HS-S86E

EtherCAT Easy Servo
User Manual

EN Version: V1.0

(Based on CH Version：V1.2)

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Contents

Foreword

Thank you for using our EtherCAT hybrid servo drive.

Before using this product, be sure to read the manual to learn the necessary safety information, precautions, and operating methods.

Incorrect handling may lead to extremely serious consequences.

Statement

This product is designed and manufactured without the ability to protect personal safety from mechanical system threats. Users are advised to consider safety precautions during use to prevent accidents caused by improper operation or product abnormalities.

Due to product improvements, the contents of this manual are subject to change without notice.

Our company will not be responsible for any modification of the product by the user.

When reading, please pay attention to the following signs in the manual:

Notice: Remind you to pay attention to the main points in the text.

Caution: Indicates that incorrect operation may result in personal injury and equipment damage.

1 Overview

1.1 Product Description

HS-S86E EtherCAT hybrid servo drive adds EtherCAT bus communication to the digital hybrid servo drive and supports intelligent motion control. It supports the COE protocol and supports the market's mainstream master controller as a standard EtherCAT slave drive unit.

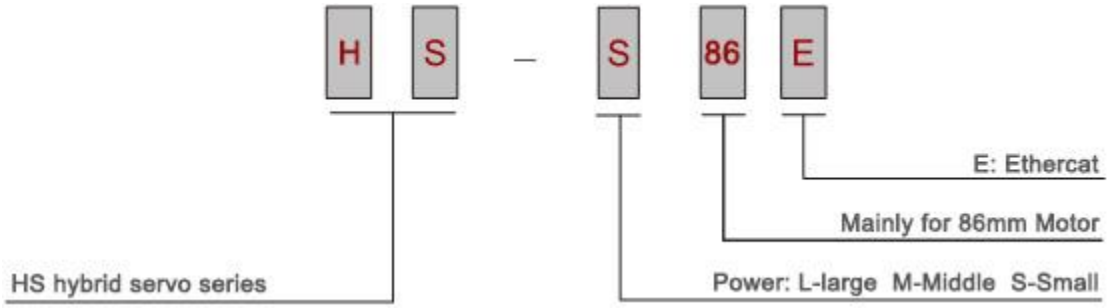
1.2 Feature

- A new generation of 32-bit DSP technology, cost-effective, smooth, low noise and low vibration
- Operating voltage range AVC24V~80V
- Adjustable working current, maximum support 6A
- Based on 100BASE-TX Ethernet transmission standards, transfer rates up to 100Mbps, full-duplex communication
- Support CoE (CANopen over EtherCAT), in line with CiA 402 standard
- Support Cyclic Sync Position, Profile Position, Profile Velocity, Homing multiple working modes
- Dual port RJ45 connector for EtherCAT communication
- 7 opto-isolated input interface, 5V ~ 24V compatible input
- 3 opto-isolated output interface
- Microstep 400 to 51200 arbitrarily set, support electronic gear
- Smooth and accurate current control, low motor heating
- Protection against overvoltage, undervoltage, overcurrent, etc.

1.3 Application Field

Mainly used in battery equipment, photovoltaic equipment, semiconductor equipment, 3C and mobile phone non-standard automation equipment, stripping machine, marking machine, cutting machine, stage lighting, machine and medical equipment, laser equipment, plotter and other automatic equipment..

1.4 Product Naming Rules



2 Performance Indicators

2.1 EtherCAT Characteristic

Parameter		HS-S86E
EtherCAT communication indicator	Link layer	100BASE-TX Ethernet
	Communication port	RJ45 Standard network port
	Network topology	Line type, tree type, star type, etc.
	Baud rate	100Mbps full duplex communication
	Sync manager	SM0: Mailbox reception
		SM1: Mailbox sending
		SM2: Process Data Output RPDO
		SM3: Process Data Input TPDO
	Communication mode	SM sync mode
		DC sync mode, sync cycle 250us~4000us
	Application layer protocol	COE：CANopen Over EtherCAT
	Cia402 working mode	Cyclic Synchronous Position Mode; Profile Position Mode; Profile Velocity Mode; Homing Mode

2.2 Electrical Characteristics

Parameter	HS-S86E			
	Minimum value	Typical value	Maximum value	Unit
Continuous Output Current	0	-	5.0	A
Input Supply Voltage	24	70	80	Vdc
Logic Input Current	10	10	50	mA
Logic Input Voltage	5	24	24	V
Pulse Frequency	0	-	200	kHz
Insulation Resistance	100	-	-	MΩ

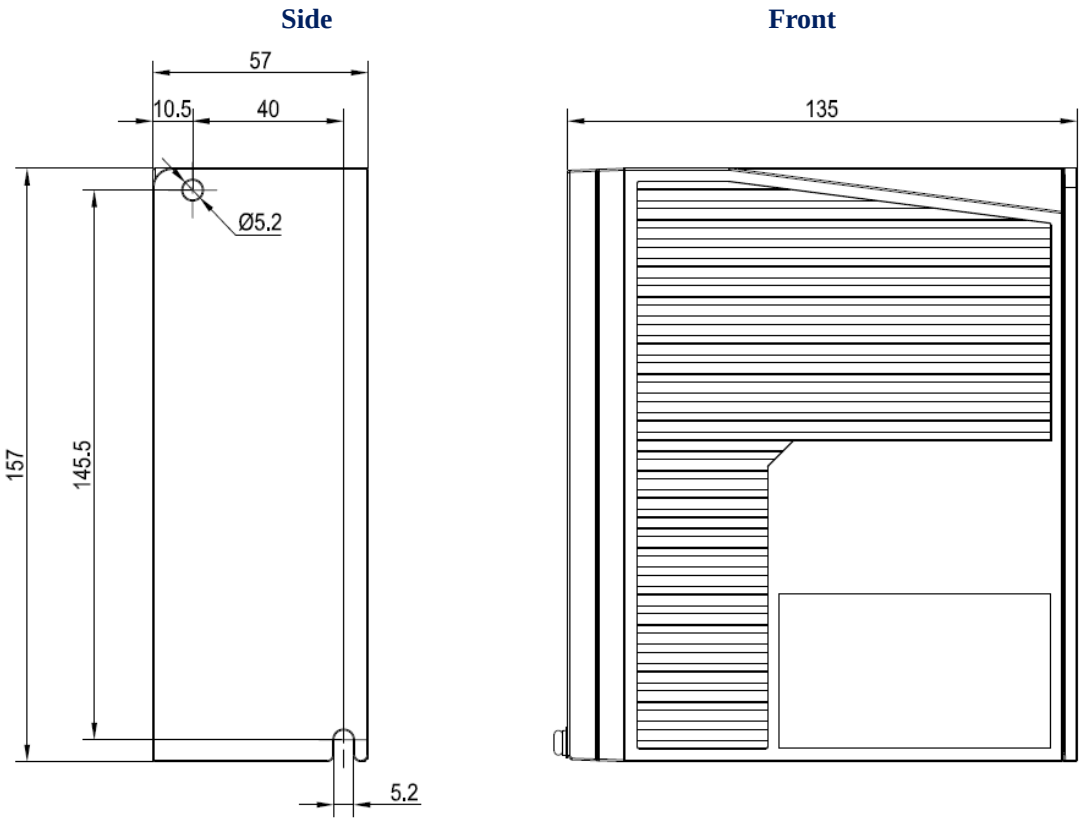
2.3 Working Environment

Cooling Method	Heat sink cooling	
Working Environment	Working occasion	Keep away from other heating equipment as far as possible to avoid dust, oil mist, corrosive gas, strong vibration, flammable gas and conductive dust
	Temperature	0℃~50℃

	Humidity	40－90%RH（No dew）
	Vibration	10~55Hz/0.15mm
Storage Temperature	-20℃~+80℃	

3 Installation

3.1 Installation Size



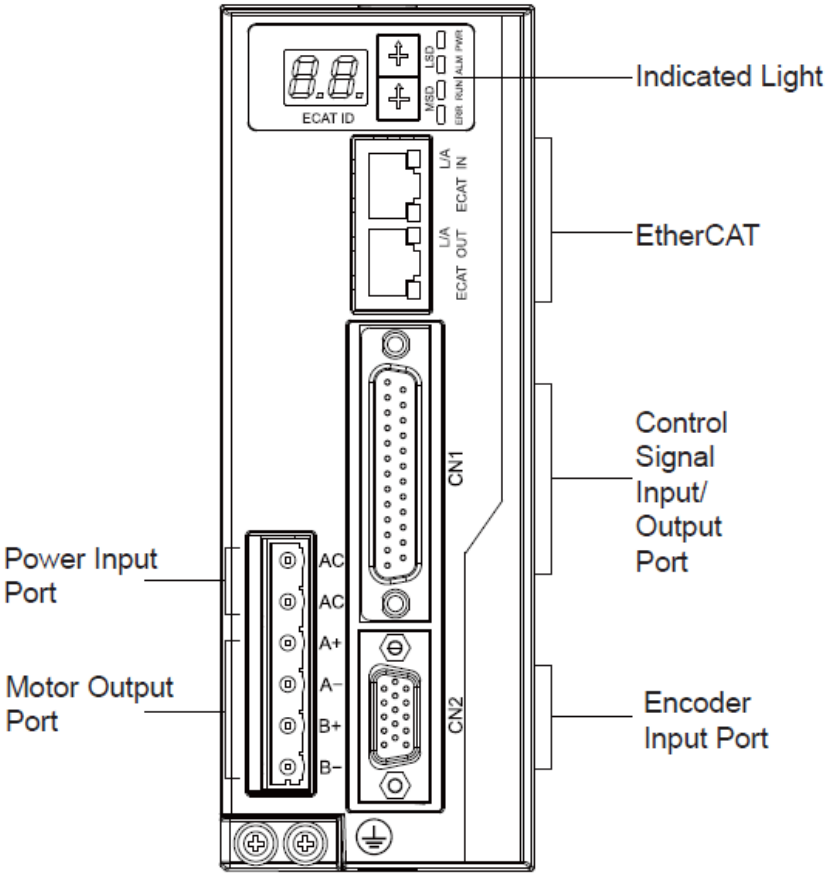
Installation dimension drawing (unit: mm)

3.2 Installation Method

Install the drive with the upright side installation to create a strong air convection on the surface of the heat sink; if necessary, install a fan near the drive to force heat dissipation to ensure that the drive works within a reliable operating temperature range (The reliable operating temperature of the drive is usually within 60 °C and the motor operating temperature is within 80 °C).

4 Drive Port and Wiring

4.1 Wiring Diagram



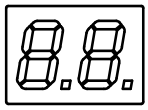
Drive Port Schematic

Caution：

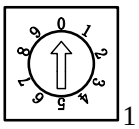
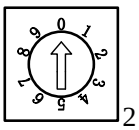
- The personnel involved in wiring must have professional capabilities.
- Do not connect wire with power on.
- Wiring work can only be done after the installation is secure.
- Do not misconnect power supply + and -, input voltage should not exceed VAC80V.

4.2 Port Definition

4.2.1 Status Indication Interface

	Symbol	Function
	ECAT ID	When the slave address DIP switch knob is not zero, the digital LED display address that is set by DIP switch knob; When the slave address from the DIP switch knob is 0, digital LED display address in register of address 0010h-0011h, which is assigned by master host.

4.2.2 Knob DIP

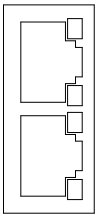
	No.	Symbol	Function
 1  2	1	LSD	Two 10-bit rotation codes can be combined into a slave address, ranging from 0 to 99. If the LSD is rotated to 1, and the MSD is rotated to 2, the slave address is: Slave address = LSD + MSD * 10; The address value is saved to register 0012h-0013h for master to check.
	2	MSD	

4.2.3 Status Indicator

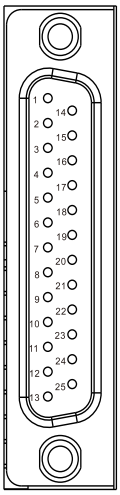
Name	Color	Status	Function
PWR	Green	ON	When powered on, the green indicator on
ALM	Red	Single Flash	Overcurrent
		Double Flash	overvoltage
		Triple Flash	Undervoltage
		Flash 4 times in a row	Wrong phase
		Flash 5 times in a row	Out of tolerance
RUN	Green	OFF	INIT state or power-down state
		Blinking	Pre-Operational state
		Single Flash	Safe-Operational state
		Flickering	BootStrap state
		ON	Operational state
ERR	Red	OFF	No error or power-down state
		Blinking	Extra error
		Single Flash	Sync error
		Double Flash	Watch-dog error
L/A	Green	OFF	Physical layer link is not established

		ON	Physical layer link establishment
		Flickering	Physical layer link data interaction

4.2.4 EtherCAT Communication Port

	Symbol	Function
	RJ45	Two standard RJ45 Ethernet ports, supports EtherCAT data transmission and reception, for in and out connection.

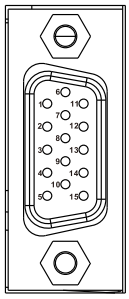
4.2.5 Control Signal Input/Output Port



No.	Symbol	Name	Function
1	YCOM	Output common port	Output signal common port
14	Y0	Output port 0	Digital output signal
2	Y1	Output port 1	
15	Y2	Output port 2	
6	XCOM	Input common port	Input signal common port
3	X0	Input port 0	Single-ended digital input signal, shared XCOM, support 5V~24V
16	X1	Input port 1	
4	X2	Input port 2	
17	X3	Input port 3	
5	X4	Input port 4	
18	X5	Input port 5	
19	X6+	Differential input port 6	Differential digital input signal, support 5V~24V
7	X6-	Differential input port 6	
20	GND	Encoder power ground	Encoder power ground
8	ZPOut	Encoder Z channel Single-ended output	Encoder output signal
23	A+	Encoder A channel positive output	
11	A-	Encoder A channel negative output	
22	B+	Encoder B channel positive output	
10	B-	Encoder B channel	

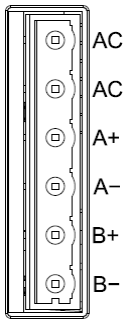
			negative output	
	21	Z+	Encoder Z channel positive output	
	9	Z-	Encoder B channel negative output	
	12~13	NC	Reserved	Reserved
	24~25	NC	Reserved	Reserved

4.2.6 Encoder Input Port



No.	Symbol	Name	Function
1	EA+	Encoder A phase input positive port	Connect encoder A channel positive input
2	EB+	Encoder B phase input positive port	Connect encoder B channel positive input
3	GND	Encoder power ground	Encoder power ground
4	EZ+	Encoder Z phase input positive port	Connect encoder Z channel positive input
5	FG	Shielded ground	Connect shielded ground wire
6~10	NC	Reserved	Reserved
11	EA-	Encoder A phase input negative port	Connect encoder A channel negative input
12	EB-	Encoder B phase input negative port	Connect encoder B channel negative input
13	5V	Encoder power supply	Encoder 5V power supply
14	EZ-	Encoder Z phase input negative port	Connect encoder Z channel negative input
15	NC	Reserved	Reserved

4.2.7 Power and Motor Output Port



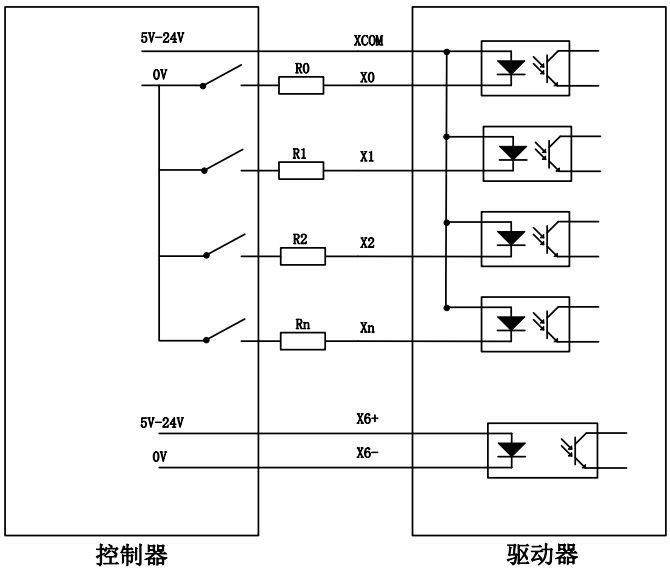
No.	Symbol	Name	Function
1	AC	Power interface	VAC：24V~80V
2	AC		
3	A-	Motor interface	Two-phase stepper motor wiring port
4	A+		
5	B-		
6	B+		

4.3 Input/Output Port Operation

- **Port Hardware Description**

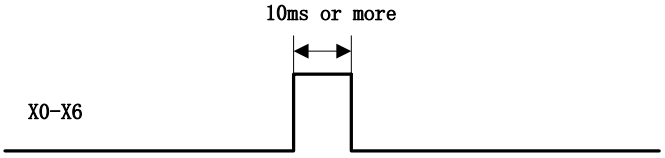
Provide 6 opto-isolated single-ended input, common anode connection, 1 opto-isolated differential inputs, and 3 opto-isolated single ended output signal.

