INOVANCE

FORWARD, ALWAYS PROGRESSING

SI-ECAT EtherCAT Communication Expansion Card

User Guide

Industrial Automation | Intelligent Elevator | New Energy Vehicle | Industrial Robot | Rail Transit

Data code 19012445 A00

Preface

Introduction

The SI-ECAT card is applicable to industrial field ultra-high speed I/O network. It operates at the I/O layer and features high efficiency, flexible topology, easy operation, and compliance with the GBT 31230 standard.

This guide describes the applicable AC drives, technical specifications, interfaces, dimensions, installation, wiring, communication, and troubleshooting of this product.

Revision History

Date	Version	Description
December 2023	A00	First release

Access to the Guide

This guide is not delivered with the product. You can obtain the PDF version in the following ways:

- Visit *www.inovance.com*, go to "Support" > "Download", search by keyword, and then download the PDF file.
- Scan the QR code on the product with your smart phone.
- Scan the QR code below to install the Inovance app, and search for MD800 in the app to obtain this guide.

Warranty

For faults and damage incurred during normal use in the warranty period, Inovance provides free repair service. (For details of the warranty period, see the purchase order.) A maintenance fee will be charged out of the warranty period.

Even in the warranty period, a maintenance fee will be charged for repair of the following damage:

- Damage caused by operations not following the instructions in the guide
- Damage caused by fire, flood, or abnormal voltage
- Damage caused by unintended use of the product
- Damage caused by use beyond the specified scope of application of the product

- Damage or secondary damage caused by force majeure (natural disaster, earthquake, and lightning strike)

The maintenance fee will be charged according to our latest Price List if not otherwise agreed upon.

For details, see the Product Warranty Card.

Table of Contents

1 Product Information

1.1 Introduction

The SI-ECAT card is applicable to industrial field ultra-high speed I/O network. It operates at the I/O layer and features high efficiency, flexible topology, easy operation, and compliance with the GBT 31230 standard.

Figure 1-1 SI-ECAT card appearance

1.2 Applicable AC Drives

Card Model	Order No.	Applicable AC Drive
SI-ECAT	01040120	MD800

1.3 Technical Specifications

Item	Technical Specifications
Communication protocol	EtherCAT protocol
Service supported	CoE (PDO and SDO)

Item	Technical Specifications
Network setup time (LINK)	Within 2 seconds
Synchronization mode	DC (default): Distributed clock (minimum synchronization time of 500 μs) FreeRun
Physical layer	100BASE-TX
Baud rate	100 Mbps (100Base-TX)
Duplex mode	Full duplex
Topology	Linear
Transmission media	Shielded Cat5e or better cable
Transmission distance	Less than 100 m between two nodes (with proper environment and cables)
EtherCAT frame length	44 bytes to 1,498 bytes
Process data	Maximum 1,486 bytes per Ethernet frame
Synchronization jitter of two slaves	< 1 μs
Communication bit error ratio	10^{-10}, Ethernet standard

1.4 Outline Dimensions

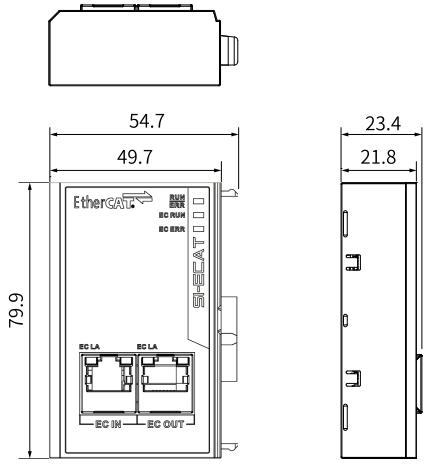


Figure 1-2 SI-ECAT card dimensions (unit: mm)

1.5 Interface Description

Interface layout

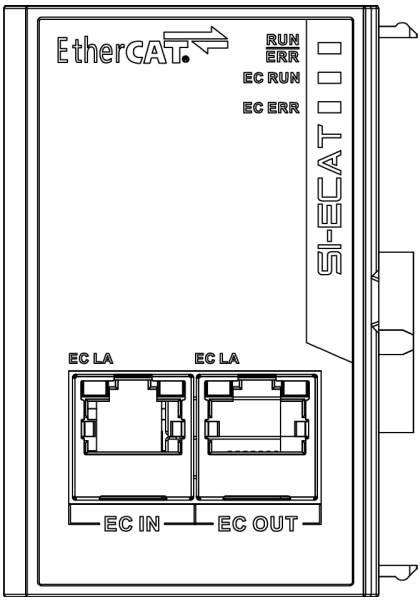


Figure 1-3 SI-ECAT card interface layout

The EtherCAT card (SI-ECAT) uses a standard Ethernet RJ45 socket to connect to an EtherCAT master. Its pin assignment aligns with standard Ethernet pins, allowing for the use of both crossover and straight-through cables.

Interfaces

Table 1–1 SI-ECAT card interface function description

Mark	Terminal Name	Description
EC IN	Input port	• After the card is installed, EC IN is on the left and EC OUT is on the right when you view them facing the RJ45 interface. The input and output ports must not be connected inversely. • To ensure stability, use the Cat5e shielded twisted pair (STP) network cable. • For enhanced communication interference resistance, it is recommended to install the card in expansion slot 2.
EC OUT	Output port	

Status indicators

Table 1–2 Status indicators

Indicator		Status Description	Action
RUN/ERR	Green light steady ON	Communication normal	None
	Red light steady ON	Communication timeout between the ECAT card and the node	Check the connector and whether there is interference.
	Red light blinking slow	Communication timeout between the ECAT card and the rectifier	1. Check whether the communication card is installed properly. 2. Check whether the rectifier module is normal.
	Red light blinking fast	ECAT card fault	Troubleshoot based on the fault code displayed on the rectifier display panel.
EC RUN	Green light blinking slow	EtherCAT state machine status: disconnected	None
	Green light OFF	EtherCAT state machine status: INIT (Initialization)	None
	Green light blinking fast	EtherCAT state machine status: PREOP (Pre-operation)	None
	Green light blinking once	EtherCAT state machine status: SAFEOP (Safe operation)	None
	Green light steady ON	EtherCAT state machine status: OP (Operation)	None
EC ERR	Red light OFF	EtherCAT communication without fault	None
	Red light steady ON	EtherCAT communication fault	Check the fault code displayed on the rectifier display panel.
EC LA	Yellow light OFF	No connection to the previous EtherCAT device	None
	Yellow light steady ON	Connected to the previous EtherCAT device	None
	Green light OFF	No data exchange through the network interface	None
	Green light blinking	Data exchange through the network interface	None

2 Installation Guide

- Before installation, cut off the power supply of the AC drive and wait for about 10 minutes until the charging indicator of the AC drive becomes off.
- Insert the SI-ECAT card into the AC drive. Check whether the card is securely inserted to prevent the signal socket between boards from being damaged by the pulling force of the external signal cable.
- The SI-ECAT does not support hot swapping.

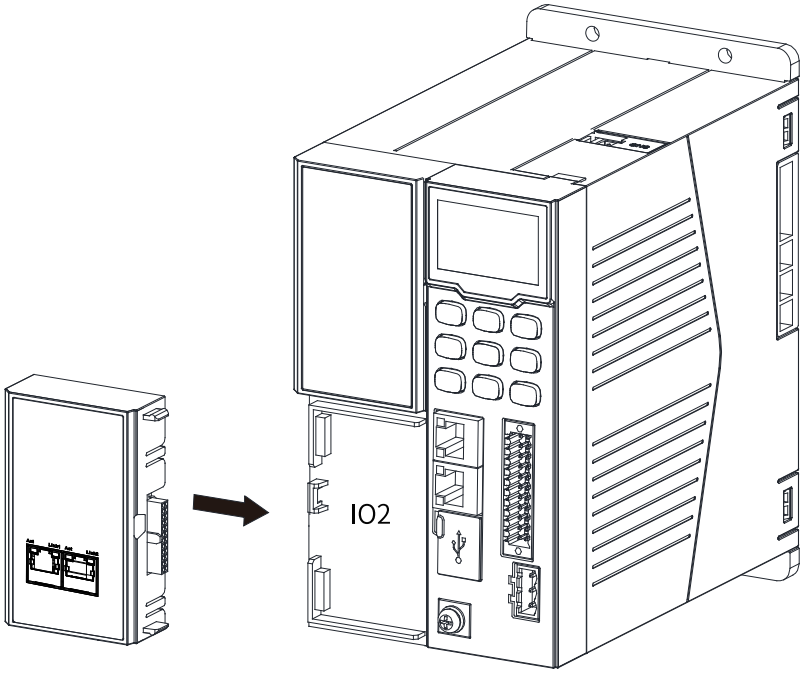


Figure 2-1 Installing the SI-ECAT card

3 Electrical Connection

The EtherCAT bus supports a variety of topologies, including bus, star, and tree topologies. Different networking modes can be implemented by using switches.

The EtherCAT connection topologies are shown in the following figures.

