

HV320 Series Inverter EtherCAT Expansion Card User's Guide

1. Overview

Thank you for using our HV320 Series Inverter and HV320-ECAT Expansion Card (herein after referred to as ECAT Card). ECAT card is an EtherCAT field bus adapter card, which can be used in ultra-high speed I/O network. This protocol is suitable for I/O layer. The card has high efficiency, flexible topology and easy operation. It is installed in HV320 series frequency converter to increase communication efficiency and realize the networking function of frequency converter. The frequency converter is controlled by the field bus master station. The ECAT card can be used for HV320 series inverters, and the software version of the ECAT card required in this user guide is 1.00 or above. The corresponding XML file is EM_EC.XML. This user guide is only applicable to Series A inverters. If you need to use the ECAT card on other inverters, please contact our technician engineer to check whether it is available and obtain the corresponding information.

Please read this user guide carefully before using this product.

Figure below shows the hardware layout of the ECAT card. P1 bus is used to connect the frequency converter. The ECAT card provides two network ports U3 for communication with the master station (or the previous slave station) and the next slave station (if present). See Table 2-1 for details on hardware

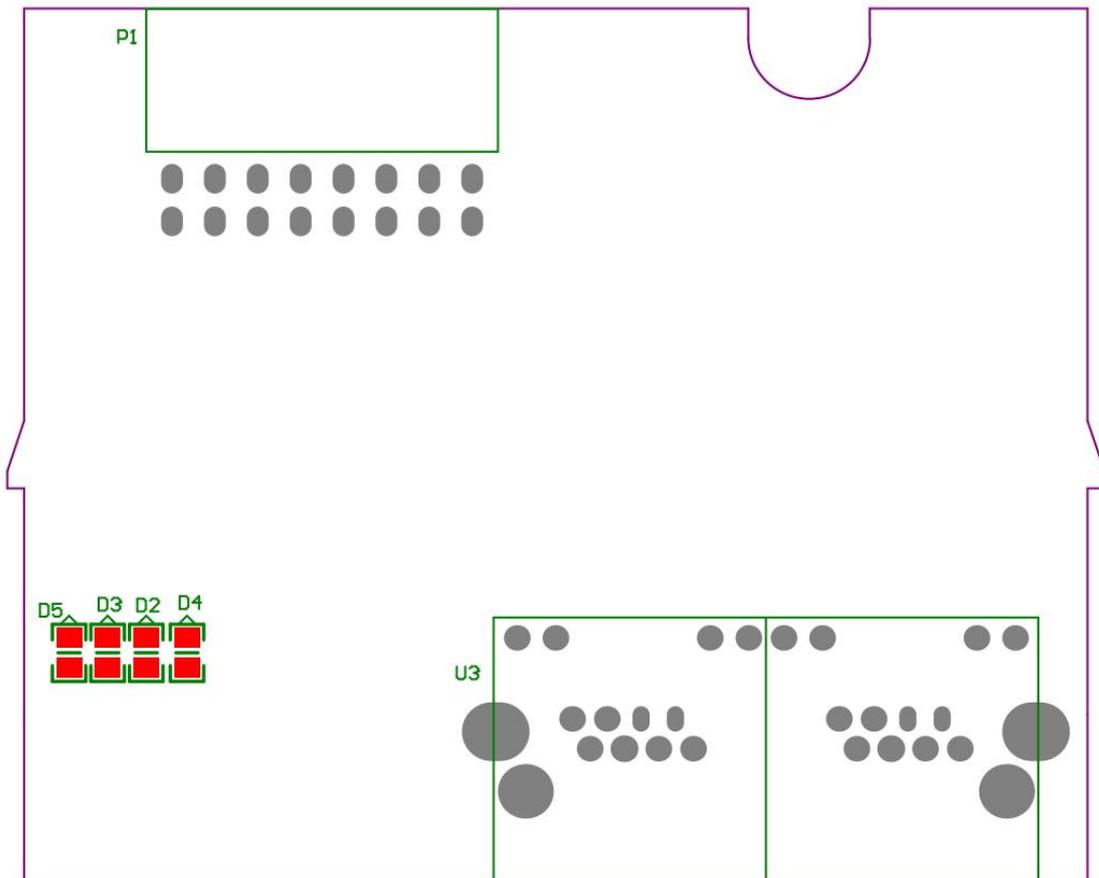


Figure ECAT Card (Hardware)

Table Hardware Description of ECAT Card

Symbol	Hardware name	Functional description
P1	Pin connector	Used to connect the frequency converter
U3	Network port	Used with the master station (or previous slave station) and the next slave station (if present). The one on the left is for input and the one on the right is for output.
D2	Ethercat Op Status Indicator (Green)	See Table 2-2 for the indicator light of ECAT card.
D3	Frequency converter communication indicator (green)	
D4	Power indicator (green)	
D5	Ethercat fault indicator (red)	

Table Indicator Description of ECAT Card

Indicating signal		State description	Solutions
D2	Green is always bright	Work in OP state	N/A
	Green flicker	Working in PREOP/Safe Mode	Check the configuration. Check whether the inverter supports ECAT card and whether the communication protocol of the inverter matches. Check that the network port is connected correctly.
	OFF status	Disconnect or work in initial mode	Check that the master station and the network port are connected correctly.
D3	Green is always bright	Normal	N/A
	OFF status	Disconnected communication with drive	Check whether the inverter supports ECAT card.
D4	Green is always bright	Normal	N/A
	OFF status	The communication board is not powered on	Check whether the P1 connector is connected normally and whether the frequency converter is powered on.
D5	OFF status	Normal	N/A
	Red is always bright	ESC internal fault	Please contact technical support.

EtherCAT RJ45 Interface

The ECAT card is connected to the EtherCAT master station RJ45 socket using standard Ethernet. Its pin signal definition is the same as that of standard Ethernet pins. They can be connected using a crossover cable or a straight-through cable.