The input interface is wired as follows, supporting 5V~24V voltage:



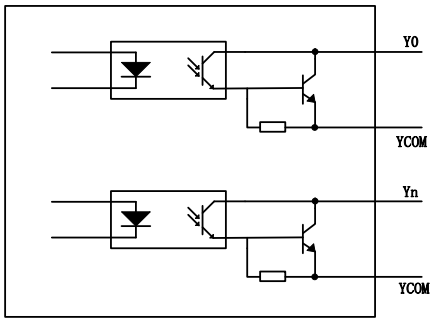
Input Port Connection Reference Circuit

Input signal must be longer than 10ms, otherwise the drive may not respond properly. X0-X6 timing diagram is shown in the following:



X0-X6 Timing Diagram

The drive provides 3 optocoupler isolated output ports, the wiring is as follows:



Y0-Y2 Output Port Internal Circuit

- **Port Function Description**

Drive input and output ports can be configured by registers 2300h, 2300h ~ 2301h change the active level state of the input signal and the output signal, 2310h ~ 2322h registers are used to

configure each terminal's function. 2330h ~ 2336h registers describes the software filter time blocked interference signal of the internal drive on input port.

Index	Subindex	Name	Description	Default Value	Parameter range
2300h	00	Input port active level logic	Bit0：Input port X0 control bit; Bit1：Input port X1 control bit; Bit2：Input port X2 control bit; Bit3：Input port X3 control bit; Bit4：Input port X4 control bit; Bit5：Input port X5 control bit; Bit6：Input port X6 control bit; Bit7~Bit15：Reserved; 0：Default; 1：Level inversion	0	0~65535
2301h	00	Output port active level logic	Bit0：Output port Y0 control bit; Bit1：Output port Y1 control bit; Bit2：Output port Y2 control bit; 0：Default; 1：Level inversion	0	0~65535
2310h	00	Input port X0 function selection	0：Undefined; 1：Home; 2：Positive limit; 3：Negative limit; 4：Stop; 5：Emergency Stop; 6：MF signal; 7：Probe 1; 8：Probe 2; 9：User-defined 0; 10：User-defined 1; 11：User-defined 2; 12：User-defined 3; 13：User-defined 4;	0	0~8
2311h	00	Input port X1 function selection		0	0~8
2312h	00	Input port X2 function selection		0	0~8
2313h	00	Input port X3 function selection		0	0~8
2314h	00	Input port X4 function selection		0	0~8
2315h	00	Input port X5 function selection		0	0~8
2316h	00	Input port X6 function selection		0	0~8
2320h	00	Output port Y0 function selection	0：Undefined;	0	0~11

2321h	00	Output port Y1 function selection	1：Alarm signal; 2：Position arrival signal; 3：Homing complete signal; 4：Brake signal; 9：User-defined 0; 10：User-defined 1; 11：User-defined 2;	0	0~11
2322h	00	Output port Y2 function selection		0	0~11
2330h	00	Input port X0 filtering time	Input port X0 filtering time	0	0~65535
2331h	00	Input port X1 filtering time	Input port X1 filtering time	0	0~65535
2332h	00	Input port X2 filtering time	Input port X2 filtering time	0	0~65535
2333h	00	Input port X3 filtering time	Input port X3 filtering time	0	0~65535
2334h	00	Input port X4 filtering time	Input port X4 filtering time	0	0~65535
2335h	00	Input port X5 filtering time	Input port X5 filtering time	0	0~65535
2336h	00	Input port X6 filtering time	Input port X6 filtering time	0	0~65535

When the output port Y0 ~ Y2 is set to a user-defined function, output valid or invalid can be controlled by 60FE object dictionary.

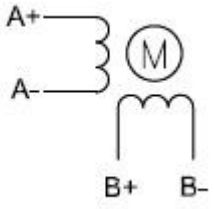
Index	Subindex	Name	Description	Default	Parameter range
60FEh	00	Subindex	Output port status	0	-
	01	Physical function	Output port function is valid Bit0~Bit15：Reserved; Bit16~Bit31：User defined; 0：Invalid output; 1：Output valid;		
	02	Output enable	Output port function enable Bit0~Bit15：Reserved; Bit16~Bit31：User defined; 0：Output disable; 1：Output enable;	0	-

For example, when bit 16 of 60FE-01 and of 60FE-02 are both 1, the Y0 port output is valid;

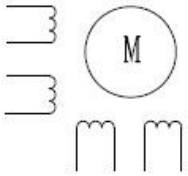
5 Matched Motor

HS-S86E mainly matches open-loop and close-loop 86mm motors.

Two phase closed loop motor wiring.



Two phase open loop motor wiring.



Notice：

- Please ensure that the motor and encoder are wired correctly, otherwise the motor will be out of tolerance after receiving the pulse.
- When installing the motor, it is forbidden to strike the back cover of the motor to avoid damage to the encoder.

6 EtherCAT

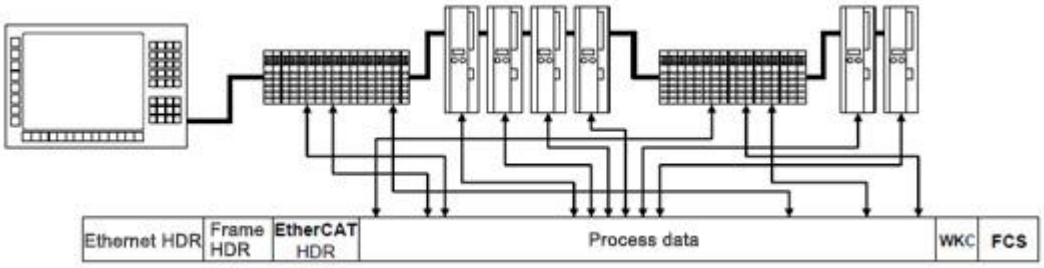
EtherCAT is a fieldbus technology based on open technology real-time Ethernet proposed by Beckhoff in Germany. It features excellent performance, flexible topology and simple system configuration. At the same time, it also meets or even reduces the cost of fieldbus. EtherCAT also features high-precision device synchronization, optional cable redundancy, and a functional safety protocol (SIL3). EtherCAT is a completely open technology that is currently incorporated into the international standards IEC61158, IEC61784 and ISO15745-4.

6.1 EtherCAT Technical Principles

Traditional Ethernet-based fieldbus solutions must receive Ethernet packets to decode them, and then copy the process data to each device, which greatly compromises the real-time capabilities of the fieldbus.

By using EtherCAT technology, Beckhoff broke through these system limitations of other Ethernet solutions: Instead of receiving Ethernet packets at each connection point as before, then decoding and copying the process data. When the frame through each of the devices (direct I / O terminal module), EtherCAT slave controller reads the data associated with the device. Similarly, input data can be quickly inserted into the data stream. When the frame is passed (only a few bits are delayed), the slave will recognize the relevant command and process it accordingly. This process is implemented in hardware in the slave controller and is therefore independent of the Run-Time system or processor performance of the protocol stack software. The last EtherCAT slave in the segment sends the fully processed message back so that the message is returned as a response message from the first slave to the primary station.

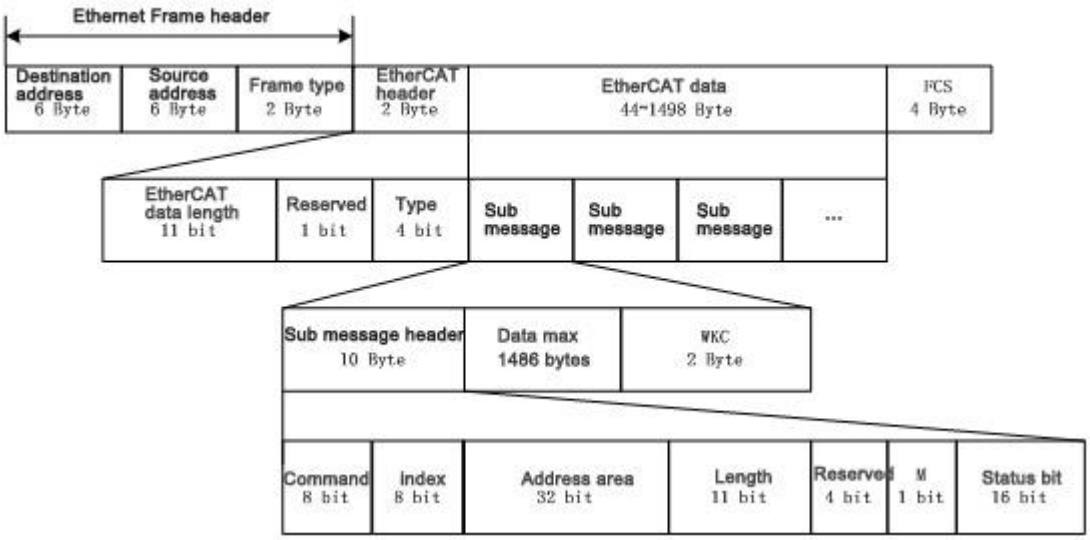
From an Ethernet perspective, the EtherCAT bus segment is a large Ethernet device that can receive and transmit Ethernet frames. However, the "device" does not include a single Ethernet controller with a downstream microprocessor, but only a large number of EtherCAT slaves. As with any other Ethernet device, EtherCAT does not require a switch to establish communication, resulting in a pure EtherCAT system.



Schematic Map of A Single Ethernet Data Fram

6.2 EtherCAT Data Structure

EtherCAT data is transmitted directly using Ethernet data frames of data frame type Ox88A4. EtherCAT data comprises 2 bytes of header and 44 to 1498 bytes of data. The data area consists of one or more EtherCAT sub-messages, each of which corresponds to a separate device or slave storage area, as shown below. The table shows the data frame structure defined EtherCAT.



EtherCAT Telegrams Embedded Ethernet Data Frame

Name	Description
Destination address	Receiver MAC address
Source address	Sender MAC address
Frame type	0x88A4
EtherCAT head: length	EtherCAT data area length, the sum of all sub-message lengths
EtherCAT head: Type	1: indicates communication with the slave, the remaining reserved
FCS（Frame Check Sequeuce）	Frame check sequence

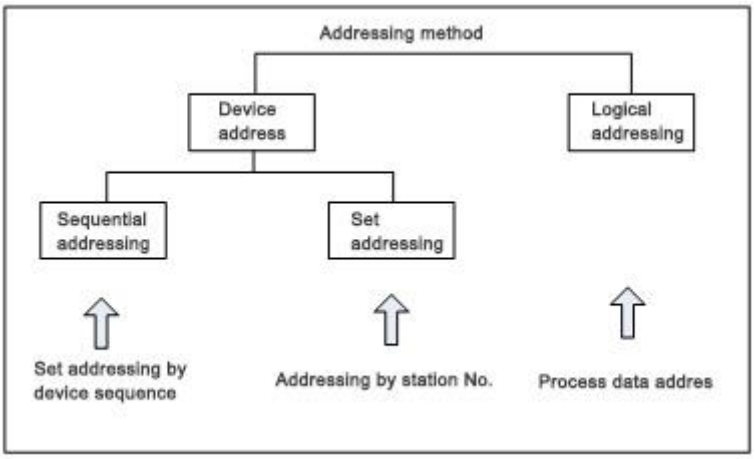
Each EtherCAT sub-message includes a sub-message header, a data field, and a corresponding work counter (WKC) that records the number of times the sub-message is operated by the slave station, and the primary station sets the expected WKC for each communication service sub-message. The initial value of the WKC in the transmitted sub-message is 0. After the sub-message is correctly processed by the slave station, the value of the WKC is incremented by one increment. The WKCs in the sub-message and expected are compared by the master station, to determine whether the sub-message is correctly processed. WKC processed while processing the data frame by the ESC, different communication services increase WKC different ways.

6.3 EtherCAT Message Addressing

EtherCAT communication is realized by the main station transmitting EtherCAT data frame to read and write the internal storage area of the slave device. EtherCAT message uses multiple

addressing modes to operate the ESC internal storage area to implement various communication services.

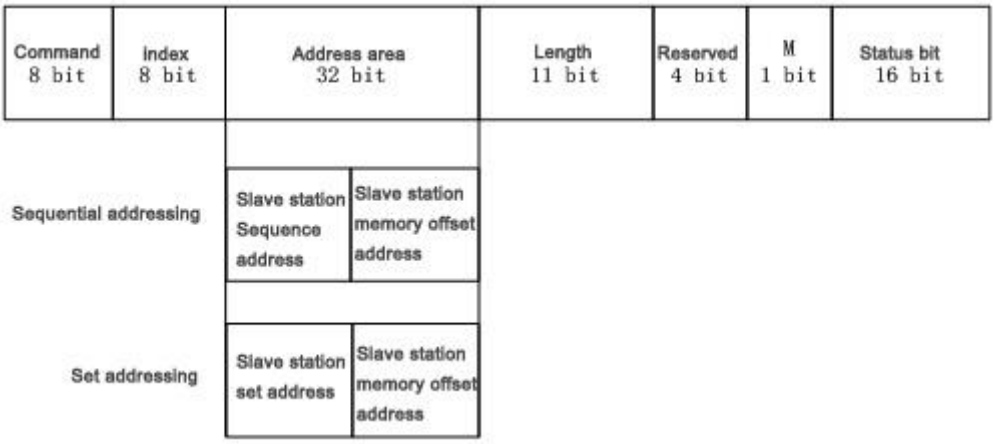
Two addressing modes are available within the EtherCAT network segment: device addressing and logical addressing. The first one is performed for a single slave to read and write. The second one is oriented to process data, which enables multicasting. The same sub-message can read and write multiple slave devices. A slave that supports all addressing modes is called a full slave, while a slave that only supports partial addressing mode is called a basic slave.