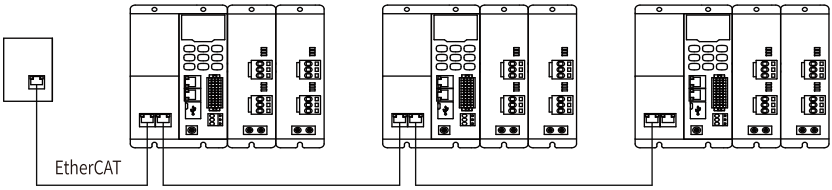


Figure 3-1 EtherCAT bus topology

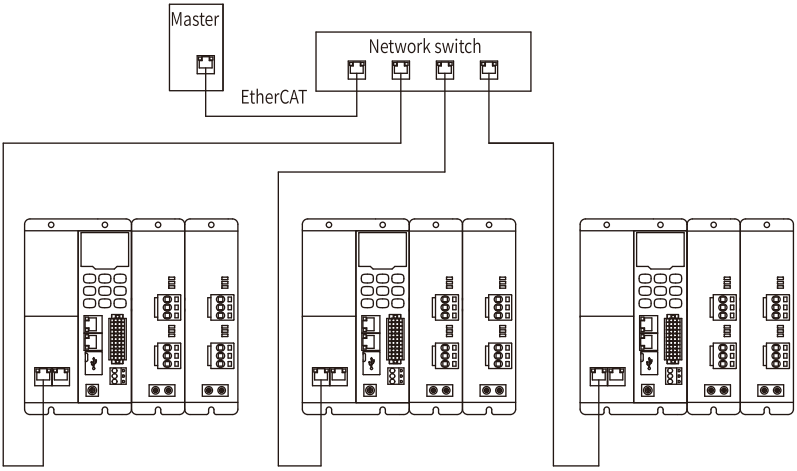


Figure 3-2 EtherCAT star topology

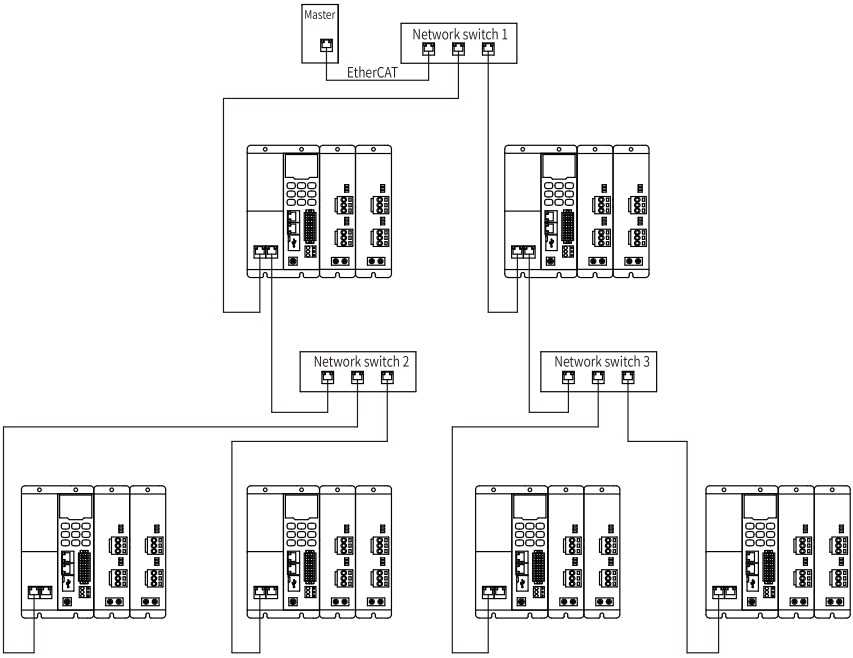


Figure 3-3 EtherCAT tree topology

4 EtherCAT Communication Protocol

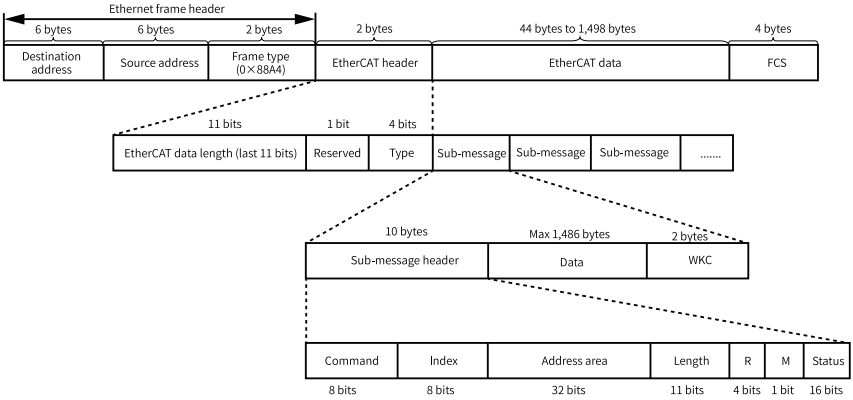
4.1 Overview

The EtherCAT communication card (hereinafter referred to as the ECAT card) supports the super-high-speed I/O network for industrial field application. The protocol can be used to directly process data at the I/O layer. It features high efficiency, flexible topology, and ease-to-use.

When this card is installed on the AC drive, the AC drive networking function is implemented and the AC drive can serve as a slave station of the field bus and be controlled by the field bus master station, improving the communication efficiency. The EtherCAT communication card supports a minimum sync period of 500 μs.

In this guide, the ECAT card software version must be 1.08 or later. After the ECAT card is installed and the AC drive is powered on, query the parameter Fd-91 of the power supply unit. The device description XML file is MD800_9Axis_Vn.nn.xml, wherein n.nn indicates the version which must be 0.16 or later.

4.2 Data Frame Structure



4.3 Data in PDO Area

PDO area

The PDO area enables the master to modify or read AC drive data in real time and exchange data with the AC drive cyclically. The data communication addresses are directly configured by the AC drive. The PZD area is used to:

- Set the AC drive control command or frequency reference in real time.
- Read the AC drive status or operation frequency in real time.

- Exchange function parameter data and monitoring parameter data between the AC drive and the EtherCAT master in real time.

PDO is used for the following cyclic data exchange between the master and each AC drive axis.

The RPDO process data must be configured. Otherwise, EtherCAT communication may fail.

Transmit PDO from the Master to Axis 1 (1601h)			Response PDO of AC Drive Axis 1 (1A01h)		
Fixed RPDO		Variable RPDO			
AC Drive Command	AC Drive Frequency Reference	Real-Time Modification of AC Drive Function Parameters	AC Drive State	AC Drive Operation Frequency	Real-Time Reading of AC Drive Function Parameters
RPDO1	RPDO2	RPDO3 to RPDO16	TPDO1	TPDO2	TPDO3 to TPDO16

Transmit PDO from the Master to Axis 2 (1602h)			Response PDO of AC Drive Axis 2 (1A02h)		
Fixed RPDO		Variable RPDO			
AC Drive Command	AC Drive Frequency Reference	Real-Time Modification of AC Drive Function Parameters	AC Drive State	AC Drive Operation Frequency	Real-Time Reading of AC Drive Function Parameters
RPDO1	RPDO2	RPDO3 to RPDO16	TPDO1	TPDO2	TPDO3 to TPDO16

Transmit PDO from the Master to Axis 3 (1603h)			Response PDO of AC Drive Axis 3 (1A03h)		
Fixed RPDO		Variable RPDO			
AC Drive Command	AC Drive Frequency Reference	Real-Time Modification of AC Drive Function Parameters	AC Drive State	AC Drive Operation Frequency	Real-Time Reading of AC Drive Function Parameters
RPDO1	RPDO2	RPDO3 to RPDO16	TPDO1	TPDO2	TPDO3 to TPDO16

Transmit PDO from the Master to Axis 4 (1604h)			Response PDO of AC Drive Axis 4 (1A04h)		
Fixed RPDO		Variable RPDO			
AC Drive Command	AC Drive Frequency Reference	Real-Time Modification of AC Drive Function Parameters	AC Drive State	AC Drive Operation Frequency	Real-Time Reading of AC Drive Function Parameters
RPDO1	RPDO2	RPDO3 to RPDO16	TPDO1	TPDO2	TPDO3 to TPDO16

Transmit PDO from the Master to Axis 5 (1605h)			Response PDO of AC Drive Axis 5 (1A05h)		
Fixed RPDO		Variable RPDO			
AC Drive Command	AC Drive Frequency Reference	Real-Time Modification of AC Drive Function Parameters	AC Drive State	AC Drive Operation Frequency	Real-Time Reading of AC Drive Function Parameters
RPDO1	RPDO2	RPDO3 to RPDO16	TPDO1	TPDO2	TPDO3 to TPDO16

Transmit PDO from the Master to Axis 6 (1606h)			Response PDO of AC Drive Axis 6 (1A06h)		
Fixed RPDO		Variable RPDO			
AC Drive Command	AC Drive Frequency Reference	Real-Time Modification of AC Drive Function Parameters	AC Drive State	AC Drive Operation Frequency	Real-Time Reading of AC Drive Function Parameters
RPDO1	RPDO2	RPDO3 to RPDO16	TPDO1	TPDO2	TPDO3 to TPDO16

Transmit PDO from the Master to Axis 7 (1607h)			Response PDO of AC Drive Axis 7 (1A07h)		
Fixed RPDO		Variable RPDO			
AC Drive Command	AC Drive Frequency Reference	Real-Time Modification of AC Drive Function Parameters	AC Drive State	AC Drive Operation Frequency	Real-Time Reading of AC Drive Function Parameters
RPDO1	RPDO2	RPDO3 to RPDO16	TPDO1	TPDO2	TPDO3 to TPDO16