Table 2-3 EtherCAT Communication Interface Description

Terminal symbol	Terminal name	Describe
U3	ECAT IN	Network interface. The left side is used for input and the right side for output.
	ECAT OUT	



After the ECAT card is installed, ECAT IN is on the left side and ECAT OUT is on the right side when facing the RJ45 interface. The two interfaces must be connected correctly.

Communication configuration

Communication configuration between ECAT card and HV320 series frequency converter. After installing ECAT card on HV320 series frequency converter, the communication configuration is completed to realize the communication between them.

■ Communication card setting of frequency converter

Inverter software version: A:

The following parameters must be set in the ECAT card and the HV320 series inverter, and the ECAT card is connected to the EtherCAT fieldbus network.

Function code	Name	Content	Setting value	Describe
P0-02	Run instruction source	0: Operation panel running command channel (LED off) 1: Terminal Command Channel (LED on) 2: Communication command channel (LED flashing)	2	Run command issued by communication
P0-03	Main frequency source X selection	0: Digital setting (preset frequency P0-08, UP/DOWN can be modified, power failure can not be remembered) 1: Digital setting (preset frequency P0-08, UP/DOWN can be modified, power failure memory) 2: AI1 3: AI2 4: AI3 5: PULSE PULSE Setting (DI5) 6: Multi-speed command 7: Simple PLC 8: PID 9: Communication given	9	Given target frequency By communication
P0-28	Serial communication protocol	0: Modbus protocol 1: Communication card bridge protocol	1	Select a special item communication card for communication

Parameters related to communication control

Function code	Name	Content	Index	Sub-index
U3-16	Set frequency (HZ)	Communication set frequency: 0HZ ~ U3-16 (minimum unit: 0.01 Hz)	16#2073	16#01
U3-17	Control command	0001: Run Forward 0002: Reverse operation 0003: Positive inching 0004: Reverse inching 0005: Free shutdown 0006: Slow down and stop 0007: Fault reset 0008: Fault reset (Fault reset is only possible in communication control mode)	16#2073	16#02
U3-18	DO	BIT0: RELAY1 Output Control BIT1: DO1 output control BIT2: RELAY2 Output Control	16#2073	16#03
U3-19	AO1	0 ~ 7FFF means 0% ~ 100%	16#2073	16#04
U3-20	AO2	0 ~ 7FFF means 0% ~ 100%	16#2073	16#05
Inverter parameters (commonly used)				

Function code Name	Name	Content	Index	Sub-index
P0-10 Maximum frequency	Maximum output frequency	50HZ ~ 500HZ	16 # 20F0	16 # 0A
P0-17 Acceleration time	Acceleration time	0.00s ~ 650.00s (P0-19=2) 0.0s ~ 6500.0s (P0-19 =1) 0s ~ 65000s (P0-19 = 0)	16 # 20F0	16#11
P0-18 Deceleration time	Deceleration time	0s ~ 65000s	16 # 20F0	16#12
P0-19 Acceleration/ Deceleration time unit	Acceleration and deceleration time unit	0: 1 second 1: 0.1 second 2: 0.01 second	16 # 20F0	16#13
P8-00 Jog frequency reference	Inching operation frequency	0.00 Hz ~ maximum frequency	16 # 20F7	16#01
P8-01 Jog acceleration time	Inching acceleration time	0.0s ~ 6500.0s	16 # 20F7	16#02
P8-02 Jog deceleration time	Inching deceleration time	0.0s ~ 6500.0s	16 # 20F7	16#03
PD-01 Upper-limit Digital Setting of Torque Ctrl	Torque digital setting	-200.0%~200.0%	16 # 20FD	16#03
PD-03 Forward Max Frq in Torque Ctrl	Maximum frequency in forward direction of torque control	0.00Hz to maximum frequency (P0-14)	16 # 20FD	16#04
PD-04 Reverse Max Frq in Torque Ctrl	Maximum frequency in reverse direction of torque control	0.00Hz to maximum frequency (P0-14)	16 # 20FD	16#05
U1-05 Output power	Output power (KW)	-	16#2070	16#06
U1-06 DI status	DI input status	-	16#2070	16#07
U1-07 DO State	DO Output Status	-	16#2070	16#08

Inverter parameters are described as follows:

Each object in the dictionary should be uniquely addressed by using indexes and sub-indexes.

"Index": This field (hexadecimal) specifies the same type of object in the dictionary.

Sub-index: This field specifies the overall arrangement of offsets for each object in the same index in hexadecimal.

The mapping between inverter parameters and object dictionaries is as follows:

Object dictionary index = 0x2000 + parameter group number

Object dictionary subindex = hexadecimal +1 of offset in parameter group

By default, when using the ECAT card, the written PDO1 and PDO2 map to U3-17 and U3-16.

Therefore, the first item of RPDO must be U3-17; Otherwise, the operation will be abnormal. In addition, if the eight high bits of U3-17 are written with any non-zero values, the AC driver will report a communication failure (Err16).

Communication setup between ECAT card and EtherCAT host

After the communication between ECAT card and HV320 series inverter is enabled, connect EtherCAT master station to correctly enable the networking function between ECAT communication card, EtherCAT master station and AC driver.

EtherCAT topology

EtherCAT supports a variety of topologies including star bus and tree topologies and combinations of them. This makes equipment connection and wiring flexible and convenient. The following figure shows the bus topology.

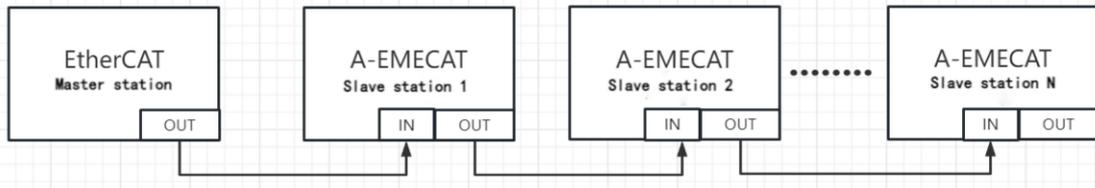


Figure 3-1 Bus Topology

3.2. 2 EtherCAT communication protocol

In DC mode, the DC Synchronization Mode period must be at least 1 ms, but less than 100 ms. Otherwise, an EtherCAT communication failure occurs.

