Leadshine
Reliable Motion Control Products

EM3E Series Stepper Drive

User Manual

EtherCAT®
Conformance tested

EM3E Passed the ETC Laboratory Conformance Tested

EtherCAT ® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

- **Thanks for purchasing Leadshine EM3E Series Products**
- **Please read this manual carefully before using product**
- **Please keep this manual**

Record of Revisions:

Reversion	Data	Description of Release	Signed
V1.00	20171201	Initial Release	Max

Preface

Thank you for choosing EM3E EtherCAT stepper drive system of Leadshine Technology Co., Ltd. This manual gives required knowledge & precautions for using EM3E Series Stepper Drives.

About EtherCAT:

EtherCAT (Ethernet for Control Automation Technology) is open network communication using real-time Ethernet between masters and slaves developed by Beckhoff Automation GmbH, Germany.
ETG (EtherCAT Technology Group) has control over it.

The Manual of EM3E Series Include:

- <EM3E Series EtherCAT Communication Protocol Manual >
  The specification is about EtherCAT communication protocol.
- <EM3E Series EtherCAT Stepper Drive User Manual>
  The user manual is about hardware, function description, parameter configuration, etc.
  Please be sure to read carefully, after understanding the contents, refer to this specification.

Please Pay Attention to The Following Reminders:

- Only the technical personnel to install debug or maintain the product.
- To ensure correct wiring before power-on test.
- Incorrect voltage or power polar can cause damage to drive or other accidents.
- Manual content may change due to product improvement, please forgive without prior notice.
- Leadshine will not undertake any responsibility in case of user's unauthorized product changes, product warranty will be invalid.

Contents

Chapter 1 Introduction

1.1 Product Introduction

These newly released EM3E series drives support CANopen over EtherCAT (CoE) control and CiA 402 operating modes including Profile Position (PP), Profile Velocity (PV), Homing (HM) and Cyclic Synchronous Position (CSP). The products can be matched with most of EtherCAT controller/PLC such as Leadshine, Beckhoff, Omron, etc. The EM3E series has excellent performance including enhanced reliability, super-low stepper noise, anti-resonance and low-speed ripple smoothing and remains 60% less cost than EtherCAT servo at least.

1.2 EtherCAT Compare with Step/Direction

Stronger anti-disturbance ability

The transmission cables of traditional step/direction are vulnerable to disturb by EMC and reduce the reliability, whereas EtherCAT communication has strong anti-disturbance ability by inbuilt error detection, limit and handling mechanisms.

Enhanced performance

EtherCAT is by and large the fastest industrial Ethernet technology, but it also synchronizes with nanosecond accuracy. This is a huge benefit for all applications in which the target system is controlled or measured via the bus system. The rapid reaction times work to reduce the wait times during the transitions between process steps, which significantly improve application efficiency.

Simple wiring and long communication distance

In step/direction control mode, the controller/PLC need to connect with each drive to send control signals, which will bring intensive signal cables and wiring complexity if many drives is required by the equimpment. While in EtherCAT applications, the controller/PLC need to connect with one of the drives, then line topology with other drives. Additionally, the EtherCAT communication allows longer distance up to 100 meters maximum.

Lower cost

EtherCAT delivers the features of industrial Ethernet at a price similar or even below that of traditional control mode. The only hardware required by the master device is an Ethernet port, no expensive interface cards or co-processors are necessary. Since EtherCAT doesn't require high-speed pulse modules or other active infrastructure components, the costs for these components and their installation, configuration, and maintenance are also eliminated. Their connection topologies are as below:

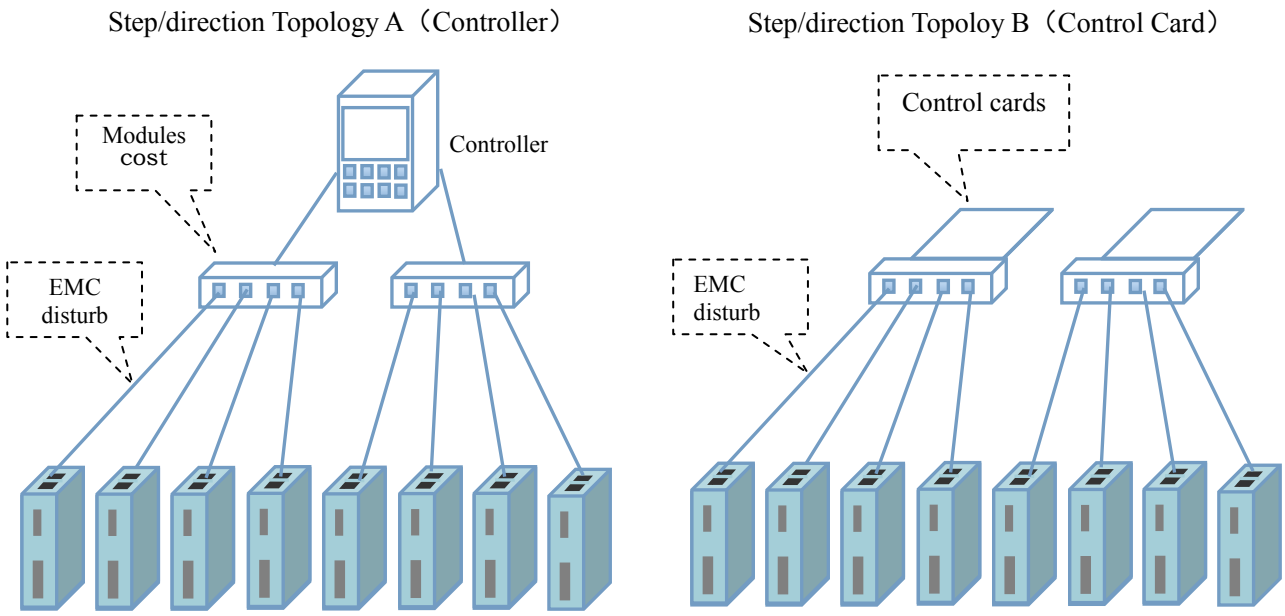


Figure 1.1 Step/direction Topologies

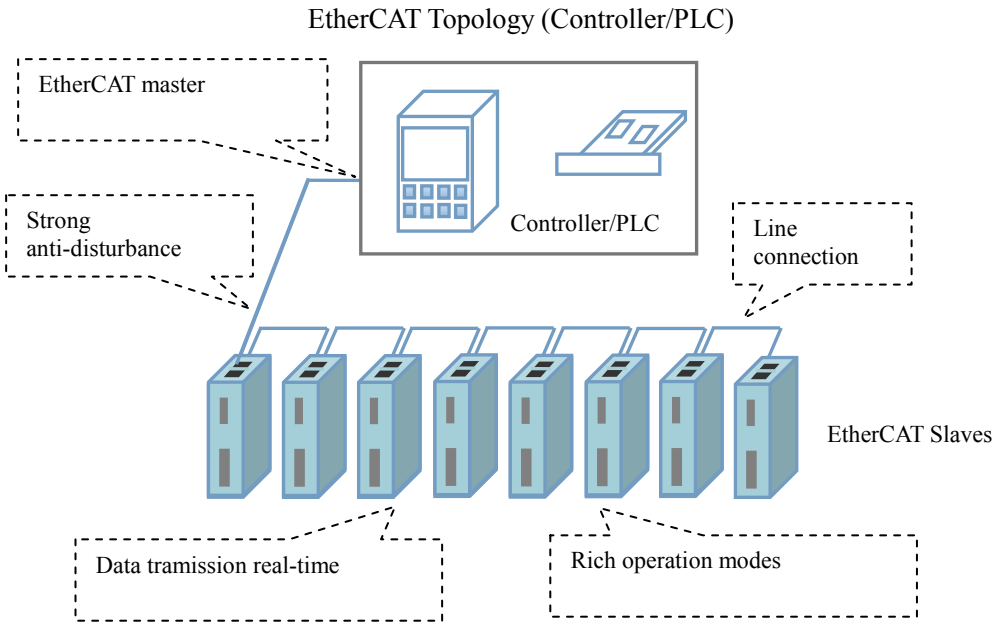


Figure 1.2 EtherCAT Topology

1.3 Check of Product

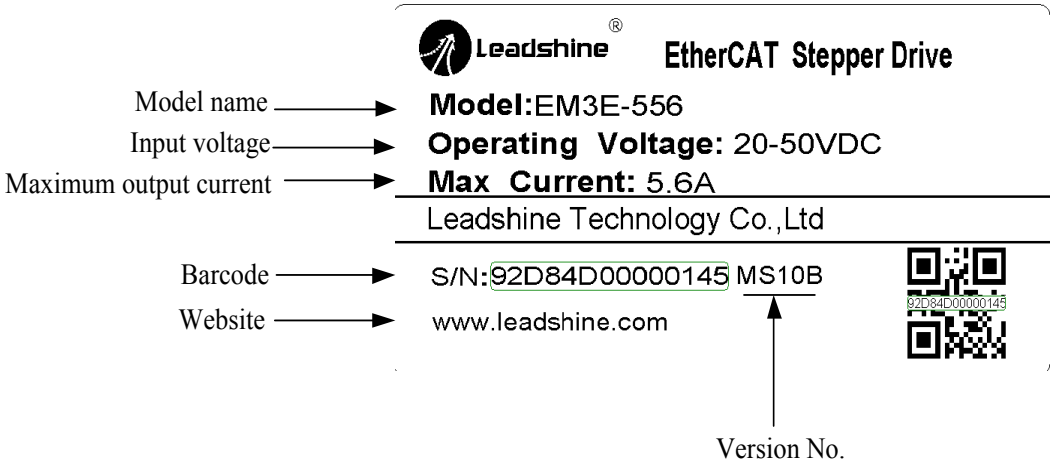
Arrival inspection

- Check if the face of the product is damaged or not during transportation.
- Check the nameplate models of the drive and motor is what you have ordered.
- Cheek if it is fully equipped with accessories.
- Cheek if it is fully equipped with accessories. Accessories include a page of simple description, power supply and motor output connector, control I/O signal connector.

CAUTION

- Neither the damage nor missing accessories of stepper system are not allowed to install.
- Contact to Leadshine or local distribution if you find any failure.

Nameplate information



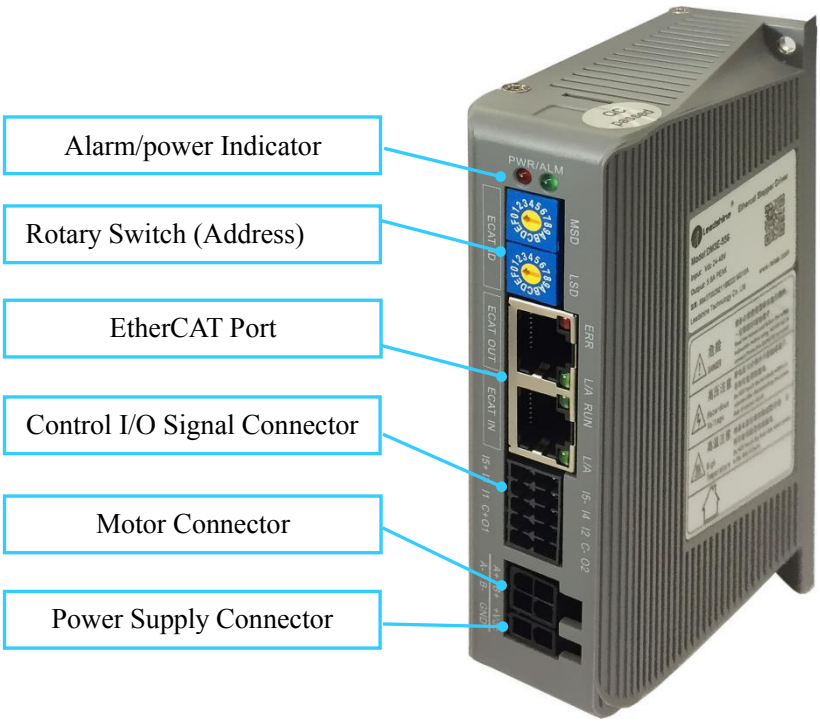
Part number

EM3E - 5 56 - □

1 2 3 4 5

1. Series Name
   EM3: 3rd generation digital stepper drives
2. Communication Mode
   E: EtherCAT
3. Maximum Operating Voltage
   5: 50VDC
4. Maximum Output Current
   56: 5.6A
5. Customerized Code
   Blank: standard

Parts description



Chapter 2 Installation

2.1 Storage and Installation Conditions

Storage condition:

- Correctly packaged and store in a clean and dry, avoid direct sunlight.
- Store within an ambient temperature range of -20℃ to +65℃.
- Store within a relative humidity rang of 40% to 90% and non-condensing.
- DO NOT store in a place subjected to corrosive gasses.

Operation ambient conditions:

- Temperature range of 0℃ to 50℃. The ambient temperature of drive for long-term reliability should be under 40℃. Please install the drive in a well-ventilated location.
- Operation within a relative humidity rang of 40% to 90% and non-condensing.
- The vibration lower than 0.15mm, 10Hz-55Hz.

CAUTION

- DO NOT mount the drive and motor in a location subjected to corrosive gasses or flammable gases, and combustibles.
- Please mount the drive and motor to an indoor electric control cabinet without liquid and direct sunlight.
- DO NOT mount the drive and motor in a location subjected to airborne dust.
- Please ensure grounding wires are securely connected

2.2 Mechanical Specification

Unit: mm, 1inch=25.4mm

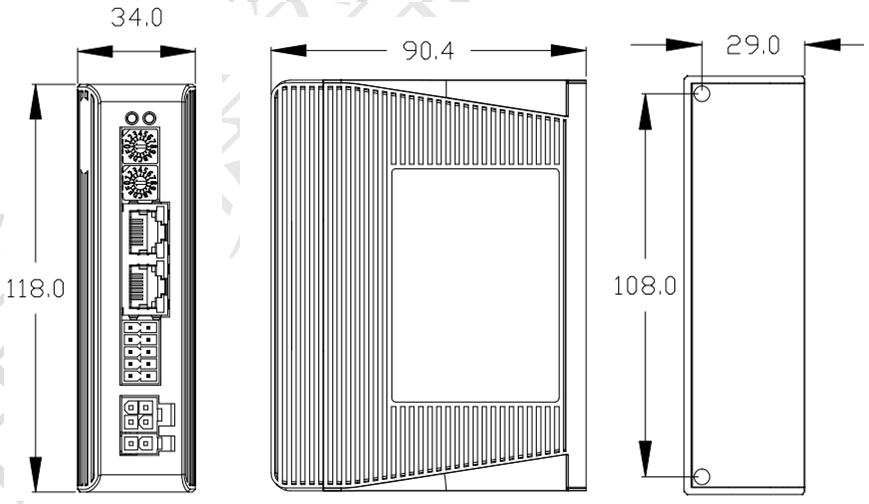


Figure 2.1 EM3E series mechanical drawing

2.3 Installation Direction and Space

- The mounting of drive, wiring and motor should be under the regulations of EN 61800-5-1.
- Incorrect installation may result in a drive malfunction or premature failure of the drive and or motor. Please follow the guidelines in this manual when installing the drive and motor.
- The drive should be mounted perpendicular to the wall or in the control panel.
- In order to ensure the drive is well ventilated, ensure that the all ventilation holes are not obstructed and

sufficient free space is given to the drive, and a cooling fan is mounted in the control panel.

- Please ensure grounding wires are securely connected.

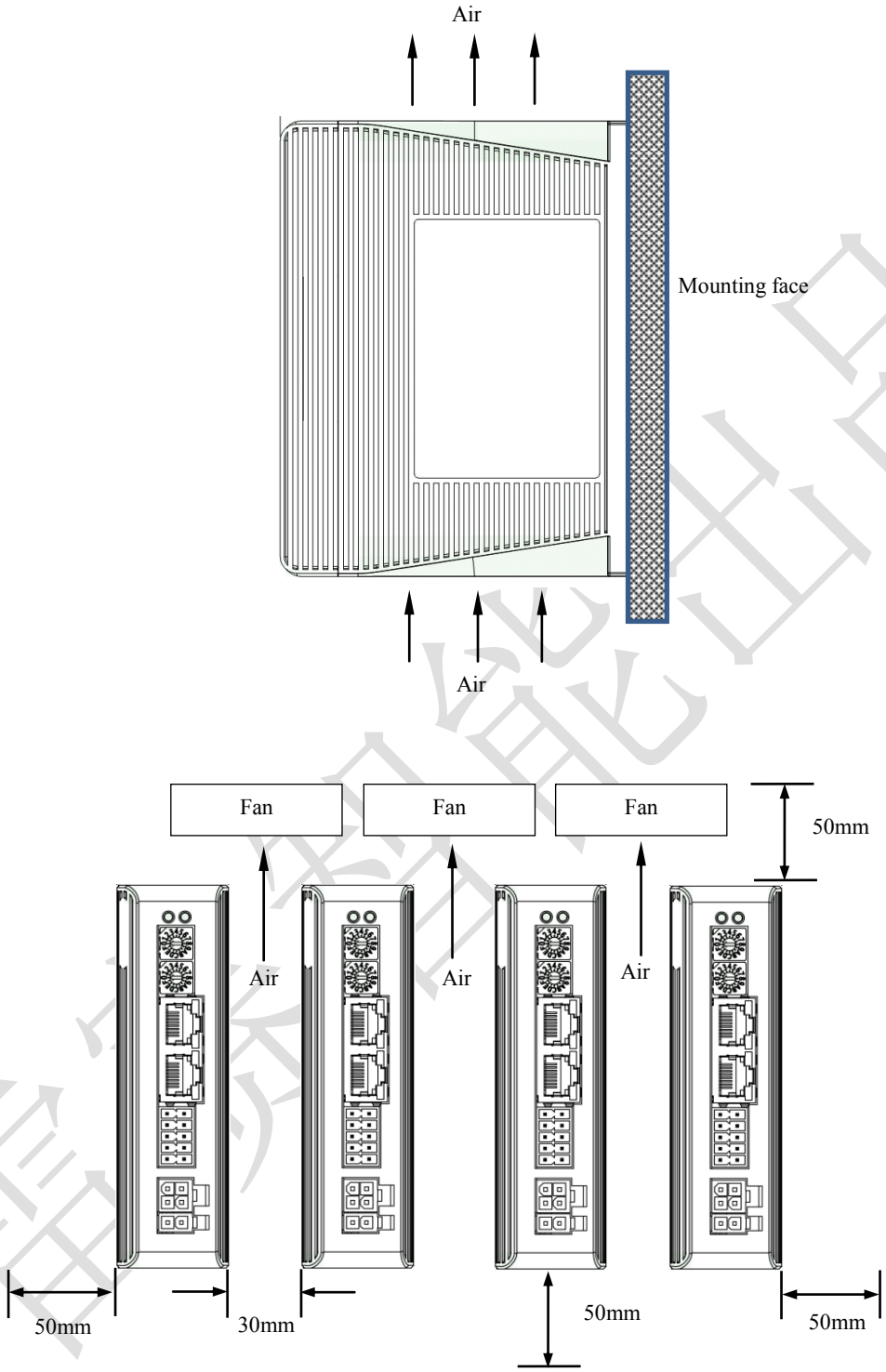


Figure 2.2 EM3E series installation drawing

Chapter 3 Production Specifications

3.1 Electrical and Operating Specifications

Table 3.1 Electrical and Operating Specifications

Parameters	EM3E-522	EM3E-542	EM3E-556	EM3E-870
Supply Voltage	20-50Vdc	20-50Vdc	20-50Vdc	20-50Vdc
Output Current (Peak)	0.5-2.2A	1.0-5.6A	1.0-5.6A	2.1-8.0A
Size (H*W*L mm)	118*90.4*34			
Weight (kg)	0.57			
Matched Motor	NEMA 11,17	NEMA 17, 23,	NEMA 23, 24	NEMA 24,34
Input Signals	Home Input, Positive Limit, Negative Limit			
Output Signals	Brake, Alarm			
Protection Funtions	Over Current, Over Voltage, Limit, Excess Velocity, etc.			
PC Software	None			
Communication Port	RJ45			
Operating Environment	Environment	Avoid dust, oil fog and corrosive gases		
	Operating Temperature	0-50℃ (32 F – 122 F)		
	Storage Temperrature	-20℃ ~ 65℃ (-4 F – 149 F)		
	Humidity	40-90%RH		
	Vibration	10-55Hz/0.15mm		
	Mount	Vertical or horizontal mounting		

3.2 Wiring Instructions

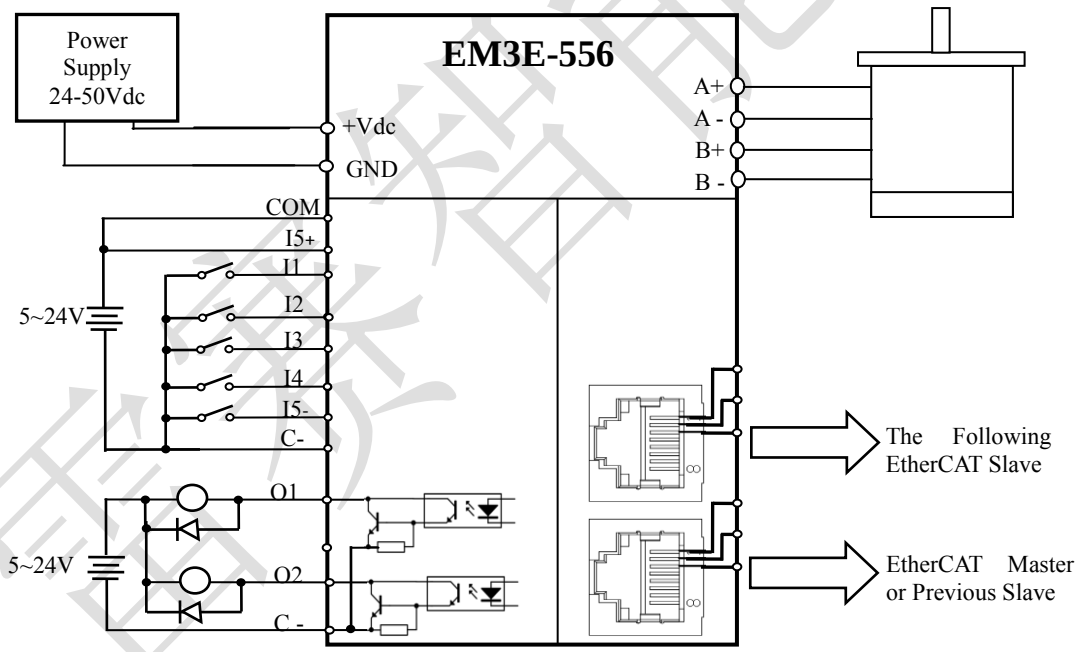


Figure 3.1 EM3E series wiring diagram

Note: There are two EtherCAT communication ports above, one of them is input port which connecting with master station or previous slave, and another is output port which connecting with the following slave.

3.2.1 Power Supply & motor Cable

- Wire diameter: +VDC, GND, A+, A-, B+, B- terminal wire diameter≥0.3mm^2 (AWG15-22)
- Recommend connecting a noise filter between power supply and drive, can improve anti-interference performance.

3.2.2 I/O Signal Cable

- Wire diameter: I1, I2, I3, I4, I5+, I5-, C+, C-, O1, O2 terminal wire diameter≥0.12mm^2 (AWG24-26)

- Recommended to adopt shielded twisted pair cable, cable length as short as possible, suggest no more than 3 meters
- Wiring: As far as possible away from the power line wiring, in order to prevent interference
- Please connect surge absorber to inductive device, such as anti-parallel diode for DC coil, parallel RC-snubbers circuit for AC coil.