Transmit PDO from the Master to Axis 8 (1608h)			Response PDO of AC Drive Axis 8 (1A08h)		
Fixed RPDO		Variable RPDO			
AC Drive Command	AC Drive Frequency Reference	Real-Time Modification of AC Drive Function Parameters	AC Drive State	AC Drive Operation Frequency	Real-Time Reading of AC Drive Function Parameters
RPDO1	RPDO2	RPDO3 to RPDO16	TPDO1	TPDO2	TPDO3 to TPDO16

Response PDO of AC Drive Rectifier Module (1A10h)		
Bus Voltage	Module Temperature	Real-Time Reading of AC Drive Rectifier Parameters
TPDO1	TPDO2	TPDO3 to TPDO16

Transmit PDO from the Master to Rectifier (1610h)	
Communication Control Word	Communication Control DO/RO
RPDO1	RPDO2

Master request

Table 4–1 Master transmit data RPDO

RPDO	Description
RPDO1	AC drive command word (valid when the command source is set to communication, that is, F0-02 = 2) 0: Stop according to the stop mode defined by F6-10 1: Forward running 2: Reverse running 3: Forward jog 4: Reverse jog 5: Coast to stop 6: Decelerate to stop 7: Fault reset
RPDO2	AC drive target frequency (valid when the frequency source is set to communication, that is, F0-03 = 9) Set the unit of written data to Hz or RPM through parameter F8-64. When F8-64 is set to 0, the unit of written data is Hz. The number of decimal places is consistent with that defined by F0-22. For example, if the decimal value 1000 is written, the frequency reference is 10.00 Hz when F0-22 is set to 2. When F8-64 is set to 1, the unit of written data is RPM. For example, if the decimal value 1000 is written, the frequency reference is 1000 RPM.
RPDO3 to RPDO16	Parameter values modified in real time, not written into EEPROM. For details about the configuration, see the "PZD area" section.

AC drive response

Table 4–2 AC drive response data TPDO

RPDO	Description
TPDO1	AC drive operation status AC drive operation status is indicated by bits, as follows: Bit 0: 0: AC drive stopped; 1: AC drive running Bit 1: 0: Forward running; 1: Reverse running Bit 2: 0: No fault; 1: AC drive fault Bit 3: 0: Frequency reference not reached; 1: Frequency reference reached
TPDO2	AC drive operation frequency (unit: 0.01 Hz) The current AC drive operation frequency is indicated by 16-bit signed data in the response.
TPDO3 to TPDO16	Function parameter values (group F and group A) and monitoring parameter values (group U) read in real time. For details about the configuration, see the "PZD area" section.

4.4 SDO Mailbox Data

EtherCAT SDO is used to transfer non-cyclic data, such as communication parameter configuration and servo drive running parameter configuration.

The CANopen over EtherCAT (CoE) service types include: emergency event message, SDO request, SDO response, TxPDO, RxPDO, remote TxPDO transmit request, remote RxPDO transmit request, and SDO information.

This product supports the SDO request and SDO response.

5 Parameter Configuration

SI-ECAT card settings on the AC drive

After the SI-ECAT card is installed on the AC drive, parameter FD-10 must be set as follows before the SI-ECAT card can communicate properly with the AC drive. Parameter FD-50 and subsequent parameters do not require additional settings unless specially needed by applications.

Table 5–1 Rectifier module parameters

Parameter	Name	Value Range	Reference	Meaning
FD-10	Communication protocol	1: CANopen 2: CANlink 3: Communication card mode	3	1 indicates CANopen communication, 2 indicates CANlink communication, and 3 indicates the communication card mode.
FD-50	Startup with slave mismatch	0: Disable 1: Enable	0	The system can operate even when the mapping configuration does not include this station.
FD-70	EtherCAT station name	0 to 65535	0	EtherCAT station name
FD-71	EtherCAT station alias	0 to 65535	0	EtherCAT station alias
FD-72	Number of synchronization interrupts allowed by EtherCAT	0 to 30	10	Number of synchronization interrupts allowed by EtherCAT
FD-73	CRC check error of EtherCAT port 0	0 to 65535	0	Maximum errors and invalid frames of EtherCAT port 0 per unit time
FD-74	CRC check error of EtherCAT port 1	0 to 65535	0	Maximum errors and invalid frames of EtherCAT port 1 per unit time
FD-75	Data forwarding error of EtherCAT port 0/1	0 to 65535	0	Maximum transfer errors of EtherCAT port per unit time
FD-76	EtherCAT processing unit and PDI error	0 to 65535	0	Maximum EtherCAT data frame processing unit errors per unit time
FD-77	Link loss of EtherCAT port 0/1	0 to 65535	0	Maximum link loss of EtherCAT port 0 per unit time

Parameter	Name	Value Range	Reference	Meaning
FD-78	EtherCAT host type	0 to 65535	0	This parameter is reserved for customized models and should be set based on the host controller type.
FD-79	EtherCAT synchronization error monitoring mode	0 to 1	0	This parameter defines the fault (synchronization loss) detection mechanism.
FD-80	EtherCAT synchronization frame loss count	0 to 65535	0	Number of synchronization loss
FD-81	EtherCAT state machine and PHYLink status	0 to 65535	0	State machine and PHYLink status
FD-82	EtherCAT AL fault code	0: No error 1 to 0xFFFF: error state code	0	AL fault code
FD-83	EtherCAT XML file version	0.00 to 655.35	0.00	XML file version
FD-84	EtherCAT FPGA firmware version	0 to 65535	0	FPGA software version
FD-86	EtherCAT EEPROM reading time	0 to 65535	0	EtherCAT EEPROM reading time
FD-87	EtherCAT DC gain	0 to 65535	0	EtherCAT DC gain
FD-88	EtherCAT DC acceleration limit	0 to 65535	0	EtherCAT DC acceleration limit
FD-89	EtherCAT DC speed limit	0 to 65535	0	EtherCAT DC speed limit
FD-90	EtherCAT DC integral coefficient	0 to 65535	0	EtherCAT DC integral coefficient
FD-91	Communication card version	0.00 to 655.35	0.00	Communication expansion card software version

Table 5–2 Inverter module parameters

Parameter	Name	Value Range	Reference	Meaning
F0-02	Command source selection	0: Rectifier operating panel/LCD keypad/ Software tool 1: Terminal I/O control 2: Communication control	2	Communication control is selected as the inverter command source.
F0-03	Main frequency source X selection	0: Digital setting (the initial value is the preset frequency (F0-08) and can be changed by pressing UP/DOWN; non-retentive at power failure) 1: Digital setting (the initial value is the preset frequency (F0-08) and can be changed by pressing UP/DOWN; retentive at power failure) 2: AI1 3: AI2 4: AI3 5: Reserved 6: Multi-reference 7: Simple PLC 8: PID 9: Communication 10: Reserved	9	Communication is selected as the main frequency source X.

Parameter	Name	Value Range	Reference	Meaning
FD-10	CANopen/CANlink switchover	1: CANopen 2: CANlink	1	CAN communication protocol of the rectifier: 1 indicates CANopen communication or communication expansion card mode, and 2 indicates CANlink communication. This parameter is read-only and can be set only through rectifier parameter FD-10.
FD-11	CANopen402 selection	0: Disable 1: Enable	0	CANopen mode selection: 0 indicates the common mode, and 1 indicates the CiA402 mode. Set this parameter when the motor is controlled with the CANopen402 protocol.

Communication control parameters

Table 5–3 Communication control parameters

Parameter		Meaning	Index	Sub-index
Inverter communication control word parameters	U3-16	Frequency set by communication	16#2073	16#11
	U3-17	Communication control command	16#2073	16#12
	U3-18	Communication control DO/RO	16#2073	16#13
Common inverter parameters	U0-06	Output torque	16#2070	16#07
	U0-07	DI state	16#2070	16#08
	U0-08	DO/RO state	16#2070	16#09
	U0-45	Fault code	16#2070	16#2E
	U0-46	Fault subcode	16#2070	16#2F
	U0-61	AC drive operation status word 1	16#2070	16#3E
	U0-68	AC drive operation status word 2	16#2070	16#45

Parameter		Meaning	Index	Sub-index
Common rectifier parameters	U0-00	Bus voltage	16#2170	16#01
	U0-01	Heatsink temperature	16#2170	16#02
	U0-03	Fan speed	16#2170	16#04
	U0-04	Input voltage Usr	16#2170	16#05
	U0-05	Input voltage Ust	16#2170	16#06
	U0-06	Input voltage Utr	16#2170	16#07
	U0-07	Three-phase unbalance degree (%)	16#2170	16#08

Each object in the object dictionary is mapped to the parameter table by using a unique index and sub-index.

An index (hexadecimal) indicates the position of a class of objects in the object dictionary.

A sub-index indicates the position of an object under an index.

The mapping between AC drive parameters and the object dictionary is as follows.

Table 5–4 Mapping between AC drive parameters and the object dictionary

Device Type	Mapping
Rectifier	Object dictionary index = 0x2100 + Parameter group number Object dictionary sub-index = Hexadecimal value of offset in parameter group + 1
Inverter	Object dictionary index = 0x2000 + ((Axis number – 1) x 0x800) + Parameter group number Object dictionary sub-index = Hexadecimal value of offset in parameter group + 1

The object dictionary mapping is as follows.