■PDO Data Description

PDO data is used for real-time modification and reading of inverter data by master station to perform periodic data exchange. Data communication address by frequency converter. Mainly includes:

- A) Real-time setting of frequency converter control command and target frequency
- b) Read the current state and operating frequency of the frequency converter in real time
- c) Functional parameters and monitoring data in AC Drive and EtherCAT Master PDO process data are used for periodic data exchange between Master and AC, as described in the following table.

Main transmitting PTO (0x1600)		
Fixed RPDO		Variable RPDO
Target frequency of frequency converter	Inverter drive command	Modify the functional parameters of the frequency converter
RPDO1	RPDO2	RPDO3 to RPDO10
Corresponding AC Driven Data PDO (0x1A00)		
Inverter state	Operating frequency of frequency converter	Read the functional parameters of the frequency converter
TPDO1	TPDO2	TPDO3 to TPDO10

Note: Up to 10 RPDOs and 10 TPDOs can be configured.

■ Data sent by master station

Master transmit RPDO	
RPDO1	The frequency converter target frequency (frequency source set to "communication") is in the range from reverse frequency upper limit (negative value) to forward frequency upper limit (including decimal point, for example, 2000 corresponds to 20.00 Hz on the frequency converter). When a given target frequency exceeds this range, the frequency converter operates at that frequency upper limit. For example, if the upper frequency limit is set to 50.00 Hz and 6000, the AC driver will run forward at 50.00 Hz. If the upper frequency limit is set to 50.00 Hz and communication is set to -6000, the AC driver will run in reverse at 50.00 Hz.
RPDO2	Inverter command word (command source set to "communication") 0001: Run Forward 0002: Reverse operation 0003: Positive inching 0004: Reverse inching

	0005: Free shutdown 0006: Slow down and stop 0007: Fault reset 0008: Fault reset (Fault reset is only possible in communication control mode)
RPDO3 to RPDO10	Real-time modification of functional parameter values (Group F and Group A) without writing to EEPROM (Electronic Read Only Memory)

■ AC Drive Response Data

Corresponding AC Drive Data TPDO	
TPDO1	Running state of frequency converter
	0001: Run Forward 0002: Reverse operation 0003: Downtime
TPDO2	Operating frequency (0.01 Hz)
	Returns the current operating frequency of the inverter. The returned data is 16-bit signed and the received data is 16-bit unsigned. Variables must be mapped to 16-bit signed data.
TPDO3 to TPDO10	Read function parameter values (Group F and Group A) and monitor parameter values (Group U)

For more information about PDO definitions for other inverters, see the corresponding AC Drive User Guide.

■ Service Data Object (SDO)

EtherCAT SDO is used to transfer acyclic data, such as communication parameter configuration and servo driver operation parameter configuration. EtherCAT CoE service type

Including:

- 1) Critical event messages
- 2) SDO Request
- 3) SDO response
- 4) TxPDO
- 5) RxPDO
- 6) Remote TxPDO send request
- 7) Remote RxPDO send request
- 8) SDO information

At present, the inverter supports SDO request and response. For more information about SDO parameters, see the HV320 series Converter User Guide.

3.3 Use ECAT card with Beckhoff controller

Taking Beckhoff's TwinCAT master station as an example, the ECAT card is described.

Note: You must use a 100M Ethernet adapter with an Intel chip. Other network adapters may not support EtherCAT.

- 1) Install TwinCAT.

Windows XP systems: tcat_2110_2230 is recommended.

Windows 7 32-bit systems: tcat_2110_2248 is recommended.

- 2) Copy the EtherCAT configuration file (EM_EC.xml) for the A-family inverter to the TwinCAT installation directory.

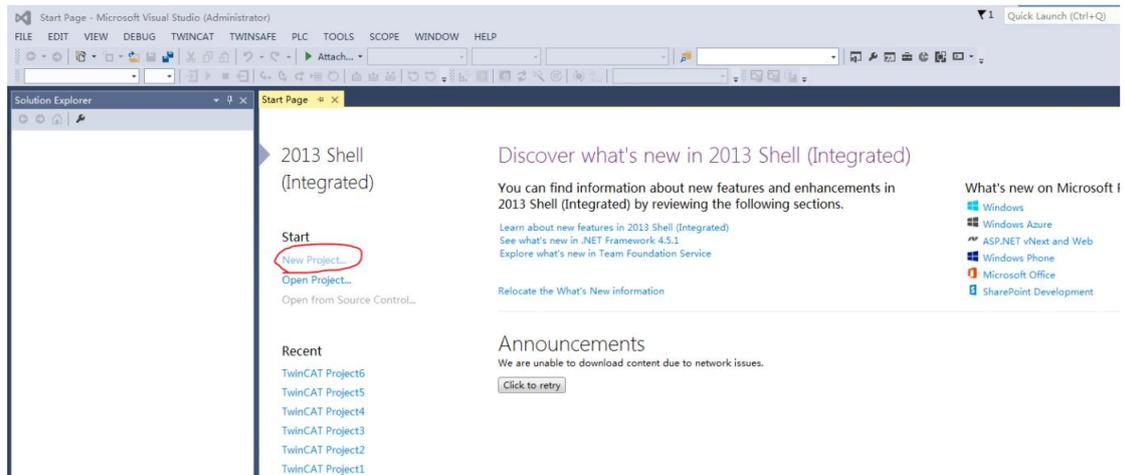
TwinCAT2 Directory: TwinCAT\IO\ EtherCAT