EtherCAT Message Addressing Mode

6.3.1 Device Addressing

When addressing devices, the 32-bit address in the EtherCAT sub-header is divided into a 16-bit slave device address and a 16-bit slave device internal physical memory space address. One slave device address can address 65,535 slave devices, each of which can have up to 64K bytes of local address space.



EtherCAT Device Addressing Structure

When the device is addressed, each message is addressed to only one slave device, but it has two different device addressing mechanisms, sequential addressing and set addressing.

- **Sequential Addressing**

In sequential addressing, the address of the slave is determined by its connection location

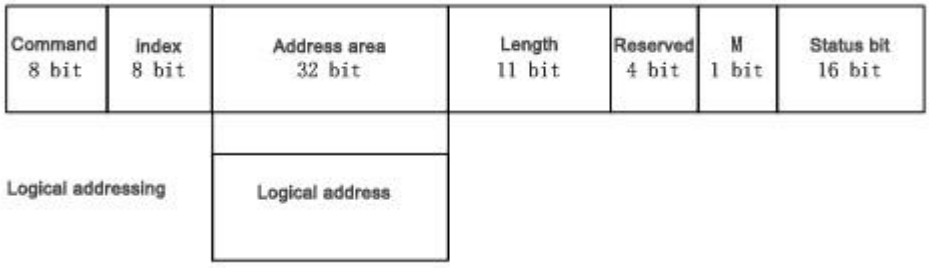
within the network segment, with a negative number indicating the position determined by the wiring sequence for each slave station segment. When the sequential addressing sub-message passes through each slave device, its location address is incremented by 1; When the slave receives the message, the message with the sequence address 0 is the message addressed to itself. Since this mechanism updates the device address as the message passes, it is also referred to as "automatic incremental addressing."

- **Set Addressing**

When set addressing, the address of the slave is independent of its connection order within the network segment. The address can be configured by the master station to the slave station during the data link startup phase, it can also be loaded from its own configuration data storage area when the slave station is initialized at power-on. The set address of each slave is then read by the master station using the sequential addressing mode during the link startup phase and used in subsequent operation.

6.3.2 Logical Addressing

In logical addressing, the slave address is not defined separately, but uses an area of the 4 GB logical address space within the addressed segment. The 32-bit address area within the message completes the logical addressing of the device as the overall logical address of the data.



EtherCAT Logical Addressing Structure

The logical addressing mode is implemented by the Fieldbus Memory Management Unit (FMMU), which is located inside each ESC, and the local physical storage address of the slave is mapped to the logical address in the network segment.

6.4 EtherCAT Distributed Clock

The Distributed Clock (DC) allows all EtherCAT devices to use the same system time to control the simultaneous execution of individual device tasks. The slave device can generate a synchronization signal based on the synchronized system time for interrupt control or triggering digital input and output. A slave station that supports a distributed clock is called a DC slave. DC has the following main functions:

- ✓ Implement clock synchronization between slaves
- ✓ Provide synchronous clock for the master station
- ✓ Produce a synchronized output signal
- ✓ Generate accurate time stamps for input events
- ✓ Generating user step interrupts
- ✓ Synchronous update digital output
- ✓ Synchronous sampling digital input

6.5 EtherCAT Communication Mode

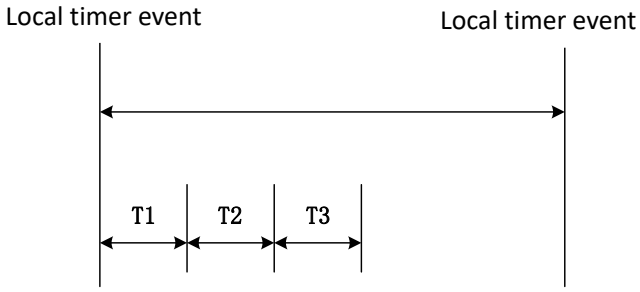
In the actual automated control system, there are generally two forms of data exchange between applications: Time critical and non-time critical. The time key indicates that a particular action must be completed within a certain time window. If the communication cannot be completed within the required time window, it may cause the control to fail. Time-critical data is usually sent periodically, called periodic process data communication. Non-time critical data can be sent aperiodically, with acyclic mailbox data communication in EtheCAT.

Acyclic data communication in the EtherCAT protocol is called mailbox data communication, which can be done in both directions: The master station to the slave station and the slave station to the master station. It supports full-duplex, two-way independent communication and multi-user protocols. The mailbox communication header includes an address field that allows the master station to resend mailbox data. Mailbox data communication is a standard way to implement parameter exchange, it is necessary to use the mailbox configuration data communication if needed periodic processes or desired other aperiodic data communication services. Typically mailbox communication only corresponds to one slave, so the device addressing mode is used in the message.

Periodic Process Data communication is typically logically addressed using the FMMU, which can use the logical read, write or read, and write commands to simultaneously operate multiple slaves. In the case of a periodic data communication mode, the master station and the slave station have multiple synchronous operation modes.

6.5.1 Free Run Mode

In free run mode, the local control cycle is generated by a local timer interrupt. The cycle time can be set by the master station, which is an optional function of the slave station. The local cycle of the free run mode is shown in the figure below. Where T1 is the time at which the local microprocessor copies data from the ESC and calculates the output data; T2 is the output hardware delay; T3 is the input latch offset time. These parameters reflect the time performance of the slave station.

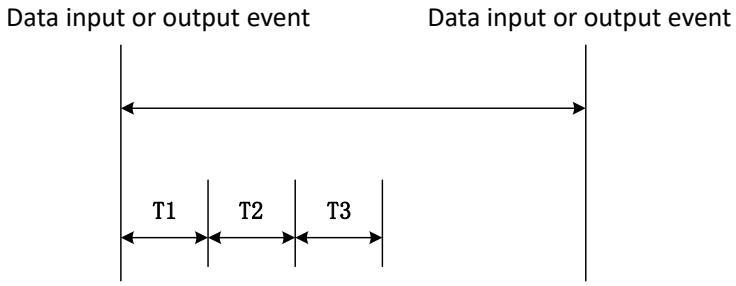


Local Cycle of Free Run Mode

6.5.2 SM2/3 Mode

The local cycle is triggered when a data input or output event occurs, as shown below. The master station can write the transmission cycle of the process data frame to the slave station, and the slave station can check whether the cycle time is supported or the cycle time is locally optimized. The slave can choose to support this function. Usually synchronized to the data output

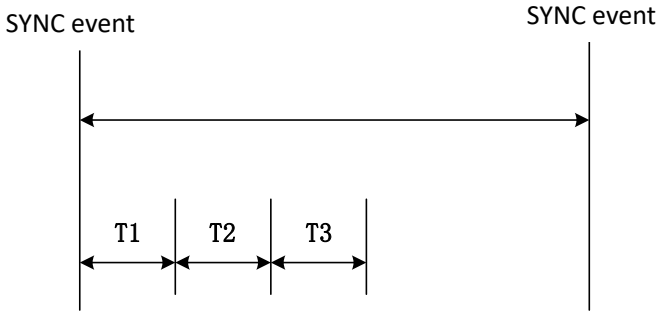
event, if the slave only has input data, it is synchronized to the data input event.



Local Cycle Synchronized to Data Input or Output Events

6.5.3 DC Mode

The local period is triggered by the SYNC event as shown below. The master station must complete the transmission of the data frame before the SYNC event. At this point, the master clock is also required to be synchronized to the reference clock. This mode is a high-precision time synchronization mode, in which the system will use the first slave time with DC clock as the system time, then use this system time as the reference time of all devices (Plus the transmission delay, jitter, etc. time error) to generate SYNC0 or SYNC1 sync signal. This mode requires the master station has strong real-time performance.



Local Cycle Synchronized to SYNC Event

6.6 EtherCAT State Machine

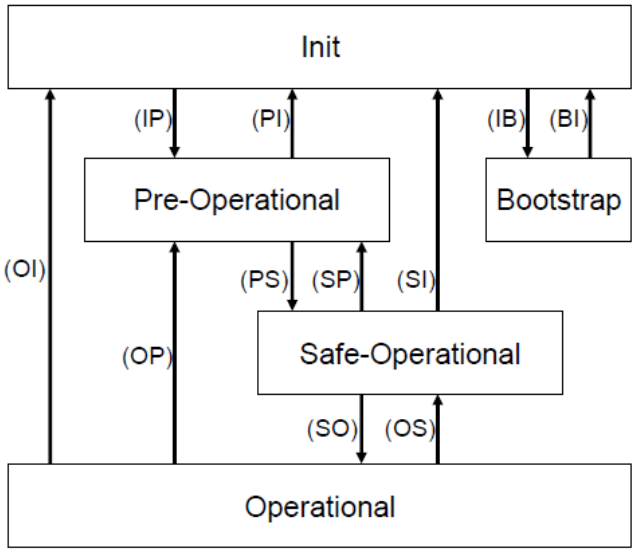
The EtherCAT Application Relational Protocol State Machine (ESM) is used to coordinate master and slave stations during startup and operation, and its state change is primarily caused by interactions between the master and the slave stations.

※ ※ESM Defines 5 States：

Name	Direction
Init	Initialization state, there is no direct communication between the master station and the slave station on the CANopen over EtherCAT (COE); If the slave supports the mailbox, in this state, the mailbox-related synchronization manager is configured;
Pre-Operational	Pre-operational state, if the slave supports the mailbox, the service data object (SDO) is enabled in this state, and further initialization and parameter

	configuration are completed, PDO is unavailable.
Safe- Operational	The safe operational state, transmit process data object (TPDO) is enabled, and the input buffer area has been configured;
Operational	The operational state, receive process data object (RPDO) is enabled, and the output buffer area has been configured;
Bootstrap	Bootstrap status, acceptable FOE protocol download permanent settings, mostly used for device firmware update;

The switching between states is shown below:



ESM Figure

According to the above figure, it can be observed that the switch from the Init state to the Operational state can only be switched step by step, cannot be leapfrog. It can be leapfrog switched from the Operational state to the Init state. The Bootstrap state can only be switched to and from the Init state.

Usually, the ESM state switch of the slave station is initiated by the master station, and when an error occurs in the slave state switch, the state switch will stop and the master station is notified of the error.

6.7 CANopen Over EtherCAT(COE)

CANopen was originally an application layer protocol for CAN bus-based systems. The EtherCAT protocol supports the CANopen protocol at the application layer and has been expanded accordingly. Its main functions are:

Use the mailbox communication to access the CANopen object dictionary and its objects for network initialization;

Network management using CANopen emergency objects and edge-enabled event-driven PDO messages;

Using the object dictionary to map process data, periodically transmitting instruction data and status data.

6.7.1 COE Object Dictionary

The COE protocol is fully compliant with the CANopen protocol and its object dictionary definition is the same. The Section 8 Object Dictionary List lists all COE communication data objects, where the associated communication objects 0x1C00~0x1C4F are extended for EtherCAT communication to set the type of storage synchronization manager, communication parameters, and PDO data allocation.

6.7.2 Service Data Object（SDO）

The SDO message is mainly used to access the device's object dictionary and configure the devices in the CANopen network. The SDO communication method is based on the client/server model, that is, the transmitted message must be confirmed by the receiver. A visitor is called a client, and a device whose object dictionary is accessed and responds to read and write requests is called a server. The protocol stipulates that the value of the read object dictionary is called upload, and the value of the modified parameter is called download.

6.7.3 Process Data Object（PDO）

The SDO protocol is used for the operation of the object dictionary, and processes data with low real-time performance. Data with high real-time requirements is usually transmitted through PDO.

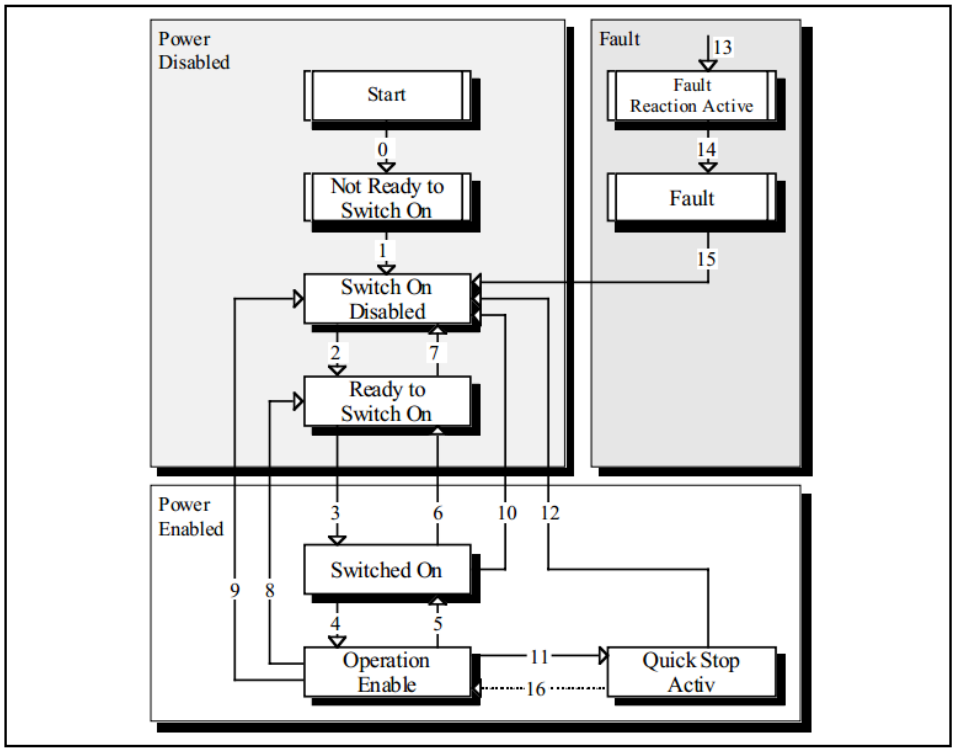
The PDO communication method is based on the producer/consumer model, data is transmitted from one device (producer) to another device (consumer) or many other devices (broadcast mode), and is transmitted in no acknowledge mode. , data transfer is limited to 1 to 8 bytes. The CANopen device performs reception or transmission by describing two parameters of the PDO: communication parameter and mapping parameter.

7 Drive Control Protocol CiA 402

7.1 CIA402 State Machine

The standard state machine for motion control devices is defined in the CiA402 protocol, as well as various operating modes and their definitions in the object dictionary.