Table 5–5 Object dictionary mapping

Device Type	Object Dictionary Index Range for I/O Device	Object Dictionary Index Range for CANopen402 Protocol
Rectifier	0x2100 to 0x2200	Not supported
Inverter axis 1	0x2000 to 0x20FF	0x6000 to 0x67FF
Inverter axis 2	0x2800 to 0x28FF	0x6800 to 0x6FFF
Inverter axis 3	0x3000 to 0x30FF	0x7000 to 0x77FF
Inverter axis 4	0x3800 to 0x38FF	0x7800 to 0x7FFF
Inverter axis 5	0x4000 to 0x40FF	0x8000 to 0x87FF
Inverter axis 6	0x4800 to 0x48FF	0x8800 to 0x8FFF
Inverter axis 7	0x5000 to 0x50FF	0x9000 to 0x97FF
Inverter axis 8	0x5800 to 0x58FF	0x9800 to 0x9FFF

When the SI-ECAT card is used, written PDO1 is mapped to U3-17 and written PDO2 is mapped to U3-16 by default. Therefore, ensure that the first two items in the TxPDO configuration of the master are U3-17 and U3-16 in sequence.

This product is applicable to multi-axis AC drives, and mapping relations must be configured according to the instructions.

Inverter communication monitoring parameters

Table 5–6 Inverter communication monitoring parameters

Parameter	Name	Unit	Decimal Address
U0-00	Operation frequency	0.01 Hz	28672
U0-01	Frequency reference	0.01 Hz	28673
U0-02	Bus voltage	0.1 V	28674
U0-03	Output voltage	1 V	28675
U0-04	Output current	0.1 A	28676
U0-05	Output power	0.1 kW	28677
U0-06	Output torque	0.1%	28678
U0-07	DI state	1	28679
U0-08	DO/RO state	1	28680
U0-09	AI1 voltage	0.01 V	28681
U0-10	AI2 voltage	0.01 V	28682
U0-11	AI3 voltage	0.01 V	28683
U0-12	Count value	1	28684
U0-13	Length value	1	28685
U0-14	Load speed display	1	28686
U0-15	PID reference	1	28687
U0-16	PID feedback	1	28688
U0-17	PLC stage	1	28689
U0-19	Feedback speed	0.01 Hz	28691
U0-20	Remaining running time	0.1 min	28692
U0-21	AI1 voltage after gain and offset adjustment	0.001 V	28693
U0-22	AI2 voltage after gain and offset adjustment	0.001 V	28694
U0-23	AI3 voltage after gain and offset adjustment	0.001 V	28695
U0-24	Linear speed	1 m/min	28696

Parameter	Name	Unit	Decimal Address
U0-25	Current power-on time	1 min	28697
U0-26	Current running time	0.1 min	28698
U0-28	Communication setting value	0.01%	28700
U0-30	Main frequency X display	0.01 Hz	28702
U0-31	Auxiliary frequency Y display	0.01 Hz	28703
U0-33	Synchronous motor rotor position	0.1°	28705
U0-34	Motor temperature	1°C	28706
U0-35	Target torque	0.1%	28707
U0-37	Power factor angle	0.1°	28709
U0-39	Target voltage upon V/f separation	1 V	28711
U0-40	Output voltage upon V/f separation	1 V	28712
U0-41	DI state display	1	28713
U0-42	DO/RO state	1	28714
U0-43	DI function state display	1	28715
U0-44	DO/RO function state display	1	28716
U0-45	Fault code	1	28717
U0-46	Fault subcode	1	28718
U0-47	Inverter module temperature	1°C	28719
U0-48	Voltage received by PTC channel 1	0.001 V	28720
U0-49	Voltage received by PTC channel 2	0.001 V	28721
U0-50	Voltage received by PTC channel 3	0.001 V	28722
U0-51	PTC1 temperature	1°C	28723
U0-52	PTC2 temperature	1°C	28724
U0-53	PTC3 temperature	1°C	28725
U0-54	Motor speed	1 RPM	28726
U0-55	Automatically allocated device ID	1	28727
U0-56	Identified axis type	1	28728
U0-57	Fan speed	1 RPM	28729

Parameter	Name	Unit	Decimal Address
U0-61	AC drive operation status word 1	1	28733
U0-64	Special protocol status word	1	28736
U0-68	AC drive operation status word 2	1	28740
U0-78	AC drive rated current	0.1 A	28750
U0-79	AC drive power	0.1 kW	28751
U0-81	Local LED state	1	28753
U0-88	Alarm code	1	28760
U0-89	Alarm subcode	1	28761
U0-90	Percentage of fan speed reference	1%	28762
U0-91	PTC1 mode	1	28763
U0-92	PTC2 mode	1	28764
U0-93	PTC3 mode	1	28765
U0-95	STO initialization flag	1	28767
U0-96	STO status word monitoring	1	28768
U0-97	STO model	1	28769
U0-98	STO AD sampling value	1	28770
U0-99	STO internal execution flag	1	28771

When the SI-ECAT card is used, for axis 1 to axis 8 of the inverter, read PDO1 is mapped to U0-68 and read PDO2 is mapped to U0-00 by default.

For axis 16 of the rectifier, read PDO1 is mapped to U0-00 and read PDO2 is mapped to U0-01 by default.

6 Communication Example

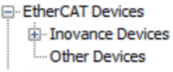
6.1 Setting EtherCAT Communication Between an AC Drive and H5U

Software acquisition and hardware connection

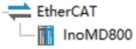
1. Log in to Inovance official website at https://www.inovance.com/ to obtain the H5U programming software and the latest XML file.
2. Use a standard network cable to connect the EtherCAT RJ45 port of the H5U to the EC IN port of the EtherCAT card on the AC drive.

Master and slave configuration

1. Open AutoShop, click "New Project", confirm that "Series and models" is set to "H5U", and click "OK". The programming screen is displayed.
2. Click

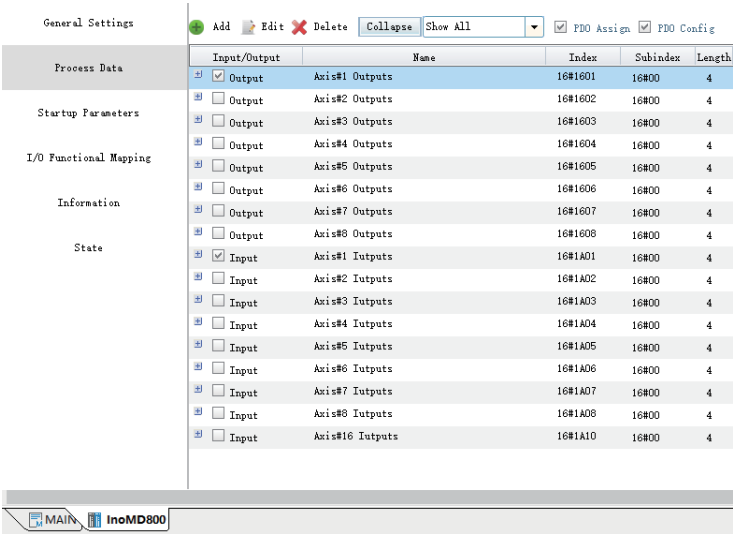


on the right. Click an AC drive, and the EtherCAT configuration item



is displayed. Click "InoMD800" to start configuring process parameters.

3. Click "Process Data" and select the slave to be configured.



As shown in the figure, "Output" means "write", which is output to the AC drive. "Input" means "read", which is output from the AC drive to the PLC.

4. By default, the "Input Frequency" and "Control Word" PDOs are configured.
   For output PDOs, corresponding parameters need to be converted according to the following rules.

   Index:

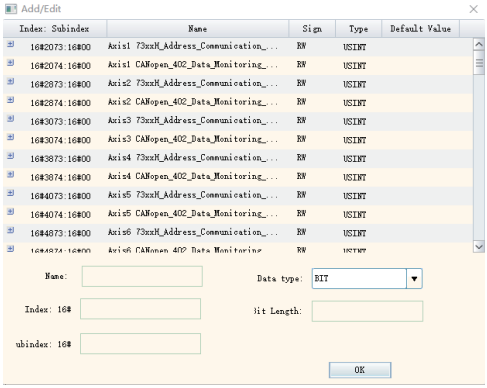
   For groups F0 to FF, convert F in high-order bits to "0" and then add 0x2000.

   For groups A0 to AF, convert A in high-order bits to "4" and then add 0x2000.

   For groups U0 to UF, convert U in high-order bits to "7" and then add 0x2000.

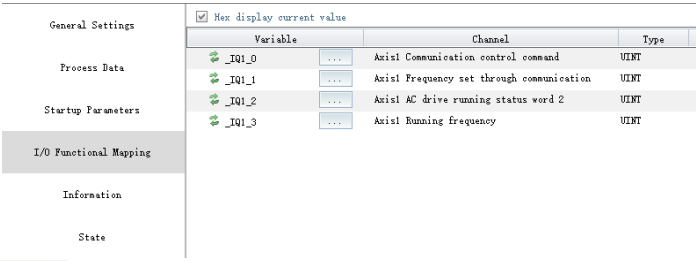
   Sub-index: For the low-order 16 bits, convert the decimal serial number to a hexadecimal equivalent and then add 1.

   For example, according to the conversion rules, the index of parameter U0-02 (bus voltage) is 0x2070, and the sub-index is 03. In this case, click the corresponding slave and then click "Add" in the upper left corner. The following screen is displayed.



   You can customize the "Name", but "Index", "Sub-index," and "Type" must be filled in according to the conversion rules. All internal data of the AC drive is of the INT type. After filling in this information, click "OK". To add another PDO, repeat this step.