TwinCAT3 Directory: TwinCAT\ 3.1\ config\ IO\ EtherCAT

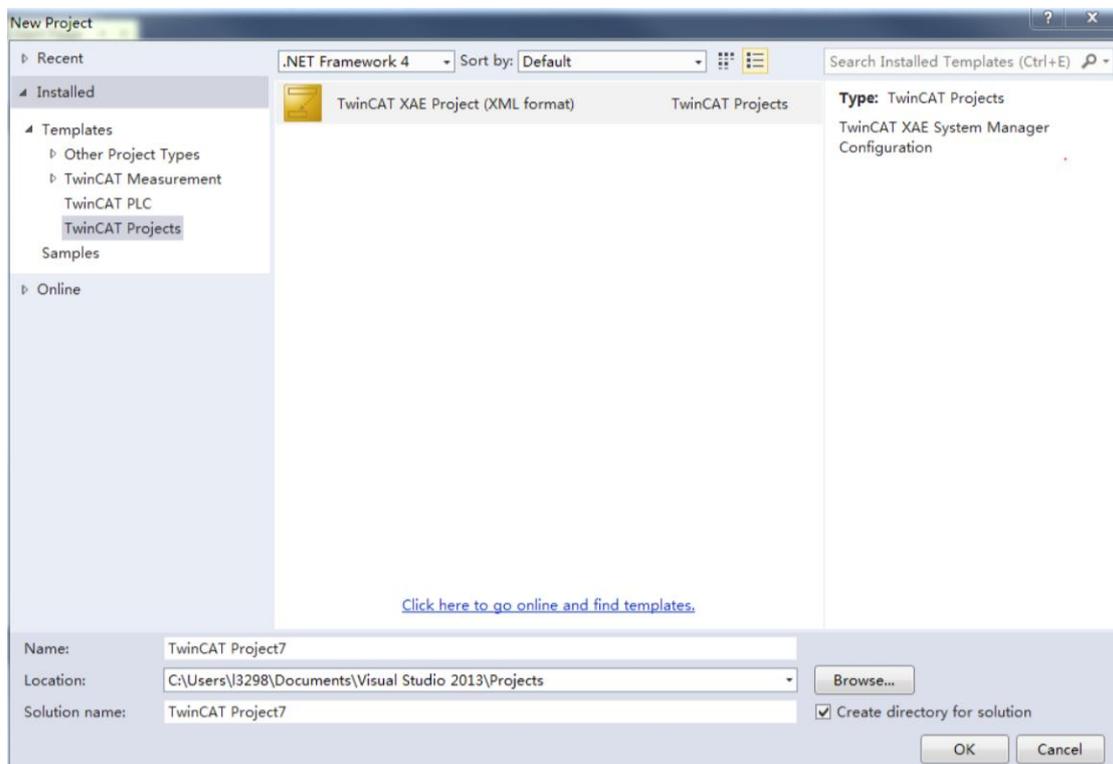
TwinCAT3 is used as an example in the next section. The steps for TwinCAT2 are similar.

3) Start TwinCAT.

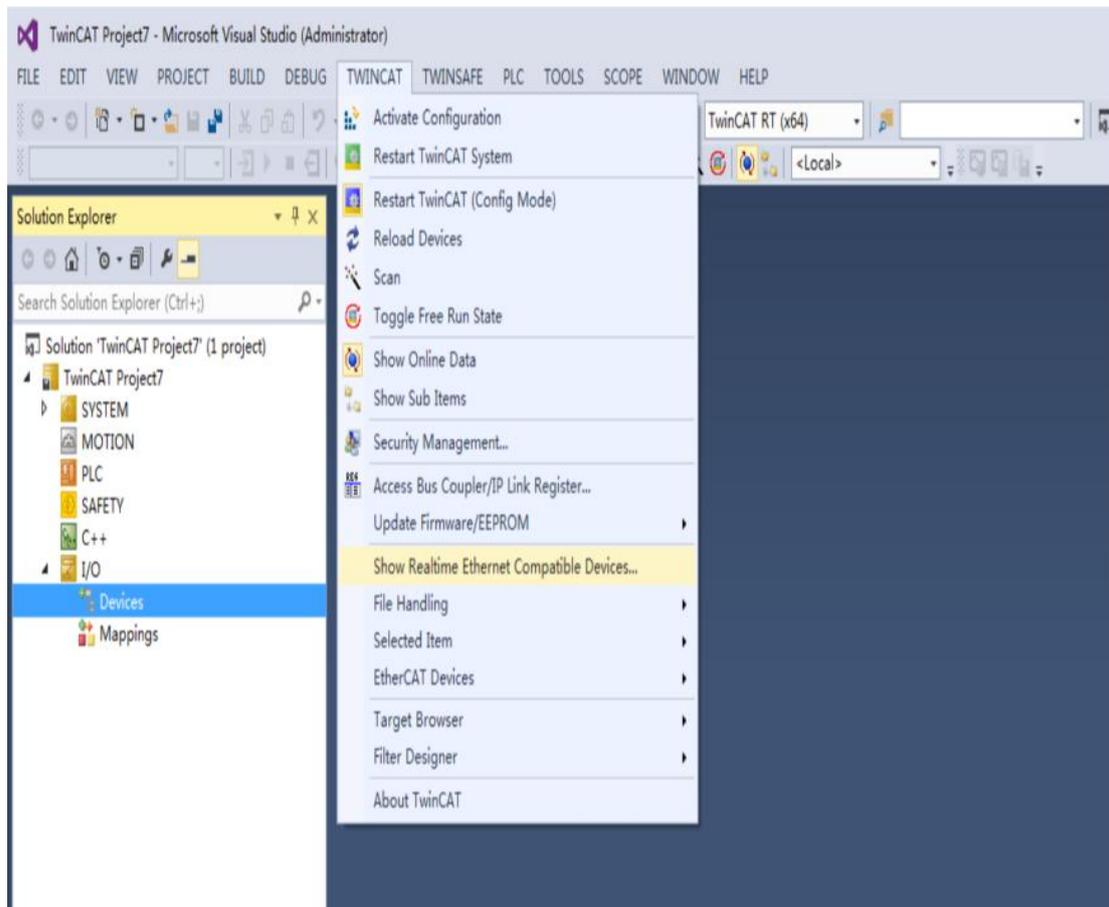
Click New Project to create a project.