The state machine describes the state of the device and the possible control sequences for the drive. Each step state represents a specific internal or external behavior, and the state of the device determines which commands can be received.



Drive State Machine

※ The status of each state machine is described as follow：

State name	Description
Not Ready to Switch on	Device powered on, the drive has been initialized, an internal self test is performed and the brake is activated.
Switch on Disabled	The CANopen communication began and the drive parameters can be set by using the SDO communication service.
Ready to Switch on	The drive continues to be parameterized and the motor is not energized.
Switched on	The drive and motor are ready, the output stage voltage will be turned on at last in this state, but the drive function cannot be performed.
Operation Enable	The drive and motor are enabled, the drive is in normal operation, and the motor is controlled in accordance with the control mode.
Quick Stop Active	The quick stop function is active, the drive function is activated and

	motor is started.
Fault Reaction Active	The drive detects that an alarm has occurred, stops according to setting mode, and motor is still enabled.
Fault	An error has occurred, drive parameters are allowed to be changed.

The drive state machine is controlled by bit0~bit3 and bit7 of the control word (object 6040h), as described in the following table:

※ Control word switching status

Command	Control word					State switching
	Bit7	Bit3	Bit2	Bit1	Bit0	
Shutdown	0	X	1	1	0	2,6,8
Switchon	0	0	1	1	1	3
Switch on + Enable operation	0	1	1	1	1	3+4
Disable voltage	0	X	X	0	X	7, 9, 10, 12
Quick stop	0	X	0	1	X	7, 10, 11
Disable Operation	0	0	1	1	1	5
Enable Operation	0	1	1	1	1	4,16
Error reset	0→1	X	X	X	X	15

Each state in the state machine can be displayed by bit0~bit3, bit5, and bit6 of the status word (object 6041h), as described in the following table:

※ Status word switching status

Status word						State
Bit6	Bit5	Bit3	Bit2	Bit1	Bit0	
0	X	0	0	0	0	Not ready to switch on
1	X	0	0	0	0	Switch on disabled
0	1	0	0	0	1	Ready to switch on
0	1	0	0	1	1	Switched on
0	1	0	1	1	1	Operation enabled
0	0	0	1	1	1	Quick stop active
0	X	1	1	1	1	Fault reaction active
0	X	1	0	0	0	Fault

The state description of the drive is mainly implemented by the control word 6040h and the status word 6041h, so the skilled use of the control word and the status word is necessary. The following table briefly describes the definition of the control word and the status word bits under work initialization.

Control word	Enable command	Function description
6040h	00	Initialization step 0: At this time, the low 4 bit state of 6041 is: 0000, motor released;
	06	Initialization step 1: At this time, the low 4 bit state of 6041 is: 0001, motor released;
	07	Initialization step 2: At this time, the low 4 bit state of 6041 is: 0011, motor enabled;
	0F	Initialization step 3: At this time, the low 4 bit state of 6041 is: 0111, motor enabled;

7.2 Mode of Operation

CANopen sets the drive operating mode through the object 6060h (Mode of Operation), and reflects the current operating mode state of the drive through the object 6061h (Mode of Operation Display).

HS-xxE drive currently supports 4 operating modes：

- ✓ Cyclic Synchronous Position Mode;
- ✓ Profile Position Mode;
- ✓ Profile Velocity Mode;
- ✓ Homing Mode.

※ Drive operating mode

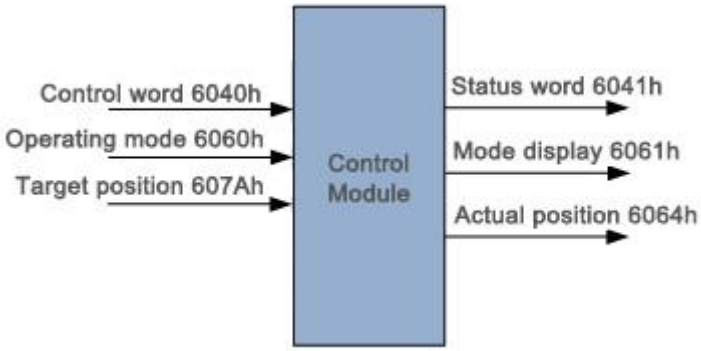
Index	Subindex	Name	Description
6060h	00	Mode of Operation	0：Undefined; 1：Profile Position Mode; 3：Profile Velocity Mode; 6：Homing Mode; 8：Cyclic Synchronous Position Mode.

7.3 Cyclic Synchronous Position Mode（CSP）

In the CSP mode, the controller completes the position command planning and outputs the planned target position 607Ah, and simultaneously sends the target position to the drive in a cycle synchronous manner, and the position and speed control are completed inside the drive.

Meanwhile, the target value for mode of operation object 6060h must be set to 8, when the mode of operation display object 6061h is read as 8, the CSP mode related operation can be performed.

The relevant communication objects are as follows:



※ Control word function description

Control word 6040h			
Byte	**Name**	**Value**	**Description**
Bit0	Switch ON	1	Bit0~Bit3 are 1, normal startup
Bit1	Enable Voltage	1	
Bit2	Quick Stop	1	
Bit3	Enable Operation	1	
Bit8	Halt	0	Move according to the target position given by 607Ah;
		1	Halt.

※ Status word function description

Status word 6041h			
Byte	**Name**	**Value**	**Description**
Bit10	Target reached	0	Halt=0：Target position did not reach; Halt=1：Shaft deceleration;
		1	Halt=0：Target position reached; Halt=1：Shaft speed is 0;
Bit12	Drive follow the command value	0	Slave station does not follow the command;
		1	Slave station follow the command;
Bit13	Following error	0	No positional deviation excessive error;
		1	Positional deviation excessive error happened

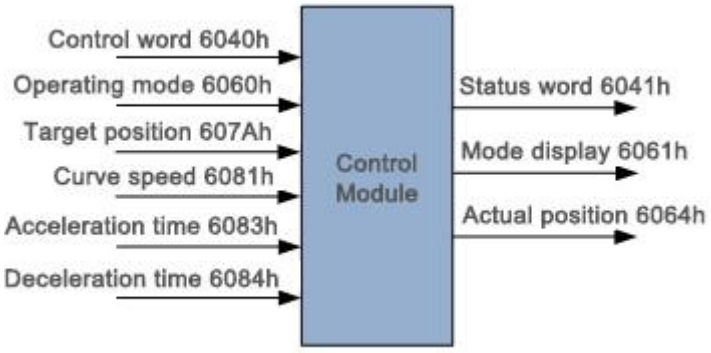
7.4 Profile Position Mode（PP）

This mode is mainly used for point positioning motion. In this mode, the controller gives the target position 607Ah, position curve speed 6081h, acceleration 6083h, 6084h deceleration parameters, internal drive will complete movement planning.

At the same time, the operating mode object 6060h value needs to be set to 1, when the operating mode state object 6061h register is read as 1, the related operation of the PP mode can

be performed.

The relevant communication objects are as follows:



※ Control word function description

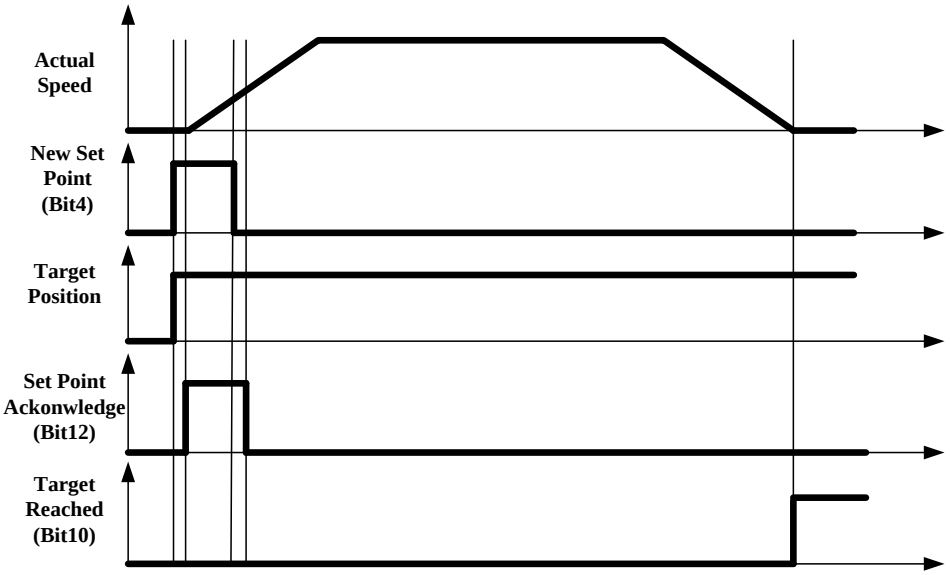
Control word 6040h			
Byte	**Name**	**Value**	**Description**
Bit0	Switch ON	1	Bit0~Bit3 are 1, normal startup;
Bit1	Enable Voltage	1	
Bit2	Quick Stop	1	
Bit3	Enable Operation	1	
Bit4	New set-point	0	No target position;
		1	Target position update, the rising edge of this bit from 0 to 1 indicates that the new target position 607A is pre-triggered;
Bit5	Change set immediately	0	Update after completing the current target position;
		1	Update immediately;
Bit6	abs/rel	0	The target position is an absolute value;
		1	The target position is a relative value;
Bit8	Halt	0	Follow the Bit4~Bit6 command to move;
		1	Halt;

※ Status word function description

Status word 6041h			
Byte	**Name**	**Value**	**Description**
Bit10	Target reached	0	Halt=0：Target speed did not reach; Halt=1：Shaft deceleration;
		1	Halt=0：Target speed reached; Halt=1：Shaft speed is 0;
Bit12	Drive follow the command value	0	Target position can be updated;
		1	Target position cannot be updated;

Bit13	Following error	0	There is no positional deviation excessive error;
		1	Positional deviation excessive error happened;

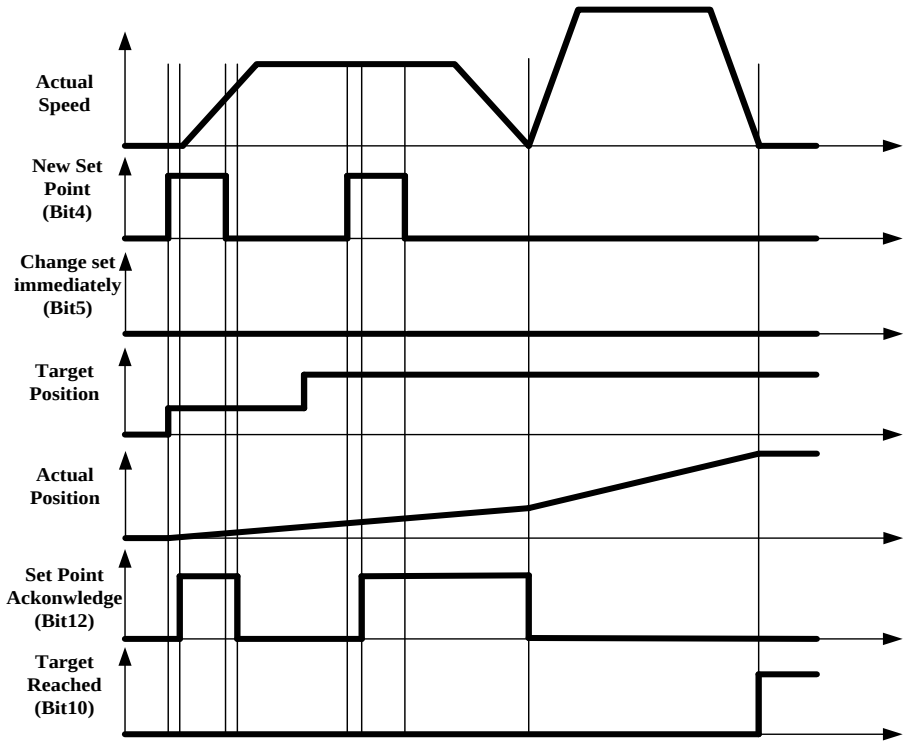
In the PP mode, a rising edge is generated by sequentially writing 0 and 1 to the Bit 4 bit of the control word 6040h to complete the motion trigger. Once the drive receives a trigger command, Bit12 of the status word is set to 1, motion begins. Meanwhile, whether the motion belongs to the absolute positioning motion or the relative positioning motion is controlled by bit 6 of the control word.



Once reached the target position, bit 10 of the status word is set to 1, if not reached, or excessive deviation of the position error happened, the bit remains in 0 state.

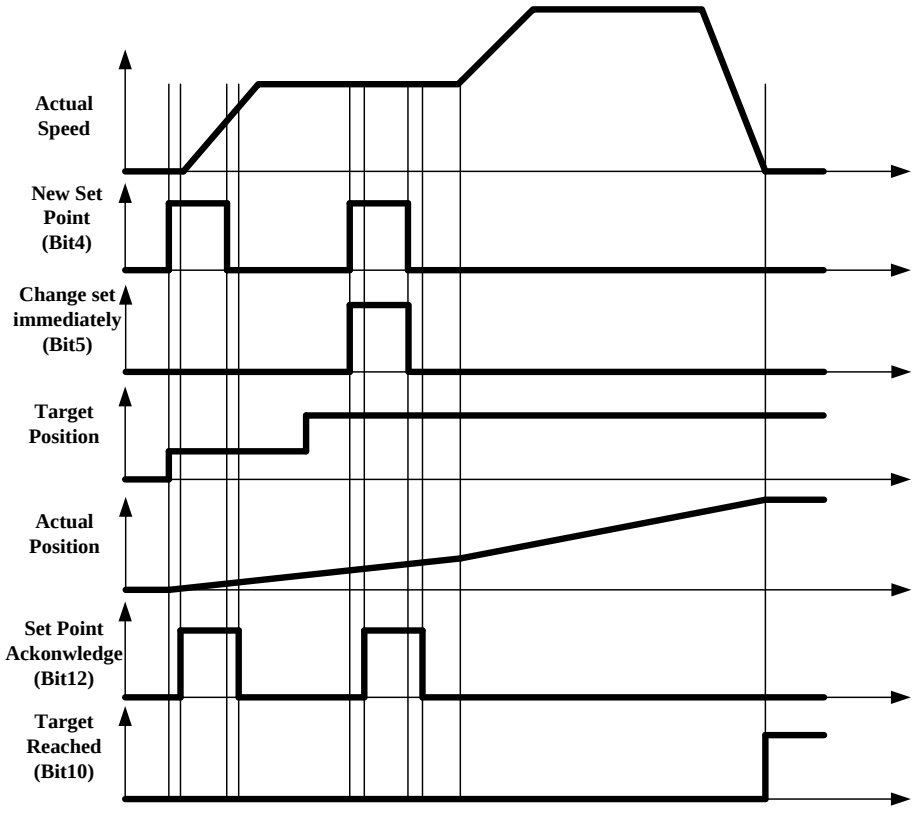
There will be two situations when the new target position updated: the current target position reached or not reached. If a new target position and a new trigger command occur when the current target position motion has not completed, the corresponding response should be made according to the Bit5 bit of the control word 6040h.