5. I/O mapping
   Map PDO data. Specifically, implement exchange of read or written data between the PLC and the AC drive by using the D elements as a bridge. Click on "I/O Functional Mapping" to access the following screen.

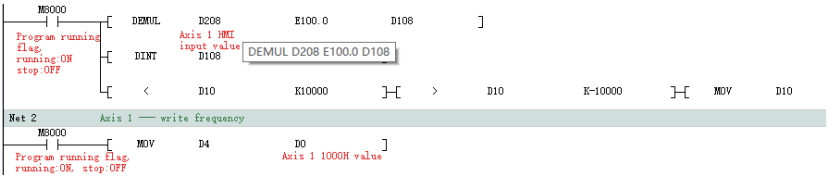


Click  in the "Variable" column to select a D element or another element. Once the I/O mapping is configured, you can program based on the configured soft elements.

Examples

1. Writing the frequency (F0-03 set to 9)
   Assign a value to D0 according to I/O mapping.

   The program is as follows (equivalent to writing a value to address 1000H in RS485 communication):



2. Implementing start/stop control on the AC drive (F0-02 set to 2)
   Assign a value to D2 according to I/O mapping. Specifically, assign a value to the D element corresponding to the control word of the station to be controlled. In this way, the AC drive is controlled through communication to run in the forward or reverse direction or stop. The control word is defined as follows:

   1: Forward running; 2: Reverse running; 3: Forward jog; 4: Reverse jog; 5: Coast to stop; 6: Decelerate to stop; 7: Fault reset

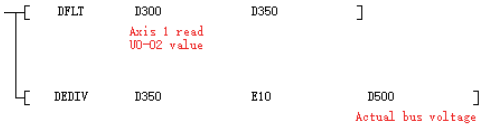
   The program for forward running is as follows:

   2000H is mapped to the D2 element of the PLC. Therefore, assigning the value of 1 to D2 controls the AC drive to run in the forward direction. Similarly, assigning the value of 6 to D2 controls the AC drive to decelerate to stop.

3. Reading the bus voltage
   Convert U0-02, the bus voltage address, according to the conversion rules. Specifically, convert the high-order "U" to "7", which means that the index is 2070.

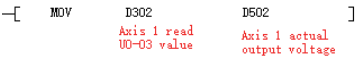
Convert the address to a hexadecimal value and add "1", which means that the sub-index is 03. According to the communication settings, the D element address of the bus voltage is D300. Convert D300 to a floating-point number and then divide this number by 10.

The program is as follows:



4. Reading the output voltage

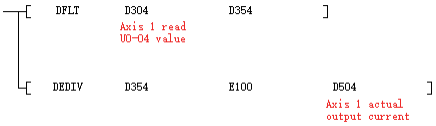
Convert U0-03, the output voltage address, to 2070sub4 according to the conversion rules. The read value is the actual output voltage. According to the communication settings, you can simply move (or not move) the value of D302 to another D element.



5. Reading the output current

Convert U0-04, the output current address, to 2070sub5 according to the conversion rules. Divide the read value by 100 to obtain the actual output current. According to the I/O mapping, D304 needs to be read.

The program is as follows:



6. Reading the AC drive state

Convert U0-61, the AC drive state address, to 2070sub3E according to the conversion rules. According to the I/O mapping, D308 needs to be read.

1: Forward running; 2: Reverse running; 3: Stopped

The program is as follows:

7. Reading the DI state

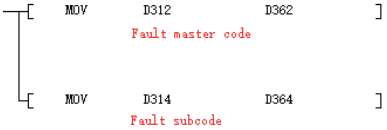
Convert U0-07, the DI state address, to 2070sub8 according to the conversion rules. Convert the read value to a binary value. The least significant bit represents DI1,

the second least significant bit represents DI2, and so on. According to the I/O mapping, D310 needs to be read.

The program is as follows:

8. Reading the fault code
   Convert U0-45 (fault code) to 2070sub2E and convert U0-46 (fault subcode) to 2070sub2F according to the conversion rules. According to the I/O mapping, D312 and D314 needs to be read.

   The program is as follows:



Common problems and solutions

Must-do: Check the value of FD-10, which must be 3 for the rectifier and 1 for the inverter.

Table 6–1 Common problems and solutions

Problem	Solution
Failure to write frequency	Check F0-03 and make sure that the address in the configuration table is correct.
Failure to start the AC drive	Check that F0-02 is set to 2 (0: Operating panel; 1: Terminal; 2: Communication).
Unstable connection	1. Check that the cable is securely connected to the PLC (Pull the cable to check for poor contact.) 2. Check that the cable is securely connected to the AC drive. 3. Check that the signal cable is far away from the power cable.
Incorrect read value	1. Check that the configuration address is correct. 2. Check whether the program performs data conversion. 3. Check that the D element is not occupied.

6.2 Example of Configuration on Beckhoff Controller Using ECAT Card

The following takes the Beckhoff TwinCAT master station as an example to describe how to configure the ECAT card.

1. Install TwinCAT.
   Windows XP system: tcat_2110_2230 is recommended.

   32-bit Windows 7 system: tcat_2110_2248 is recommended.

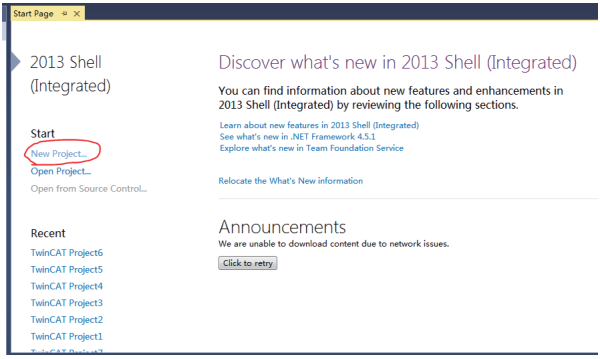
2. Copy the EtherCAT configuration file (MD800_9Axis_V0.16.xml) of the AC drive to the TwinCAT installation directory.
   TwinCAT2 directory: TwinCAT\IO\EtherCAT.

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

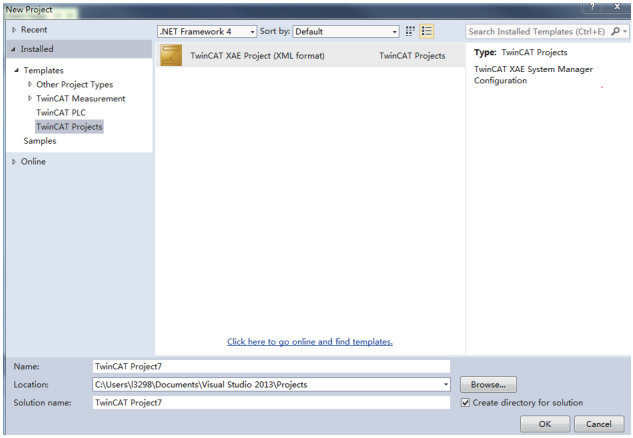
   The following takes TwinCAT3 as an example. TwinCAT2 can be configured in the same way as TwinCAT3.

3. Run TwinCAT.

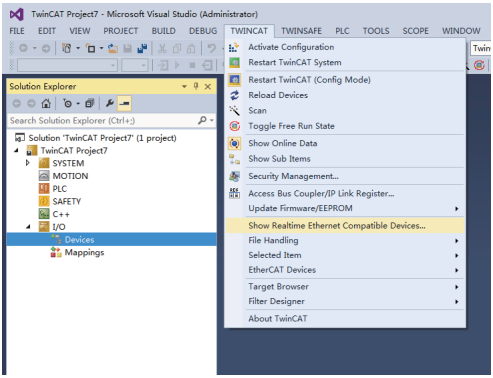
   a. Click "New Project".



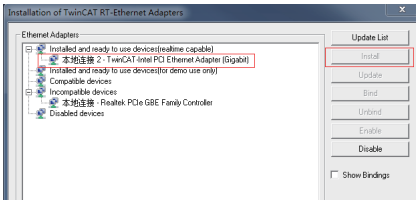
   b. Click "OK". A new project is created.



4. Install the TwinCAT network card drive.

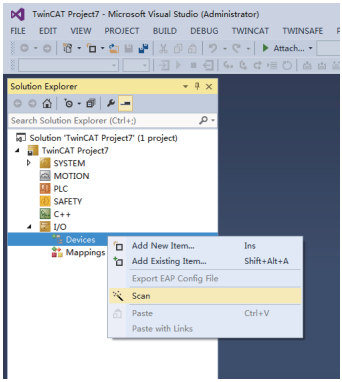


Access the menu "Show Real Time Ethernet Compatible Devices…" in the preceding figure. In the dialog box displayed, select the local device from the "Incompatible devices" field, and then click "Install". Then, the network card is installed and displayed in the "Installed and ready to use devices" column, as shown below.

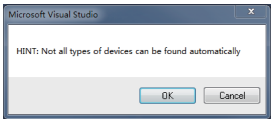


5. Search for the device.

   a. Create a project. On the page displayed, right-click "Devices", and select "Scan" to scan devices, as shown below.

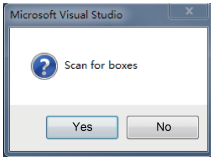


b. Click "OK".

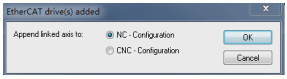


c. Click "OK".