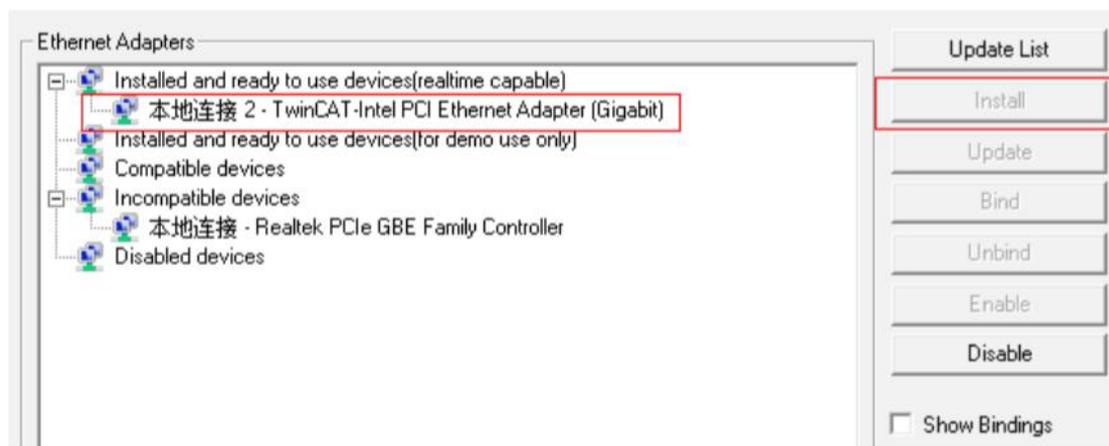
Click OK



4) Install the TwinCAT network adapter driver

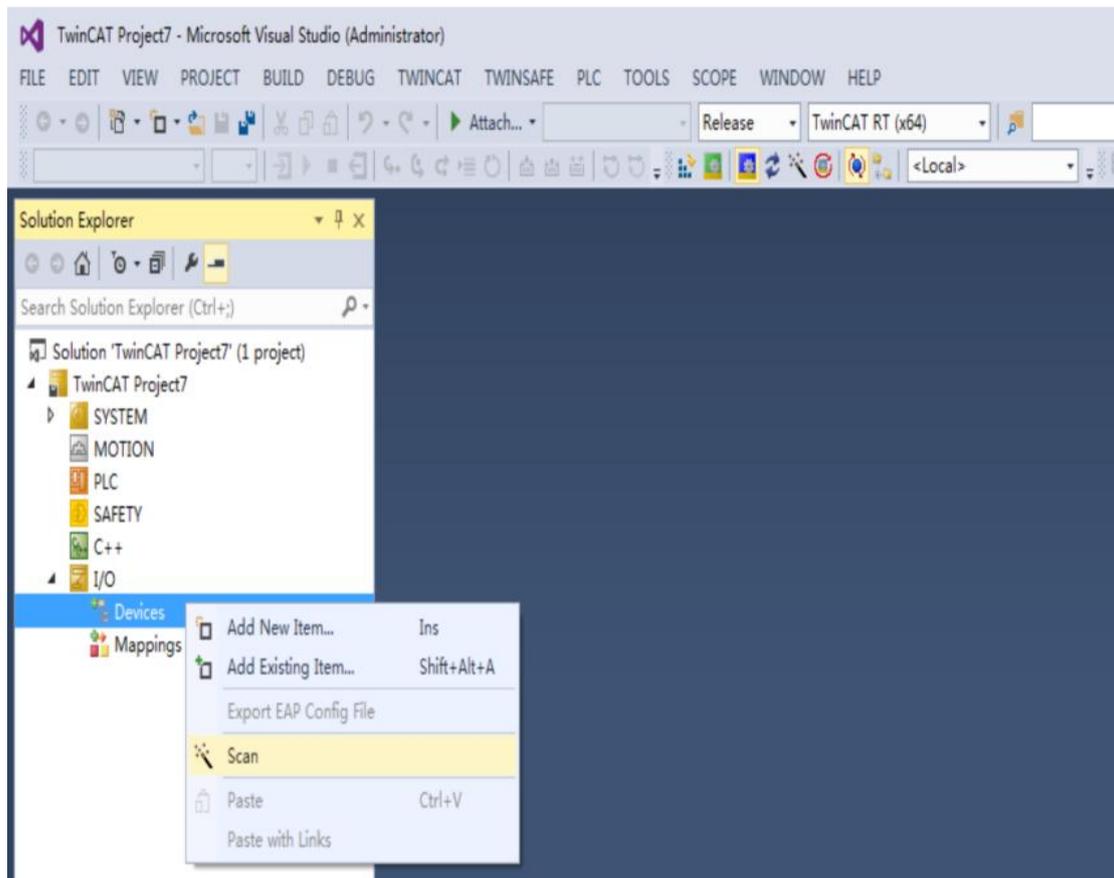


Select TWINCAT > Show Real Time Ethernet Compatible Devices In the dialog box that displays, select the local network adapter in the incompatible devices, and then click Install. When you install later, the installed network adapter appears in Devices Installed and Ready for Use.