When the Bit 5 bit of 6040h is 0, it means that the current motion must be completed first, and then respond to the new target position and trigger command. The control word and status word related bit changes as shown below:



New target position does not update immediately after it appears

When the Bit 5 bit of 6040h is 1, it means that the current motion is interrupted and responds to the given new target position and trigger command. The control bit and status word related bit changes as shown below:



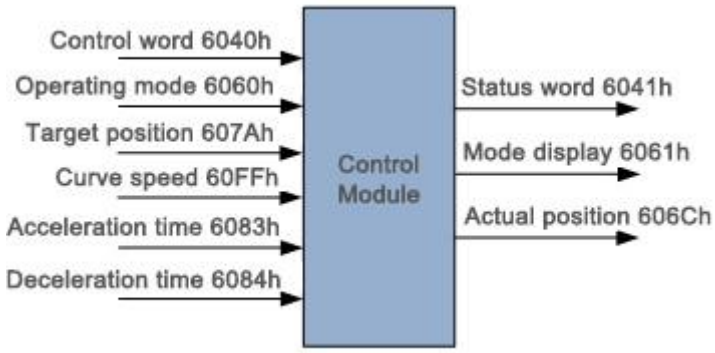
Update immediately after the new target position appears

7.5 Profile Velocity Mode（PV）

In this mode, the controller sends the target speed 60FFh, acceleration time 6083h and deceleration time 6084h to the drive, the speed curve is planned internally by the drive.

Meanwhile, the operation mode object 6060h value needs to be set to 3, when the working mode state object 6061h register is read as 3, related operation of PV mode can be performed.

The relevant communication objects are as follows:



※ Control word function description

Control word 6040h			
Byte	**Name**	**Value**	**Description**
Bit0	Switch ON	1	Bit0~Bit3 are 1, normal startup
Bit1	Enable Voltage	1	
Bit2	Quick Stop	1	
Bit3	Enable Operation	1	
Bit8	Halt	0	Move at a given target speed of 60FFh;
		1	Halt;

※ Status word function description

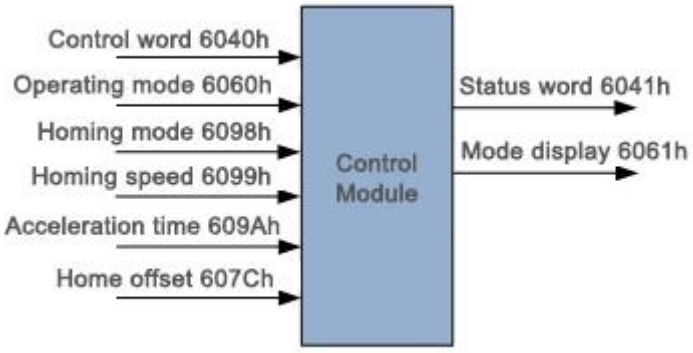
Status word 6041h			
Byte	**Name**	**Value**	**Description**
Bit10	Target reached	0	Halt=0：Target speed did not reach; Halt=1：Shaft deceleration;
		1	Halt=0：Target speed reached; Halt=1：Shaft speed is 0;
Bit12	Speed	0	Speed is not 0;
		1	Speed is 0;

7.6 Homing Mode（HM）

In the homing mode, the home signal needs to be connected to the input terminal of the drive, and the drive completes the search and positioning of the mechanical home.

At the same time, the operation mode object 6060h value needs to be set to 6, and when the

operation mode state object 6061h register is read as 6, the HM mode related operation can be performed. The objects involved in this mode are as follows:



※ Control word function description

Control word 6040h			
Byte	**Name**	**Value**	**Description**
Bit0	Switch ON	1	Bit0~Bit3 are 1, normal startup
Bit1	Enable Voltage	1	
Bit2	Quick Stop	1	
Bit3	Enable Operation	1	
Bit4	New set-point	0	Homing does not start;
		0->1	Homing operation start;
		1	Homing start;
		1->0	Homing operation interrupted;
Bit8	Halt	0	Follow the Bit~Bit6 command to move;
		1	Halt;

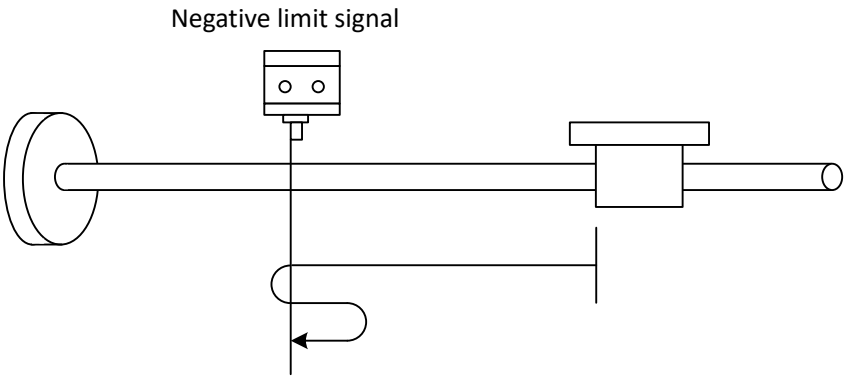
※ Status word function description

Status word 6041h			
Byte	**Name**	**Value**	**Description**
Bit10	Target reached	0	Halt=0：Not reached the home position; Halt=1：Shaft deceleration;
		1	Halt=0：Home position arrives; Halt=1：Shaft speed is 0;
Bit12	Drive follow the command value	0	Homing mode is not completed;
		1	Homing mode is completed;
Bit13	Following error	0	No homing error;
		1	Homing action fails;

The drive currently supports 4 homing modes:

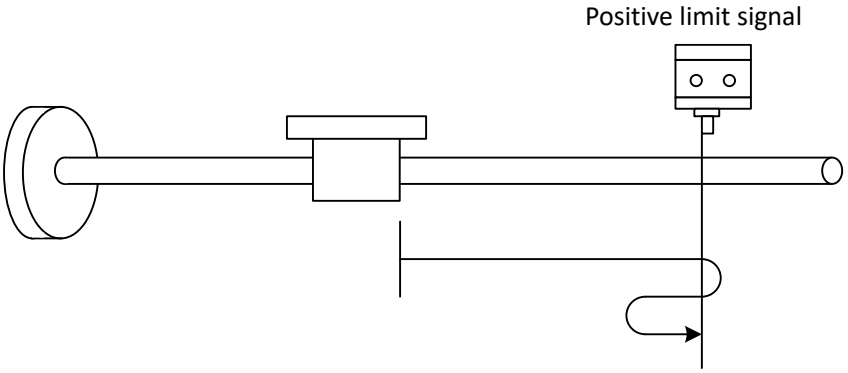
1) 6098h = 17：Look for the negative limit signal in the opposite direction. When the

negative limit signal is encountered, decelerate to stop and retreat for a certain distance. Then, the negative limit signal is searched in the opposite direction at a slow speed. After home was found and stopped, homing action completed.



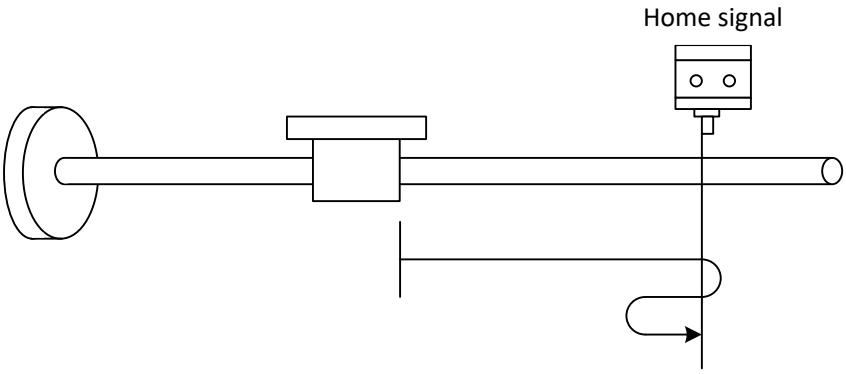
Homing mode 17

2) 6098h = 18：Move in positive direction to find positive limit signal, when encountered positive limit signal, slow down and stop, then move some distance back, then forward again to slowly find positive limit signal. After home was found and stopped, homing operation is completed.



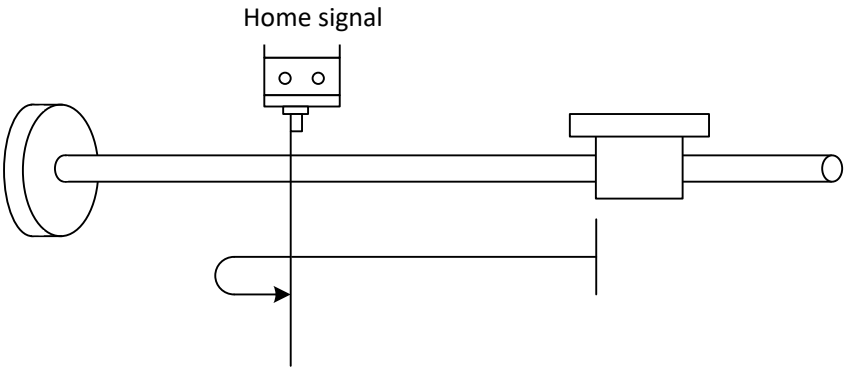
Homing mode 18

3) 6098h = 24：Homing in positive direction, when encountered the home signal, deceleration to stop and reverse some distance, then positive move again at a slow speed to find home, stop after home is found. Homing operation is completed. When the positive limit is encountered during the homing process, reverse motion and continues to find home.



Homing mode 24

4) 6098h = 29：Homing in negative direction, when encountered the home signal, deceleration to stop and reverse some distance, then negative move again at a slow speed to find home, stop after home is found. Homing operation is completed. When the negative limit is encountered during the homing process, reverse motion and continues to find home.



Homing mode29

The object 609901h is the home search speed, the object 609902h is the home slow search speed. The lower the value of 609902h is, the higher the search accuracy can be. In addition, if the home position needs to be set to a position away from the mechanical home, it can be done by setting the home offset 607Ch.

7.7 Probe Function

The probe function is to lock the current position information by capturing external sensor rising or falling edge signal, probe function is usually applied to CSP or PP mode. This product supports 2 probes, and X0 or X1 can be selected as the probe function.

7.7.1 Related Object Dictionary

※ Related object dictionary

Index	Subindex	Name	Description	Default	Parameter range
60B8h	00	Probe control	Probe control object;	0	-

60B9h	00	Probe status	Probe status object	0	-
60BAh	00	Probe latch	Probe 1 rising edge latch position	0	-
60BBh	00	Probe latch	Probe 1 falling edge latch position	0	-
60BCh	00	Probe latch	Probe 2 rising edge latch position	0	-
60BDh	00	Probe latch	Probe 2 falling edge latch position	0	-
60D5h	00	Probe latch counter	Probe 1 rising edge latch count	0	-
60D6h	00	Probe latch counter	Probe 1 falling edge latch count	0	-
60D7h	00	Probe latch counter	Probe 2 rising edge latch count	0	-
60D8h	00	Probe latch counter	Probe 2 falling edge latch count	0	-

7.7.2 Probe Function Description

Before using the probe function, configure X0 or X1 as a probe function. The specific configuration can be configured through the following registers.

※ Probe function configuration object dictionary

Index	Subindex	Name	Description	Value	Parameter Range
2310h	00	Terminal function	Input terminal X0 function selection	7	0~65535
2311h	00	Terminal function	Input terminal X1 function selection	8	0~65535

The probe function setting can be completed through the probe configuration of object dictionary. The probe state object dictionary can be used to check the current operation state of the probe. The following table shows the specific configuration of the 60B8h object dictionary and the 60B9h object dictionary.

※ 60B8h Probe control object dictionary

Index	Subindex	Function Description	
60B8h	00	Bit0	0：Probe 1 is not enabled; 1：Probe 1 is enabled;
		Bit1	0：Probe 1 single mode; 1：Probe 1 continuous mode;
		Bit2~ Bit3	Reserved

		Bit4	0：Probe 1 rising edge is not enabled; 1：Probe 1 rising edge is enabled;
		Bit5	0：Probe 1 falling edge is not enabled; 1：Probe 1 falling edge is enabled;
		Bit6~ Bit7	Reserved
		Bit8	0：Probe 2 is not enabled; 1：Probe 2 is enabled;
		Bit9	0：Probe 2 single mode; 1：Probe 2 continuous mode;
		Bit10~ Bit11	Reserved
		Bit12	0：Probe 2 rising edge is not enabled; 1：Probe 2 rising edge is enabled;
		Bit13	0：Probe 2 falling edge is not enabled; 1：Probe 2 falling edge is enabled;
		Bit14~ Bit15	Reserved

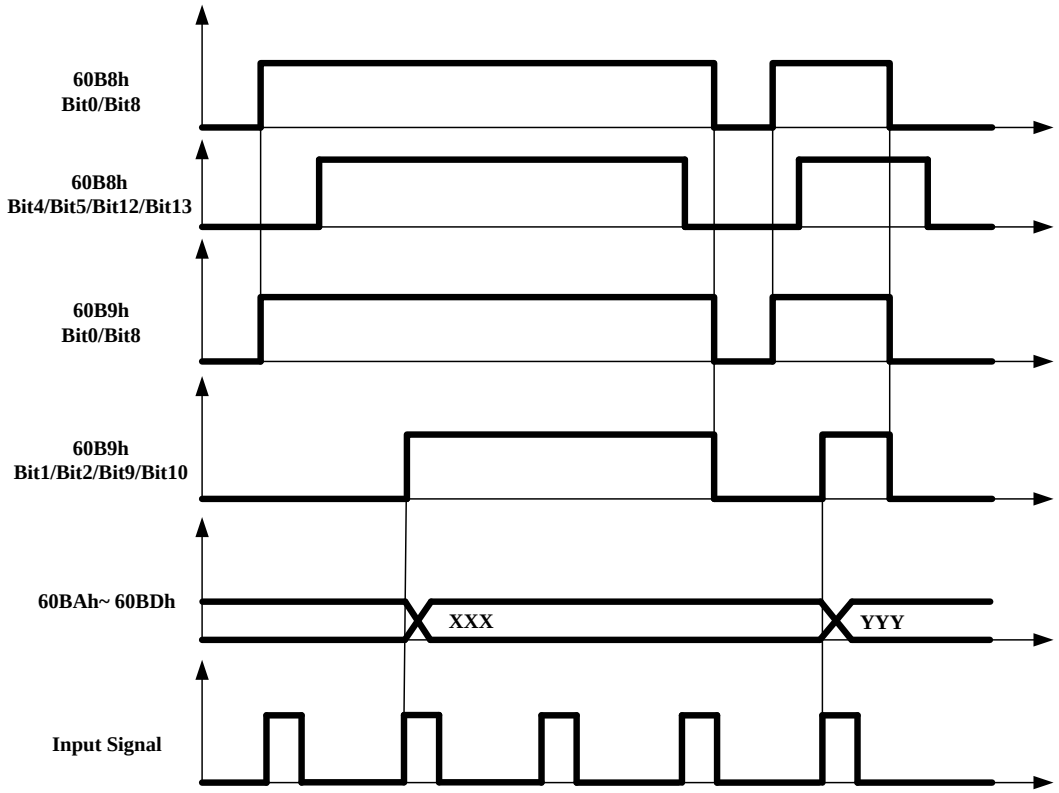
※ 60B9h Probe status object dictionary

Index	Subindex	Function Description	
60B9h	00	Bit0	0：Probe 1 is not operating; 1：Probe 1 is operating;
		Bit1	0：Probe 1 rising edge capture is not completed; 1：Probe 1 rising edge capture is complete;
		Bit2	0：Probe 1 falling edge capture is not completed; 1：Probe 1 falling edge capture is complete;
		Bit3~Bit7	Reserved
		Bit8	0：Probe 2 is not operating; 1：Probe 2 is operating;
		Bit9	0：Probe 2 rising edge capture is not complete; 1：Probe 2 rising edge capture is complete;
		Bit10	0：Probe 2 falling edge capture is not complete; 1：Probe 2 falling edge capture is complete;
		Bit11~Bit15	Reserved