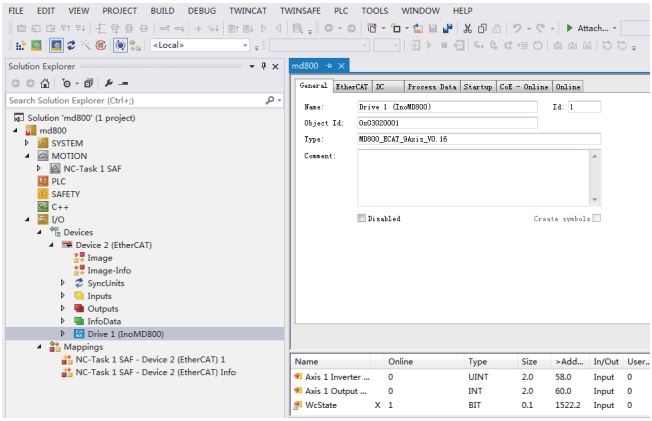
d. Click "Yes".



e. Click "OK".



f. Click "No". Then, the device searching is finished.

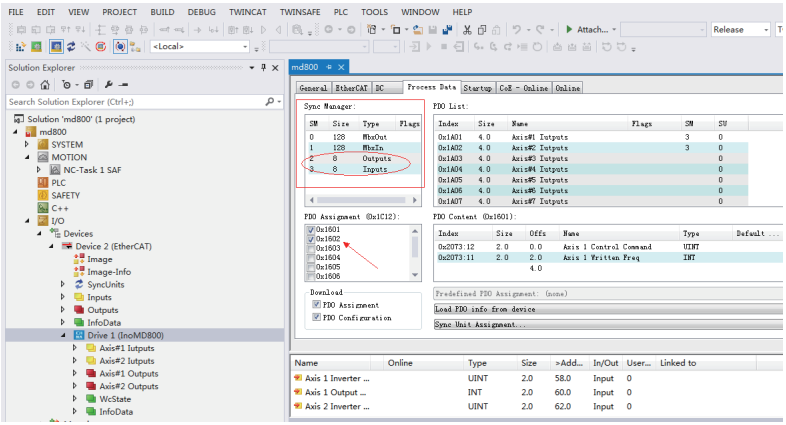


6. Configure the PDO parameters.

   This AC drive has multiple axes. When configuring the PDO parameters, match each TPDO and RPDO with the corresponding axis.

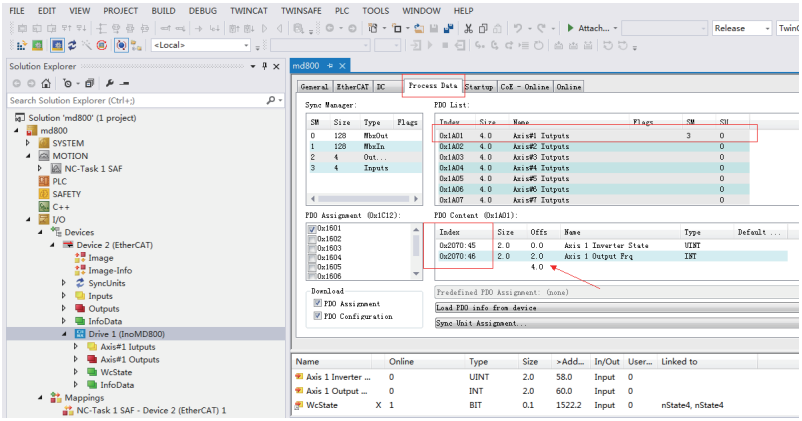
   a. Configure the axis PDO.

      Select the PDO to be configured according to the number of axes of the AC drive. In "Sync Manager", click "SM2" or "SM3" to switch the corresponding TPDO and RPDO under "PDO Assignment". Then, select the axis to be configured.



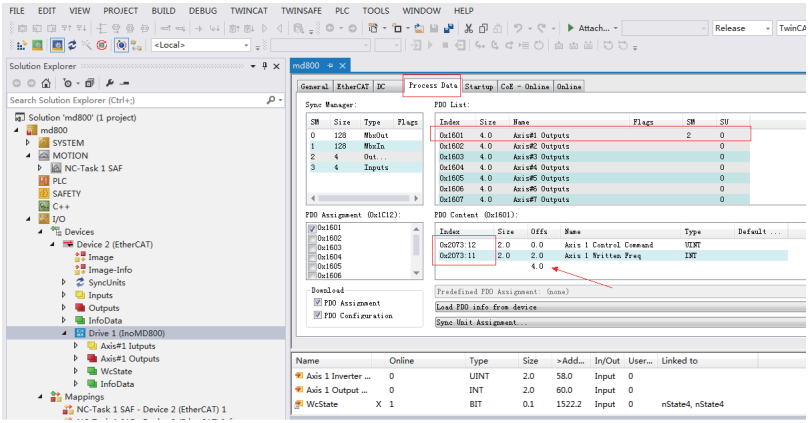
   b. Configure TPDO.

      When you configure TPDO, 0x1A01 (Axis 1) is selected by default. The first two items are the default TPDOs, which can be modified as needed. Right-click the arrow position in the figure and add the required TPDO mapping.



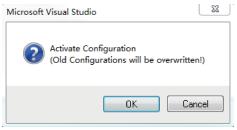
c. Configure RPDO.

When you configure RPDO, 0x1601 (Axis 1) is selected by default. The first two items are the default RPDOs, which can be modified as needed. Right-click the arrow position in the figure and add the required RPDO mapping.

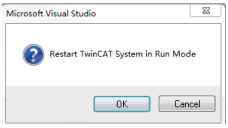


7. Configure the SDO list (not supported now).
8. Activate the configuration and switch the mode to OP.

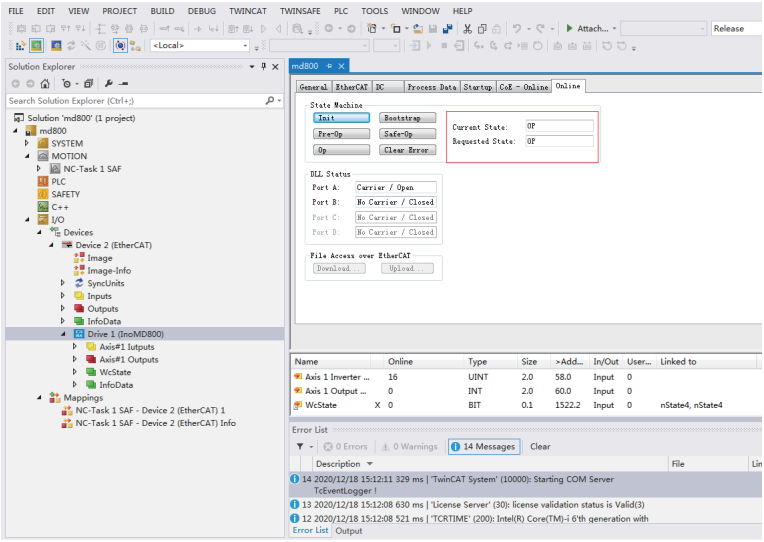
a. Click  . The following page is displayed.



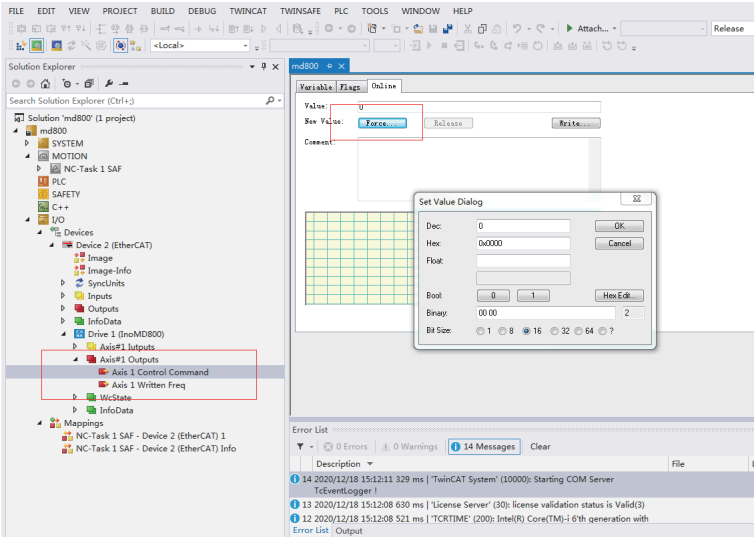
b. Click "OK".



c. Click "OK". The current state changes to OP.



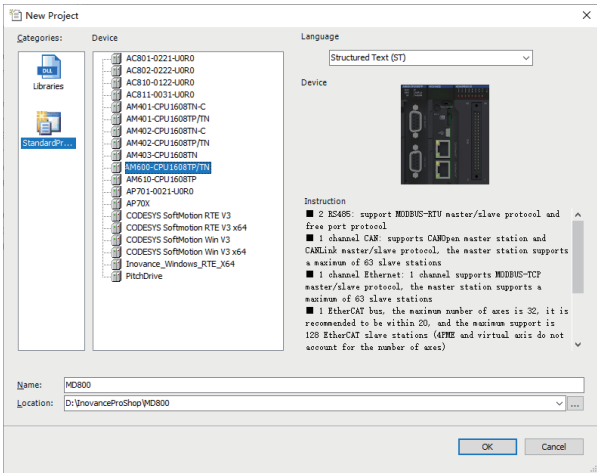
9. Set PDO to control the AC drive operation mode.
   Write a corresponding value to RPDO to control the AC drive operation mode.