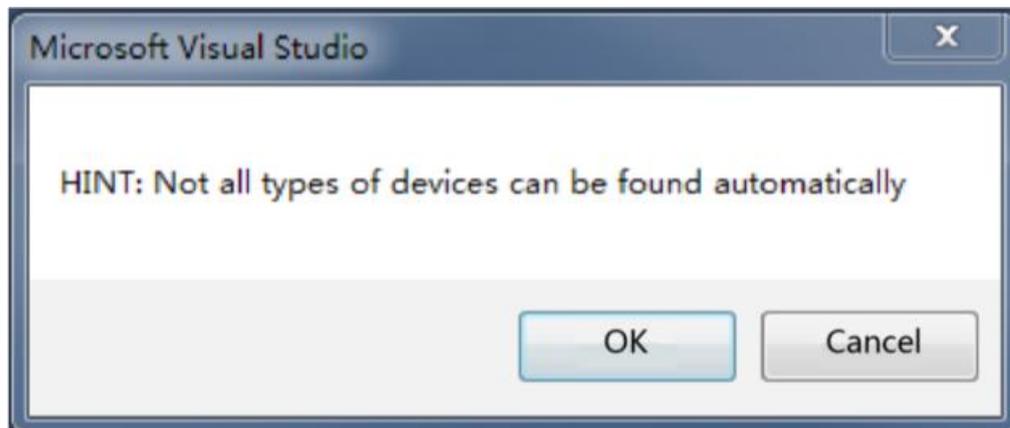


5) Search for the device. Create the project, right-click the device, and then click Scan to search for the device, such as

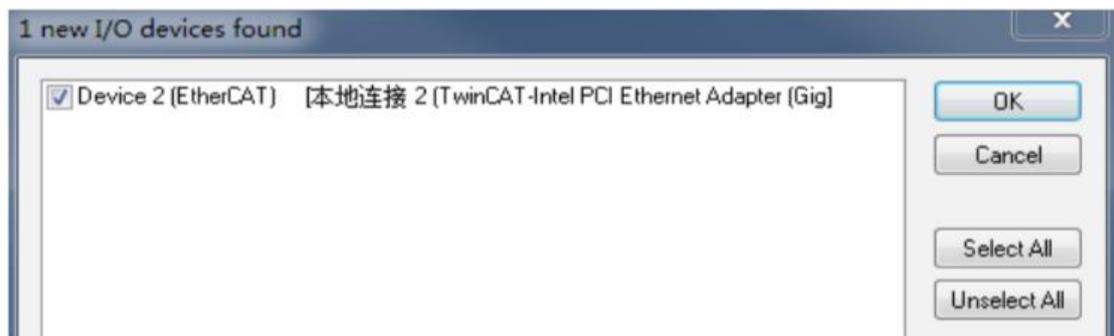
As shown in the following figure.



Click OK



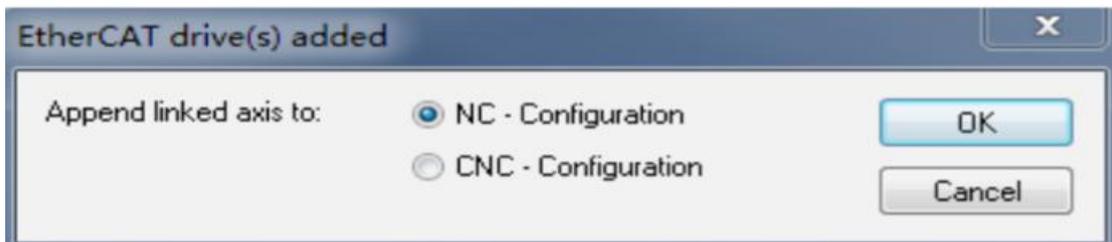
Click OK



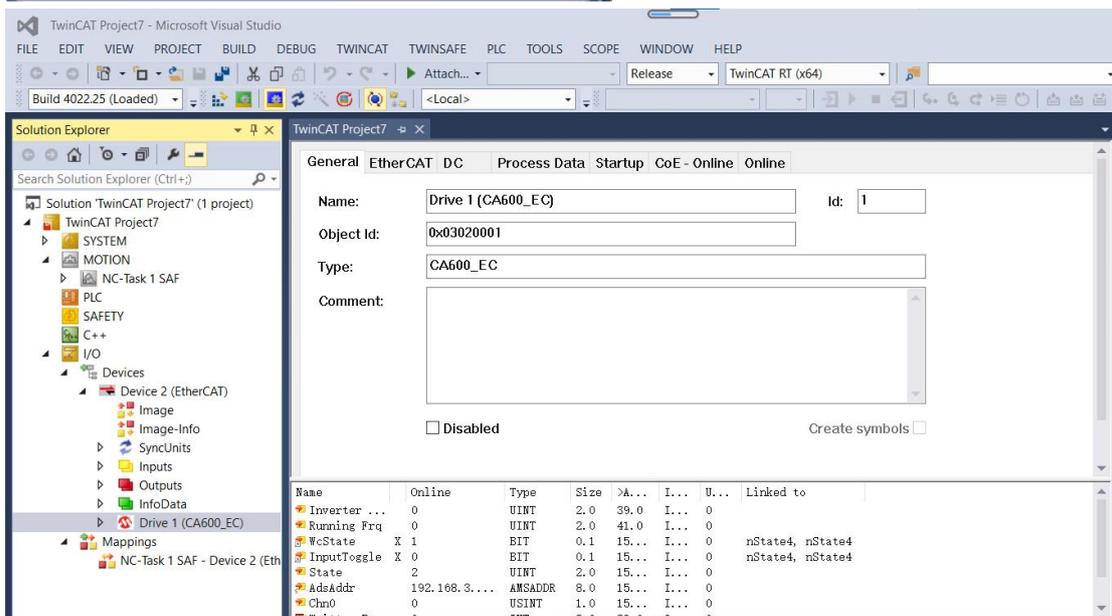
Click Yes



Click OK



Click No, and the device search is complete, as shown in the following figure:



6) 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 the location indicated by the red arrow in the figure below to add TPDO mapping as needed.

The screenshot shows the TwinCAT Project7 interface with the 'Process Data' tab selected. The 'PDO List' table is highlighted, showing the configuration for TPDO. A red box highlights the 'Index' column, and a red arrow points to the 'Index' value '0x1A00' in the 'PDO Content (0x1A00)' table.