3.2.3 EtherCAT Communication Cable

It is recommended to ues standard Ethernet network cables does not exceed 100 meters.

CAUTION

- DO NOT connect the reversed polarity of power supply.
- Cables must be fixed and far away from motor cover and drives heat sink to avoid to reducing insulation performance as be heated.
- Be sure to turn off power and wait for at least 5 minutes when using EM3E-870, and then you can transport, wiring and inspecting the drives and motors.

3.3 Interface Specifications

3.3.1 Connectors Definition

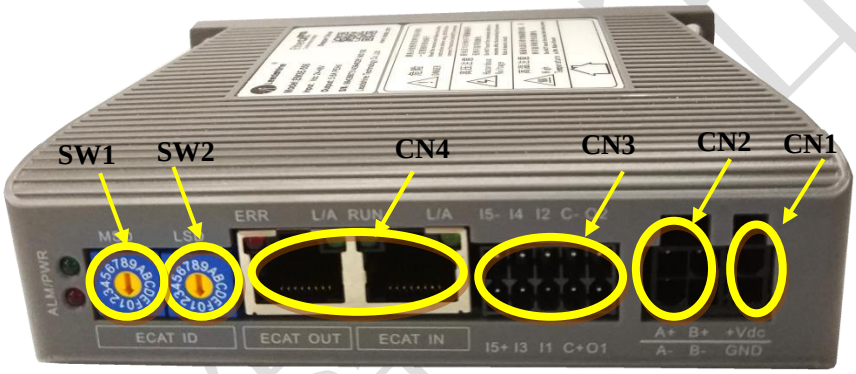
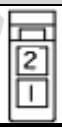


Figure 3.2 EM3E series connectors

Name	Description
CN1	Input power connector
CN2	Motor connector
CN3	I/O signals connector
CN4	EtherCAT communication connector
SW1	Setting communication high address
SW2	setting communication low address

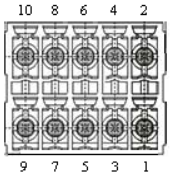
3.3.2 Input Power Connector

Name	Pic	PIN	Signal	Description
CN1		1	VDC	24V~ 50V
		2	GND	GND

3.3.3 Motor Connector

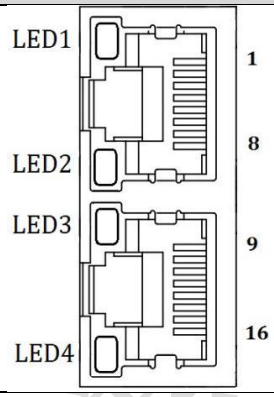
Name	Pic	PIN	Signal	Description
CN2		1	A+	Motor phase A+
		2	B+	Motor phase B+
		3	A-	Motor phase A-
		4	B-	Motor phase B-

3.3.4 I/O Signals Connector

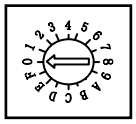
Name	Pic	PIN	Siganl	I/O	Description
CN3		1	O1	O	Digital OC output 1, single-end, Max. 24V/50mA, alarm function
		2	O2	O	Digital OC output 2, open drain, Max. 24V/50mA, in place function.
		3	C+	I	Input common voltage 5V to 24V, provided by controller/PLC
		4	C-	O	Output common ground
		5	I1	I	Digital input 1, single-end, 5V to 24V, proble 1 function
		6	I2	I	Digital input 2, single-end, 5V to 24V, homing function
		7	I3	I	Digital input 3, single-end, 5V to 24V, positive limit function
		8	I4	I	Digital input 4, single-end, 5V to 24V, negative limit function
		9	I5+	I	Digital input 5+, difference, 5V to 24V
		10	I5-	I	Digital input 5-, difference, 5V to 24V

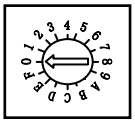
Remark: I/O interface and corresponding parameter setting refer to chapter 3.4

3.3.5 EtherCAT Communication Connector

Name	Pic	PIN	Signal	Description
CN4		1, 9	E_TX+	EtherCAT TxD+
		2, 10	E_TX-	EtherCAT TxD-
		3, 11	E_RX+	EtherCAT RxD+
		4, 12	/	/
		5, 13	/	/
		6, 14	E_RX-	EtherCAT RxD-
		7, 15	/	/
		8, 16	/	/
		Cover	PE	Shield earthing
Note	(1) LED1 as'Link/Activity IN' indicator, green (2) LED3 as'Link/Activity OUT' indicator, green (3) LED2 as'RUN' indicator, green (4) LED4 as'ERR' indicator, red			

3.3.6 EtherCAT ID (Site Alias) Setting


MSD (SW1)


LSD (SW2)

The EtherCAT ID (Site Alias) of EM3E series can be set by the following 3 methods:

Setting via rotary switch

When 2151h is set to value '0', user can set a value non-zero via the two rotary switches as the ID address of slave, the specific definition as below:

The EtherCAT ID of drives comes from the constituent hexadecimal value by rotary switch 1 (SW1) and rotary switch 2 (SW2). For example, when the SW1 is set value 'A' , and the SW2 is set value '8' , the ID is 168 (decimalism).

Setting via reading the SII site alias of ESC

The EtherCAT master can configurate site alias to the EEPROM address 0004h of ESC, when object 2051h is set to 0, and the both two rotary switches are set to 0, the value at address 0004h is the site alias of the slave, actived after restarting the power supply.

Setting via the site alias of object dictionary

When the address 2151h is set to 0, the value of address 2150h is as the site alias, actived after restarting the power supply.

Note: The EtherCAT ID address is actived after restarting the power supply for above three methods.

3.4 I/O Interface and Corresponding Parameters Setting

3.4.1 Digital Input

Wiring

There are two types of input signals: single-end and difference, the wirings are as below:

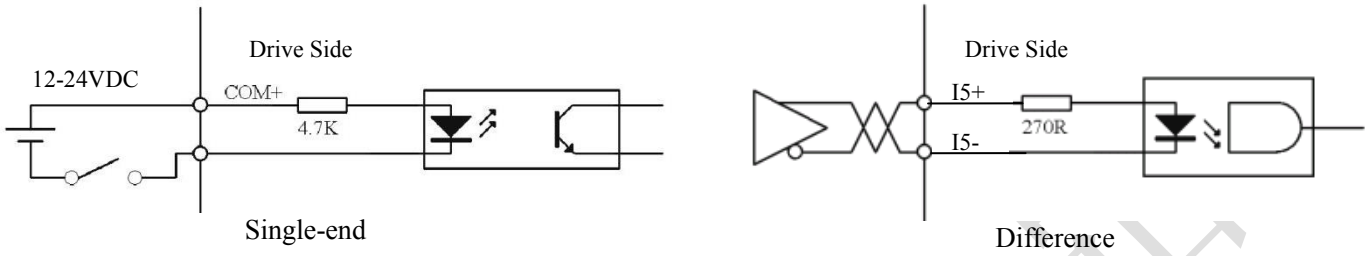


Figure 3.3 Input Interface Wiring

Note:

(1) Controller/PLC/Control card should provide input DC power 12-24V (5-24VDC is allowed, 12-24V is recommended), current ≥ 100mA.

(2) If the polarity of input DC power is reversed, the EtherCAT stepper drive won't work; you need to turn the wiring.

Mainly parameters related to digital input

Parameter Address Index + sub-index	Name	Access	Default Value	Range	Description	
2152+01	Digital input 1 function	R/W/S	32	0~32768	1: homing signal 2: positive limit 4: negative limit 8: emergency stop 16: user-defined	
2152+02	Digital input 2 function	R/W/S	1	0~32768	1: homing signal 2: positive limit 4: negative limit 8: emergency stop 16: user-defined	
2152+03	Digital input 1 function	R/W/S	2	0~32768	1: homing signal 2: positive limit 4: negative limit 8: emergency stop 16: user-defined	
2152+04	Digital input 1 function	R/W/S	4	0~32768	1: homing signal 2: positive limit 4: negative limit 8: emergency stop 16: user-defined	
2152+05	Digital input 1 function	R/W/S	16	0~32768	1: homing signal 2: positive limit 4: negative limit 8: emergency stop 16: user-defined	
2153+01	Digital input 1 filter time	R/W/S	1000	50~60000	unit:us	Note: Too large filter time may cause time delay of control command
2153+02	Digital input 2 filter time	R/W/S	1000	50~60000	unit:us	
2153+03	Digital input 3 filter time	R/W/S	1000	50~60000	unit:us	
2153+04	Digital input 4 filter time	R/W/S	1000	50~60000	unit:us	
2153+05	Digital input 5 filter time	R/W/S	1000	50~60000	unit:us	
2154+00	Digital input active	R/W/S	0	0~65535	0: active low level (in default)	

	level configuration				1: active high level(bit0 mapping digital input1, and so on), bit0 to bit4 mapping I1 to I5

Note: (1) I/O signal pin assignments refer to chapter 3.3.4 connector –CN3.

Other parameters related to digital input

Reading digital input active level state

2155+00	Digital input state	RO	0	0~32768	0: active low level 1: active high level (bit0 mapping input1, and so on)

Reading digital input function state

60FD+00	Digital input function	RO	unsigned 32 bits	bit0: negative limit bit1: positive limit bit2: homing signal bit16: emergency stop bit17-bit21: mapping the input level of I1-I5 when they are set to user-defined function bit26: Probe1 trigger complete instructions bit27: Probe2 trigger complete instructions Note: Field bus version 202 or above are vaild

3.4.2 Digital Output

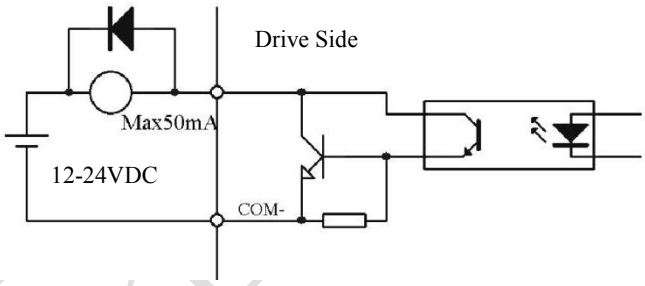


Figure 3.4 Output Interface Wiring

Note:

(1) The power supply (12-24VDC) above is provided by user, and if the polarity of power supply is reversed, it will damage the drive.

(2) Digital output is OC output with the maximum capacity of 50mA/25V, the provided power supply (12-24VDC) should under this limit, if not, and it will damage the drive.

(3) It must to connect a freewheeling diode in parallel as above if the load is inductive loads such as relays, if the diode is reversed, it will damage the drive.

Digital output-related parameter list

Parameter Address Index + sub-index	Number	Access	Default Value	Range	Description
2005+01	Digital output 1 function	R/W/S	1	1~16	bit0: alarm output bit2: in-position output bit4: master station control
2005+02	Digital output 2 function	R/W/S	4	1~16	bit0: alarm output bit2: in place output bit4: master station control
2008+00	Digital outout state	R/W/S	0	0~3	0: positive logic 1: negative logic bit0 is mapping digital ouput1, and so on

When the bit4 of object 2005h+01/02 is set to 1(the value of 2005h+01 or 2005h+02 is 16), the related parameter is set as below:

Parameter Address Index + sub-index	Number	Access	Data Type	Description
60FE+01	Output function available	RW	unsigned 32 bits	When I/O output function set to master station control, master controller can use the combination of 60FE+01 and 60FE+02 to control I/O output: When bit16 of 60FE+01and 60FE+02 are both '1', O1 have output When bit17 of 60FE+01and 60FE+02 are both '1', O2 have output, and so on……
60FE+02	Output function enable	RW	unsigned 32 bits	

Chapter 4 EtherCAT Technology

4.1 EtherCAT Technology Principles

The traditional Ethernet device composed of network, each device can receive all the data packets in the network, the useful information specified in the application layer of the device must be extracted one by one, which seriously affected the efficiency of the application layer.

EtherCAT technology has broken the system limitations of traditional Ethernet solutions, and no other Ethernet connections are allowed to receive all packets from Ethernet. When the data frame passes through each device, the EtherCAT slave station reads the corresponding address data when the message passes through its node. Similarly, the input data can be inserted into the message when the message is passed. The slave station identifies the relevant commands and processes them when the frame is delivered (a few nanoseconds delay). This process is implemented by hardware in the slave controller; therefore there is nothing to do with the performance of the protocol stack processor. Since Ethernet frames arrive at the data of many devices, the available data rates are increased to over 90% in the transmit and receive directions, full use of the 100BaseTX full duplex function enables the effective data rate of > 100 M Bit/S (> 2 * 100 M Bit/S 90%) can be achieved.

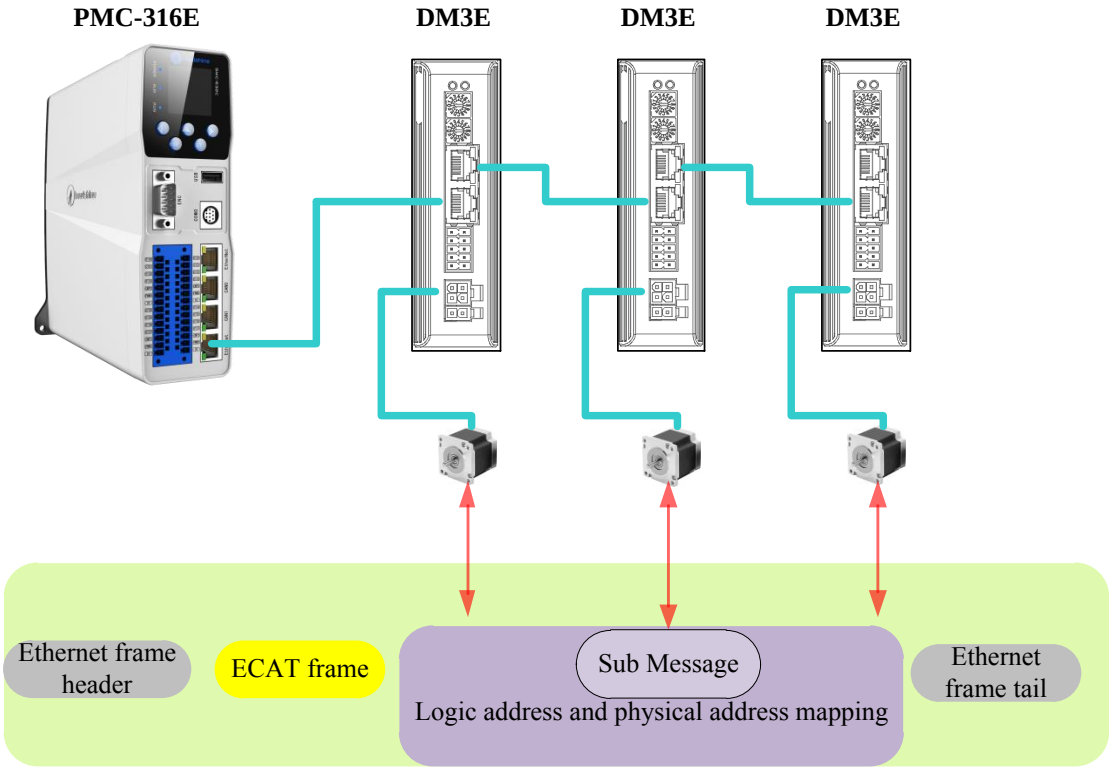


Figure 4.1: Digital packaging of process data

4.2 EtherCAT Data Frame Structure

EtherCAT uses Ethernet data frames for transmission; the frame type is fixed to 0x88A4. EtherCAT data frame contains two bytes of EtherCAT frame header and 44~1498 bytes of EtherCAT data. The EtherCAT data region consists of one or more EtherCAT sub messages, each of which corresponds to a storage area of the slave station. EtherCAT date frame structure as shown in figure 4.2. And the specific meaning of the data frame structure is shown in Table 2.1.

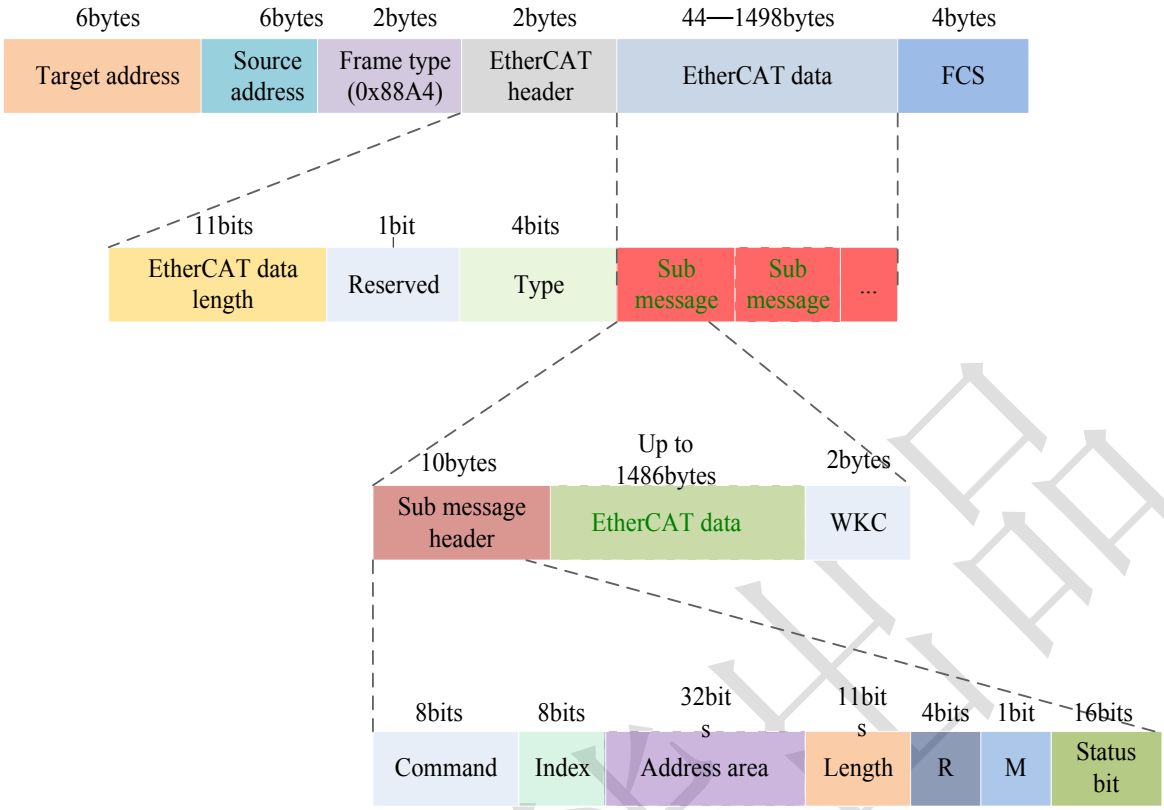


Figure 4.2 : EtherCAT data frame structure

Table 4.1: EtherCAT frame structural meaning

Frame structure	Meanings
Target address	Receiver MAC address
Source address	Sender MAC address
EtherCAT frame header: data length	EtherCAT the total length of all sub messages in the data region
EtherCAT frame header: type	1: communication with slave stations; other reserved
FCS	Frame check

4.3 Synchronous Mode

4.3.1 Free running mode

EM3E uses asynchronous mode to process data sent by the main station under free running mode, it applies only to asynchronous motion modes, such as origin mode, protocol positions mode, etc.

4.3.2 Distributed clock synchronization mode

EM3E uses the distributed clock synchronization mode shown in Fig. 4.3, which reads the process data immediately after the master station transmits the process data to the slave station, then wait for the sync signal to trigger the process data and act on the drive.

The process data must reach the EM3E drive ahead of the SYNC0 signal T1 time, and the drive has completed the analysis of the process data and the related control calculations before the SYNC0 event arrives, when the SYNC0 event is received, EM3E immediately implements the control action, which has higher synchronization performance, which applies to the EM3E synchronous motion pattern referred to in section 3.5 of this manual.

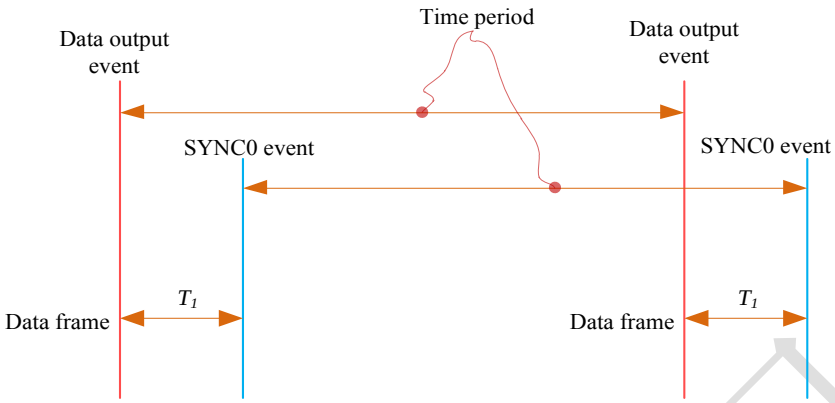


Figure 4.3: High performance synchronous mode

4.4 EtherCAT state machine

EtherCAT state machine, commonly known as "communication state machine", is mainly used for the management of communication between master and slave stations, and the communication function mainly includes mail and process data communication. The EtherCAT state transition relationship is shown in Figure 4.4.

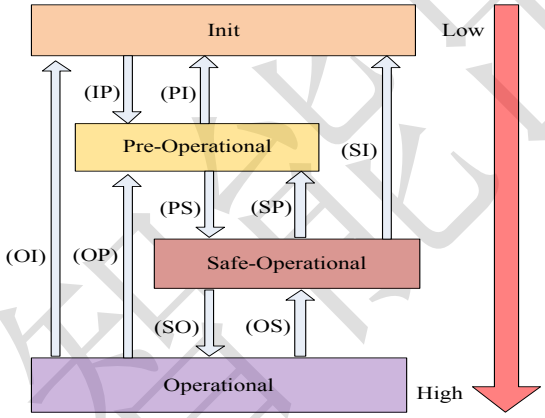


Figure 4.4: EtherCAT state machine transformation

The transformation of the EtherCAT state machine has the following characteristics:

(1) From initialization to operation, you must switch from low to high in order of initialization, > pre-operational > Safe-operational > > operation > not skip.

(2) From high to low transition, you can skip the transition.

(3) The master station is the initiator of all state transitions, from which the slave station responds to the state requested by the master station.

(4) If the status transition requested by the master fails, the error message is sent from the station to the master station.

Table 4.2: The communication function of EtherCAT state machine

State machines and transformations	Communication function
Init	Communication between master and slave stations
Pre-Operational	Mailbox communication is valid and process free data communication, that is, SDO function is effective
Safe-Operational	Mailbox communication and sending process data objects are valid, that is, SDO and TXPDO are valid
Operational	Mailbox communication, receive and send process, data object is effective, namely SDO, RXPDO and TXPDO are effective

4.5 COE

4.5.1 COE VS CANopen DS301

COE is similar to the CANopen DS301 protocol, but on its basis, changes and extensions are made, and their differences are listed in table 2.3.