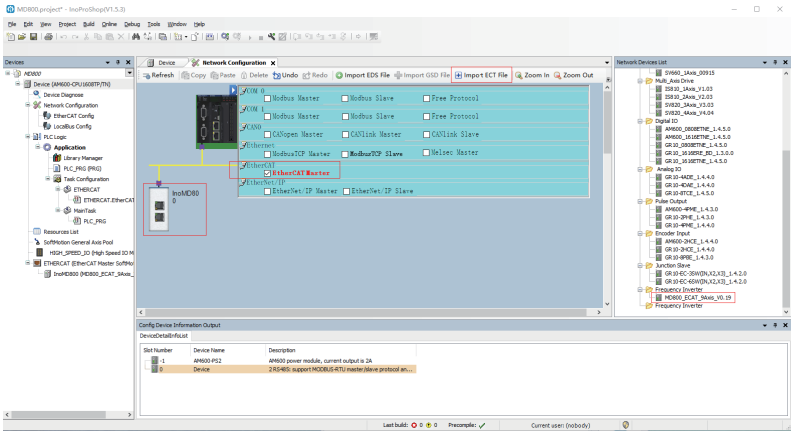
6.3 Example of Configuration on AM600 Master Station Using ECAT Card

The following takes the AM600 master station as an example to describe how to configure the AC drive to work with the master station.

1. Run the software and create an AM600 project.
   Select "AM600-CPU1608TP/TN" from the device list. The following screen is displayed.



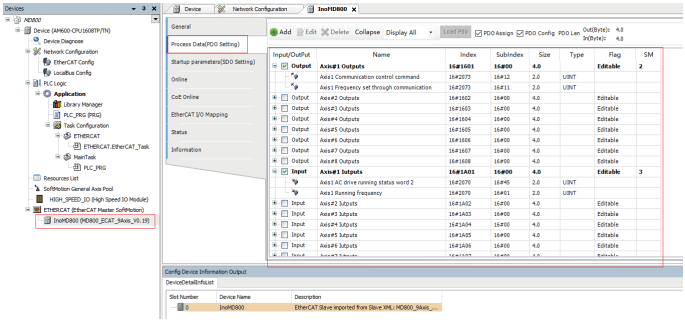
2. Add this device as an AC drive slave station.
   a. Access the "Network Configuration" page and import the EtherCAT configuration file of this product. If configuration files of other versions exist, delete them first.



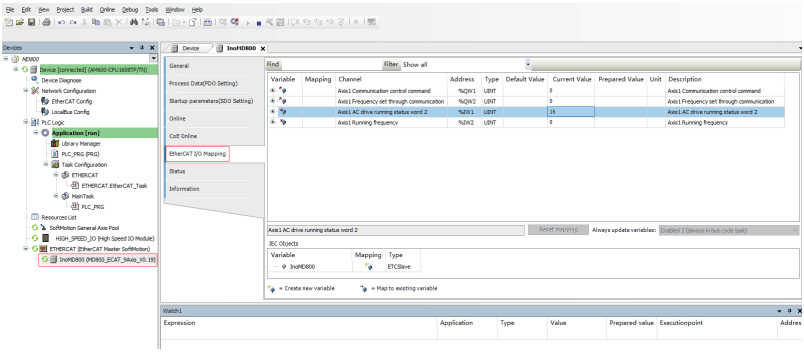
b. Select a device from "Network Devices List" and add it as an AC drive slave station through drag-and-drop.

3. Configure the PDO parameters.

a. Right-click the arrow position in the figure and add the required TPDO mapping. The control command of RPDO and inverter state of TPDO can be modified. RPDO must be configured; otherwise, an error may occur during operation. Axis#1 Outputs means the control data received by axis 1 from the master station. Axis#1 Inputs means the state data sent by the axis 1 to the master station. MD800 can configure up to eight axes. You can select Axis#16 Inputs to enable the power supply unit to send the state data to the master station.



b. Download the project to the PLC.
Click EtherCAT I/O Mapping, and you can view the TPDO data and RPDO data in real time.

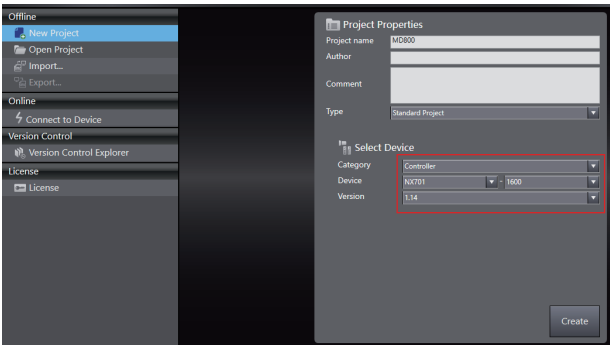


6.4 Example of Configuration on Omron Master Station Using ECAT Card

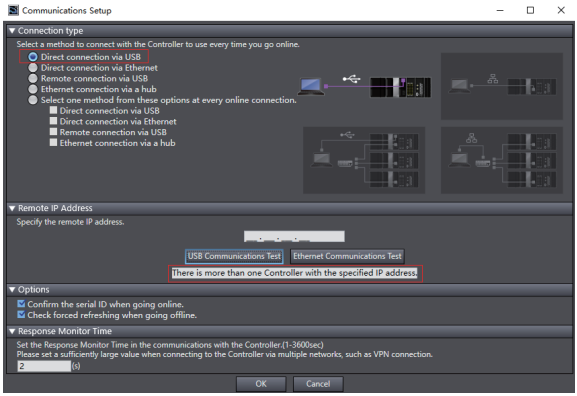
The following takes the Omron NX701-1600 master station as an example to describe how to configure the AC drive to work with the master station.

1. Copy the XML file of this product to the installation directory "E:\OMRON\Sysmac Studio\IODeviceProfiles\EsiFiles\UserEsiFiles" of Sysmac Studio, run the software, and import the XML file.
2. Create a project.
   Device: Select the model of the controller.

   Version: Select the device version.

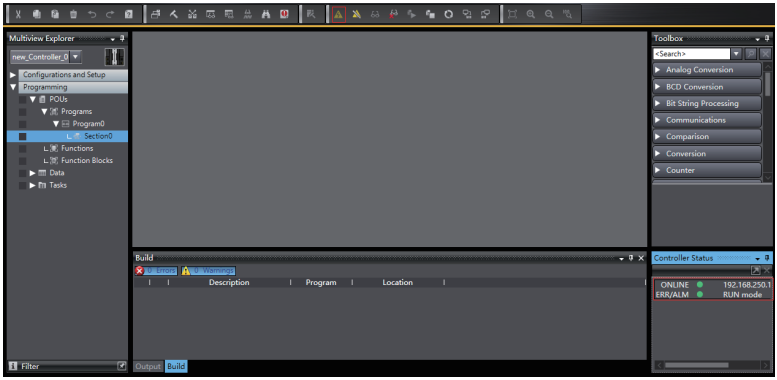


3. Configure communication parameters.
   a. Access the main screen and choose "Controller" > "Communications Setup".
   b. Select "Direct connection via USB". If the test is successful, proceed to the next step.

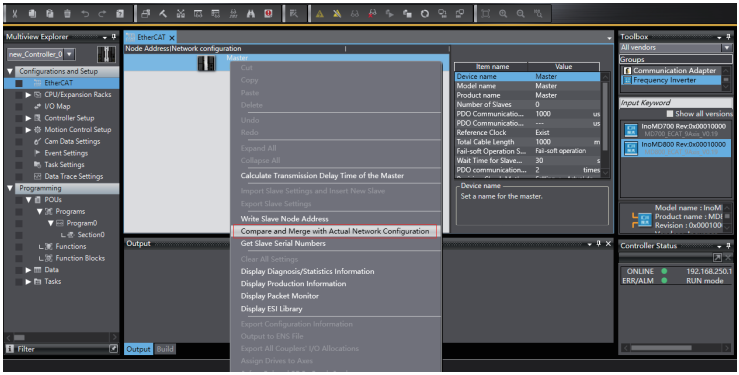


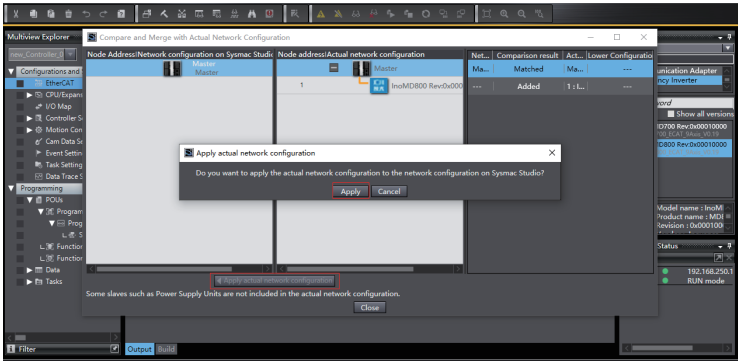
4. Scan the device.