Index	Size	Name	Flags	SM	SU
0x1A00	4.0	Inputs Map		3	0
0x1600	4.0	Output Map		2	0

Index	Size	Offs	Name	Type	Default...
0x2070:28	2.0	0.0	Inverter State	UINT	
0x2070:01	2.0	2.0	Running Frq	UINT	
		4.0			

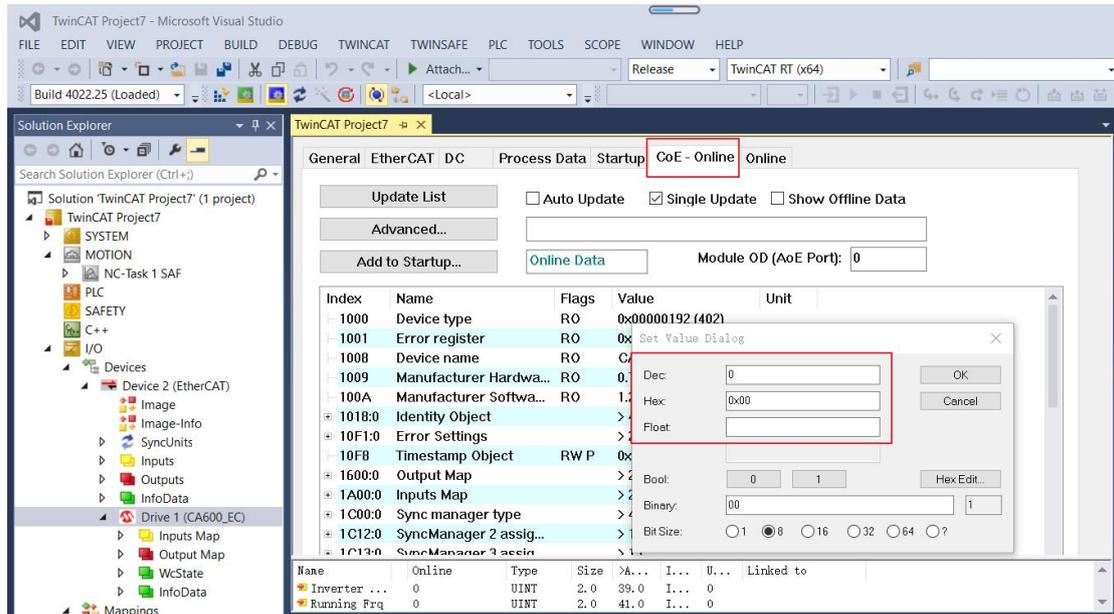
2. Configure RPDO. Select 0x1600 when configuring RPDO. The first two items are set to RPDO by default and cannot be changed. Right-click the location indicated by the red arrow in the figure below to add the RPDO map as needed.

The screenshot shows the TwinCAT Project7 interface with the 'Process Data' tab selected. The 'PDO List' table is highlighted, showing the configuration for RPDO. A red box highlights the 'Index' column, and a red arrow points to the 'Index' value '0x1600' in the 'PDO Content (0x1600)' table.

Index	Size	Name	Flags	SM	SU
0x1A00	4.0	Inputs Map		3	0
0x1600	4.0	Output Map		2	0

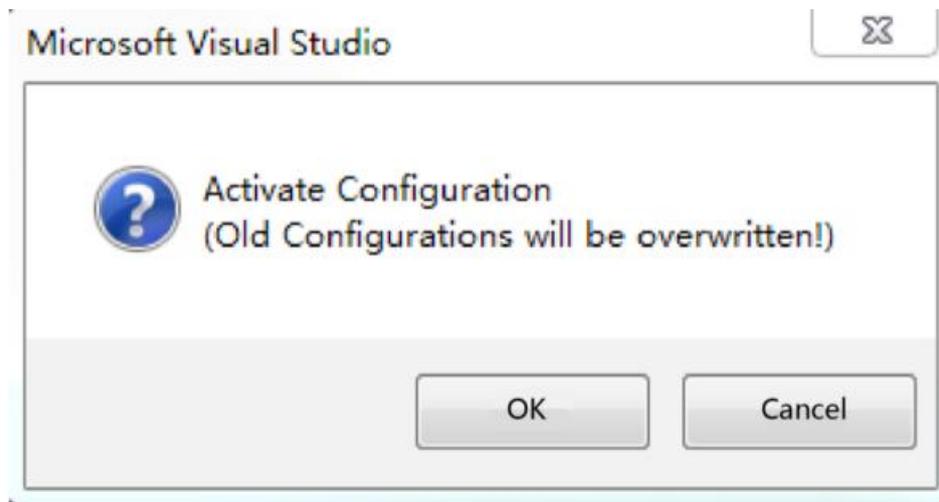
Index	Size	Offs	Name	Type	Default...
0x2073:01	2.0	0.0	Written Freq	INT	
0x2073:02	2.0	2.0	Control Command	UINT	
		4.0			