Table 4.3: COE and CANopen DS301 comparison

Contrast items	COE	DS301
Fieldbus	EtherCAT	CAN
Message structure	Standard Ethernet	CAN 2.0A standard
SDO date collection	SM mailbox data area	CAN message
PDO data collection	SM process data area	CAN message
Each PDO mapping length	Maximum 32 bytes *1)	Maximum 8 bytes
Communication state machine swiching	0x120/0x130 register	NMT (network management tool)
Indentification of communication objects	Synchronization management (SM)	COB-ID (object dictionary indentification code)

*1) EM3E supports each PDO mapping 8 object dictionary objects with a maximum of 32 bytes

4.5.2 EM3E network structure

The structure of the network module of the EM3E stepping system is shown in figure 4.5:

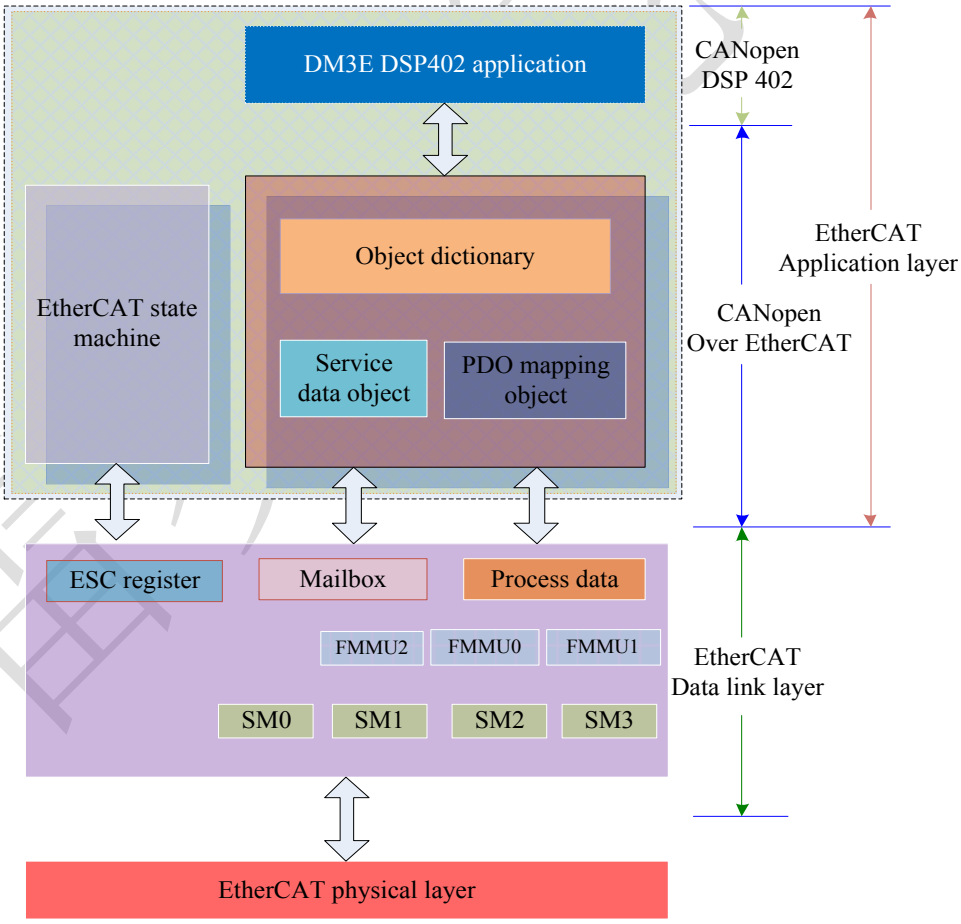


Figure 4.5: EM3E device structure

- The realization of data link layer is mainly from EtherCAT station controller (ESC) to realize the EM3EEtherCAT application layer protocol mainly includes the application part (CANopen DSP402), the three part of the object dictionary and communication function (red gridlines part), the object dictionary and

communication function can be collectively referred to as the COE.

- Core part: **Object dictionary**——the brige between communication function and application part
- Key part: **Communication function**——Implementation of communication rules (SDO, PDO, etc.).
- Important part: **Application part**——Determines the device's specific functions, such as drives and IO modules.

4.5.3 Object dictionary

EtherCAT master to read and write through the parameter / equipment status information to control the EM3E driver, in order to achieve this goal, the driver can read and write the defined parameters and read-only state value is a set of these parameters and the state of the object dictionary.

The EM3E object dictionary contains all data objects related to DSP402 and CoE in a standardized manner. It is a collection of EM3E parameter data structures.

Object dictionary access interface

EM3E object dictionary of master station and its communication interface, as shown in figure 4.6.

The EtherCAT main station implements the motion control function of EM3E, which is accomplished by the object dictionary interface

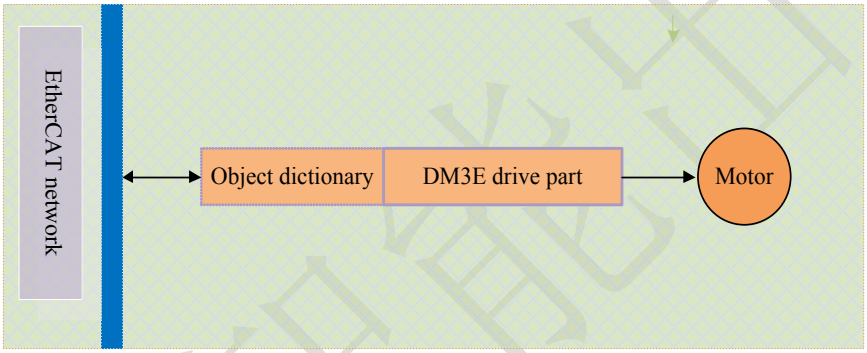


Figure 4.6: Object dictionary as access interface

Object dictionary and application layer protocol

The application layer protocols (COE and DSP402) specify a large number of mandatory objects and optional objects. EM3E communication part (COE) and EtherCAT network to realize the interactive function, the application shall be part of the communication is the object dictionary, for example, the configuration object dictionary to receive data sent by the master station; the application part of EM3E (CANopen DS402) is to achieve how to access the device of movement function, it is required to use the application part of the object dictionary, for example, a configuration object dictionary to control the origin of EM3E movement; these functions are based on object dictionary interface.

Object dictionary structure and visit characteristics

Basic structure of the object dictionary as table 4.4

Table 4.4 : Object dictionary structure

Index	16bit, such as 1000h
Subindex	8bit, such as 00h、01h
Name	
Object type	Var、array etc.
Data type	Such as unsigned 32-bit
Visit property	Such as RO
PDO mapping	No mapping
Value range	
Default value	

Object dictionary visit has the following features:

A. Follow the method of the dictionary, for example, you look up a word, syllable sequence index first found, then query other parts of syllables.

B. Fixed indexes and sub indexes correspond to the objects that are determined.

C. The object dictionary access methods include the service data object (SDO) and the process data object (PDO)

4.5.4 Service data object (SDO)

SDO overview

The EM3E series stepping system supports the SDO service, and the EtherCAT master can configure, monitor and control the EM3E stepping system by using SDO to read and write the object dictionary of the EM3E stepping system.

The SDO adopts the client / server model, the master station corresponds to the client in the SDO operation, and the EM3E slave station is the server, all the transfers must be client initiated, then the server responds.

In traditional CANopen DS301 mode, the SDO protocol can only transmit 8 bytes at a time in order to match the data length of CAN packets. In the COE enhancement mode, only the payload data is expanded without changing the protocol header. In this way, the SDO protocol uses a mailbox with a larger data length, thereby improving the transmission efficiency of large data.

SDO protocol and message format

Currently, EM3E supports the following two SDO services:

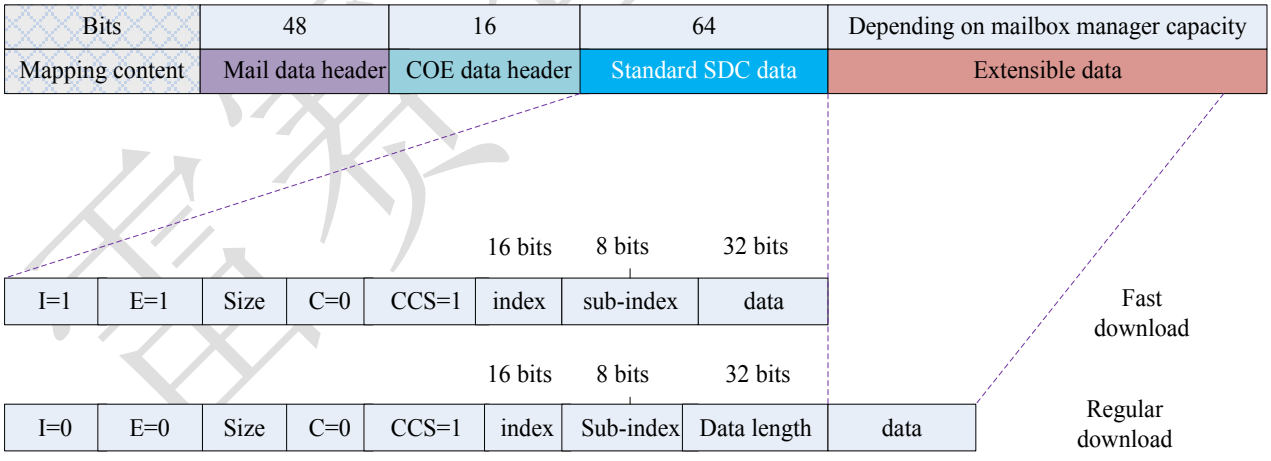
(1) Fast transmission service:

Consistent with the CANopen DS301 protocol, it uses only 8 bytes to transmit up to 4 bytes of valid data.

(2) Conventional transmission service:

The maximum number of bytes to transmit depends on the allocated mailbox synchronization manager capacity.

SDO transport is divided into two types of download and upload, this manual is only a brief introduction to download services, upload and more detailed, please refer to the ETG specification (ETG1000-5 and ETG1000-6) application layer protocol section. The SDO data frame format is shown in figure 4.7.



I： quantity mark
E： transmission type
Size: transport bytes
C： complete visit
CCS：command code

Figure 4.7: SDO download service data frame format

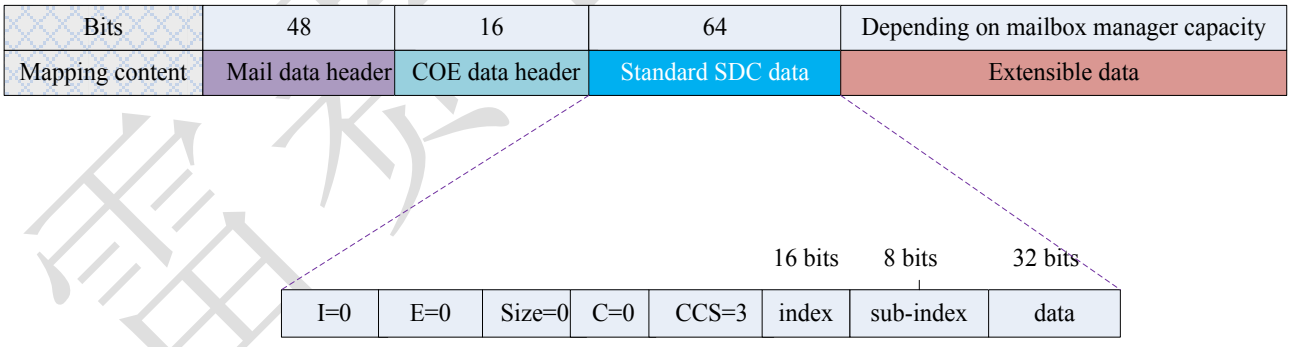
SDO download the transport request service data, as specified in table 4.5

Table 4.5: SDO download service data content list

Data area	Bytes	Bits	Name	Description
Mail header	2	16	Length n	n≥0x0A,COE command and SDO data length
	2	16	Address	Data original address
	1	0~5	Channel	Reserved
		6~7	Priority level	0: lowest priority 3: highest priority
	1	0~3	Type	3: COE
		4~7	Reserved	
COE command	2	0~8	PDO code	0
		9~11	Reserved	
		12~15	Service type	2: SDO request
SDO data	1 (control byte)	0	Quantity mark	0: Not set; 1: Set byte transmission
		1	Transmission type	0: conventional /segment transmission; 1: fast transmission
		2~3	Byte transmission	0: conventional /segment transmission invalid;others:number of byte transmission
		4	Complete visit	0: incomplete visit; 1: complete visit
		5~7	Command code	0: segment download request 1: download request
	2	16	Index	Object dictionary index
	1	8	Subindex	Object dictionary subindex
	4	32	Data	Fast transmission: object dictionary data Conventional transmission: total bytes of object dictionary
	n-10	*1)	Extended data	Conventional transmission for extended data

*1) It can be used conventional transmission mode as long as the length is no more than the mailbox synchronization manager settings.

After EM3E receives the download request of the main station SDO, EM3E parses its contents; if parsing does not make errors, EM3E sends the data frame of the download response to the main station; the format is shown in Figure 4.8



I： quantity mark
E： transmission type
Size: transport bytes
C： complete visit
CCS：command code

Figure 4.8: SDO download response data frame format

SDO download response data detailed content, as shown in table 4.6

Table 4.6: SDO download response data description

Data area	Bytes	Bits	Name	Description
Mail header	2	16	Length n	n≥0x0A,COE command and SDO data length
	2	16	Address	Data original address
	1	0~5	Channel	reserved
		6~7	Priority level	0:lowest priority,…3:highest priority
	1	0~3	Type	3:COE
		4~7	Reserved	
COE command	2	0~8	PDO code	0
		9~11	Reserved	
		12~15	Service type	3:SDO response
SDO data	1 (control byte)	0	Quantity mark	0
		1	Transmission type	0
		2~3	Byte transmission	0
		4	Complete visit	0:incomplete visit;1:complete visit
		5~7	Command code	0:segment download request;1:download request
	2	16	Index	Object dictionary index
	1	8	Subindex	Object dictionary subindex
	4	32	Reserved	

Stop SDO transmission

During the SDO transmission, if an error occurs in the EM3E data analysis, the SDO can be sent to terminate the transmission request, and the master station will terminate the current SDO transmission after receiving the request. Table 2.7 is the data content terminated by the SDO transmission.

Table 4.7: SDO stop data transmission description

Data area	Bytes	Bits	Name	Description
Mail header	2	16	Length n	n≥0x0A,COE command and SDO data length
	2	16	Address	Data original address
	1	0~5	Channel	reserved
		6~7	Priority level	0:lowest priority,…3:highest priority
	1	0~3	Type	3:COE
		4~7	Reserved	
COE command	2	0~8	PDO code	0
		9~11	reserved	
		12~15	Service type	2:SDO request
SDO data	1 (control byte)	0	Quantity mark	0
		1	Transmission type	0:conventional /segment transmission
		2~3	Byte transmission	0
		4	Reserved	
		5~7	Command code	4:stop transmission request
	2	16	Index	Object dictionary index
	1	8	Subindex	Object dictionary subindex
	4	32	Stop code	Details refer to table 2.10

Table 4.7 shows the termination code of 4 bytes, which indicates the reason for the termination of the transmission, as defined in table 4.8

Table 4.8: Transmission terminated code supported by EM3E SDO

Termination code	Meanings
0x05040000	SDO transmission time out
0x05040001	Command code invalid or unkown
0x05040005	Memory overflow
0x06010000	An attempt to manipulate objects that do not support access *1)
0x06010001	An object that attempts to write only properties
0x06010002	An object that attempts to write a read-only property
0x06020000	The object to access does not exist
0x06040041	Object cannot be mapped to PDO
0x06040042	The length of the PDO mapping exceeds the prescribed length
0x06090011	The object subindex does not exist
0x06090031	The input value exceeds the maximum value and is automatically set to the maximum value
0x06090032	The input value exceeds the minimum and is automatically set to the minimum
0x08000000	General error
0x08000020	Unsupported transport / save operation *2)
0x08000021	Invalid save operation *3)

*1) Currently only support the save / restore of the vendor parameters, attempting to save / restore other class objects will report the error.

*2) Operate the 1010h/1011h object to save / restore parameters, and the input data does not conform to the COE specification.

4.5.5 Process data object (PDO)

PDO overview

PDO is generally used for real-time data updates. It is divided into PDO (RXPDO) and PDO (TXPDO). The data flow direction of the former is from the main station to the slave station and the latter from the station to the main station.

The EM3E PDO feature supports synchronous cycle refresh and also supports non periodic updates. When the master station chooses the distributed clock synchronization mode, the PDO will be updated at the same synchronization period (see Figure 2.4 for more information); if the free run mode is selected, then the update of the PDO data will be aperiodic.

PDO mapping

Through PDO mapping, real-time transmission of mapping objects can be achieved. EM3E supports 4 groups of RXPDO and 2 groups of TXPDO simultaneous transport, each PDO object can map 8 object dictionary objects (maximum length 32 bytes), PDO mapping content format, as shown in the table 4.9.

Table 4.9: PDO mapping content format

Bit	**31~16**	**15~8**	**7~1**
Content	Subindex of mapped object	Subindex of mapped object	Bit length (hexadecimal form)
Example	6040h	00h	10h (length: 16bits)

The default PDO mapping (consistent with the XML file) is shown in table 4.10.

Table 4.10: Default PDO mapping

PDO mapping object index	PDO object subindex	Mapping content	Mapping content decomposition			Name of the mapping content
			Index	Subindex	Bit length	
RXPDO1 (1600h)	01h	60400010h	6040h	00h	10h (16 bits)	Control byte
	02h	607A0020h	607Ah	00h	20h (32 bits)	Target position
	03h	60B00020h	60B0h	00h	20h (32 bits)	Position offset
	04h	60B80010h	60B8h	00h	10h (16 bits)	Probe function
RXPDO2 (1601h)	01h	60400010h	6040h	00h	10h (16 bits)	Control byte
	02h	607A0020h	607Ah	00h	20h (32 bits)	Target position
	03h	60810020h	6081h	00h	20h (32 bits)	Max. speed
	04h	60830020h	6083h	00h	20h (32 bits)	Acceleration
	05h	60840020h	6084h	00h	20h (32 bits)	Deceleration
	06h	60600008h	6060h	00h	08h (8 bits)	Operation mode
RXPDO3 (1602h)	01h	60400010h	6040h	00h	10h (16 bits)	Control byte
	02h	60FF0020h	60FFh	00h	20h (32 bits)	Target speed
	03h	60830020h	6083h	00h	20h (32 bits)	Acceleration
	04h	60840020h	6084h	00h	20h (32 bits)	Deceleration
	06h	60600008h	6060h	00h	08h (8 bits)	Operation mode
RXPDO4 (1603h)	01h	60400010h	6040h	00h	10h (16 bits)	Control byte
	02h	60980008h	6098h	00h	08h (8 bits)	Homing method
	03h	60990120h	6099h	01h	20h (32 bits)	Homing speed (fast)
	04h	60990220h	6099h	02h	20h (32 bits)	Homing speed (slow)
	05h	609A0020h	609Ah	00h	20h (32 bits)	Homing acceleration/deceleration
	06h	607C0020h	607Ch	00h	20h (32 bits)	Homing offset
	07h	60600008h	6060h	00h	08h (8 bits)	Operation mode
TXPDO1 (1A00h)	01h	603F0020h	603Fh	00h	10h (16 bits)	Latest error code
	02h	60410010h	6041h	00h	10h (16 bits)	Status word
	03h	60610008h	6061h	00h	08h (8 bits)	Operation mode display
	04h	60640020h	6064h	00h	20h (32 bits)	Actual position
	05h	60B90008h	60B9h	00h	10h (16 bits)	Probe status
	06h	60BA0020h	60BAh	00h	20h (32 bits)	Probe 1 rising edge position
	07h	60FD0020h	60FDh	00h	20h (32 bits)	Digital input status
TXPDO2 (1A01h)	No default mapping					

PDO dynamic mapping

Unlike CIA DS301, COE uses the PDO specified object (1C12h/1C13h) to configure the PDO mapping object (1600h~1603h/1A00h~1A01h) to the PDO object synchronization manager (synchronization manager 2/3), and PDO specifies the object definition, such as table 4.11.

Table 4.11: PDO specified object definition

Index	Subindex	Range	Data type	Access property
RXPDO Specified object (1C12h)	00h	0~4	U8 *1)	RO *2)
	01h	1600h~1603h	U16	RW
	02h		U16	RW
	03h		U16	RW
	04h		U16	RW
TXPDO Specified object (1C13h)	00h	0~2	U8	RO
	01h	1A00h~1A01h	U16	RW
	02h		U16	RW

*1) U stands for unsigned types, such as U8, which stands for unsigned 8 bits, and U16 for unsigned 16 bits.

*2) Access property expression, RO means read only, RW means readable, and WO stands for writing only.

EM3E PDO dynamic mapping setting process

A. Switch the EtherCAT state machine to the pre operation. In this state, you can configure the PDO mapping using SDO, and each state communication function can refer to the contents described in table 2.2.

B. Clears the PDO mapping object of the PDO specified object, that is, set 1C12-00h/1C13-00h to 0.

C. The PDO mapping object is invalid, that is, the subindex 0 of the 1600h~1603h/1A00h~1A01h is assigned to value '0'.

D. To configure the PDO mapping, mapping the object according to table 2.11 format written to a 1600-01h~1600-08h, 1601-01h~1601-08h, 1602-01h~1602-08h, 1603-01h~1603-08h (1600h-01 to begin writing for RXPDO mapping, 1A00-01h~1A00-08h content) or 1A01-01h~1A01-08h (1A00h-01 to begin writing for TXPDO content range object mapping).

E. Sets the total number of PDO map objects to be written to 1600-00h, 1601-00h, 1602-00h, 1603-00h, 1A00-00h, or 1A01-00h. The total number of PDO mapped objects that do not have mapped content will be 0.

F. Write PDO to PDO mapping object the effective index of the specified object, RXPDO mapping object index 1600h~1603h will effectively write to 1C12-01h~1C12-04h, the effective TXPDO mapping object index 1A01h,1A00h are written in 1C13-01h, 1C13-02h.

G. Sets the total number of PDO specified objects, and writes the number of mapped objects to 1C12-00h and 1C13-00h.

H. Converting the EtherCAT state machine to security operations or more, the configured PDO mapping will be valid.

EM3E PDO examples of dynamic mapping processes

This example uses a RXPDO to add 6081-00h (protocol position mode, maximum speed) and 6083-00h (acceleration) mapping objects in RXPDO1 as an example.

Table 4.10 shows that there are already 5 objects in RXPDO1, and this example writes 6081-00h and 6083-00h objects in table 4.9 to 1600-06h and 1600-07h.

Step B: Set 1C12-00h to 0

1C12h PDO specified object content					
Subindex	00h	01h	02h	03h	04h
Mapping content	0	——	——	——	——

Figure 4.9: Clear PDO specified object data

After the 1C12-00h is set to 0, the 1C12-01h~1C12-04h will automatically fail.

Step C: Set 1600-00h to 0

1600h mapping content combination table									
Subindex	00h	01h	02h	03h	04h	05h	06h	07h	08h
Mapping content	0	——	——	——	——	——	——	——	——

Figure 4.10: Clear PDO mapping object data

When the 1600-00h is set to 0, the mapping content in the 1600-01h~1600-08h will automatically fail.

Step D: Configure the contents of 1600-01h~1600-07h

1600h mapping content combination table								
subindex	01h	02h	03h	04h	05h	06h	07h	08h
Mapping content	60400010h	607A0020h	60B00020h	60B10020h	60B20010h	60810020h	60830020h	0

Mapping content decomposition			Mapping content
Index	subindex	Bit length	
6040h	00h	10h	60400010h
607Ah	00h	20h	607A0020h
60B0h	00h	20h	60B00020h
60B1h	00h	20h	60B10020h
60B2h	00h	10h	60B20010h
6081h	00h	20h	60810020h
6083h	00h	20h	60830020h

Figure 4.11: Set PDO mapping object content

Configuring a subindex of a 1600h object (not contain subindex 0), the subindex which has no content will be 0 (for example, 1600-08h).

Step E: Write to the 1600-00h object, that is, set the total number of 1600h mapping objects.