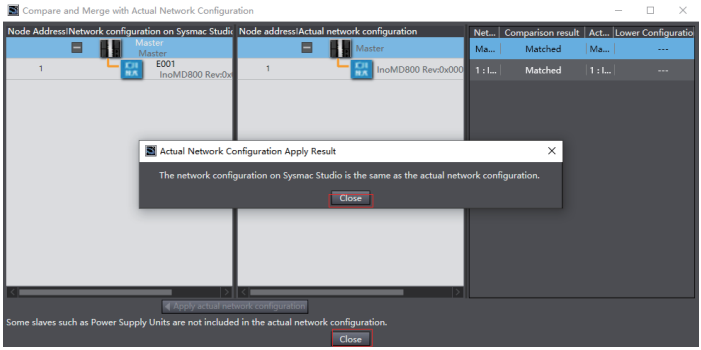
   a. Switch the controller status to ONLINE and RUN mode.
   The controller status is displayed in the lower right corner.



   b. Scan the device and add a slave station.
   Choose "Configurations and Setup" > "EtherCAT". Right-click "Master" and select "Compare and Merge with Actual Network Configuration". The controller automatically scans all slave stations in the network (an error is reported when the number of a station is 0). In the "Apply actual network configuration" dialog box, click "Apply", and the slave station is added. The added slave station is displayed on the main screen.

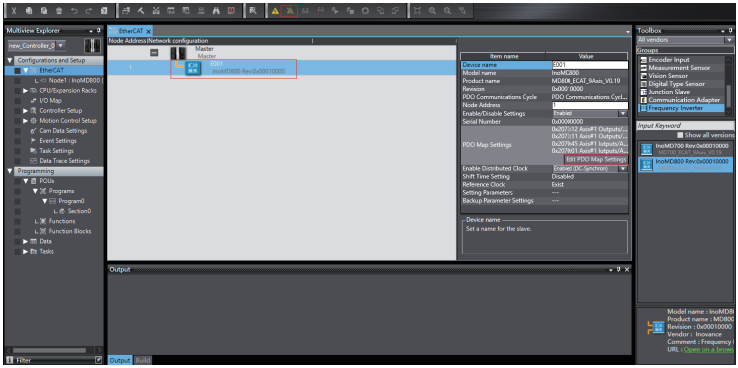




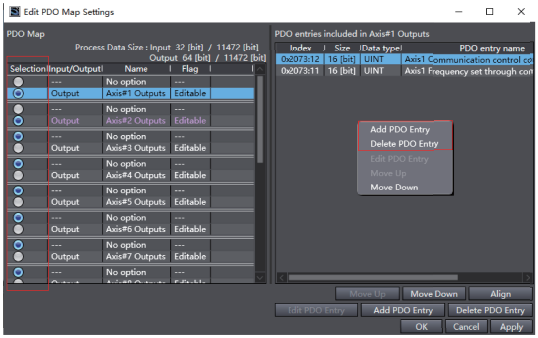


5. Configure the parameters.

   a. Change the controller status to OFFLINE, select this device, and click "Edit PDO Map Settings".

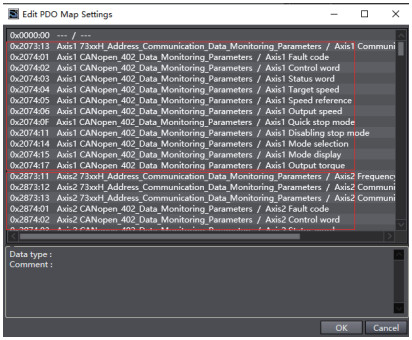


b. On the "Edit PDO Map Settings" page displayed, select the axis number to be configured and right-click in the blank area on the right, and then click "Add PDO Entry" or "Delete PDO Entry" to add or delete a PDO entry.

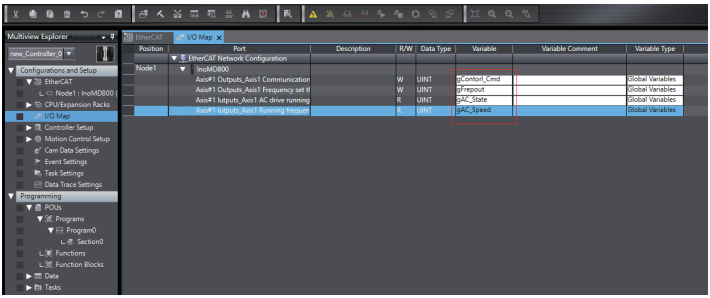


Caution

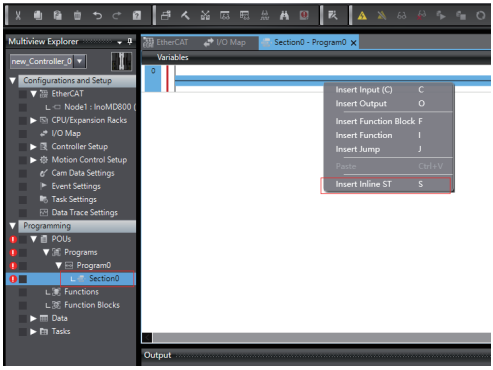
When adding a PDO entry, you must select the entry corresponding to the specific axis. Otherwise, an error is reported and the AC drive cannot run.

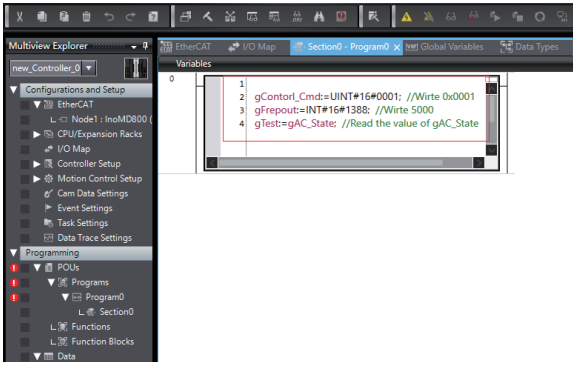


c. Set the PDO mapping (assign the I/O mapping).



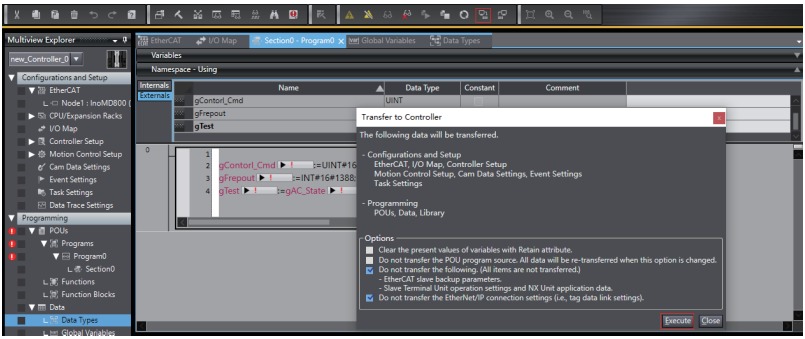
6. Edit the PLC program.



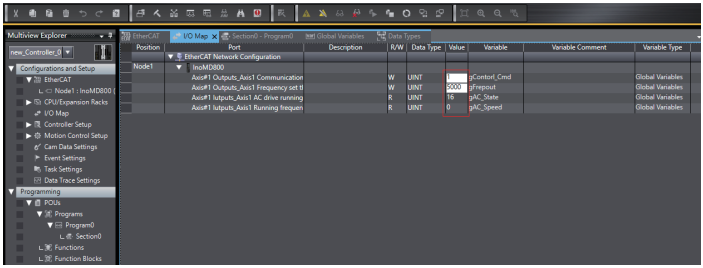


7. Download the PLC program to the controller.

   a. After finishing the configuration and programming, change the controller status to ONLINE, click "Execute" and then download the program to the controller.



   b. After the PLC program is run, access "I/O Map", and the real-time data is displayed.



7 Troubleshooting

Communication fault codes are all displayed on the rectifier module panel.

Table 7–1 ECAT card communication faults

Fault Code	Cause	Action	Reset Method
E16.52	EtherCAT card EEPROM fault	1. If the programming or upgrading of the communication card fails, program the communication card again. 2. If this fault occurs during normal use, replace the communication card.	Automatic reset if FD-06 is set to 1 Manual reset if FD-06 is set to 0
E16.53	EtherCAT card slave control chip fault	1. If the programming or upgrading of the communication card fails, program the communication card again. 2. If this fault occurs during normal use, replace the communication card.	
E16.55	EtherCAT system parameter error	In the case of a master error, check whether the master sends the sync frame (FD-78). If not, make sure that TPDO and RPDO have been configured for the master PDO. If the master PDO is configured correctly, check the network port status (FD-72 to FD-77) and make sure that the communication cable is connected properly.	
E16.71	Master offline during communication card operation	Check for poor contact between the communication card and the PLC. Make sure that they are properly connected.	
E16.72	Internal slave offline during communication card operation	Check for poor contact between the communication card and the rectifier. Make sure that they are properly connected.	
E16.74	Communication card configuration error	Check whether the configured slave exists. Ensure that "startup with slave mismatch" is disabled (rectifier parameter FD-50).	
E16.75	Communication card inverter mapping error	Check whether the number of PDOs match the number of mapping relations in the inverter configuration. Make sure that they match.	
E16.76	Communication card rectifier mapping error	Check whether the number of PDOs match the number of mapping relations in the rectifier configuration. Make sure that they match.	

19012445A00

Shenzhen Inovance Technology Co., Ltd.

www.inovance.com

Add.: Inovance Headquarters Tower, High-tech Industrial Park,
Guanlan Street, Longhua New District,
Shenzhen 518000, P.R. China
Tel: (0755) 2979 9595 Fax: (0755) 2961 9897

Suzhou Inovance Technology Co., Ltd.

www.inovance.com

Add.: No.52, Tian'e Dang Road, Wuzhong District,
Suzhou 215104, P.R. China
Tel: (0512) 6637 6666 Fax: (0512) 6285 6720