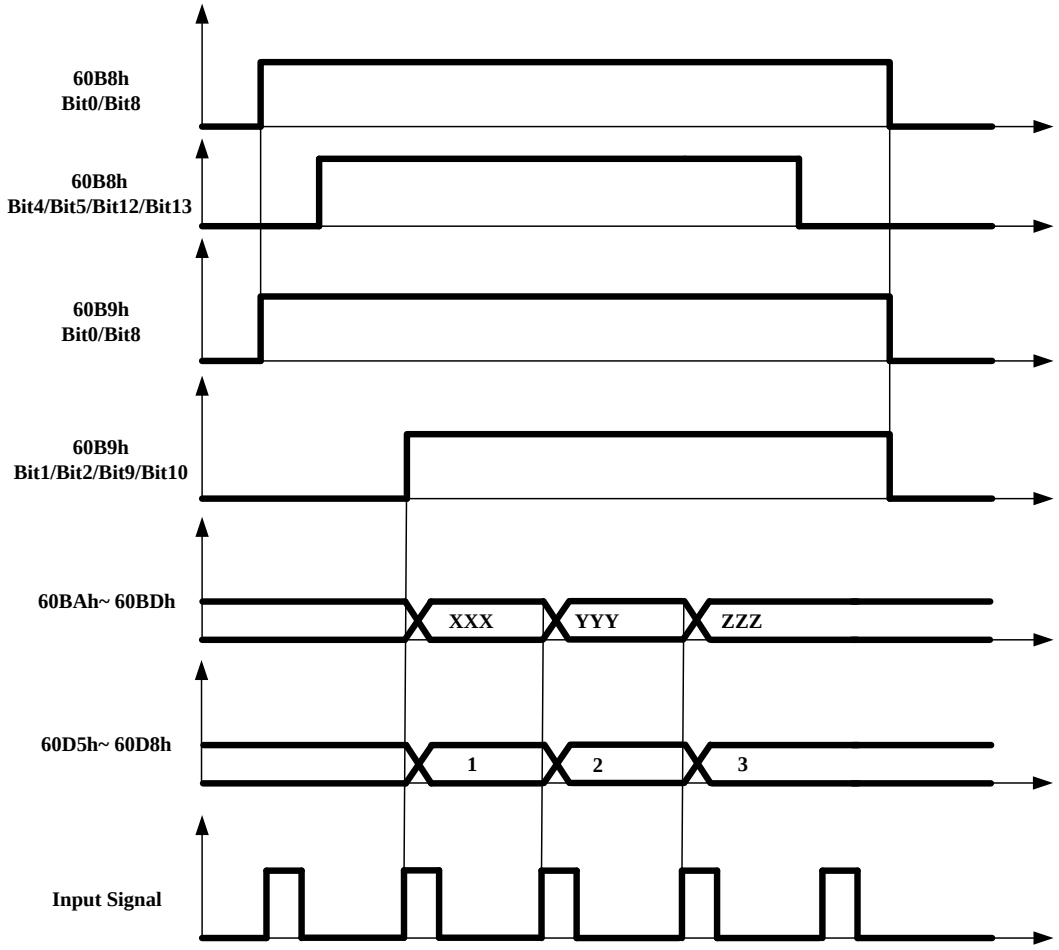
The probe operation mode is available in single mode or continuous mode, controlled by Bit1/Bit9 of 60B8h. In single mode, the probe captures only one rising or falling edge signal and latches the instantaneous position information into the 60BAh~60BDh object dictionary. In continuous mode, the probe captures each rising or falling edge signal. At the same time, the instantaneous location information is latched into the 60BAh~60BDh object dictionary, and the

number of captured signals is latched into the 60D5h~60D8h object dictionary.

The start of the probe function is controlled by Bit0/Bit8 of 60B8h. The start command is: first write “0”, then write “1” to complete a command trigger. When the probe function needs to be started again, the start command operation needs to be performed again. The following figure depicts the probe operation in single mode and continuous mode.



Single mode probe function



Continuous mode probe function

The above diagram only indicates the rising edge trigger latch, and the falling edge trigger mode is similar. The only difference is the latch is completed at falling edge.

8 Object Dictionary

8.1 Object Dictionary List

The object dictionary consists of three parts, which are the 1000h~1FFFh registers defined by CIA301, the factory-defined 2000h~2FFFh registers, and the 6000h~6FFFh registers defined by CIA402.

The 1000h~1FFFh register is the basic communication parameters related to COE defined by CIA301, including SDO, PDO and mapping registers;

The 2000h~2FFFh registers are the contents of the drive function parameters and the manufacturer's setting parameters, including microstep, current and other parameters that can be modified in drive;

The 6000h~6FFFh registers are motion control-related motion parameters defined by CIA402, including position mode, velocity mode, homing mode, and other motion mode registers and related motion parameter registers.

Index	Subindex	Name	Description	Type	Property	PDO mapping	Parameter range	Default value
CiA 301 Basic communication parameter group								
1000h	00	Equipment type	This device supports CIA301 and CIA402 protocols.	U32	RO	NO	-	0x00040192
1001h	00	Error register	Drive current error status	U08	RO	NO	-	0
1008h	00	Device name	Synchronous message COB identifier	-	RO	NO	-	MS-ECAT
1009h	00	Hardware version	Hardware version	-	RO	NO	-	-
100Ah	00	Software version	Software version	-	RO	NO	-	-
1018h	00	Manufacturer information	Subindex	U08	RO	NO	-	4
	01	Vendor ID	Vendor ID	U32	RO	NO	-	0x0994
	02	Product Code	Supplier product number	U32	RO	NO	-	0x1100
	03	Revision number	Product version number	U32	RO	NO	-	0x0001
	04	Serial number	Product serial number	U32	RO	NO	-	0x0001
1600h	00	Number of sub indexes	Number of sub indexes	U08	RW	NO	1~12	1
	01	RPDO0-Mapping1	Map to 6040h register	U32	RW	NO	-	60400010h
	02	RPDO0-Mapping2	Unmapped	U32	RW	NO	-	-
	03	RPDO0-Mapping3	Unmapped	U32	RW	NO	-	-
	04	RPDO0-Mapping4	Unmapped	U32	RW	NO	-	-
	05	RPDO0-Mapping5	Unmapped	U32	RW	NO	-	-
	06	RPDO0-Mapping6	Unmapped	U32	RW	NO	-	-
	07	RPDO0-Mapping7	Unmapped	U32	RW	NO	-	-
	08	RPDO0-Mapping8	Unmapped	U32	RW	NO	-	-

	09	RPDO0-Mapping9	Unmapped	U32	RW	NO	-	-
	10	RPDO0-Mapping10	Unmapped	U32	RW	NO	-	-
	11	RPDO0-Mapping11	Unmapped	U32	RW	NO	-	-
	12	RPDO0-Mapping12	Unmapped	U32	RW	NO	-	-
1601h	00	Number of sub indexes	Number of sub indexes	U08	RW	NO	-	-
	01	RPDO1-Mapping1	Unmapped	U32	RW	NO	-	-
	02	RPDO1-Mapping2	Unmapped	U32	RW	NO	-	-
	03	RPDO1-Mapping3	Unmapped	U32	RW	NO	-	-
	04	RPDO1-Mapping4	Unmapped	U32	RW	NO	-	-
	05	RPDO1-Mapping5	Unmapped	U32	RW	NO	-	-
	06	RPDO1-Mapping6	Unmapped	U32	RW	NO	-	-
	07	RPDO1-Mapping7	Unmapped	U32	RW	NO	-	-
	08	RPDO1-Mapping8	Unmapped	U32	RW	NO	-	-
	09	RPDO1-Mapping9	Unmapped	U32	RW	NO	-	-
	10	RPDO1-Mapping10	Unmapped	U32	RW	NO	-	-
	11	RPDO1-Mapping11	Unmapped	U32	RW	NO	-	-
	12	RPDO1-Mapping12	Unmapped	U32	RW	NO	-	-
1A00h	00	Number of sub indexes	Number of sub indexes	U08	RW	NO	-	-
	01	TPDO0-Mapping1	Unmapped	U32	RW	NO	-	-
	02	TPDO0-Mapping2	Unmapped	U32	RW	NO	-	-
	03	TPDO0-Mapping3	Unmapped	U32	RW	NO	-	-
	04	TPDO0-Mapping4	Unmapped	U32	RW	NO	-	-
	05	TPDO0-Mapping5	Unmapped	U32	RW	NO	-	-

	06	TPDO0-Mapping6	Unmapped	U32	RW	NO	-	-
	07	TPDO0-Mapping7	Unmapped	U32	RW	NO	-	-
	08	TPDO0-Mapping8	Unmapped	U32	RW	NO	-	-
	09	TPDO0-Mapping9	Unmapped	U32	RW	NO	-	-
	10	TPDO0-Mapping10	Unmapped	U32	RW	NO	-	-
	11	TPDO0-Mapping11	Unmapped	U32	RW	NO	-	-
	12	TPDO0-Mapping12	Unmapped	U32	RW	NO	-	-
1A01h	00	Number of sub indexes	Number of sub indexes	U08	RW	NO	-	-
	01	TPDO1-Mapping1	Unmapped	U32	RW	NO	-	-
	02	TPDO1-Mapping2	Unmapped	U32	RW	NO	-	-
	03	TPDO1-Mapping3	Unmapped	U32	RW	NO	-	-
	04	TPDO1-Mapping4	Unmapped	U32	RW	NO	-	-
	05	TPDO1-Mapping5	Unmapped	U32	RW	NO	-	-
	06	TPDO1-Mapping6	Unmapped	U32	RW	NO	-	-
	07	TPDO1-Mapping7	Unmapped	U32	RW	NO	-	-
	08	TPDO1-Mapping8	Unmapped	U32	RW	NO	-	-
	09	TPDO1-Mapping9	Unmapped	U32	RW	NO	-	-
	10	TPDO1-Mapping10	Unmapped	U32	RW	NO	-	-
	11	TPDO1-Mapping11	Unmapped	U32	RW	NO	-	-
	12	TPDO1-Mapping12	Unmapped	U32	RW	NO	-	-
1C00h	00	Number of sub indexes	Number of sub indexes	U08	RO	NO	0	4
	01	SM0	Communication type	U08	RO	NO	1	1
	02	SM1	Communication type	U08	RO	NO	2	2

	03	SM2	Communication type	U08	RO	NO	3	3
	04	SM3	Communication type	U08	RO	NO	4	4
1C12h	00	Number of sub indexes	Number of sub indexes	U08	RO	NO	1~2	1
	01	RPDOAssignment object	RPDOAssignment object	U16	RW	NO	1600h~1601h	1600h
1C13h	00	Number of sub indexes	Number of sub indexes	U08	RO	NO	1~2	1
	01	TPDOAssignment object	TPDOAssignment object	U16	RW	NO	1A00h~1A01h	1A00h
1C32h	00	Number of sub indexes	SM2 synchronization manager output parameters	U08	RO	NO	-	-
	01	Synchronization type	Synchronization type	U16	RO	NO	-	-
	02	Cycle Time	Cycle Time	U32	RO	NO	-	-
	04	Supported sync types	Supported sync types	U16	RO	NO	-	-
	05	Minimum cycle time	Minimum cycle time	U32	RO	NO	-	-
	06	Calculation and copying time	Calculation and copying time	U32	RO	NO	-	-
	08	Enquire cycle time	Enquire cycle time	U16	RO	NO	-	-
	09	Delay time	Delay time	U32	RO	NO	-	-
	10	SYNC0 cycle Time	SYNC0 cycle Time	U32	RO	NO	-	-
	11	SM event lost count	SM event lost count	U16	RO	NO	-	-
	12	Cycle overflow count	Cycle overflow count	U16	RO	NO	-	-
	32	Sync error	Sync error	BOOL	RO	NO	-	-
1C33h	00	Number of sub indexes	SM3 synchronization manager input parameters	U08	RO	NO	-	-
	01	Synchronization type	Synchronization type	U16	RO	NO	-	-
	02	Cycle Time	Cycle Time	U32	RO	NO	-	-
	04	Supported sync types	Supported sync types	U16	RO	NO	-	-