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

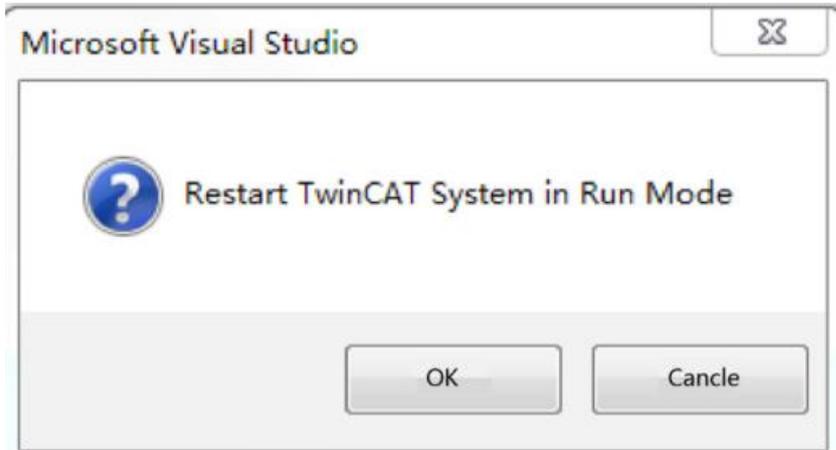


4. Activate the configuration and switch to run mode.

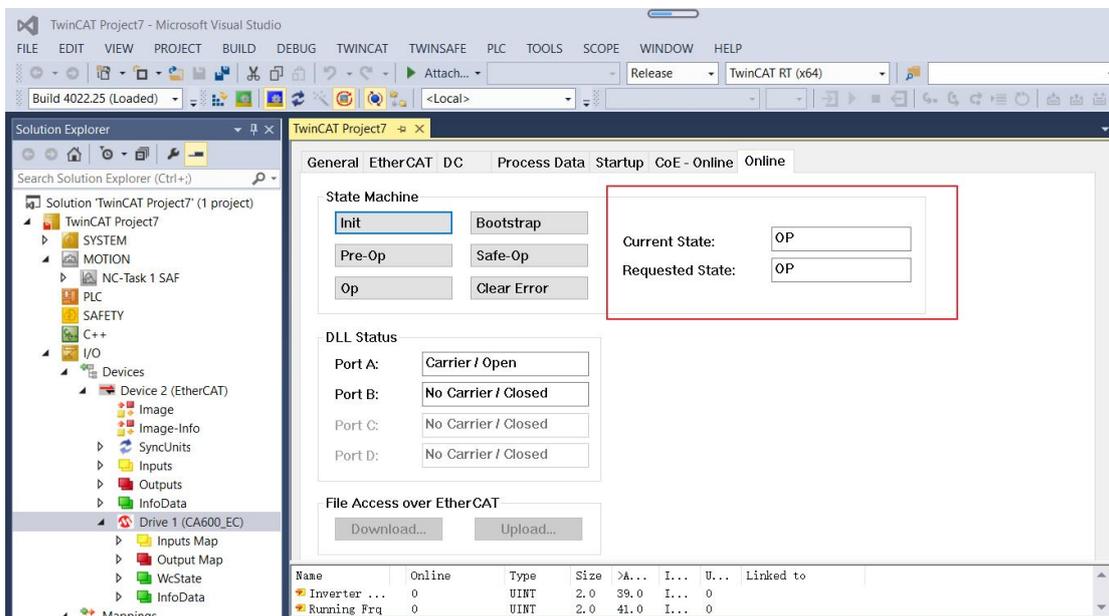
Click  to display the following dialog box.



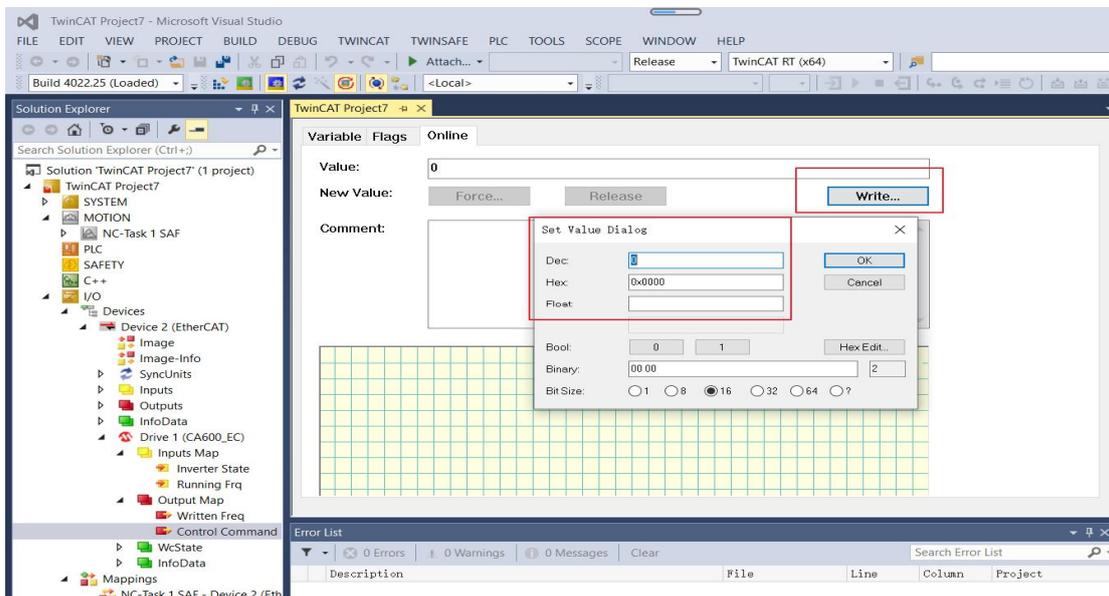
Click OK



Click OK to enter the OP state



5. AC drive is controlled by PDO. The corresponding value is written through the configured RPDO to control the frequency converter.



1. Troubleshooting

The following table describes the possible failures and frequency converters during the use of ECAT cards.

Table 4-1 Failure Causes and Solutions

Fault name	Possible causes	Solutions
Communication failure between ECAT card and AC driver	1. The inverter does not support EtherCAT communication. 2. The communication configuration of the ECAT card is incorrect. 3. Hardware failure of ECAT card	1. Check whether the inverter supports EtherCAT communication. 2. Set the EtherCAT communication parameters correctly. 3. Replace the ECAT card.

When the slave node fails, the ECAT card can be replaced directly (only the ECAT card fails) without performing the device configuration again.

Prerequisites for direct replacement of ECAT card:

1. Ensure the wiring sequence is consistent before and after replacing ECAT card.
2. The internal XML file versions of the original ECAT card and the new ECAT card must be consistent.
3. If the workstation alias device is configured for the original ECAT card, the device must be the same as the original device.