1600h mapping content combination table									
Subindex	00h	01h	02h	03h	04h	05h	06h	07h	08h
Mapping content	7	60400010h	607A0020h	60B00020h	60B10020h	60B20010h	60810020h	60830020h	0

Figure 4.12: Set the total number of mapping objects

In this example, the 1600h object is configured with 7 mapping objects, so the 1600-00h is set to 7.

Step F: The PDO mapping object 1600h is written to 1C12-01h as content

1C12h PDO specified object content				
Subindex	01h	02h	03h	04h
Mapping content	1600h	0	0	0

Figure 4.13: Configuring PDO specified object content

This example uses only one RXPDO, so the 1600h data will be written to 1C12-01h, and 1C12-02~1C12-04h will be 0.

Step G: Set the number of PDO mapping objects in the specified object

1C12h PDO specified object content					
subindex	00h	01h	02h	03h	04h
Mapping content	1	1600h	0	0	0

Figure 4.14: Set the number of PDO specified object

In this example, only the RXPDO mapping object 1600h is used, so the data for 1C12-00h is 1.

Tip: steps A and H are not included in this example, the specific example of appendix B corresponds to this example, and contains the simulation of the A and H steps.

EM3E PDO dynamic mapping example overview settings as shown in Figure 2.15

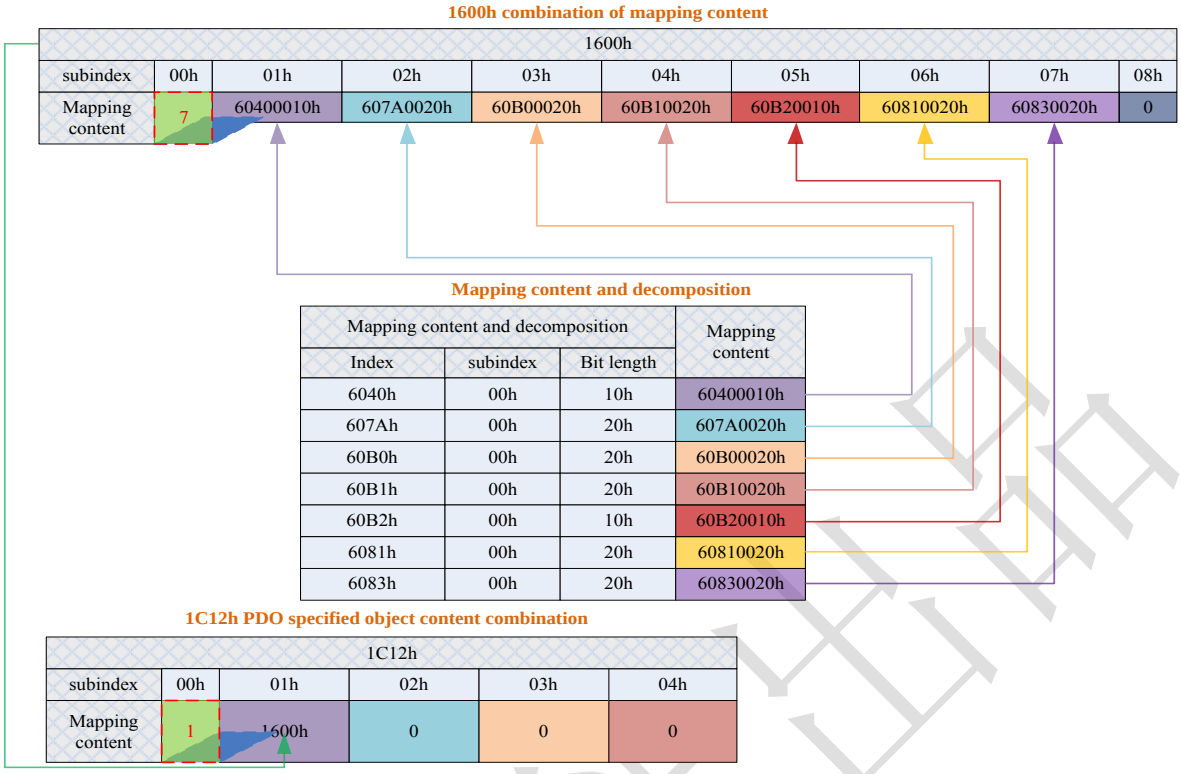


Figure 4.15: EM3E PDO dynamic mapping set example overview

4.5.6 SDO VS PDO

The difference and relation between SDO and PDO can be summarized as table 4.12.

Table 4.12: The difference and relation between SDO and PDO

Contrast terms	PDO	SDO
Communication ability	Maximum 64 bytes	General 4 bytes (fast transmission)
efficiency	high	low
Priority level	high	low
Real-time performance	Real-time(synchronous mode)	Non-real time
Transmission initiative	Active transission	Passive transimission
Object dictionary visit	Indirect visit	Direct visit
	Visit PDO mapping object	Visit arbitrary objects
synchronism	synchronization/asynchronization	Asynchronization
Application situation	Real-time data transmission	Configure PDO mapping、parameter settings

Note: the contrast entries in table 2.14 are based on the EM3E stepping system and do not represent the relevant product data of other vendors.

4.5.7 Quick event

The Quick message is sent to the main station by an internal error event triggered by the EM3E drive. The internal error contains network warnings and drive error alarms. When a warning / error occur, EM3E will embed the error code into the urgent message and send it to the main station.

The data format of the Quick message is shown in table 4.13.

Table 2.15: Quick message format

Content	Mailbox header	Command	Error code	Error registor	User defined area
	Type =3(COE)	Type =1	Details 4.2	Details 4.1	*1)
Bytes	6	2	2	1	5

*1) Low 2 bytes are consistent with the error code 603Fh object contents, 3 bytes high, all 0.

4.6 Slave station alias settings and network status display.

4.6.1 Specification of network status display

EM3E can determine the network connection status according to the LED lights of the network port of the drive

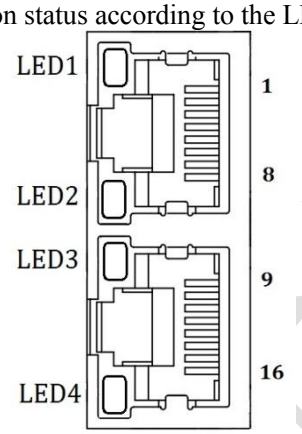


Figure 4.16: EM3E network port

① LED1 is “Link/Activity IN” status lamp, green.

② LED3 is “Link/Activity OUT” status lamp, green.

③ LED2 is “RUN” status lamp, green, EtherCAT state machine indicator.

④ LED4 is “ERR” status lamp, red, network error indicator, indicator details see 4.3 section.

LED display specification as table 4.14

Table 4.14: LED display specification

Name	Color	Status	Description
RUN	Green	OFF	Initialization status
		Blinking	Pre-operational status
		Single flash	Safe-operational status
		ON	Operating status
ERR	Red	OFF	See 4.3 section for details
		Blinking	
		Single flash	
		Double flash	
		Flickering	
		ON	
L/A IN	Green	OFF	Not established on physical layer link
		ON	Established on physical layer link
		Flickering	After the link is established, the interactive data
L/A OUT	Green	OFF	Not established on physical layer link
		ON	Established on physical layer link
		Flickering	After the link is established, the interactive data

Indicator lamp state description as figure 4.17

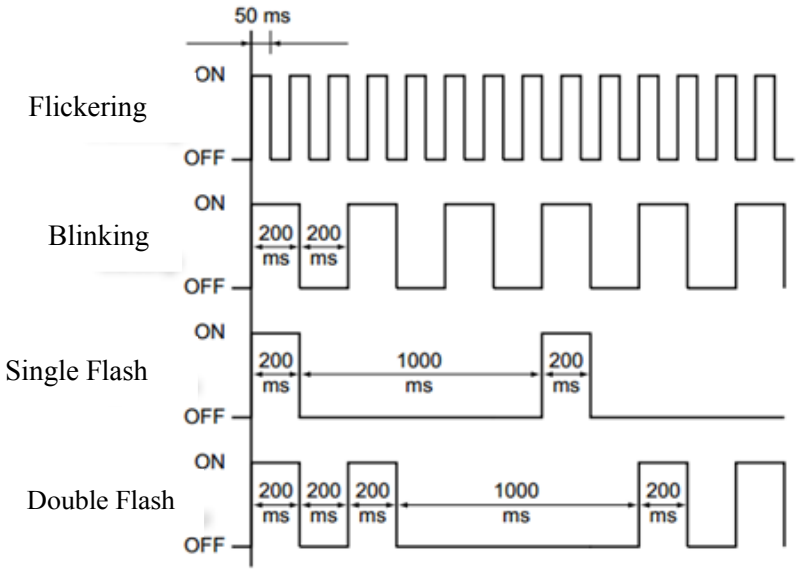


Figure 4.17: LED indicator lamp state

4.7 Save parameters

EM3E supports the storage function of the vendor parameters. After modifying the parameters, the 0x1010 object can be saved by the master operation.

The master station can operate 0x1010-04 to save user parameters to EEPROM, if the driver detects a master to send 0x1010-04 data to 0x65766173, the driver will save the current parameters to EEPROM (including 0x2000 to 0x5FFF parameter preservation properties).

Note: do not turn off the power during the EEPROM write operation; otherwise, you may cause write error data; if this happens, reset all parameters before entering the EEPROM write operation.

4.8 Restore factory parameters

The master station can operate 0x1011-04 to restore the factory user parameters. If the drive detects that the data of the 0x1010-04 sent by the master is 0x64616f6c, the drive will restore the factory default.

Chapter 5 EM3E CiA 402 Control Introduction

5.1 EM3E Stepper System Control Motion Steps

Table 5.1 Sequence of EM3E stepper system motion steps

Sequence	Action Meaning
1	EtherCAT master station sends Controlword (6040h) to initialize EM3E stepper drives
2	EM3E stepper drives feedback Stateword (6041h) to EtherCAT master station for getting raedy
3	EtherCAT master station sends Enable command (Controlword transition) to drives, refer to chapter 3.2
4	EM3E stepper drives get Enable and feedback the state to EtherCAT master
5	EtherCAT master station sends Homing command (homing related object and Controlword transition). If using internal homing methods of EM3E stepper drives, refer to homing modes in chapter 3.6.4
6	EM3E stepper drives complete homing and feedback the state to EtherCAT master
7	EtherCAT master station sends position/velocity command (operation mode related object and Controlword transition), refer to operation modes in chapter 3.5 and 3.6
8	EM3E stepper drives complete motion and feedback the actual position/velocity to EtherCAT master
9	EtherCAT master station send command for the following motion

5.2 402 State Control and Transition

5.2.1 State Transition Diagram

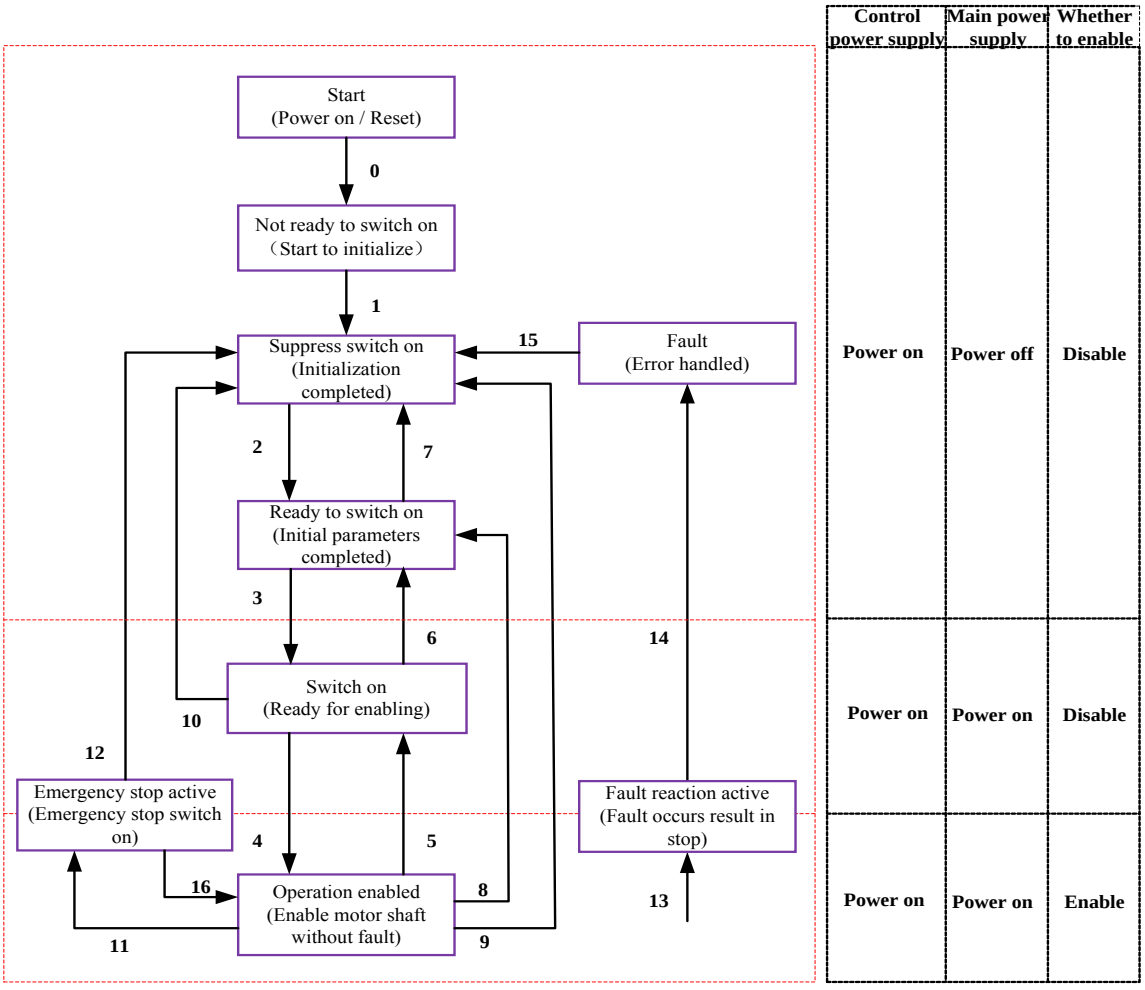


Figure 5.1 EM3E series 402 state machines

The drive's actions mapping to the drive states in above figure are in the table as below:

Table 5.2 States mapping drive actions

States	EM3E EtherCAT stepper drive actions
Not ready to switch on	The drive is powered on and starts to initialize. The motor is disabled; if the motor with brake, it will be locked by brake
Suppress switch on	Initialization completed and start to initial parameters, no fault, motor is disabled

Ready to switch on	Complete parameters initialization, motor is disabled
Switch on	Drive is ready to enable
Operation enable	The motor is enabled, no fault.
Quick stop active	Quick stop switch on
Fault reaction active	Fault occured and unhandled, which result in drive stop and disable
Fault	Fault is handled, reday to convert the 401 state machine from 'Fault' to 'Switch on disable', motor is disabled.

Eath transition of 402 state machines is depended on configure the Controlword (6040h) of EM3E stepper drive, and Stateword can indicate every state transition of drive.

The condition of state transition (Controlword trigger) and corresponding action (Stateword transition) are shown as the following table.

Table 5.3 States transition

402 State transition		Trigger	6040h Value *1)	Action	6041h State*2)
0	Start —> Not ready to switch on	Control power supply switch on/auto-transition after reset	Auto-transition after power on, no need control command	Drive self-test and initialization	0000h
1	Not ready to switch on —> Suppress switch on	Auto-transition after complete initialzation	No command/0000h	Communication state pre-operation or above *3)	×250h
2	Suppress switch on —> Ready to switch on	Receive the command of power off *4)	0006h	Parameters initializing	×231h
3	Ready to switch on —> Switch on	Receive the command of switch on	0007h	Turn on main power supply, waiter for enabel	×233h
4	Switch on —> Operattion enable	Receive the command of operation enable	000Fh	Operation enable	×237h
5	Operation enable—> Switch on	Receive the command of disabled operation	0007h	Disabled operation	×233h
6	Switch on —> Ready to switch on	Receive the command of turn off main power sullpy	0006h	Turn off main power supply, control power supply is still on	×231h
7	Ready to switch on —> Suppress switch on	Receive the command of disable voltage output	0000h	No action	×270h
8	Operation enable —> Ready to switch on	Receive the command of control power supply	0006h	Disable operation, turn off main power supply	×231h
9	Operation enable —> Suppress switch on	Receive the command of disable voltage output	0000h	Disable operation and turn off main power supply	×270h
10	Switch on —> Suppress switch on	Receive the command of disable voltage output	0000h	Turn off main power supply, control power supply is still on	×270h
11	Operation enable —> Quick stop active	Receive the command of quick stop	0002h	Enable quick stop	×317h
12	Quick stop active —> Suppress switch on	Receive the command of disable voltage output	0000h	Disable operation and turn off main power supply	×350h
13	—> Fault reaction active	EM3E detectes errors occur	Drive automatically switches Stop error	Stop error occur, wait for processing	×23Fh
14	Fault reaction active —> Fault	Automatic switching	No command	Disablo operation, and turn off main power supply	×218h
15	Fault —> Suppress switch on	Receive the command of alarm restore	0080h	After processing this error, then execute restor drive.	×270h

× It means that the state is unaffected by this bit.

*1) The value of (6040h) is only as a recommended command.

*2) The value of (6041h) is the state corresponding to the (6040h).

*3) The communication state is refered to ESM state machines in chapter 2.4.

*4) The command of turn off power supply is command name, not the action of turning off power supply.

5.2.2 CIA DSP402 Controlword

Contorlword (6040h) is defined as shown in the following table.

Table 5.4 Controlword (6040h) bit definition

Bit	15~9	8	7	6~4	3	2	1	0
Definition	invalid	suspend	Wrong reset	Depond on operating mode	Operation enable	Quick stop	Output voltage	Switch on

State is controlled by combining the bit 7 and bit 3~0 in the Controlword (6040h) as shown in the following table.

Table 5.5 Bit 7 and bit 3~0 mapping transition command

Transition command	**bit 7 and bit 3~0**					**6040h Typical value**	**402 state machines transition *3)**
	7: Fault reset	**3: Operation enable**	**2: Quick stop**	**1: Enable voltage output**	**0: Switch on**		
Shutdown	0	x	1	1	0	0006h	2, 6, 8
Switch on	0	0	1	1	1	0007h	3+4 *1)
Switch on + enable operation	0	1	1	1	1	000Fh	3*
Disable voltage output	0	x	x	0	x	0000h	7;9;10;12
Quick stop	0	x	0 *2)	1	x	0002h	7;10;11
Disable operation	0	0	1	1	1	0007h	5
Enable operation	0	1	1	1	1	000Fh	4;16
Fault reset	Rising edge	x	x	x	x	0080h	15

x It is not affected by this state. * The drive executes this transition command during Swithced on state.

*1) Move to Operation enabled state after Switched on state.

*2) Quick stop command is active by level ‘0’.

*3) The transition is refered to figure 5.1.

The state in different operation mode is indicated by the combination of bit 8 and bit 6~4 in the Controlword (6040h), as shown in the following table.

Table 5.6 Bit8 and bit 6~4 in different operation mode

bit	Operation mode			
	PP mode	PV mode	HM mode	CSP mode
8	Deleceration stop	Deleceration stop	Deleceration stop	x
6	Absolutely/Relatively	x	x	x
5	Triggered immediately	x	x	x
4	New location point	x	Switch on motion	x

5.2.3 CIA DSP402 Stateword

Stateword (6041h) is defined as shown in the following table.

Table 5.7 Stateword Definition

Bit	Definition
15~14	Depond on operation mode
13~12	Depond on operation mode
11	Limit switch effective
10	Depond on operation mode

9	Remote
8	Depond on operation mode
7	Reserved
6	Switch on disabled
5	Quick stop
4	Enable voltage output
3	Fault
2	Enable operation
1	Switch on
0	Ready to switch on

State is indicated by the combination of bit 6, bit 5 and bit 3~0 in Statusword (6041h), as shown in the following table.

Table 5.8 Bit6, bit 5 and bit 3~0

Bit6, bit 5 and bit 3~0	6041h typical value *1)	State of state mashine	State of EM3 dtepper drives
××××,××××,×**0**××,**0000 b**	××00h	Not ready to switch on	The control circuit power supply is turned ON and initialization is being executed.
××××,××××,×**1**××,**0000 b**	××40h	Switch on disabled	Initialization has been completed. EM3E drive parameters initialized.
××××,××××,×**01**×,**0001 b**	××21h	Ready to switch on	Parameters nitialization has been completed.
××××,××××,×**01**×,**0011 b**	××23h	Switched on	The main circuit power supply is ON. EM3E drive parameters can be set.
××××,××××,×**01**×,**0111 b**	××27h	Operation enabled	The drive is enabled, without fault.
××××,××××,×**00**×,**0111 b**	××07h	Quick stop active	Quick stop is executed
××××,××××,×**0**××,**1111 b**	××0Fh	Fault reaction active	There is an error in the EM3E drive and the cause isn't processed.
××××,××××,×**0**××,**1000 b**	××08h	Fault	The error was processed, wait for state transition

× It is not affected by this state.

*1) Only the typical values of Stateword (6041h) are presented, they are the basic configurated bits; user can also set other bits.

Additional descriptions:

When the main circuit power supply is ON, the bit 4 will be turn on.

The quick stop will be active when the bit 5 is logic '0'. Pay attention to that the actived logic is contrary to other bits

When the state machines (chapter 2.4) is initialization or pre-operation state, right now bit 9 = 0 and the command in Controlword (6040h) can't be executed.

Bit 11 will be turn on when the hardware limit switch is effectived

Other bits in different operation mode have different meaning, as shown in the following table.

Table 5.9 Bit 15~12 and bit 8 in different operation mode

Bit	Operation mode			
	PP mode	**PV mode**	**HM mode**	**CSP mode**
15	Can trigger responses	x	Can trigger responses	x
14	At least one parameter value is 0	At least one parameter value is 0	At least one parameter value is 0	x
13	x	x	Fault in looking for origin	x
12	New location point response	Velocity is 0 *1)	Homing completed	Following is enable
10	Position arrived	Velocity arrived	Position arrived	x
8	Aabnormal stop	Quick stop	Aabnormal stop	Abnormal stop

Bit 8 mapping Abnormal stop is effective when hardware limit switch, deceleration stop and quick stop are all triggered.

In CSP mode, bit 12 mapping follow master station is not effective when the drive is in disabled state or not respond the instruction of master station.

*1) In PV mode, bit 12 is effective when the deceleration stop or hardware limit switch is active.

5.3 Operation Modes Setting

5.3.1 Supported Drive modes object (6502h)

This object indicates Operation modes currently suppoertd, the bit definitions are shown as the following table.

Table 5.10 Bits definition of 6502h

Bit	31~10	9	8	7	6	5	4	3	2	1	0
Modes	Reserved	Reserved	Reserved	CSP	Reserved	HM	Reserved	Reserved	PV	Reserved	PP
Data	0	0	1	1	0	1	0	0	1	0	1

Full name	Abbreviation
Profile position mode	PP
Profile velocity mode	PV
Homing mode	HM
Cyclic synchronous position mode	CSP

5.3.2 Operation Mode Object (6060h) and Operation Mode Display Object (6061h)

The object (6060h) is to set operation mode and object (6061h) is to display actual operation mode currently requested. The bits definitions of the two objects are the same, as shown in the following table.

Table 5.11 6060h/6061h Data Meaning

Data	Full name	Abbreviation
1	Profile position mode	PP
3	Profile velocity mode	PV
6	Homing mode	HM
8	Cyclic synchronous position mode	CSP

5.3.3 Note

(1) Set the Operation Mode object (6060h) can switch operation mode.