	05	Minimum cycle time	Minimum cycle time	U32	RO	NO	-	-
	06	Calculation and copying time	Calculation and copying time	U32	RO	NO	-	-
	08	Enquire cycle time	Enquire cycle time	U16	RO	NO	-	-
	09	Delay time	Delay time	U32	RO	NO	-	-
	10	SYNC0 cycle Time	SYNC0 cycle Time	U32	RO	NO	-	-
	11	SM event lost count	SM event lost count	U16	RO	NO	-	-
	12	Cycle overflow count	Cycle overflow count	U16	RO	NO	-	-
	32	Sync error	Sync error	BOOL	RO	NO	-	-
Drive function parameters group								
2000h	00	Drive version number	Drive version number	U16	RO	NO	-	0x0320
2001h	00	Software version number	Software version number	U16	RO	NO	-	0x0000
2002h	00	External given command	The number of externally given commands, the default: 1 circle given value is the same as the segment value;	I32	RO	YES	-	0
2003h	00	Encoder feedback command	The number of encoder feedback commands, the default: 1 circle command number is 4 times the encoder resolution;	I32	RO	YES	-	0
2004h	00	Input signal status	7 input signal level status Bit0~Bit8: X0~X8 input level status;	U16	RO	YES	-	0
2005h	00	Output signal status	3 output signal level status Bit0~Bit2: Y0~Y2 output status;	U16	RO	YES	-	0
2100h	00	Encoder feedback command and current position clear	0：Invalid; 1：Clear;	U16	RW	YES	0~1	0
2101h	00	Clear current error	0：Invalid; 1：Clear;	U16	RW	YES	0~1	0
2102h	00	EEPROM operation	0：Invalid; 1：2000h groups of parameters restore to factory settings; 2：2000h groups of parameters	U16	RW	YES	0~2	0

			are saved to the EEPROM;					
2200h	00	In-position mode selection in CSP mode	0：In position after drive finished motion (valid only for closed loop control); 1：In position after given command is completed;	U16	RW	NO	0~1	1
2201h	00	Electronic gear ratio and mictostep switching	0：Microstep valid; 1：Electronic gear ratio valid;	U16	RW	NO	0~1	0
2202h	00	Lock shaft setting when drive is not enabled	0：Lock the shaft; 1：Do not lock the shaft;	U16	RW	NO	0~1	1
2203h	00	Enable signal clear error selection	0：Clear the current error; 1：Do not clear current error;	U16	RW	NO	0~1	0
2204h	00	Overtravel stop mode	0：Stop; 1：Emergency stop; 2：Invalid;	U16	RW	NO	0~2	0
2205h	00	Motor Default direction	0：Default; 1：Reverse;	U16	RW	NO	0~1	0
2206h	00	Drive operation mode	0：Invalid; 1：Open-loop mode; 2：Close-loop lead angle mode 1; 3：Close-loop lead angle mode 2; 4：Close-loop vector control mode;	U16	RW	NO	0~4	1
2207h	00	Matching drive motor	The 2500h group object dictionary content is different under different options; 000：Default;	U16	RW	NO	0~65535	0
2208h	00	Pulse command filtering enable	0：Invalid; 1：Valid;	U16	RW	NO	0~1	0
2209h	00	Pulse command filter coefficient	Pulse command filter coefficient, the smaller the value, the more significant filtering effect;	U16	RW	NO	0~1024	5
220Ah	00	Microstep enable	0：Invalid; 1：Valid;	U16	RW	NO	0~1	0
220Bh	00	Positioning algorithm	0：Algorithm 1; 1：Algorithm 2;	U16	RW	NO	0~1	0
220Ch	00	Sensor response	0：No response; 1：Shutdown alarm;	U16	RW	NO	0~1	0
2300h	00	Input terminal active level logic	Bit0：Input terminal X0 control bit; Bit1：Input terminal X1 control	U16	RW	NO	0~65535	0

			bit; Bit2：Input terminal X2 control bit; Bit3：Input terminal X3 control bit; Bit4：Input terminal X4 control bit; Bit5：Input terminal X5 control bit; Bit6：Input terminal X6 control bit; Bit7~Bit15：Reserved; 0：Default normally closed; 1：Normally open;					
2301h	00	Output terminal active level logic	Bit0：Output terminal Y0 control bit; Bit1：Output terminal Y1 control bit; Bit2：Output terminal Y2 control bit; 0：Default normally closed; 1：Normally open;	U16	RW	NO	0~65535	0
2310h	00	Input terminal X0 function selection	0：Undefined; 1：Home; 2：Positive limit; 3：Negative limit; 4：Stop; 5：Emergency stop; 6：MF signal; 7：Probe 1; 8：Probe 2; 9：User-defined 0; 10：User-defined 1; 11：User-defined 2; 12：User-defined 3; 13：User-defined 4;	U16	RW	NO	0~8	1
2311h	00	Input terminal X1 function selection		U16	RW	NO	0~8	2
2312h	00	Input terminal X2 function selection		U16	RW	NO	0~8	3
2313h	00	Input terminal X3 function selection		U16	RW	NO	0~8	0
2314h	00	Input terminal X4 function selection		U16	RW	NO	0~8	0
2315h	00	Input terminal X5 function selection		U16	RW	NO	0~8	0
2316h	00	Input terminal X6 vfunction selection		U16	RW	NO	0~8	0
2320h	00	Output terminal Y0 function selection	0：Undefined; 1：Alarm signal; 2：In position signal; 3：Homing completed signal; 4：Brake signal; 9：User-defined 0; 10：User-defined 1; 11：User-defined 2;	U16	RW	NO	0~11	0
2321h	00	Output terminal Y1 function selection		U16	RW	NO	0~11	0
2322h	00	Output terminal Y2 function selection		U16	RW	NO	0~11	0

2330h	00	Input terminal X0 filter time	Input terminal X0 filter time	U16	RW	NO	0~65535	2
2331h	00	Input terminal X1 filter time	Input terminal X1 filter time	U16	RW	NO	0~65535	2
2332h	00	Input terminal X2 filter time	Input terminal X2 filter time	U16	RW	NO	0~65535	2
2333h	00	Input terminal X3 filter time	Input terminal X3 filter time	U16	RW	NO	0~65535	2
2334h	00	Input terminal X4 filter time	Input terminal X4 filter time	U16	RW	NO	0~65535	2
2335h	00	Input terminal X5 filter time	Input terminal X5 filter time	U16	RW	NO	0~65535	2
2336h	00	Input terminal X6 filter time	Input terminal X6 filter time	U16	RW	NO	0~65535	2
2400h	00	Microstep setting	The number of pulses of one round of the motor;	U16	RW	NO	400~51200	50000
2401h	00	Maximum effective current	Unit mA;	U16	RW	NO	0~6000	6000
2402h	00	Base current percentage	Basic current during operation, unit: %;	U16	RW	NO	0~100	50
2403h	00	Close-loop maximum current percentage	Maximum current in close-loop operation, unit: %;	U16	RW	NO	0~150	100
2404h	00	Open-loop maximum current percentage	Maximum current in Open-loop operation, unit: %;	U16	RW	NO	0~100	100
2405h	00	Lock motor current percentage	Lock motor current, unit :%;	U16	RW	NO	0~100	30
2406h	00	Lock motor time	Lock motor time,unit: ms;	U16	RW	NO	0~5000	200
2407h	00	Encoder resolution	Encoder resolution	U16	RW	NO	4000	4000
2408h	00	Electronic gear ratio denominator	Electronic gear ratio denominator	U16	RW	NO	1~51200	1000
2409h	00	Electronic gear ratio numerator	Electronic gear ratio numerator	U16	RW	NO	1~51200	4000
240Ah	00	Position tolerance alarm threshold	Position tolerance alarm threshold	U16	RW	NO	0~4000	4000
240Bh	00	Positioning error range	Positioning error range	U16	RW	NO	1~100	5
240Ch	00	End time of in-position	End time of in-position	U16	RW	NO	1~65535	1000
240Dh	00	Pulse command average value filter	Pulse command average value filter	U16	RW	NO	1~1024	512

Factory parameter group								
2500h	00	Current loop Kp gain multiple	Current loop Kp gain multiple	U16	RW	NO	0~65535	-
2501h	00	Current loop Kp gain	Current loop Kp gain	U16	RW	NO	0~65535	-
2502h	00	Current loop Ki gain	Current loop Ki gain	U16	RW	NO	0~65535	-
2503h	00	Current loop Kc gain	Current loop Kc gain	U16	RW	NO	0~65535	-
2504h	00	LA position loop Kp gain	LA position loop Kp gain	U16	RW	NO	0~65535	-
2505h	00	LA speed loop Kv gain	LA speed loop Kv gain multiple	U16	RW	NO	0~65535	-
2506h	00	LA speed feedforward Kvf gain	LA speed feedforward Kvf gain	U16	RW	NO	0~65535	-
2507h	00	LA position loop Ki gain	LA position loop Ki gain	U16	RW	NO	0~65535	-
2508h	00	LA speed node 1	LA speed node 1	U16	RW	NO	0~65535	-
2509h	00	LA speed Kp1	LA speed Kp1	U16	RW	NO	0~65535	-
250Ah	00	LA speed Kv1	LA speed Kv1	U16	RW	NO	0~65535	-
250Bh	00	LA speed node 2	LA speed node 2	U16	RW	NO	0~65535	-
250Ch	00	LA speed Kp2	LA speed Kp2	U16	RW	NO	0~65535	-
250Dh	00	LA speed Kv2	LA speed Kv2	U16	RW	NO	0~65535	-
250Eh	00	PVIA position Kp	PVIA position Kp	U16	RW	NO	0~65535	-
250Fh	00	PVIA position Ki	PVIA position Ki	U16	RW	NO	0~65535	-
2510h	00	PVIA position Kc	PVIA position Kc	U16	RW	NO	0~65535	-
2511h	00	Speed feedback Kv1	Speed feedback Kv1	U16	RW	NO	0~65535	-
2512h	00	Speed feedback Kv2	Speed feedback Kv2	U16	RW	NO	0~65535	-
2513h	00	Speed feedforward Kvf	Speed feedforward Kvf	U16	RW	NO	0~65535	-
2514h	00	Acceleration feedforward Kaf	Acceleration feedforward Kaf	U16	RW	NO	0~65535	-

CiA 402 parameter group								
603Fh	00	Drive error code	The factory-defined drive error condition, which is the same as the lower 16 bits of the 1003h register. 0000h：No error; FF01h：Overcurrent; FF02h：Overvoltage; FF03h：Undervoltage; FF04h：Wrong phase; FF05h：Out of tolerance alarm; FF08h：Sensor alarm;	U16	RO	YES	-	0
6040h	00	Control word	Control word;	U16	RW	YES	0~65535	0
6041h	00	Status word	Status word;	U16	RO	YES	0~65535	0
605Dh	00	Halt control register	Drive processing mode after control word halt command 0：Normal stop, maintain the operation enabled status; 1：Emergency stop, maintain operation enabled status;	I16	RW	NO	-32768~32767	0
6060h	00	Operation mode control register	0：Undefined; 1：Profile Position Mode; 3：Profile Velocity Mode; 6：Homing mode; 8：Cyclic Sync Position Mode;	I8	RW	YES	-128~127	0
6061h	00	Operating mode status register	0：Undefined; 1：Profile Position Mode; 3：Profile Velocity Mode; 6：Homing mode; 8：Cyclic Sync Position Mode;	I8	RO	YES	-128~127	0
6062h	00	Position command value register	The drive gives the position value in real time, unit: pul;	I32	RO	YES	-	0
6064h	00	Actual position value register	Actual position of the motor, unit: pul;	I32	RO	YES	-	0
606Bh	00	Speed command value register	The drive gives the speed value in real time, unit: pul/s;	I32	RO	YES	-	0
606Ch	00	Real-time speed value register	Current motor speed, unit: pul/s;	I32	RO	YES	-	0
607Ah	00	Total number of pulses	The total number of pulses in the PP mode (including the total number of steps in the	U32	RW	YES	-	0

			acceleration, constant speed and deceleration), unit: pul;					
607Ch	00	Home compensation value	Home compensation value, unit: pul;	I32	RW	YES	-	0
6081h	00	Maximum speed	Maximum speed in PP mode, unit : pul/s;	U32	RW	YES	-	0
6083h	00	Acceleration	Acceleration, unit: pul / s^2	U32	RW	YES	-	0
6084h	00	Deceleration	Deceleration, unit: pul/s^2;	U32	RW	YES	-	0
6098h	00	Homing mode	17：Negative limit mode; 18：Positive limit mode; 24：Forward homing mode; 29：Reverse homing mode;	I08	RW	YES	-	0
6099h	00	Number of sub indexes	Number of sub indexes	U08	RO	NO	-	2
	01	Homing speed	Run speed when finding the home position, unit: pul/s;	U32	RW	YES	-	0
	02	Homing query speed	Returning speed after found the home, unit: pul/s;	U32	RW	YES	-	0
609Ah	00	Homing acceleration and deceleration	Acceleration and deceleration, unit: pul/s^2;	U32	RW	YES	-	0
60B8h	00	Probe control	Probe control object;	U16	RW	YES	-	0
60B9h	00	Probe status	Probe status object;	U16	RO	YES	-	0
60BAh	00	Probe latch	Probe 1 rising edge latch position	I32	RO	YES	-	0
60BBh	00	Probe latch	Probe 1 falling edge latch position	I32	RO	YES	-	0
60BCh	00	Probe latch	Probe 2 rising edge latch position	I32	RO	YES	-	0
60BDh	00	Probe latch	Probe 2 falling edge latch position	I32	RO	YES	-	0
60D5h	00	Probe latch counter	Probe 1 rising edge latch count	U32	RO	YES	-	0
60D6h	00	Probe latch counter	Probe 1 falling edge latch count	U32	RO	YES	-	0
60D7h	00	Probe latch counter	Probe 2 rising edge latch count	U32	RO	YES	-	0
60D8h	00	Probe latch counter	Probe 2 falling edge latch count	U32	RO	YES	-	0
60F4h	00	Position error	Given position and actual position error, unit: 1 encoder	I32	RO	YES	-	0

			resolution unit;					
60FDh	00	Input terminal status	Bit0：Negative limit status; Bit1：Positive limit status; Bit2：Home status; Bit3~Bit15：Reserved; Bit16：Probe 1; Bit17：Probe 2; Bit18：User-defined 0; Bit19：User-defined 1; Bit20：User-defined 2; Bit21：User-defined 3; Bit22：User-defined 4; Bit23~Bit31：User-defined;	U32	RO	YES	-	0
60FEh	00	Subindex	Output terminal status	U08	RO	NO	-	2
	01	Physical function	Output terminal function effective Bit0~Bit15：Reserved; Bit16~Bit31：User-defined; 0：Output invalid; 1：Output valid;	U32	RW	YES	-	0
	02	Output enable	Output terminal function enable Bit0~Bit15：Reserved; Bit16~Bit31：User-defined; 0：Output failure; 1：Output enable;	U32	RW	YES	-	0
60FFh	00	Maximum speed	Maximum speed in PV mode, unit: pul/s;	I32	RW	YES	-	0
6502h	00	Supported mode of operation	Bit0：Profile Position Mode; Bit 1：Velocity Mode; Bit 2：Profile Velocity Mode; Bit 3：Torque Profile Mode; Bit 4：Reserved; Bit 5：Homing Mode; Bit 6：Interpolated Position Mode; Bit 7：Cyclic Sync Position Mode; Bit 9：Cyclic Sync Torque Mode; Bit 10~31：reserved;	U32	RO	NO	-	0x00A5

Notice: U16 represents unsigned 16 bits; I16 represents signed 16 bits; U32 represents unsigned 32 bits; I32 represents signed 32 bits.

8.2 Drive Related Parameters Description

※ 2002h~2003h command monitoring objects

Index	Subindex	Name	Description	Default value	Parameter range
2002h	00	External given command	The number of external given commands. Default: 1 circle given value is the same as the microstep value;	-	-
2003h	00	Encoder feedback command	Encoder feedback command number. Default: 1 circle is 4 times the Encoder resolution;	-	-

2002h describes the external given command, for example, when the drive microstep is set to 50000, the default is drive needs external 50000 pulse command for 1 round;

2003h describes the encoder feedback command, which is 4 times the number of motor encoder lines. The Default factory configuration is 1000 lines encoder, so the 2003h value is 4000 when the motor rotates 1 circle.

