mapping parameters in the drive parameter group 50.17—50.23



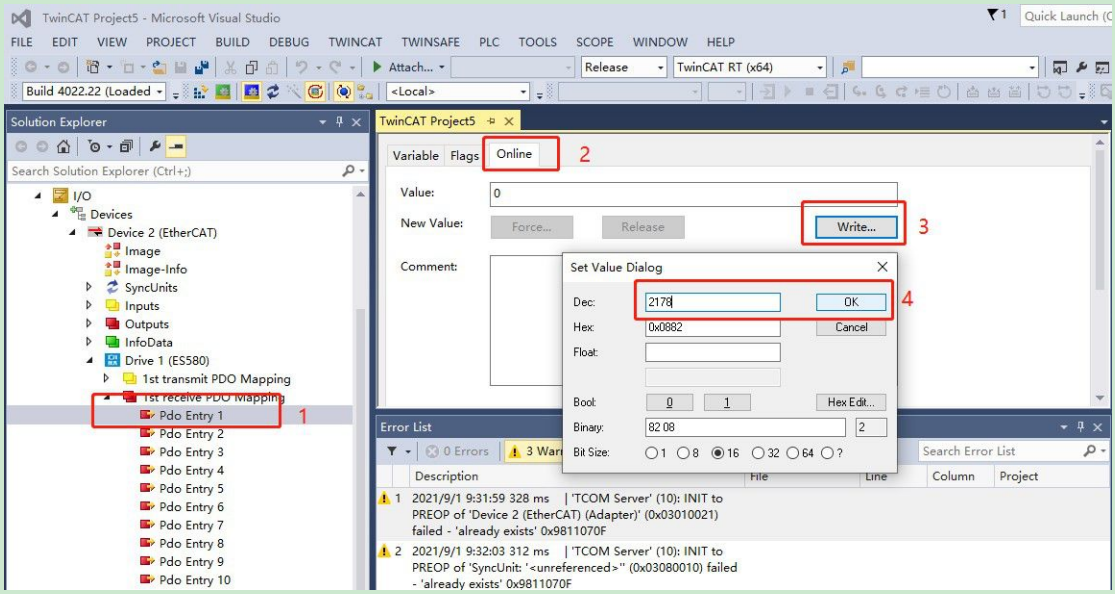
8)Example of drive mapping parameter setting

Set up below perameters，monitore P.01.00 motor speed、P.01.01 output fre、P.01.02 DC link voltage、P.01.02 motor current and control P.20.00 Max speed、P.20.01 Min speed、P.22.00 Acc time 1、P.22.01 Dec time 1。

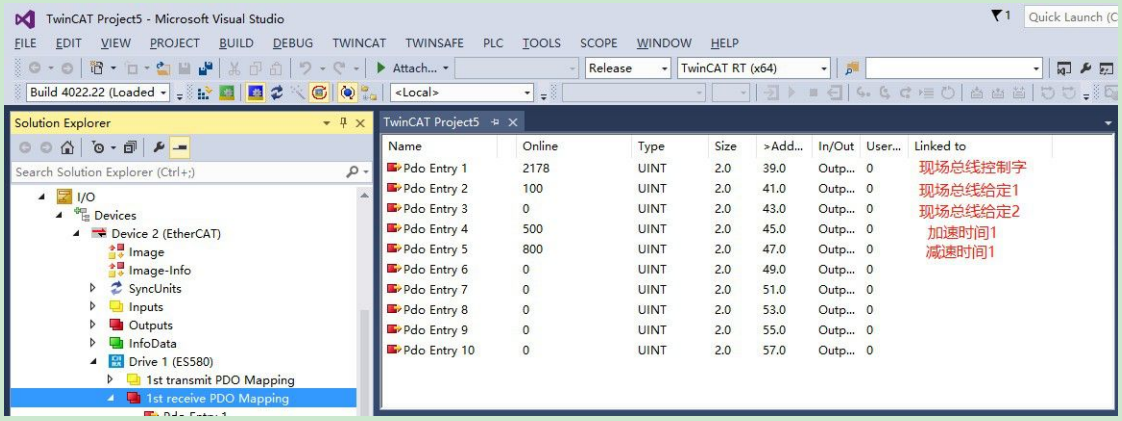
a) 50.03（Actual value 1 signal source）setted up P.01.00 motor speed；
b) 50.04（Actual value 2 signal source）setted up P.01.02 DC link voltage；
c) 50.05（input data 1）set up P.22.00 acc time 1；
d) 50.06（output data 2）set up P.22.01 dec time 1；
e) 50.19（input data 3）set up P.22.00 acc time 1；
f) 50.20（output data 4）set up P.22.01 dec time 1；

8) Running drive

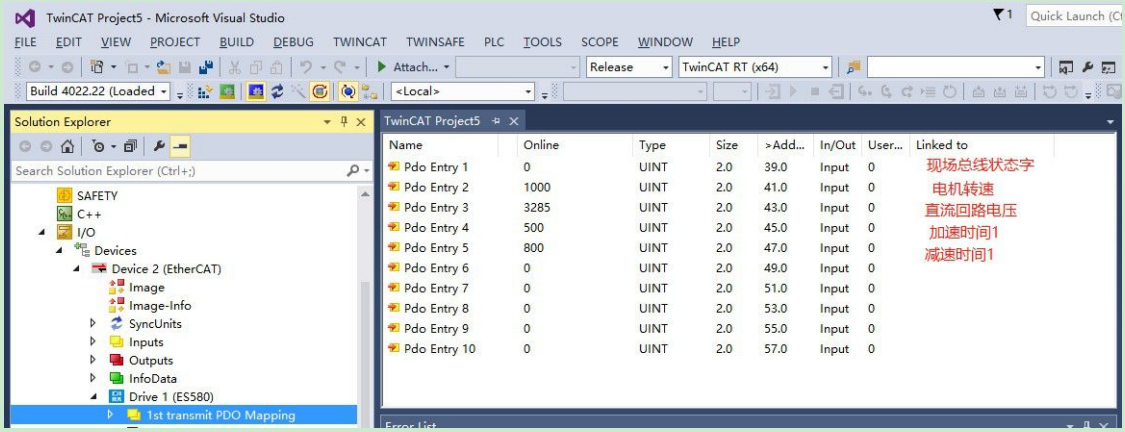
Set up acc time 1 =5s，dec time 1 =8s，given speed 100rpm running



Follow the steps above to set the value of given speed、acc time 1、dec time 1



Monitor the master station receive data



Speed 100rpm，DC bus voltage 328.5V，acc time 5s，dec time 8s,Verify that the master station data is successfully read and written.