(2) Read the Operation Mode Display object (6061h) cans confirme the actual operation mode currently.

(3) When switch different operation mode, it may need to change the mapping objects of RXPDO and TXPDO; please refer to chapter 4.5.5.

(4) After enable the EM3E drives, the 402 state machines won't transition if the current operation mode is not suppoeted in this software version.

5.4 Common Functions in Each Operation Mode

5.4.1 Digital Input / Output

Digital Input Setting

The object (2152h), (2053h) and (2154h) indicate digital input functions setting, filter time setting and polarities setting respectively, as shown in the following table, please refer to chapter 3.4.1

Table 5.12 Digital input parameters setting

Parameter Address Index + sub-index	Name	Access	Default Value	Range	Description
2152+01	Digital input 1 function	R/W/S	32	0~32768	1: homing signal 2: positive limit

					4: negative limit 8: emergency stop 16: user-defined	
2152+02	Digital input 2 function	R/W/S	1	0~32768	1: homing signal 2: positive limit 4: negative limit 8: emergency stop 16: user-defined	
2152+03	Digital input 3 function	R/W/S	2	0~32768	1: homing signal 2: positive limit 4: negative limit 8: emergency stop 16: user-defined	
2152+04	Digital input 4function	R/W/S	4	0~32768	1: homing signal 2: positive limit 4: negative limit 8: emergency stop 16: user-defined	
2152+05	Digital input 5 function	R/W/S	16	0~32768	1: homing signal 2: positive limit 4: negative limit 8: emergency stop 16: user-defined	
2153+01	Digital input 1 filter time	R/W/S	1000	50~60000	unit:us	Note: Too large filter time may cause time delay of control command
2153+02	Digital input 2 filter time	R/W/S	1000	50~60000	unit:us	
2153+03	Digital input 3 filter time	R/W/S	1000	50~60000	unit:us	
2153+04	Digital input 4 filter time	R/W/S	1000	50~60000	unit:us	
2153+05	Digital input 5 filter time	R/W/S	1000	50~60000	unit:us	
2154+00	Digital input active level configuration	R/W/S	0	0~65535	0: active low level (in default) 1: active high level(bit0 mapping digital input1, and so on), bit0 to bit4 mapping I1 to I5	

Digital input active level state

EM3E have two methods to set digital input active level state.

Method 1: Physical state setting

Physical state setting uses the bit 4~0 of object (2155h) to map the input active level states of digital input I5~I0, the definitions are shown as the following table.

Table 5.13 Physical state of 2155h

Bit	15~6	4	3	2	1	0
Definition	Invalid	0: IN5 invalid 1:IN5 valid	0:IN4 invalid 1:IN4 valid	0:IN3 invalid 1:IN3 valid	0:I2 invalid 1:I2 valid	0:I1 invalid 1:I1 valid

Method 2: Function state setting

Function state setting uses the bit value of 60FDh, which conforms to the IEC61800-200 input standard. The bitdefinitions are shown as the following table.

Table 5.14 60FDh bit definition

Bit	I/O mapping
0	Sin state of negative limit
1	Sin state of positive limit
2	Sin state of home signal
3	Sin state of quick stop
4~16	Reserved
17	I1 input state by user defined

18	I2 input state by user defined
19	I3 input state by user defined
20	I4 input state by user defined
21	I5 input state by user defined
22	Reserved
23	Reserved
24	Reserved
25	Reserved
26	Probe 1 state
27	Probe 2 state
28~31	Reserved

Digital output setting

The object (2005h) and (2008h) indicate digital output functions setting and polarities setting respectively, as shown in the following table.

Table 5.15 Digital output parameters setting

Parameter Address Index + sub-index	Name	Access	Defaul t Value	Range	Description
2005+01	Digital output 1 function	R/W/S	1	1~16	bit0: alarm output bit2: in-position output bit4: master control output
2005+02	Digital output 2 function	R/W/S	4	1~16	bit0: alarm output bit2: in place output bit4: master control output
2008+00	Digital outout state	R/W/S	0	0~3	0: positive logic 1: negative logic bit0 is mapping digital ouput1, and so on

Digital output function of master control

When EM3E series drives' digital outputs is set to master station control function, please refer to chapter 3.4.2,

5.4.2 Rotation Direction Setting

The parameter related rotation direction setting is shown as following table.

Table 5.16 Rotation direction setting

Operation mode		Object dictionary	Description
Position mode	PP	2051h	0: Keep the motor dorection 1: Reverse the motor direction
	HM		
	CSP		
Velocity mode	PV		

Note: The setting of positive and negative rotation is in terms of target position, not for clockwise and counterclockwise.

5.4.3 Stop Mode Setting

There are two kinds of stop modes which are quick stop and deceleration stop for EM3E series stepper drive.

(1) If object (6085h) is set to value '0', the EM3E drive will execute quick stop, and if not, the EM3 drive will execute deceleration stop with the deceleration velocity value which in object (6085h)

(2) The stop command in limit switch state is means quick stop.

(3) If the bit 8 (Halt) of object (6040h) is to set value '1', the drive will execute deceleration stop with the deceleration velocity value which in object (6084h).

5.4.4 Limit Switch

Limit switch in EM3E series stepper drive indicates hardware limit switch, which takes advantage of external digital signal to limit the motor motion range.

It is available for all the operation modes.

5.5 Operation Modes

The meaning of the corresponding abbreviations:

Abbr.	Meaning
P	Pulse number
Unit	Instruction unit
Uint/S^2	Acceleration/Deceleration unit,
RPM	Revolutions per minute
Uint/S	Instruction unit per second
rev	Revolution

The Operation modes include position mode and velocity mode.

Position Mode is a point-to-point operating mode via execution related command sending by EtherCAT master; consist of profile position (PP), cyclic synchronous position mode (CSP) and homing mode (HM).

Velocity Mode is a relatively simple operating mode via execution related command sending by EtherCAT master, include profile velocity mode (PV).

5.5.1 Position Mode—PP Mode

Description

Profile Position control mode is general point to point operation, to move to target position of Target position (607Ah) object with receipt of Controlword (6040h) input, need to set Profile Position Mode at operation mode object (6060h). The Operation Mode Display object (606lh) is shown as Profile Position Mode. The track plan is created by EM3E drives, and the control block diagram is shown as following figure.

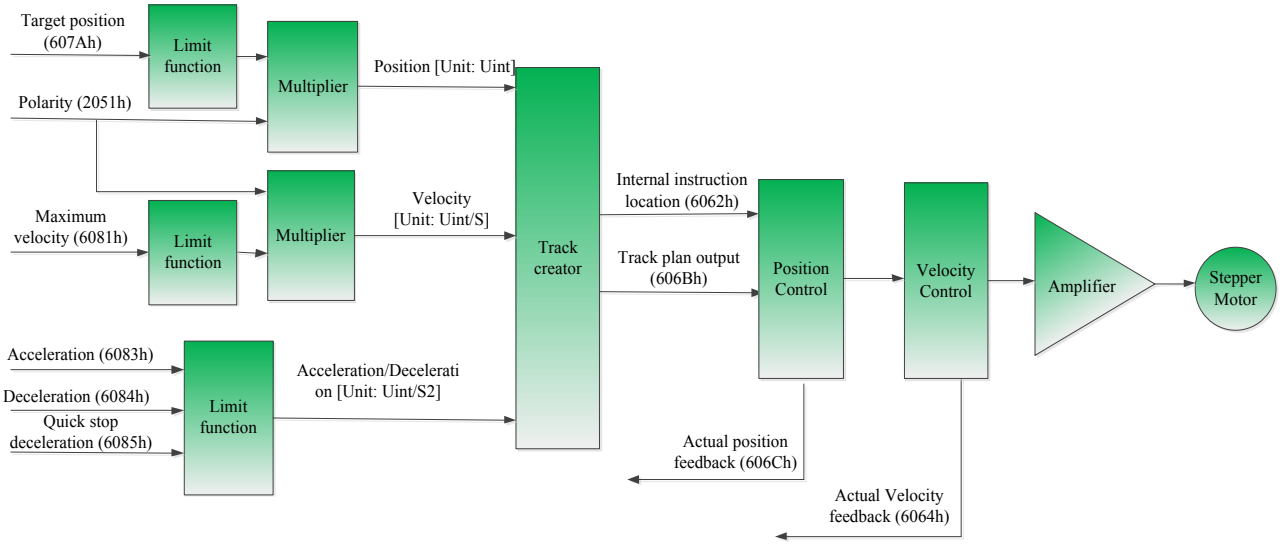


Figure 5.2 PP Mode control block diagram

Related objects

Main related objects as below:

Table 5.17 Main related in PP mode

Data Direction *1)	Object	Description	Value	Unit
Output	6060h	Operation Mode	1	-
	6040h	Controlword	User Defined	-
	607Ah	Target Position	User Defined	Unit
	6081h	Maximum Velocity	User Defined	Unit/S
	6083h	Profile Accelation	User Defined	Unit/S^2
	6084h	Profile Deceleration	User Defined	Unit/S^2
	6085h	Quick stop deceleration, due to the value of 605Ah	User Defined	Unit/S^2
	605Ah	Enable the quick stop deceleration (5: Yes; Others: No)	User Defined	-
	2000h	Pulses for motor turnning one round	User Defined	P
Input	6041h	Stateword	Read only	-
	6064h	Actual Position Feedback	Read only	Unit
	606Ch	Actual Velocity Feedback	Read only	Unit/S
	603Fh	Recently error code	Read only	-

	6061h	Operation mode display	Read only	-

*1) The data transmission direction regards the master station as reference, “Output” means the data output from master station to EM3E Drives, “Input” means the data feedbake from EM3E drives to master station.

Controlword and Stateword

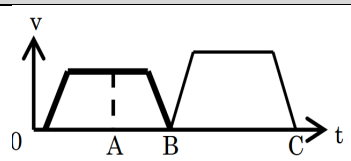
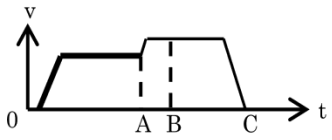
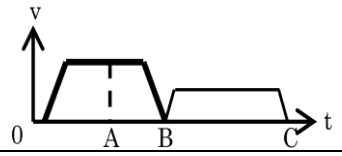
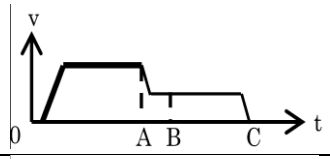
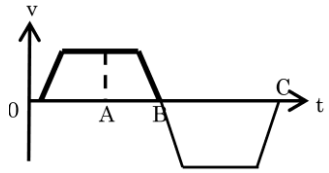
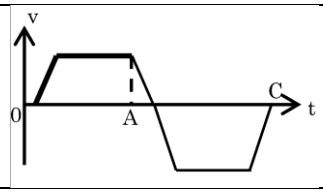
In PP Mode, the bits 6~4 of Controlword (6040h) are shown as following table.

Table 5.18 Bits 6~4 of Controlword (6040h) in PP mode

Bit (Name)	Value	Description
Bit4 (new location)	0 —> 1	Start position motion with new location (607Ah), maximum velocity (6081h), acceleration/ deceleration (6083h/6084h)
Bit5 (trigger immediately)	0	Complete current position motion to trigger a new position motion
	1	Interrupt current position motion, and start a new position motion immediately
Bit6 (absolutely / relatively)	0	Process target position (607Ah) as absolutely position
	1	Process target position (607Ah) as relatively position

The action models of bit5 of Controlword (6040h) in PP mode are shown as following table.

Table 5.19 Action models of bit5 of Controlword (6040h)

Bit5	0	1
Update new position with the same direction during acceleration/uniform velocity		
Update new position with the same direction during deceleration velocity		
Update new position with the reverse direction		

A: Means time of master station changed command

B: Means arrival time of target position (before update)

C: Means arrival time of target position (after update)

Thick line: Means action before update

Fine line: Means action after update

In PP Mode, the bits 15~12, 10, 8 of Stateword (6041h) are shown as the following table.

Tbale 5.20 Bits 15~12, 10, 8 of Stateword (6041h) in PP Mode

Bit (Name)	Value	Description
Bit 8 (abnormal stop)	0	Normal motion
	1	Trigger by abnormal stop, motor will stop *1)
Bit 10 (position reached)	0	Motion cotinued
	1	Traget position reached
Bit 12 (new location response)	0	When current motion completed/ interruptable, it can update new target position *2)
	1	When current motion uncompleted/uninterruptable, it can not update new target position
Bit 14 (motion parameters are value 0)	0	Motion parameters are available, and all necessary parameters are not value 0

	1	At least one of necessary parameters such as maximum velocity (6081h), acceleration (6083h) and deceleration (6084h) is value 0
Bit 15 (response that can be triggered)	0	When current motion uncompleted/ uninterruptable, it can not update a new target position *3)
	1	When current motion completed/ interruptable, it can update new target position

*1) Bit8 abnormal stop is available in the triggered states of hardware limit switch, deceleration stop and quick stop

*2) Bit 12 of Stateword (6041h) will clear zero if the bit 4 of controlword (6040h) is available trigger and bit 5 of (6040h) is invalid trigger (for example 6040h = 0x2F/4F), it can be interrupted, the action refer to table 5.19

*3) The logic of bit 5 and bit 12 is always reverse in PP mode.

5.5.2 Position Mode—CSP Mode

Description

Cyclic Synchronous Position mode (CSP Mode) assigns target position to EM3E drives by Master's operation profile creation function through cyclic communication. Drives internally execute position/velocity control with receipt of target position in each cycle. e.

The supported synchronizing cycles are: 250us, 500us, 750us, 1000us, 2000us and 4000us.

The control block diagram of CSP mode is shown as the following figur

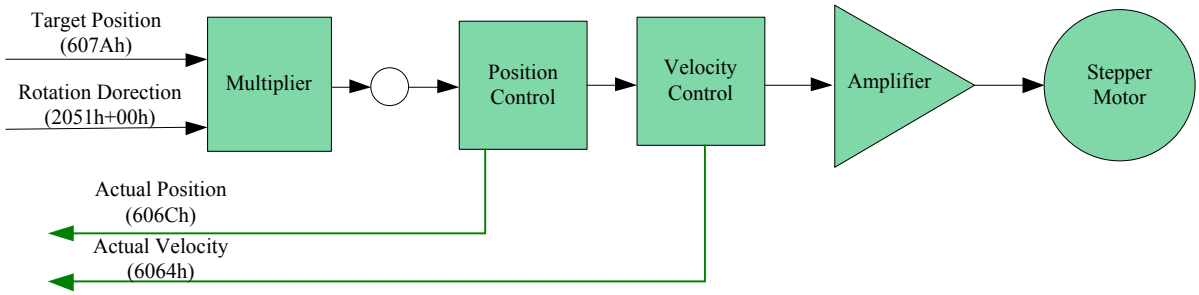


Figure 5.3 CSP Mode Diagram

Related objects

To use CSP Mode, Operation Mode object (6060h) needs to be set to value “8”. Operation Mode Display object (6061h) is shown as CSP mode, Target position Object (607Ah) transmitted from master, then target position is executed.

Table 5.21 Main related objects in CSP mode

Data Direction *1)	Object	Description	Value	Unit
Output	6060h	Operation Mode	8	-
	6040h	Controlword	User Defined	-
	607Ah	Target Position	User Defined	Unit
	2000h	Pulse for motor turnning one round	User Defined	P
	60B0h	Position offset	User Defined	-
	6085h	Quick stop deceleration, due to the value of 605Ah	User Defined	Unit/S^2
	605Ah	Enable the quick stop deceleration (5: Yes; Others: No)	User Defined	-
Input	6041h	Stateword	Read only	-
	6064h	Actual Position Feedback	Read only	Unit
	606Ch	Actual Velocity Feedback	Read only	Unit/S
	603Fh	Recently error code	Read only	-
	6061h	Operation mode display	Read only	-

*1) The data transmission direction regards the master station as reference, “Output” means the data output from master station to EM3E Drives, “Input” means the data output from EM3E drives to master station.

Controlword and Stateword

In CSP mode, the bit 6~4 of Controlword (6040h) are invalid present in table 5.6, and user can operation refer to table 5.5.
The bit 15~12 of Stateword (6041h) are shown in table 5.9

Software Limitation (EM3E series doesn't have this feature)

Description: Using software command to limit the motion range of motor.

Application Range: Be only valid to absoluted motion in CSP and PP modes.

Method: Set the object 607D-01h as the maximum value of negative direction, set the object 607D-02h as the maximum value of positive direction, the unit is in accordance with position instruction. The setting can't be saved in EM3E series EtherCAT drives at present.

Pulses per Revolution/Electronic Gear

EM3E Series no need to set electronic gear, but to set the value of pulses per revolution (2001h), the range is 6400-51200.

Position Command Filter

This feature can make the position instructions smoother and provide more reliable motion.

Adress	Name	Access	Default Value	Range	Description
2009+00	FIR Enable	R/WS	0	0/1	0: No 1: Yes
2010+01	FIR Time	R/WS	1000	50~25600	Unit: us

When enable the feature of filter, it will smooth the command wave, for example if the target velocity Vc is squarewave, it will be processed to trapezoidal wave after filter, which is shown as below:

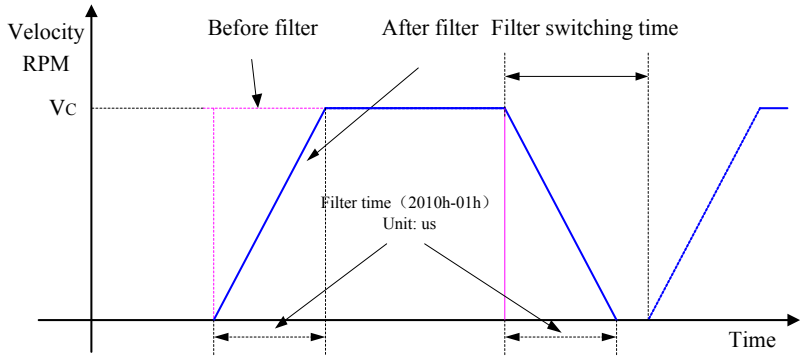


Figure 5.4 Filtering effect for squarewave command

If the target velocity Vc is trapezoidal wave, it will be processed to 'S' wave after filter, which is shown as below:

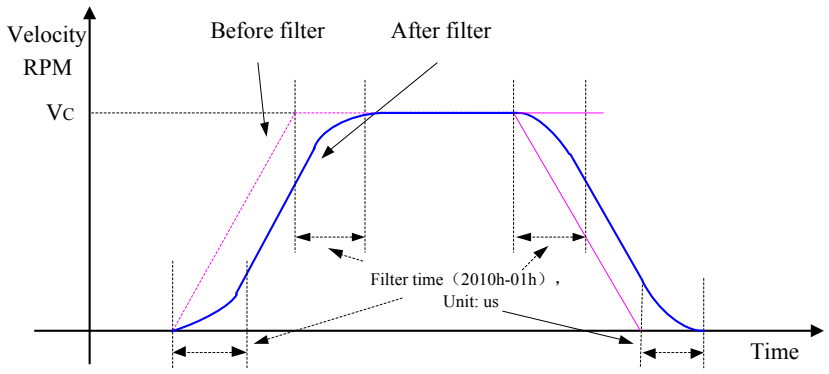


Figure 5.5 Filtering effect for trapezoidal wave command

Note: Prevent to modify this value when the motor is running.

5.5.3 Position Mode—HM Mode

Description

Origin search mode is the way of heading to origin with command of Controlword (6040h). To use origin search mode, need to set Homing Mode at object (6060h). Able to origin search command once Mode of operation display (6061 h) indicates Homing Mode. The homing methods refer to Appendix B

Related objects

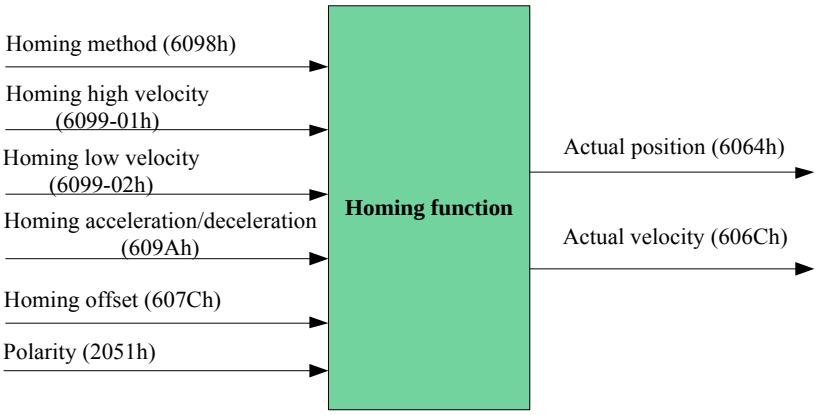


Figure 5.6 Homing mode related object

Table 5.22 Objects Main related in HM mode

Data Direction *1)	Object	Description	Value	Unit
Input	6060h	Operation Mode	6	-
	6040h	Controlword	User Defined	-
	6098h	Homing Method	User Defined	-
	6099-01h	Homing high velocity (search for limit switch)	User Defined	Unit/S
	6099-02h	Homing low velocity (search for origin signal)	User Defined	Unit/S
	609A-00h	Homing Acceleration/Deceleration	User Defined	Unit/S
	607C+00h	Homing Offset	User Defined	P
Output	6041h	Stateword	Read only	-
	6064h	Actual Position Feedback	Read only	Unit
	606Ch	Actual Velocity Feedback	Read only	Unit/S
	603Fh	Recently error code	Read only	-
	6061h	Operation mode display	Read only	-

*1) The data transmission direction regards the master station as reference, “Output” means the data output from master station to EM3E Drives, “Input” means the data output from EM3E drives to master station.

Controlword and Stateword

In HM Mode, bits 6~4 of Controlword (6040h) are shown as the following table.

Table 5.23 Bits 6~4 of (6040h) in HM Mode

Bit (Name)	Value	Description
Bit 4 (homing motion start/ suspend)	0 —> 1	Start homing motion
	1 —> 0	Suspend homing motion, the motor stop immediately
Bit 5 (undefined)	0	-
	1	-
Bit 6 (undefined)	0	-
	1	-

In HM Mode, bits 15~12, 10, 8 of Stateword (6041h) are shown as the following table.

Table 5.24 Bits 15~12, 10, 8 of (6041h) in HM Mode

Bit (Name)	Value	Description
Bit 8 (abnormal stop)	0	Normal motion
	1	Trigger by abnormal stop, motor will stop *1)
Bit 10 (position reached)	0	Motion cotinued
	1	Traget position reached
Bit 12 (Homing completed)	0	Homing cotinued
	1	Homing completed, bit 12 will be available when the target position is reached *2)
Bit 14 (motion	0	Motion parameters are available, all necessary parameters are not value 0

parameters are value 0)	1	At least one of necessary parameters such as homing method (6098h), homing high velocity (6099h-01), homing low velocity (6099h-02) and homing acceleration (609Ah) is value 0
Bit 15 (response that can be triggered)	0	Homing motion is triggered/completed *3)
	1	Homing motion that can be triggered

*1) Bit8 abnormal stop is available in the triggered states of hardware limit switch, deceleration stop and quick stop

*2) Detection bit 10 and bit 12 are all setting to judge homing motion is completed or not.

*3) Be used to indicate that homing motion is or can be triggered.

5.5.4 Velocity Mode—PV Mode

Description

Velocity Mode is a relatively simple operating mode via execution related command sending by EtherCAT master, include profile velocity mode (PV).