※ 2004h~2005h signal status object

Index	Subindex	Name	Description	Default value	Parameter range
2004h	00	Input signal status	7 input signal level status Bit0~Bit6： X0~X6 input level status;	-	-
2005h	00	Output signal status	3 output signal level status Bit0~Bit2：Y0~Y2 output status;	-	-

2004h describes the current physical signal status given by the Input terminal. For example, when the X0 terminal is externally connected to the active level signal, the Bit0 value of 2004h is 1; this register reflects the physical signal of the current external input terminal; Object 2300h determined level signal is normally open or normally closed;

2005h describes the current output terminal status. For example, when 2005h-Bit0 is 1, the Y0 output signal is valid at this time; object 2301h determined the valid status is normally open or normally closed;

※ 2100h~2102h command object

Index	Subindex	Name	Description	Default value	Parameter range
2100h	00	Encoder feedback command and current position clear	0：Invalid; 1：Clear;	0	0~1

2101h	00	Clear current error	0：Invalid; 1：Clear;	0	0~1
2102h	00	EEPROM operation	0：Invalid; 1：2000h groups of parameters restore to factory settings;; 2：2000h groups of parameters are saved to the EEPROM;	0	0~2

2100h is the clear command. When the command is triggered, 2002h~2003h and 6064h object value is cleared;

2101h is an error clear command, which clears the current drive error when triggered.

2102h is an EEPROM operation command, which is used to save or restore the factory settings of the 2000h group parameters;

Notice that the above operation command triggering methods are: first write “0”, then write “1” to complete a command trigger;

※ 2200h~2206h configuration object

Index	Subindex	Name	Description	Default value	Parameter range
2200h	00	In-poition mode selection in CSP mode	0：Drive motion completed is in-position (valid only for closed loop control); 1：Given command completed is in-position;	1	0~1
2201h	00	Electronic gear ratio and microstep switching	0：Microstep valid; 1：The electronic gear ratio is invalid;	0	0~1
2202h	00	Lock shaft selection when not enabled	0：Lock the shaft; 1：Do not lock the shaft;	1	0~1
2203h	00	Enable signal clear error selection	0：Clear the current error; 1：Does not clear the current error;	0	0~1
2204h	00	Overtravel stop mode	0：Stop; 1：Emergency stop; 2：Invalid;	0	0~2
2205h	00	Motor Default direction	0：Default; 1：Reverse;	0	0~1
2206h	00	Drive operation mode	0：Invalid; 1：Open-loop mode; 2：Close-loop lead angle 1 mode;	1	0~4

			3：Close-loop lead angle 2 mode; 4：Close-loop vector control mode;		

The 2200h object describes the in position mode in CSP mode;

The 2201h object describes the control method of required pulse number for the motor's one round rotation. Microstep method is used by default. When switching to electronic gear ratio, the gear ratio can be defined by 2408h~2409h.

The 2202h object describes whether the motor locks the shaft when the motor is not enabled. The non-enable condition includes giving valid MF signal and EtherCAT disable command;

The 2203h object describes whether the enable signal clears the drive error at the same time, the default is clear.

The 2204h object describes the response when the overtravel limit signal is encountered during motor motion. It stops after the limit is encountered by default;

The 2205h object describes the default positive direction of the motor;

The 2206h object describes the drive mode of operation. Currently, it supports 4 kinds of default modes. When the open-loop motor is adapted, the object is set as 1. When the close-loop motor is adapted, the value can be set as 2~4, and the default is open- Loop control mode;

※ 2208h~220Ch Configuration object

Index	Subindex	Name	Description	Default value	Parameter range
2208h	00	Pulse command filtering enable	0：Invalid; 1：Valid;	0~1	0
2209h	00	Pulse command filter coefficient	Pulse command filter coefficient, the smaller the value, the more obvious the filtering effect;	0~1024	5
220Ah	00	Microstep enable	0：Invalid; 1：Valid;	0~1	0
220Bh	00	Positioning algorithm	0：Algorithm 1; 1：Algorithm 2;	0~1	0
220Ch	00	Sensor response	0：No response; 1：Stop and alarm;	0~1	0

The 2208h object controls the pulse command filtering enable bit. When enabled, the pulse command sent by the master station is low-pass filtered; the 2209h object controls the pulse command filter coefficient. The smaller the parameter, the stronger the filtering effect;

220Ah object control internal drive microstep enable bit;

220Bh object control internal drive positioning algorithm, default using algorithm 0;

The 220Ch object defines the reflection of the motor when external signal of the drive interferes with drive motion; external signals of the drive include: stop signal, emergency stop signal, MF release signal and positive and negative position limit signal;

※ 2300h~2336h terminal configuration object

Index	Subindex	Name	Description	Default value	Parameter range
2300h	00	Input terminal effective level logic	0：Normally closed; 1：Normally open;	1	0~65535
2301h	00	Output terminal effective level logic	0：Normally closed; 1：Normally open;	0	0~65535
2310h	00	Input terminal X0 function selection	0：Undefined; 1：Home; 2：Positive limit; 3：Negative limit; 4：Stop; 5：Emergency stop; 6：MF signal; 7：Probe 1; 8：Probe 2; 9：User-defined 0; 10：User-defined 1; 11：User-defined 2; 12：User-defined 3; 13：User-defined 4;	1	0~8
2311h	00	Input terminal X1 function selection		2	0~8
2312h	00	Input terminal X2 function selection		3	0~8
2313h	00	Input terminal X3 function selection		0	0~8
2314h	00	Input terminal X4 function selection		0	0~8
2315h	00	Input terminal X5 function selection		0	0~8
2316h	00	Input terminal X6 function selection		0	0~8
2320h	00	Output terminal Y0 function selection	0：Undefined; 1：Alarm signal; 2：In-position signal; 3： Homing completed signal; 4：Brake signal; 9：User-defined 0; 10：User-defined 1; 11：User-defined 2;	0	0~11
2321h	00	Output terminal Y1 function selection		0	0~11
2322h	00	Output terminal Y2 function selection			
2330h	00	Input terminal X0 filter time	Input terminal filter time	2	0~65535
2331h	00	Input terminal X1 filter time		2	0~65535

2332h	00	Input terminal X2 filter time		2	0~65535
2333h	00	Input terminal X3 filter time		2	0~65535
2334h	00	Input terminal X4 filter time		2	0~65535
2335h	00	Input terminal X5 filter time		2	0~65535
2336h	00	Input terminal X6 filter time		12	0~65535

The 2300h~2301h object is used to configure the valid status of the input terminal and output terminal signals. When the XCOM is connected to a high level (such as 24V), the X signal is connected to 0V as a normally closed signal.

The 2310h~2322h object is used to configure the input terminal and output terminal functions.

The 2330h~2336h object is used to configure the filter time of the input terminal signal. The larger the value, the stronger the filtering effect.

※ 2400h segment object

Index	Subindex	Name	Description	Default value	Parameter range
2400h	00	Segment setting	The number of pulses of the motor rotates a circle	50000	400~51200

2400h object is used to configure the drive segment to support any value in the range of 400~51200;

※ 2401h Maximum current object

Index	Subindex	Name	Description	Default value	Parameter range
2401h	00	Maximum current	Maximum current,Unit mA;	5000	0~6000

The 2401h object is used to configure the drive's maximum effective current and supports any value in the range of 0~6000mA.

※ 2402h Base current percentage object

Index	Subindex	Name	Description	Default value	Parameter range
2402h	00	Base current percentage	Basic current during operation, in %;	50	0~100

2402h object is used to configure the basic current given by the drive during motor motion.

For example, when 2401h object sets as 6000mA, if the value of 2402h is 50, the basic current value of the drive is 6000 * 0.5 = 3000mA;

※ 2403h Close-loop maximum current percentage object

Index	Subindex	Name	Description	Default value	Parameter range
2403h	00	Close-loop maximum current percentage	Maximum current in close-loop operation, in %;	100	0~150

2403h object is used to configure the maximum current of the drive in close-loop mode. For example, when 2401h is set to 6000mA, if the value of 2403h is 100, the maximum current value of the drive is 6000 * 1.0 = 6000mA.

According to the 2402h object, the operating current range of the drive in the close-loop mode is between 2A ~ 6A, and the current is adjusted in real time according to the load;

※ 2404hOpen-loop maximum current percentage object

Index	Subindex	Name	Description	Default value	Parameter range
2404h	00	Open-loop maximum current percentage	Maximum current in Open-loop operation, in %;	100	0~100

2404h object is used to configure the maximum current of the drive in open-loop mode. For example, when 2401h is set to 6000mA, if the value of 2404h is 100, the maximum current value of the open loop operation of the drive is 6000 * 1.0 = 6000mA;

According to the 2402h object, the operating current range of the driver in the open-loop mode is between 3A ~ 6A, and the current is adjusted in real time according to the speed.

※ 2405h Lock machine current percentage object

Index	Subindex	Name	Description	Default value	Parameter range
2405h	00	Lock machine current percentage	Lock machine current, in%;	40	0~100

The 2405h object is used to configure the lock current in the case of motor lock. For example, when the 2401h object is set to 6000mA, if the 2405h value is 40, the drive closed loop maximum current value is 6000 * 0.4 = 2400mA; Reducing the lock current can effectively improve the heating of the motor when the machine is locked for a long time;

※ 2406h Lock machine time object

Index	Subindex	Name	Description	Default value	Parameter range
2406h	00	Lock machine time	Lock machine time, in ms;	40	0~5000

The 2406h object is used to configure the motor lock time. When the drive does not receive the motion command after the lock time expires, the motor running current is switched from the

working current to the lock current;

※ 2407h Encoder resolution object

Index	Subindex	Name	Description	Default value	Parameter range
2407h	00	Encoder resolution	Encoder resolution	4000	4000~51200

2407h object is used to configure the drive input encoder resolution, the value must be 4 times the encoder value installed on the matching motor, for example, a 1000-line close-loop motor, the value is set to 4000;

※ 2408h~2409h Electronic gear ratio object

Index	Subindex	Name	Description	Default value	Parameter range
2408h	00	Electronic gear ratio denominator	Electronic gear ratio denominator	1000	1~51200
2409h	00	Electronic gear ratio molecule	Electronic gear ratio molecule	4000	1~51200

The 2408h~2409h object describes the electronic gear ratio of the drive. The gear ratio can be configured by default to be the same as the motor encoder resolution. The gear ratio denominator is the number of pulses required when the motor rotates one revolution.

※ 240Ah Position tolerance alarm threshold object

Index	Subindex	Name	Description	Default value	Parameter range
240Ah	00	Position tolerance alarm threshold	Position tolerance alarm threshold	4000	0~4000

The 240Ah object describes the alarm threshold for the encoder to lose the pulse value in the close-loop operation mode. The default is 4000, that is, the tolerance alarm after losing one revolution;

※ 240BhPositioning error range object

Index	Subindex	Name	Description	Default value	Parameter range
240Bh	00	Positioning error range	Positioning error range	5	1~100

The 240Bh object describes the positioning accuracy in the close-loop mode of operation, in units of 1 encoder unit;

※ 240Ch End time of in-position object

Index	Subindex	Name	Description	Default value	Parameter range
240Ch	00	End time of in-position	End time of in-position	1000	1~65535

The 240Ch object describes the drive in-position stop time in closed-loop mode of operation. It's the time interval after the positioning is completed and before the motion command is received. After the time is exceeded, the in-position signal is output; the longer the time, the more stable the in-position signal is;

※ 240Dh Pulse command filter object

Index	Subindex	Name	Description	Default value	Parameter range
240Dh	00	Pulse command filter	Pulse command filter	512	1~1024

The 240Dh object describes the filter time for a pulse given command, the larger the value, the lower the rigidity of the drive;

※ 2500h~2514h Factory parameter object

The group of parameters for the factory parameter object, default value can be used;

9 Alarm Exclusion

9.1 Drive Error

The drive has five kinds of alarm information. After the drive alarms, the ALM alarm indicator flashes several times according to the alarm code. The specific alarm code and processing method are shown in the following table.

Error code	Error information	ALM indicator	Reset
Err1：0x01	Phase short circuit or overcurrent	Flash 1 time	Lock machine/ Power down reset
Err2：0x02	Power supply voltage is too high	Flash 2 times	Lock machine/Automatic recovery
Err3：0x03	Power supply voltage is too low	Flash 3 times	Lock machine/Automatic recovery
Err4：0x04	Wrong phase	Flash 4 times	Power down reset
Err5：0x05	Out of tolerance	Flash 5 times	Power down reset

9.2 EtherCAT Communication Error

EtherCAT communication errors mainly include the following three categories: After a communication error occurs:

Error code	Error information	ERR indicator	Reset
Err1：0x11	Extra error	Blinking	Resettable

Err2：0x12	Sync error	Single Flash	Resettable
Err3：0x13	Watch-dog error	Double Flash	Resettable

Appendix 1: Getting Started with HS-S86E Drive Quick Configuration

The default parameters of the HS-S86E drive are used in the factory. When using the HS-S86E drive for the first time, the user may need to modify some function parameters of the drive according to the actual usage. This document describes the most common parameters to help users complete the configuration of drive-related parameters in the fastest time.

※ 2206h Drive mode of operation object

Index	Subindex	Name	Description	Default value	Parameter range
2206h	00	Drive mode of operation	0：Invalid; 1：Open-loopmode; 2：Close-loop lead angle 1 mode; 3：Close-loop lead angle 2 mode; 4：Close-loop vector control mode;	1	0~4

The default setting of the drive is Open-loop control. The default is to match the 86mm open-loop stepper motor. When the user needs to select the closed-loop motor, the parameter can be changed to 3, that is close-loop lead angle 2 control mode;

※ 2400h Segment object

Index	Subindex	Name	Description	Default value	Parameter range
2400h	00	Segment setting	The number of pulses of the motor rotates a circle	50000	400~51200

2400h object is used to configure the drive segment to support any value in the range of 400~51200. The default segment is 50000;

Users may be based on actual usage, such as the motor screw connection structure, the linear motion converted from the segment according to the motor and lead;

※ 2401h~2405h Current related object

Index	Subindex	Name	Description	Default value	Parameter range
2401h	00	Peak current	Peak current,Unit mA;	6000	0~6000
2402h	00	Base current percentage	Basic current during operation, in %;	50	0~100
2403h	00	Close-loop maximum current percentage	Maximum current in close-loop operation, in %;	100	0~150
2404h	00	Open-loop maximum	Maximum current in	100	0~100

		current percentage	Open-loop operation, in %;		
2405h	00	Lock machine current percentage	Lock machine current, in%;	40	0~100

When the driver works in open-loop mode, the working current interval is calculated as follows. The operating current range is automatically adjusted internally with the speed. The higher the speed, the larger the current:

Operating current interval = (2402h ~ 2404h) * 2401h / 100;

For example, when 2401h = 6000mA, 2402h = 40, 2404h = 100, the working current range is: 3000mA~6000mA;

When the drive operates in close-loop mode, the working current interval is calculated as follows. The operating current range is automatically adjusted internally with the load. The higher the speed, the larger the current:

Operating current interval = (2402h ~ 2403h) * 2401h / 100;

For example, when 2401h = 6000mA, 2402h = 50, 2404h = 100, the working current range is: 3000mA~6000mA;

The lock current calculation method is similar to the above current calculation method. For example, when 2405h = 40, the current value when the machine is locked is 2405h * 6000. The reduction of the lock current can effectively improve the heating condition of the motor;

Notice: After the 2000 group parameters are modified, they can be saved to the EEPROM. The save command is to write "0" to the 2102h object dictionary first, and then write "2".