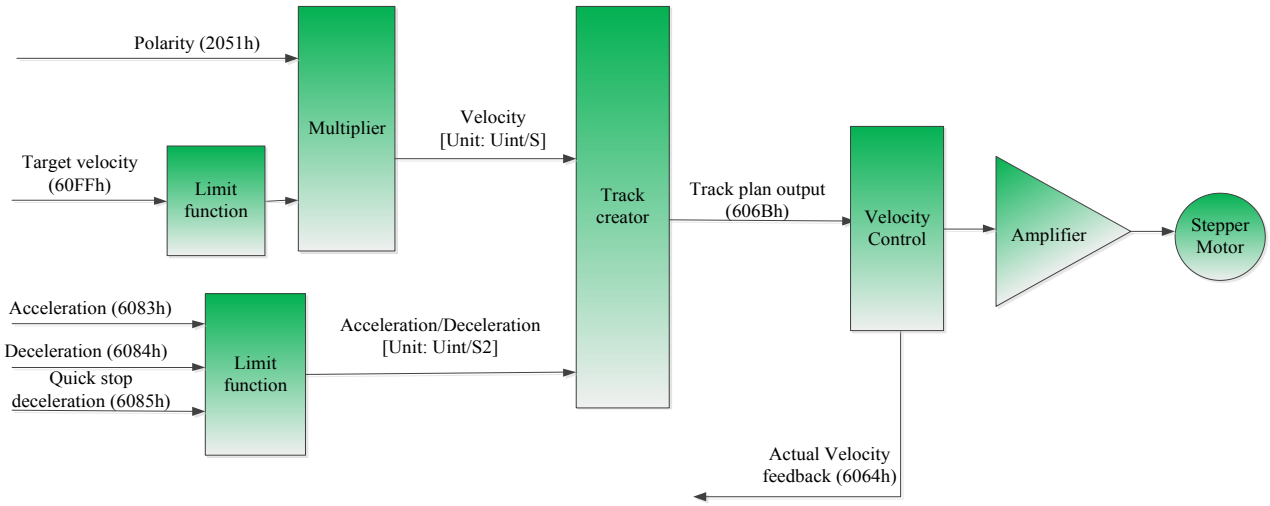


Figure 5.7 PV mode control block diagram

Related objects

Table 5.25 Main related objects in PV mode

Data Direction *1)	Object	Description	Value	Unit
Input	6060H	Operation Mode	3	-
	6040H	Controlword	User Defined	-
	60FFH	Profile Velocity in PV Mode	User Defined	Unit/S
	6083+00H	Profile Acceleration	User Defined	Unit/S^2
	6084+00H	Profile Deceleration	User Defined	Unit/S^2
Output	6041h	Stateword	Read only	-
	6064h	Actual Position Feedback	Read only	Unit
	606Ch	Actual Velocity Feedback	Read only	Unit/S

*1) The data transmission direction regards the master station as reference, “Output” means the data output from master station to EM3E Drives, “Input” means the data output from EM3E drives to master station.

Controlword and Stateword

In PV Mode, bits 6~4 of Controlword (6040h) are not available, so it need only to set motion parameters: target velocity (60FFh), acceleration/deceleration (6083h/6084h).

In PV Mode, bits 15~12, 10, 8 of Stateword (6041h) are shown as the following table.

Table 5.26 Bits 15~12, 10, 8 of (6041h) in PV Mode

Bit (Name)	Value	Description
Bit 8 (quick stop)	0	Quick stop is not triggered
	1	Quick stop is triggered
Bit 10 (velocity reached)	0	Current velocity don’t reache target velocity

	1	Target velocity reached
Bit 12 (velocity is value 0)	0	Velocity is not 0, motor is moving
	1	Velocity is value 0 or ready to reduce to value 0*1)

*1) In PV Mode, the bit will be available if the deceleration stop or hardware limit is available.

5.6 Touch Probe Function Instructions

Touch probe function is to record current position with sensing inputs from external signal in the operation mode of CSP or PP. There are two channels of digital input signal support the touch probe functions in EM3E series stepper drives.

5.6.1 Trigger Signal Setting

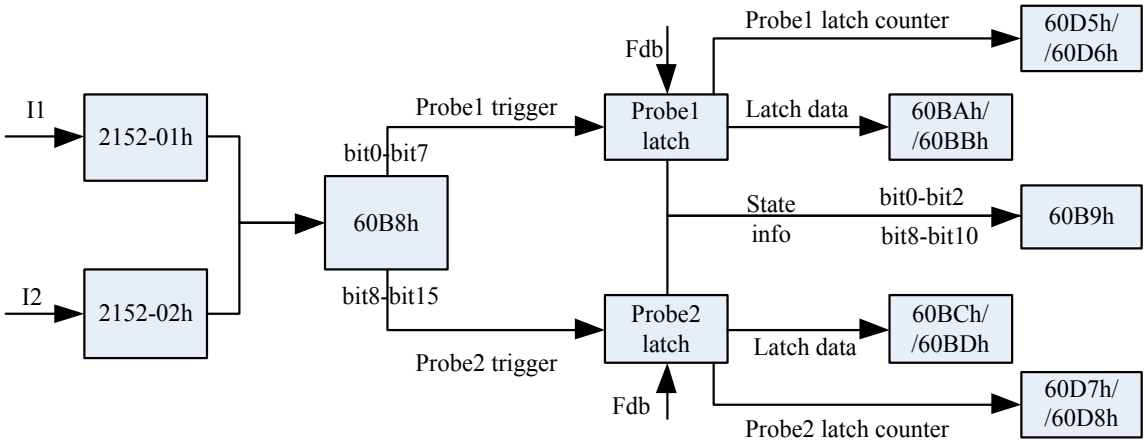


Figure 5.8 Touch probe function

When I1 or I2 is set to touch probe function, please refer to the notes as below:

a) When setting I1 or I2 as touch Probe1 (or touch Probe2), corresponding parameter 0x2152-01h or 0x2152-02h is set to value '32' (or '64');

b) When setting Controlword (60B8h) (low 8 bits mapping touch probe1, high 8 bits mapping touch probe2), include switch on, time mode, trigger edge, and so on, you need to refer to the following notes:

(i) When using I1 or I2 signal to trigger touch probe, the logic setting of I1 or I2 must be the same as the 60B8h (touch probe), otherwise, the touch probe function is invalid.

(ii) In single time mode, the active edge can not be set to both rising edge and falling edge, but for continuous time mode.

(iii) When I1 and I2 are set to the same touch probe, if I1 and I2 have the same pulse inputs, the touch probe will respond one of them; and if not, the touch probe will respond the overlay events triggered by I1 and I2.

5.6.2 Related Object

Table 5.27 Related object list of touch probe

Index	Sub-index	Name	Access type	Data type	Unit	Range	Default value
2152h	01h	I1 function setting	RW	Uint16	——	0~32768	1
	02h	I2 function setting	RW	Uint16	——	0~32768	2
60B8h	00h	Touch probe function	RW	Uint16	——	0-65535	0
60B9h	00h	Touch probe state	RO	Uint16	——	0-65535	0
60BAh	00h	Rising edge of touch probe1 to latch position	RO	int32	Instruction unit	-2147483648–2147483647	0
60BBh	00h	Falling edge of touch probe1 to latch position	RO	int32	Instruction unit	-2147483648–2147483647	0
60BCh	00h	Rising edge of touch probe2 to latch position	RO	int32	Instruction unit	-2147483648–2147483647	0
60BDh	00h	Falling edge of touch probe2 to latch	RO	int32	Instruction unit	-2147483648–2147483647	0

		position					
60D5h	00h	Rising edge of touch probe1 to trigger counter	RO	Uint16	——	0~32768	0
60D6h	00h	Falling edge of touch probe1 to trigger counter	RO	Uint16	——	0~32768	0
60D7h	00h	Rising edge of touch probe2 to trigger counter	RO	Uint16	——	0~32768	0
60D8h	00h	Falling edge of touch probe2 to trigger counter	RO	Uint16	——	0~32768	0

5.6.3 I1 or I2 Pin Function Setting

Table 5.34 Pin function of touch probe input object (2152h-01h/02h)

Value	1	2	4	8	16	32	64
Function	Home signal	Negative limit switch	Positive limit switch	Quick stop	User defined	Probe1	Probe2

5.6.4 The Object of Touch Probe Function Control

Table 5.35 Touch probe control object (60B8h)

Bit	**Value**	**Description**	
0	0	Touch probe1 disabled	Touch probe1 switch on / stop
	1	Touch probe1 enabled	
1	0	Single time mode	Time mode selection
	1	Continuous time mode	
2	-	Reserved	Reserved
3	-	Reserved	Reserved
4	0	Rising edge disabled	Rising edge selection
	1	Rising edge enabled	
5	0	Falling edge disabled	Falling edge selection
	1	Falling edge enable	
6	-	Reserved	Reserved
7	-	Reserved	Reserved
8	0	Touch probe2 disabled	Touch probe1 switch on / stop
	1	Touch probe2 enabled	
9	0	Single time mode	Time mode selection
	1	Continuous time mode	
10	-	Reserved	Reserved
11	-	Reserved	Reserved
12	0	Rising edge disabled	Rising edge selection
	1	Rising edge enabled	
13	0	Falling edge disabled	Falling edge selection
	1	Falling edge enable	
14	-	Reserved	Reserved
15	-	Reserved	Reserved

5.6.5 The Object of Touch Probe State

Table 5.36 Touch probe state object (60B9h)

Bit	**Value**	**Description**
0	0	Touch probe1 no action
	1	Touch probe1 in action

1	0	Rising edge of probe1 incompleted
	1	Rising edge of probe1 completed
2	0	Falling edge of probe1 incompleted
	1	Falling edge of probe1 completed
3-5	-	Reserved
6-7	-	Reserved
8	0	Touch probe2 no action
	1	Touch probe2 in action
9	0	Rising edge of probe2 incompleted
	1	Rising edge of probe2 completed
10	0	Falling edge of probe2 incompleted
	1	Falling edge of probe2 completed
11-13	-	Reserved
14-15	-	Reserved

5.6.6 Latch Data Registers

Table 5.37 Touch probe latch object (60BAh/60BBh/60BCh/60BDh)

Object dictionary	Description
60BAh	Indicates the latch position point of touch probe1 rising edge
60BBh	Indicates the latch position point of touch probe1 falling edge
60BCh	Indicates the latch position point of touch probe2 rising edge
60BDh	Indicates the latch position point of touch probe2 falling edge

5.6.7 Latch Counter Registers

Table 5.38 Touch proble latch register object (60D5h/60D6h/60D7h/60D8h)

Object dictionary	Description
60D5h	Indicates in continuous mode, the rising edge of touch probe1 to latch counter
60D6h	Indicates in continuous mode, the falling edge of touch probe1 to latch counter
60D7h	Indicates in continuous mode, the rising edge of touch probe2 to latch counter
60D8h	Indicates in continuous mode, the falling edge of touch probe2 to latch counter

5.6.8 Touch probe Action Switches On

During the time of bit0 / bit8 of object (60B8h) changed from value "0 (stop) →1 (switch on) ", to get other bits setting (60B8h: bit1~7 / bit9~15), then switch on touch probe.

After enable other bits setting, the bit0 / bit8 of 60B8h need return to "0 (stop) ", then change to "1 (switch on) " once again.

5.6.9 Time Mode of Touch Probe

Time mode selection object (60B8h) can be set to "0 (single time mode) "and "1 (continuous time mode)".

(1) Single time mode:

After switching on, it will execute latch position in the first trigger, you need to restart touch probe action (the bit0 / bit8 of 60B8h need return to "0", then change to "1") once again for another latch position value, which is shown as below:

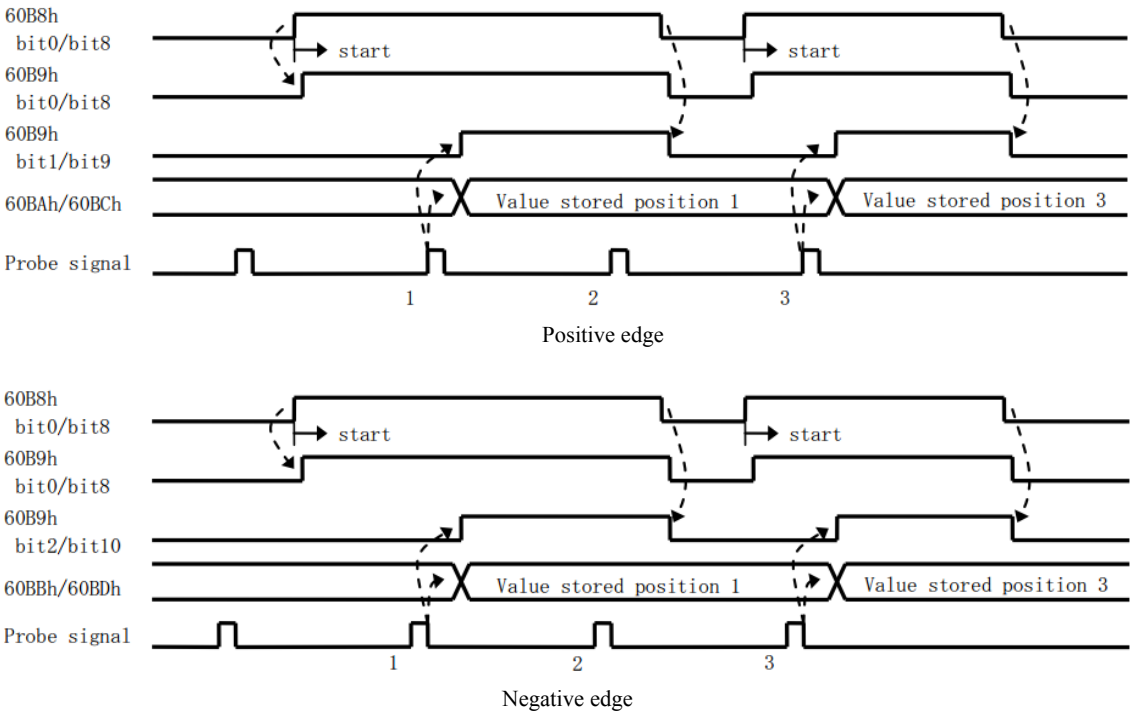


Figure 5.9 Single time mode

(2) Continuous time mode:

After switching on this continuous mode, each latch position value triggered by the probe signal can be stored until to the last probe signal trigger, which is shown as below:

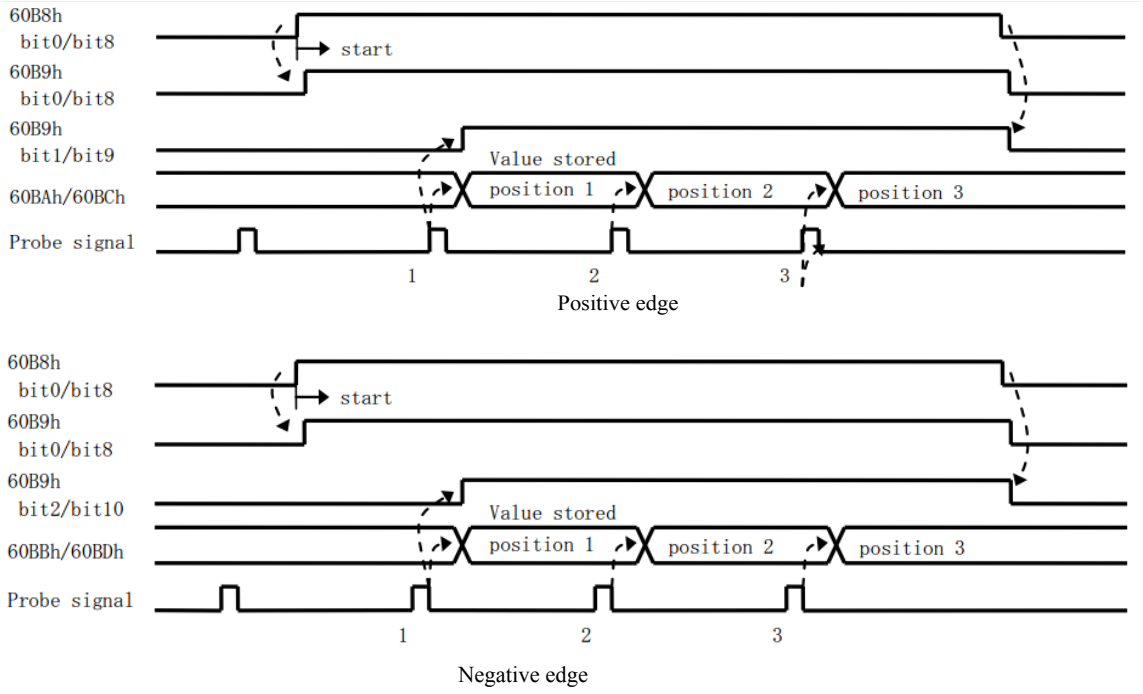


Figure 5.10 continuous time mode

5.6.10 Other state indication of touch probe

You can observe the object (60FDh) to judge whether touch probe action completed.

Table 5.37 Touch probe state indication

60FDH	Bit 26	Bit 27
	Trigger flag of touch probe1	Trigger flag of touch probe2

Chapter 6 Drive Operating Instructions

6.1 Function Operating

6.1.1 Save parameters

EM3E series stepper drives provide a method of saving parameter through setting the address 1010h+04. If the address 1010h+04 is set to value 0x65766173, the drive will save all of the present parameter to EEPROM.

Note: (1) Don't turn off the power when saving parameters to EEPROM; otherwise it will save wrong parameters to EEPROM. If it happens, you need to configurate all of the parameters once again, then write 0x65766173 to the address 1010h+04.

6.1.2 Factory reset

EM3E series stepper drives provide a method of factory reseting through setting the address 1011h+04, if the address1011h+04 is set to value 0x64616f6c, the drive will restore the factory setting.

6.2 Before Using

Table 6.1 Check items before operation

No	Item	Description
1	Accessories and wiring check	1. Accessories: Power connector, motor connector, control I/O signals connector. 2. Wirirng: EtherCAT communication port need correct and stable wiring, power and motor wiring should advoid short circuit.
2	Power voltage check	1. The polarity of power supply must be correct. 2. The power supply must within the range of operation voltage.
3	Fixed installation check	1. The motor and drive must be fixed to install.
4	Unload check	1. The shaft of motor must be unloading in the package.
5	Control signals check	1. All of the switch must be off state.

6.3 Field Bus Product Network

EM3E Series network diagram

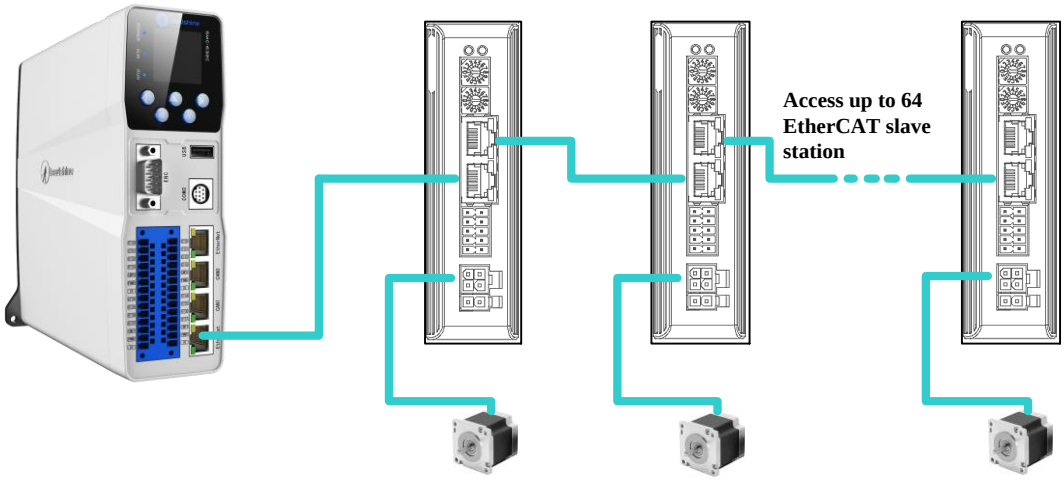


Figure 6.1 EM3E series network diagram

Note: SMC616 is the EtherCAT Controller designed by Leadshine.

6.3.1 Operation Mode

Relating to operation mode parameter setting:

Table 6.2 The corresponding object settings of each operation mode

Instruction type	Object	Operation mode
Field bus instruction	(6060h) = 1	Profile position mode (PP)
	(6060h) = 3	Profile Velocity mode (PV)
	(6060h) = 6	Homing mode (HM)
	(6060h) = 8	Syclic Synchronous Position mode (CSP)

6.3.2 The Necessary Configuration

Slave ID Adress Setting

If you want to control the EM3E series drives by EtherCAT instructions, first you need to set the node ID address, the related objects are shown as below: (Please refer to chapter 3.36)

Parameter Address	Name	Access	Default Parameter	Range	Description
2150+00	Slave Address	R/W/S	1	1-65535	Slave Address
2151+00	How to set Slave Address	R/W/S	0	0-2	0: Rotary Switches 1: Object 2150_h 2: ESC EEPROM

XML Files Setting

You need to configure the XML file through the software of controller / PLC to matche the EM3E series drive, and especially the PDO items (the items include the readable and writable objects in the chapter 5).

Chapter 7 Alarm and Processing

L1: Power/Alarm Indicator L2: EtherCAT Communication Indicator

Figure 7.1 LED Indicator

7.1 Alarm Code List

7.1.1 EM3E Series Drives Alarm

If a fault has occurred in the EM3E Series EtherCAT drives, the red LED of L1 (Fig 7.1) will flash and the stepper motor will stop working. The alarm codes and the red LED of L1 state are shown as below:

Table 7.1 Alarm code of drives and flash times of L1 red LED

3FFEh①	1001h②	603Fh③	Alarm Description	Flash Times	Alarm Can Be Cleared④
0x0e0	0x02	0x2211	Over current	1	No
0x0a0	0x04	0x3150	A phase amplifier failure	12	No
0x0a1	0x04	0x3151	B phase amplifier failure	12	No
0x0c0	0x04	0x3211	Over voltage	2	Yes
0x1a0	0x20	0x8402	Excess velocity range	5	Yes
0x240	0x80	0x5530	Save parameters failure	8	Yes

① The alarm codes mean history alarm show in the object 3FFEh.

② The alarm codes mean current alarm from CIA profile, show in the object 1001h.

③ The alarm codes mean current alarm from IEC 61800 profile, show in the object 603Fh.

④ It means after resolving the problem that caused the error, whether need to restart power to clear alarm of the drives. 'No' is means it must to restart power; 'Yes' is means it no need to restart power, and the two processing methods are as below:

A. Set the value 1 to the object 2057h to clear alarm.

B. Set the value of object 6040h+07h range from 0 to 1, to change the 402 state machines from fault to switch on disabled.

Note: If there are multiple faults occurred in EM3E series drives, the all alarm code will be updated and saved.

7.1.2 EtherCAT Communication Alarm

If a fault has occurred in the EtherCAT communication, the alarm codes and the red LED of L2 (Fig 7.1) state are shown as below:

Table 7.2 Alarm codes of drives and flash state of L2 red LED

603Fh	1001h	Alarm Description	3FFEh	Alarm Can Be Cleared⑥	Save or not	ERR LED⑤
0x8213	0x10	BOOT is not supported	-	Yes	No	Flickering Flash
0x8215	0x10	Invalid configuration in BOOT mode	Blanks are not saved	Yes	No	Flickering Flash
0x8216	0x10	Invalid configuration of Preop	-	Yes	No	Flickering Flash
0x8217	0x10	Invalid configuration of SM	-	Yes	No	Flickering Flash
0x821B	0x10	Watchdog time-out of SM	0x001B	Yes	Yes	Double Flash
0x821C	0x10	Invalid type of SM	0x001C	Yes	Yes	Blinking Flash
0x821D	0x10	Invalid configuration of output	-	Yes	No	Blinking Flash
0x821E	0x10	Invalid configuration of input	-	Yes	No	Blinking Flash
0x821F	0x10	Invalid configuration of watchdog	-	Yes	No	Blinking Flash
0x8224	0x10	Invalid TPDO mapping	-	Yes	No	Blinking Flash
0x8225	0x10	Invalid RPDO mapping	-	Yes	No	Blinking Flash
0x871A	0x10	Synchronous mode error	0x001A	Yes	Yes	Single Flash
0x8727	0x10	Free-run mode is not supported	-	Yes	No	Blinking Flash
0x8728	0x10	Synchronous mode is not supported	-	Yes	No	Blinking Flash
0x872C	0x10	Fatal synchronous error	-	Yes	Yes	Blinking Flash
0x872D	0x10	No synchronous error	-	Yes	No	Single Flash
0x872E	0x10	Too small synchronous cycle	-	Yes	No	Blinking Flash
0x8730	0x10	Invalid configuration of DC	-	Yes	No	Blinking Flash
0x8732	0x10	DC PLL error	0x0032	Yes	Yes	Single Flash
0x8733	0x10	DC synchronous IO erroe	0x0033	Yes	Yes	Single Flash
0x8734	0x10	DC synchronous overtime	0x0034	Yes	Yes	Single Flash
0x8735	0x10	Invalid DC cycle	-	Yes	No	Blinking Flash
0x8736	0x10	Invalid sync0 cycle	-	Yes	No	Blinking Flash
0xA001	0x10	Invalid ESM state transition	0x0011	Yes	Yes	Blinking Flash
0xA002	0x10	Unknow ESM transition request	0x0012	Yes	Yes	Blinking Flash
0xA003	0x10	A request of slave waite for initialization	0x0021	Yes	Yes	Blinking Flash
0xA004	0x10	A request of slave waite for pre-operation	0x0022	Yes	Yes	Blinking Flash
0xA005	0x10	A request of slave waite for secure operation	0x0023	Yes	Yes	Blinking Flash

⑤ ERROR LED display meaning refer to the chapter 4.6.1.

⑥ All of the communication errors can be cleared without restoring power, the master station processing steps are as below:

A. Master station write value 1 to the bit4 (error state) of EM3E stepper drive ESC control register (0x120).

B. After handling errors, the value of EM3E stepper drive ESC state register (0x134~0x135) will be value 0, and then the communication alarms are released.

C. Set the value of object 6040h+07h range from 0 to 1, to change the 402 state machines from 'Fault' to 'Switch on disabled'.

Note: When multiple alarms occur, all the related objects will update to the newest state.

Appendix A: Parameters List

Object Address	Parameters Name	Access Type	Default Value	Range	Description
1000+00	Device Type	R	0x00040192	-	Bit 0~15: Device profile number Bit 16~31: Additional information
1001+00	Error Register	R	0	-	Bit definition Bit0: generic error Bit1: current Bit2: voltage Bit3: temperature Bit4: communication error (overrun, error state) Bit5: device profile specific Bit6: Reserved (always 0) Bit7: manufacturer specific
1008+00	Device Name	R	EM3E-556	-	-
1009+00	Hardware Version	R	V1.0	-	-
100A+00	Software Version	R	V1.0	-	-
1010+04	Save Parameters of Manufacture	R/W	0	-	Write 0x65766173 to save parameters
1011+04	Restore Default Parameters of Manufacture	R/W	0	-	Write 0x64616f6c to restore default value
1018+01	Manufacture ID	R	0x00004321	-	-
1018+02	Product Code	R	0x00008100	-	-
1018+03	Revision Code	R	0x00000001	-	-
1018+04	SN	R	0x00000001	-	-
1600+01-08	RXPDO Mapping 1	R/W		-	Configurable object dictionary index + sub-index
1601+01-08	RXPDO Mapping 2	R/W		-	Configurable object dictionary index + sub-index
1602+01-08	RXPDO Mapping 3	R/W		-	Configurable object dictionary index + sub-index
1603+01-08	RXPDO Mapping 4	R/W		-	Configurable object dictionary index + sub-index
1A00+01-08	TXPDO Mapping 1	R/W/S		-	Configurable object dictionary index + sub-index
1A01+01-08	TXPDO Mapping 2	R/W/S		-	Configurable object dictionary index + sub-index
1C00+01	Mailbox Output Type	R	1	-	-
1C00+02	Mailbox Input Type	R	2	-	-
1C00+03	Process Output Data Types	R	3	-	-
1C00+04	Process Input Data Types	R	4	-	-
1C12+00	RXPDO Assignment	RW	0x1600	0x1600-0x1603	-
1C13+00	TXPDO Assignment	RW	0x1A00	0x1A00-0x1A01	-
Object Address	**Parameters Name**	**Access Type**	**Default Value**	**Range**	**Description**
2000+00	Output Peak Current	R/W/S	1000®	1000 to Maximum Current of Drives	Unit: mA, defined by user, but can't exceed the maximum output current of drives
2001+00	Pulse per Revolution	R/W/S	50000	6400-51200	Required pulses for motor running one cycle
2002+00	Standby Time	R/W/S	500	100-10000	Unit: ms
2003+00	Standby Current Percentage	R/W/S	50	0-100	Unit: %
2005+01	Digita Output O1 Function Setting	R/W/S	1	1-16	Bit0: Alarm output (default) Bit2: In place output Bit4: Master station control
2005+02	Digital Output O2 Function Setting	R/W/S	4	1-16	Bit0: Alarm output Bit2: In place output Bit4: Master station control
2007+00	Whethet Lock Motor Shaft in	R/W/S	0	0/1	0: Unlock motor shaft 1: Lock motor shaft

	Non-enable State				
2008+00	Digital Output Impedance Setting	R/W/S	0	0/1	0: Optocoupler conduction when alarm activated 1: Optocoupler shut off when alarm activated Bit Definition: bit0 is mapping O1 output bit1 is mapping O2 output
2009+00	Enable FIR Filter	R/WS	0	0/1	0: No 1: Yes
2010+01	Instructions FIR Time Setting	R/WS	1000	50-25600	Unit: us
2012+00	Soft-start Time	R/WS	4096	4000-65535	Unit: 50us
2013+00	Current Loop Auto-configuration	R/W/S	1	0/1	Current loop parameters auto-configuration when power on. 0: No 1: Yes
2015+00	Current Loop Kp	R/W/S	300	200-32767	If the object 2013h+00 is set 1, this object can be read only; If the object 2013h+00 is set 0, this object can be wrote, read and saved.
2016+00	Current Loop Ki	R/W/S	30	0-32767	If the object 2013h+00 is set 1, this object can be read only; If the object 2013h+00 is set 0, this object can be wrote, read and saved.
2017+00	Current Loop Kc	R/W/S	75	80-300	Don't allow to modify
2020+00	Motor Resistance	R/W/S	1000	1-20000	Unit: mOhms
2021+00	Motor Inductance	R/W/S	1	1-6000	Unit: uH
2028+00	Output Level Setting	R/W/S	0	0-0xffff	Bit0 and Bit1are used to control the polarities of output O1 and O2 respectively. 0 is means low level, 1 is means high level
2039+00	External Position H	R	0		High 16bit of received sum of position instructions
2040+00	External Position L	R/W	0		Low 16bit of received sum of position instructions Write:Write 1 to clear counter
2043+00	Reference Velocity	R	0		Unit: r/min
2048+00	Bus Voltage	R	0		Unit: V
2051+00	Motor Rotation Direction	R/W/S	0	0/1	0: Motor rotation direction unchanged 1: Motor rotation direction reversed
2056+00	Alarm detection selection	R/W/S	0xc3	0-0xffff	Select for whether detection the alarm by setting the bit value of this parameter : 1: Yes 0: No Bit0: Over currenr (The red LED of L1 flashed once), default setting 1; Bit1: Over voltage (The red LED of L1 flashed twice), default setting 1; Bit2: EEPROM (The red LED of L1 flashed 8 times), default setting 0; Bit3: Command exceed velocity range (The red LED of L1 flashed 5 times) ®, default setting 0; Bit11: Amplefier error (The red LED of L1 flashed 12 times), default setting 0.
2057+00	Clear Current Alarm	R/W	0	0/1	0: No 1: Yes
2058+00	Enable Soft Start Function	R/W/S	0	0/1	0: No 1: Yes
2060+00®	First anti-vibration amplitude values	R/W/S	0	0-100	First low speed resonance point inhibition amplitude values
2061+00®	First anti-vibration phase A	R/W/S	0	0-255	First low speed resonance point inhibition phase A
2062+00®	First anti-vibration phase B	R/W/S	0	0-255	First low speed resonance point inhibition phase B
2063+00®	Second anti-vibration amplitude values	R/W/S	0	0-100	Second low speed resonance point inhibition amplitude values
2064+00®	Second anti-vibration phase A	R/W/S	0	0-255	Second low speed resonance point inhibition phase A

2065+00⑦	Second anti-vibration phase B	R/W/S	0	0-255	Second low speed resonance point inhibition phase B
2066+00⑦	Third anti-vibration amplitude values	R/W/S	0	0-100	Third low speed resonance point inhibition amplitude values
2067+00⑦	Third anti-vibration phase A	R/W/S	0	0-255	Third low speed resonance point inhibition phase A
2068+00⑦	Third anti-vibration phase B	R/W/S	0	0-255	Third low speed resonance point inhibition phase B
2069+00⑦	Fourth anti-vibration amplitude values	R/W/S	0	0-100	Fourth low speed resonance point inhibition amplitude values
2070+00⑦	Fourth anti-vibration phase A	R/W/S	0	0-255	Fourth low speed resonance point inhibition phase A
2071+00⑦	Fourth anti-vibration phase B	R/W/S	0	0-255	Fourth low speed resonance point inhibition phase B
2072+00⑦	Z axis anti-vibration phase	R/W/S	0	0-255	Z axis low speed resonance point inhibition phase
2073+00	Motor auto-running when power on	R/W/S	0	0/1	0: No 1: Yes, motor auto-turns 30°and reverse 30° when power on, then in stansby state.
2093+00	Clear Alarm History	R/W	0	0/1	0: No 1: Yes
2150+00	Slave Address	R/W/S	1	1-65535	Slave station address: Activate after repower
2151+00	Slave Address Comes From	R/W/S	0	0-2	0: From rotation switch 1: From object 2150h 2: From ESC EEPROM ⑦
2152+01	Digital Input I1 Function Setting	R/W/S	32⑧	0-32768	1: Homing signal; 2: Positive limit; 4: Negative limit; 8: Emergency stop; 16: User defined; 32: Probe1 function; 64: Probe2 function
2152+02	Digital Input I2 Function Setting	R/W/S	1⑧	0-32768	1: Homing signal; 2: Positive limit; 4: Negative limit; 8: Emergency stop; 16: User defined; 32: Probe1 function; 64: Probe2 function
2152+03	Digital Input I3 Function Setting	R/W/S	2⑧	0-32768	1: Homing signal; 2: Positive limit; 4: Negative limit; 8: Emergency stop; 16: User defined;
2152+04	Digital Input I4 Function Setting	R/W/S	4⑧	0-32768	1: Homing signal; 2: Positive limit; 4: Negative limit; 8: Emergency stop; 16: User defined;
2152+05	Digital Input I5 Function Setting	R/W/S	16⑧	0-32768	1: Homing signal; 2: Positive limit; 4: Negative limit; 8: Emergency stop; 16: User defined;
2153+01	Digital Input I1 Filter Time	R/W/S	1000	50-60000	Unit: us
2153+02	Digital Input I2 Filter Time	R/W/S	1000	50-60000	Unit: us
2153+03	Digital Input I3 Filter Time	R/W/S	1000	50-60000	Unit: us
2153+04	Digital Input I4 Filter Time	R/W/S	1000	50-60000	Unit: us
2153+05	Digital Input I5 Filter Time	R/W/S	1000	50-60000	Unit: us
2154+00	Digital Input Levels	R/W/S	0	0-65535	0: Unchange 1: Reverse (bit0 is mapping digital input I1, and so on)
2155+00	The State of Digital Input	R	0	0-32768	bit0 is mapping digital input I1, and so on
2163+00	In Place Funciton of Mode 1	RW/S	0	10	0: Come from completing planning 10: Come from EtherCAT drives

3100+01	Software Version of EtherCAT Drives	R	106®	0-65535	106 is as the initial version
3100+02	Software Version of FPGA	R	0®	0-65535	None
3100+03	Software Version of Field Bus	R	203®	0-65535	203 is as the initial version
3FFE+01-09	Alarm List	R/W/S	0		3FFE+01 is the nearly alarm, others are history alarm
4000+00⑦	Motor Model	R/W/S	0	0-255	0: Configure the low speed vibration resistance parameters by user. 1-255: Default internal low speed vibration resistance parameters
4001+00⑦	Motor Stalling Detection Sensorless	R/W/S	0	0/1	0: No 1: Yes
4002+00⑦	Drives Action When detect motor stalling	R/W/S	0	0/1	0: No action 1: Stop running motor and alarm
5000+00⑦	State of Internal Program	R	0xffff	0-0xffff	Displays the state of motion planning
5001+00	Internal Enable	R	0	0-1	For internal tuning
5002+00	ESC Contorl Register	R/W	0	0-0xffff	For internal tuning
5003+00	ESC Date Register	R	0	0-0xffff	For internal tuning
5004+00	DC Watchdog Counter	R	0	0-0xffff	For internal tuning
5010+00	Watchdog Time	R/W	0	0-0xffff	For internal tuning
5013+00®	The Code of Motor Don't Move	R	0	0-0xffff	23: Don't support current mode 30: Command exceed velocity range
5014+00®	Velocity Limit	R/W	1600	0-3000	Unit: r/min
Object Address	**Parameters Name**	**Access Type**	**Data Type**		**Description**
603F+00	Nearly error code	R	Unsigned 16-bit		The last time error code
6040+00	Controlword	R/W	Unsigned 16-bit		Controlword
6041+00	Stateword	R	Unsigned 16-bit		Stateword
605A+00	Emergency Stop Code	RW	Signed 16-bit		5: Slow down on slow down ramp and stay in Quick Stop Active Others: Invalid
6060+00	Operating Mode	RW	Unsigned 8-bit		Operating Mode: 1: Position Mode 3: Velocity Mode 6: Homing Mode 8: CSP Mode
6061+00	Mode Check	R	Unsigned 8-bit		Display EtherCAT drives operating mode
6062+00	Command Position	R	Signed 32-bit		Display motor command position
6064+00	Actual Position	R	Signed 32-bit		Display motor actual position
606B+00	Command Velocity	R	Signed 32-bit		Display motor command velocity
606C+00	Actual Velocity	R/W	Signed 32-bit		Display motor actual velocity
607A+00	Targe Position	R/W	Signed 32-bit		Target position in position mode
607C+00	Home Offset	R/W	Signed 32-bit		Home offset
6081+00	Trapezoidal Velocity	R/W	Unsigned 32-bit		Maximum velocity in position mode
6082+00	Start and Stop Velocity	R/W	Unsigned 32-bit		Strat and stop velocity in mode 1
6083+00	Trapezoidal Acceleration	R/W	Unsigned 32-bit		Acceleration with trapezoidal curve
6084+00	Trapezoidal Deceleration	R/W	Unsigned 32-bit		Deceleration with trapezoidal curve
6085+00	Emergency Stop Deceleration	R/W	Unsigned 32-bit		Deceleration of emergency stop, this effect depends on the object 605Ah
6098+00	Homing Mode	R/W	Unsigned 8-bit		Search for home signal
6099+01	Velocity in Homing Mode	R/W	Unsigned 32-bit		The velocity of searching for limit switch
6099+02	Velocity in Homing Mode	R/W	Unsigned 32-bit		The velocity of home siganl
609A+00	Homing Acceleration/ Deceleration	R/W	Unsigned 32-bit		Acceleration/deceleration of homing mode

60B8+00	Probe Function	R/W	Unsigned 16-bit	Setting the function of probe (refer to the detail description of probe function)
60B9+00	Probe State	R	Unsigned 16-bit	Display the state of probe function (refer to the detail description of probe function)
60BA+00	Probe 1 Rising Edge Latched Position	R	Signed 32-bit	Probe 1 rising edge latched position data
60BB+00	Probe 1 Falling Edge Latched Position	R	Signed 32-bit	Probe 1 falling edge latched position data
60BC+00	Probe 2 Rising Edge Latched Position	R	Signed 32-bit	Probe 2 rising edge latched position data
60BD+00	Probe 2 Falling Edge Latched position	R/	Signed 32-bit	Probe 2 falling edge latched position data
60C2+01	Interpolation Time Value	R	Unsigned 32-bit	Setting interpolation time cycle
60C2+02	Interpolation Time Unit	R	Unsigned 32-bit	Setting interpolation time index number
60D5+00	Probe 1 Rising Edge Trigger Counter	R	Unsigned 32-bit	Recorde the trigger times probe 1 rising edge
60D6+00	Probe 1 Falling Edge Trigger Counter	R	Unsigned 32-bit	Recorde the trigger times probe 1 falling edge
60D7+00	Probe 2 Rising Edge Trigger Counter	R	Unsigned 32-bit	Recorde the trigger times probe 2 rising edge
60D8+00	Probe 2 Falling Edge Trigger Counter	R	Unsigned 32-bit	Recorde the trigger times probe 2 falling edge
60F4+00	Position Error	R	Unsigned 32-bit	Position error
60FD+00	Digital Input State	R	Unsigned 32-bit	bit0: Negative limit bit1: Positive limit bit2: Homing signal bit16: Emergency stop bit17-bit21: Input level of IN1-IN5 with user defined bit26: Probe 1 command of competing trigger⑥ bit27: Probe 2 command of competing trigger⑥
60FE+01	Open the Physical Output	RW	Unsigned 32-bit	When 2005h+01/02 is set to main station control, master controller can use the combination of 60FE+01 and 60FE+02 to control IO output: When bit16 of 60FE+01and 60FE+02 are both '1', O1 has output When bit17 of 60FE+01and 60FE+02 are both '1', O2 has output, and so on.
60FE+02	Enable the Physical Output	RW	Unsigned 32-bit	
60FF+00	Target Velocity	R/W	Signed 32-bit	Maximum velocity in velocity mode
6502+00	Supported Operating Mode	R	Unsigned 32-bit	Supportde operating mode

⑥ It is available when the software version of field bus >= 202
⑦ It is not available for this version EtherCAT stepper drives
⑧ It is available when the software version of field bus >= 203

If the software version of field bus >=203, the default values of some object will be changed as beloe:

Object	**2000:00**	**2152:01**	**2152:02**	**2152:03**	**2152:04**	**2152:05**	**3100:01**	**3100:02**	**3100:03**
The software version of field bus <=**202**	3200	1	2	4	8	0	201	102	None
The software version of field bus >=**203**	1000	32	1	2	4	16	106	0	203

Appendix B: Homing Methods

As EM3E series EtherCAT stepper drives are open loop drives, supported 17-34, 35/37 homing modes currently. Specific motion trail of various homing methods are shown as below:

No. 17:

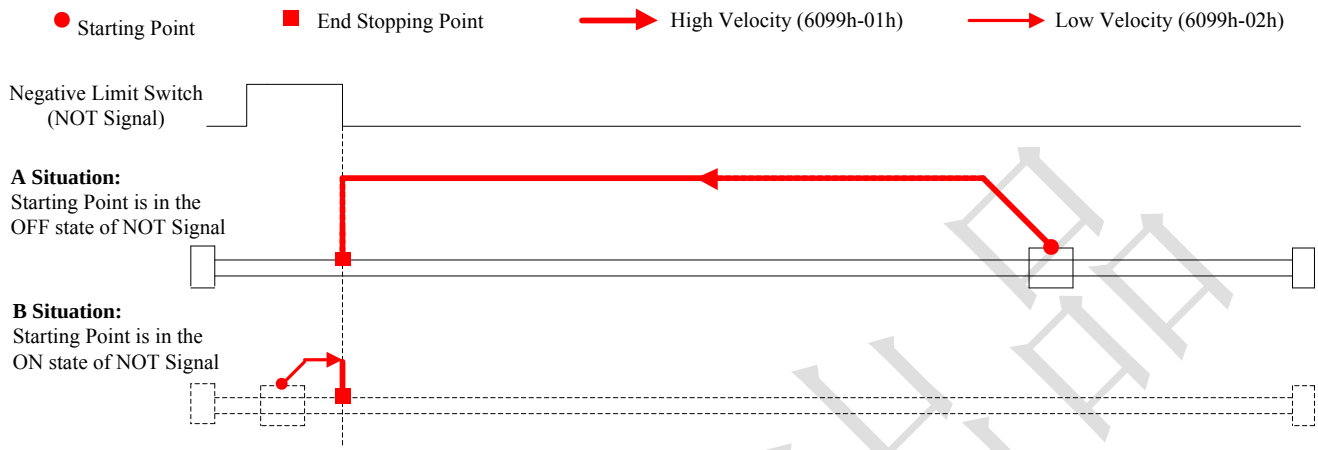


Figure 8.1 No.17 homing method

No. 18:

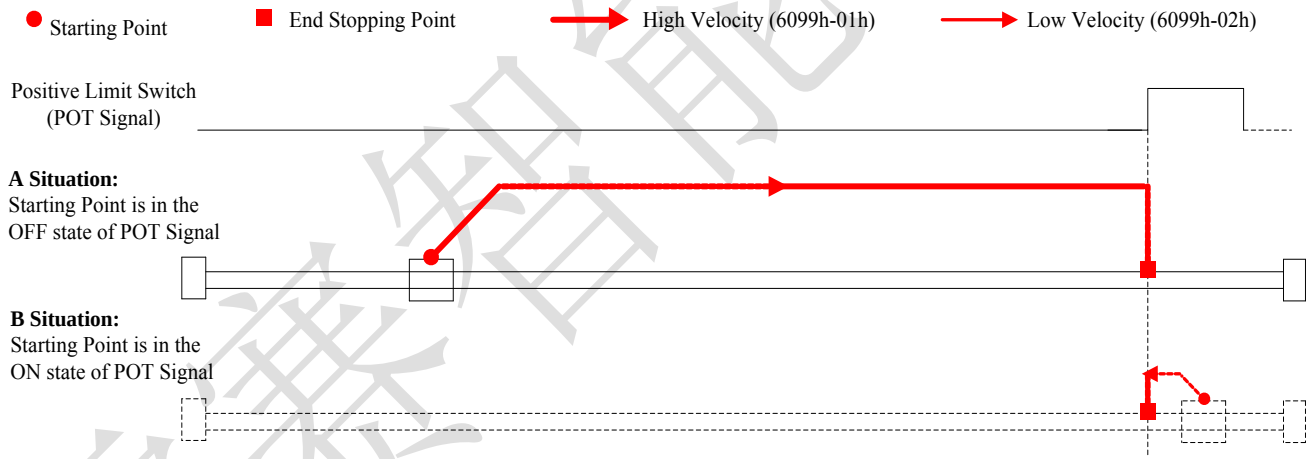


Figure 8.2 No.18 homing method

No. 19:

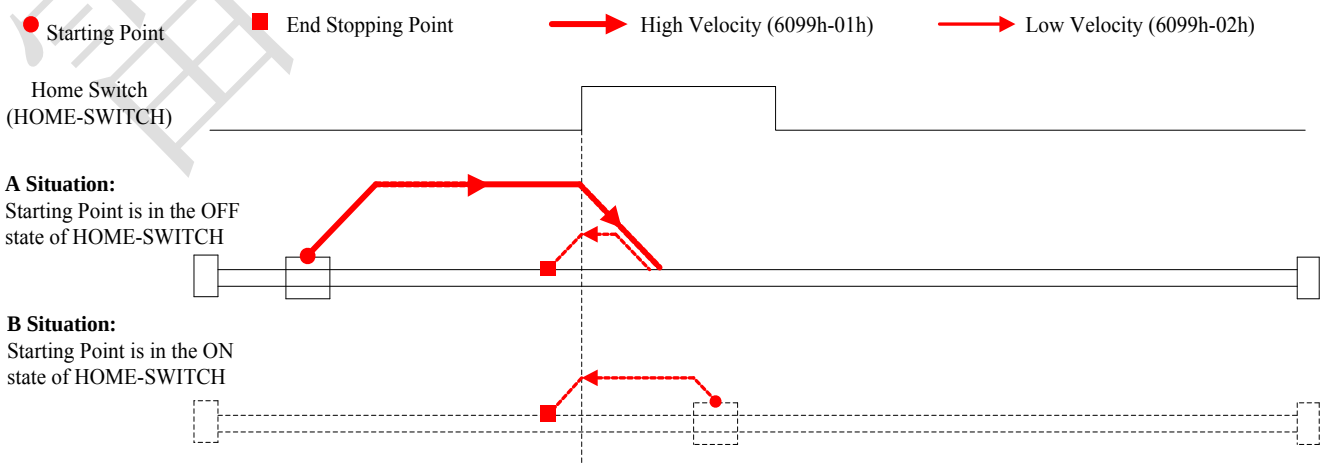


Figure 8.3 No.19 homing method

No. 20:

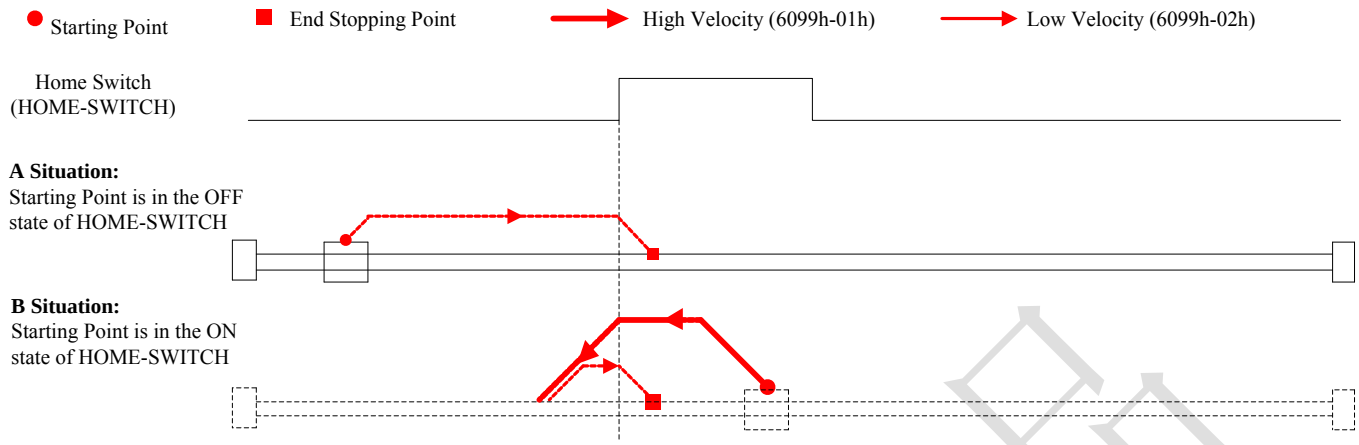


Figure 8.4 No.20 homing method

No. 21:

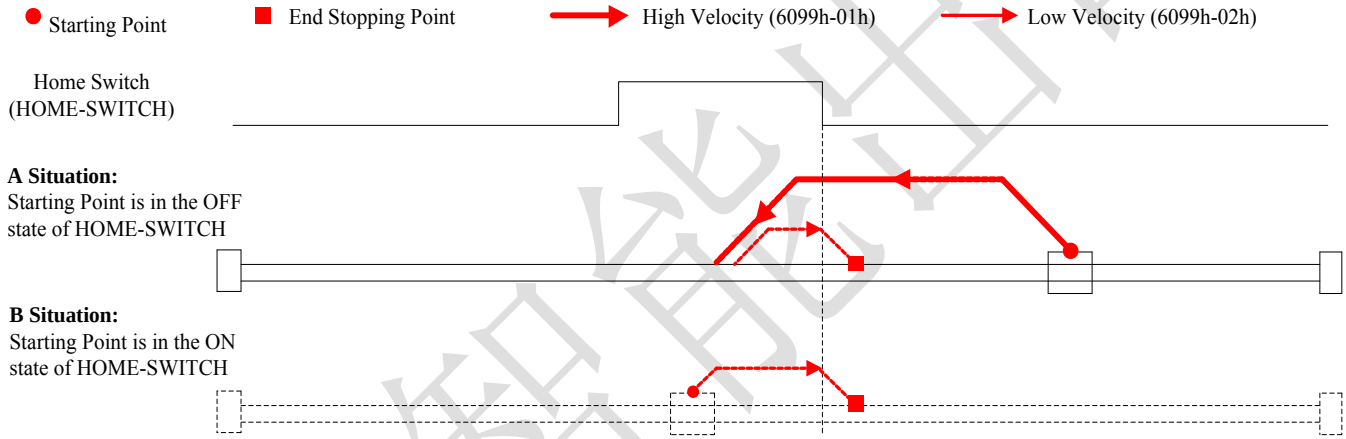


Figure 8.5 No.21 homing method

No. 22:

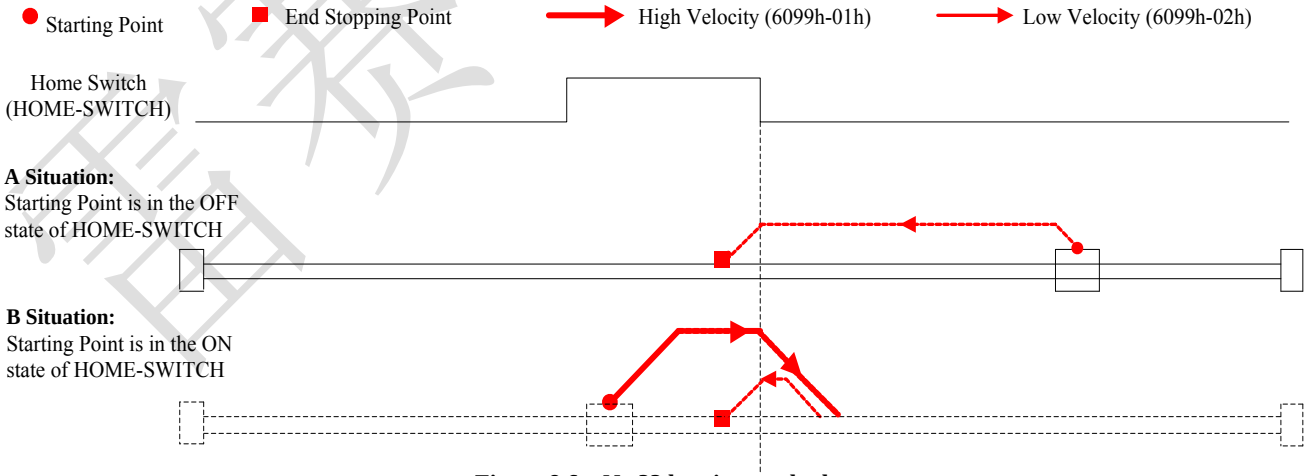


Figure 8.6 No.22 homing method

No. 23:

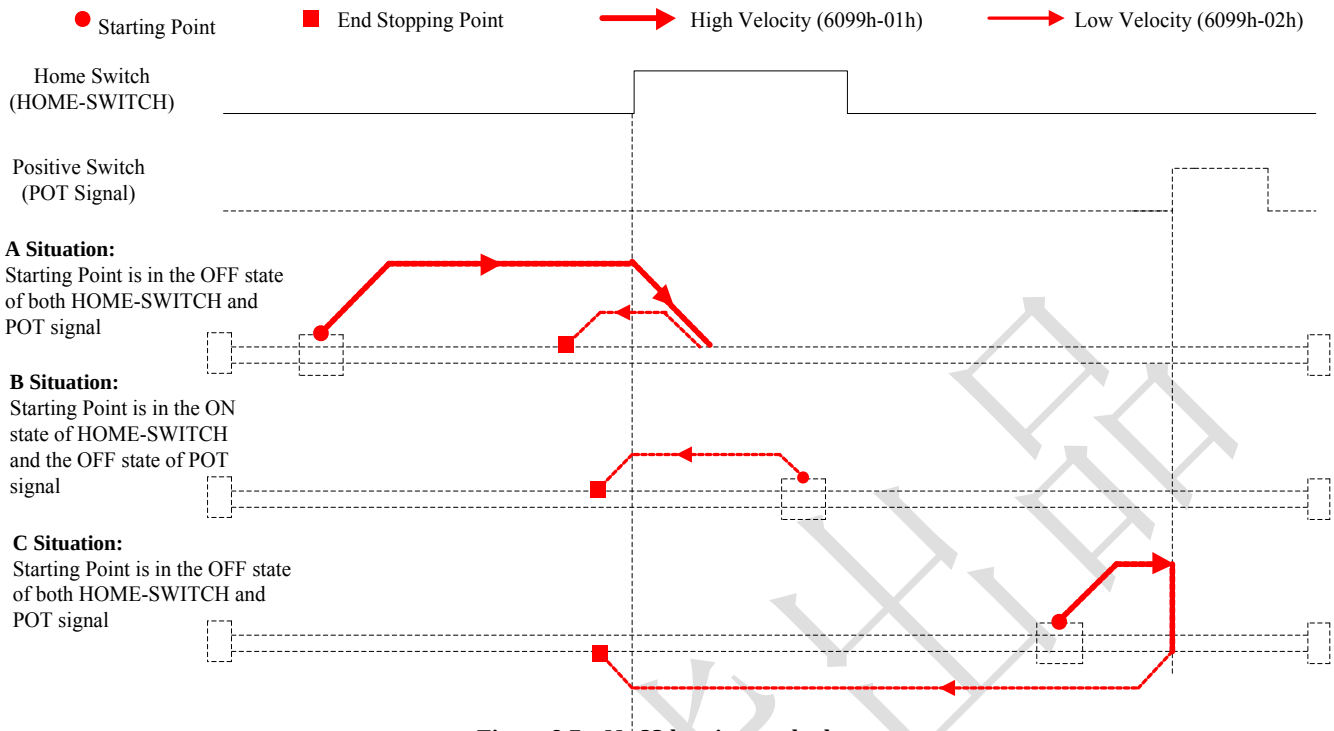


Figure 8.7 No.23 homing method

No. 24:

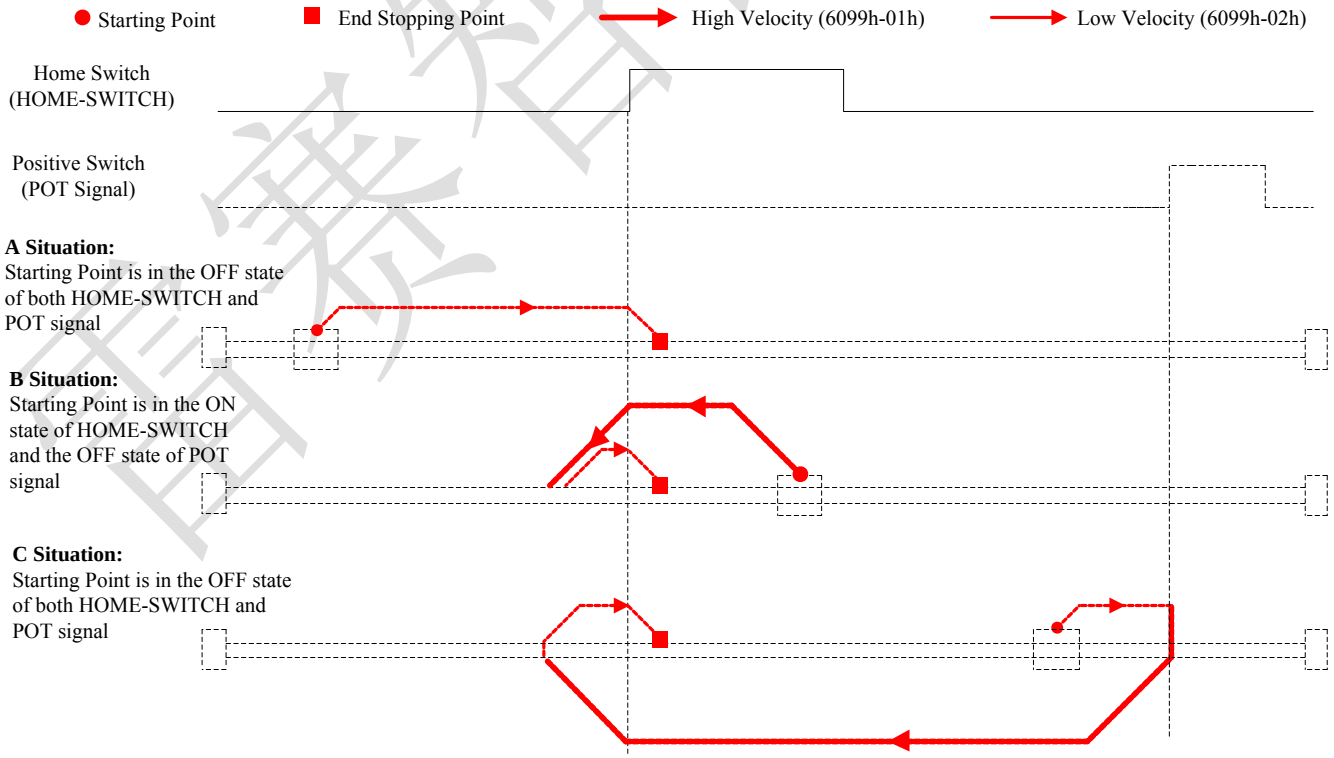


Figure 8.8 No.24 homing method

No. 25:

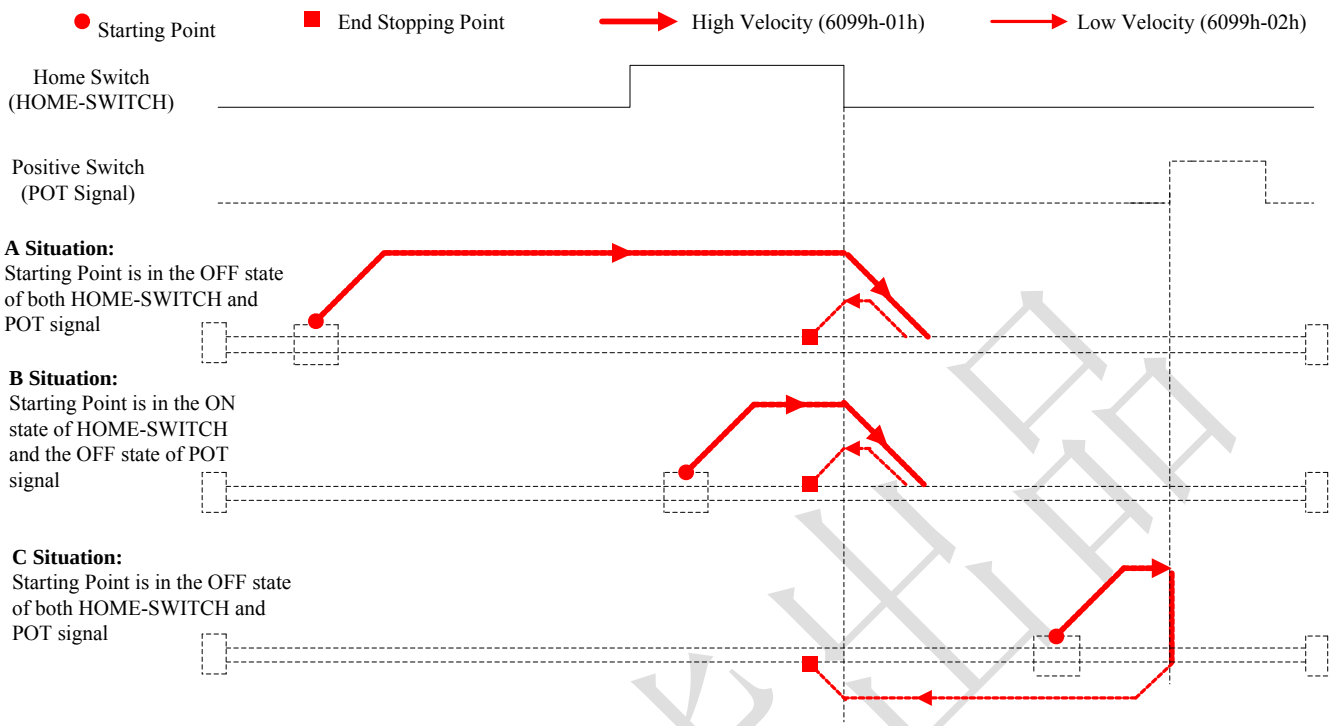


Figure 8.9 No.25 homing method

No. 26:

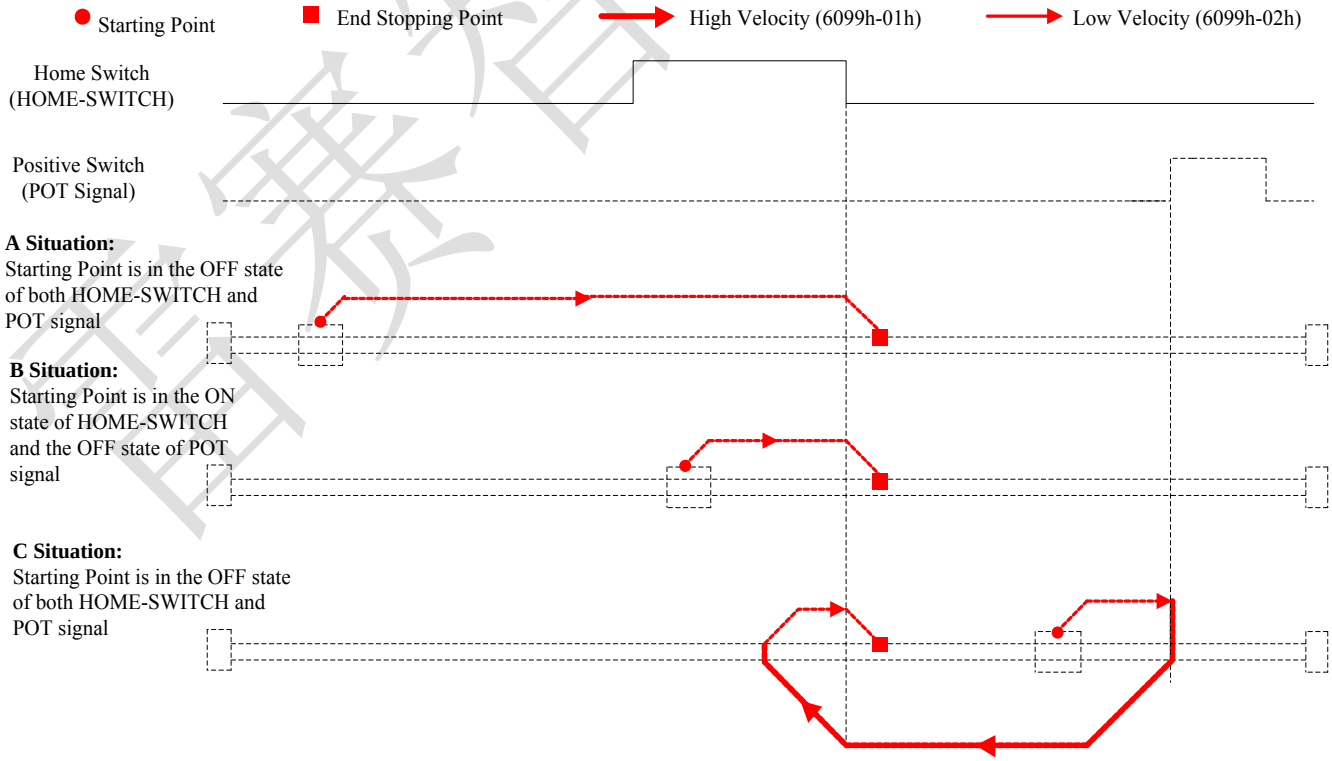


Figure 8.10 No.26 homing method

No. 27:

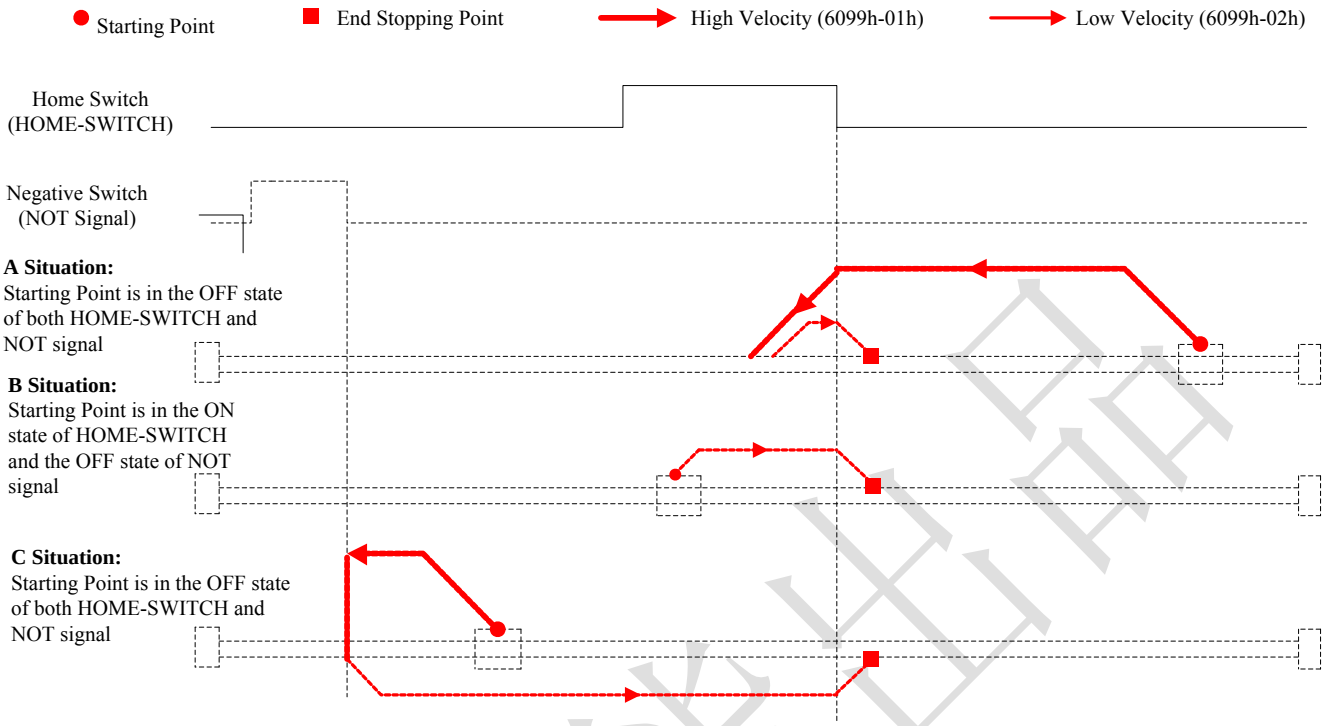


Figure 8.11 No.27 homing method

No. 28:

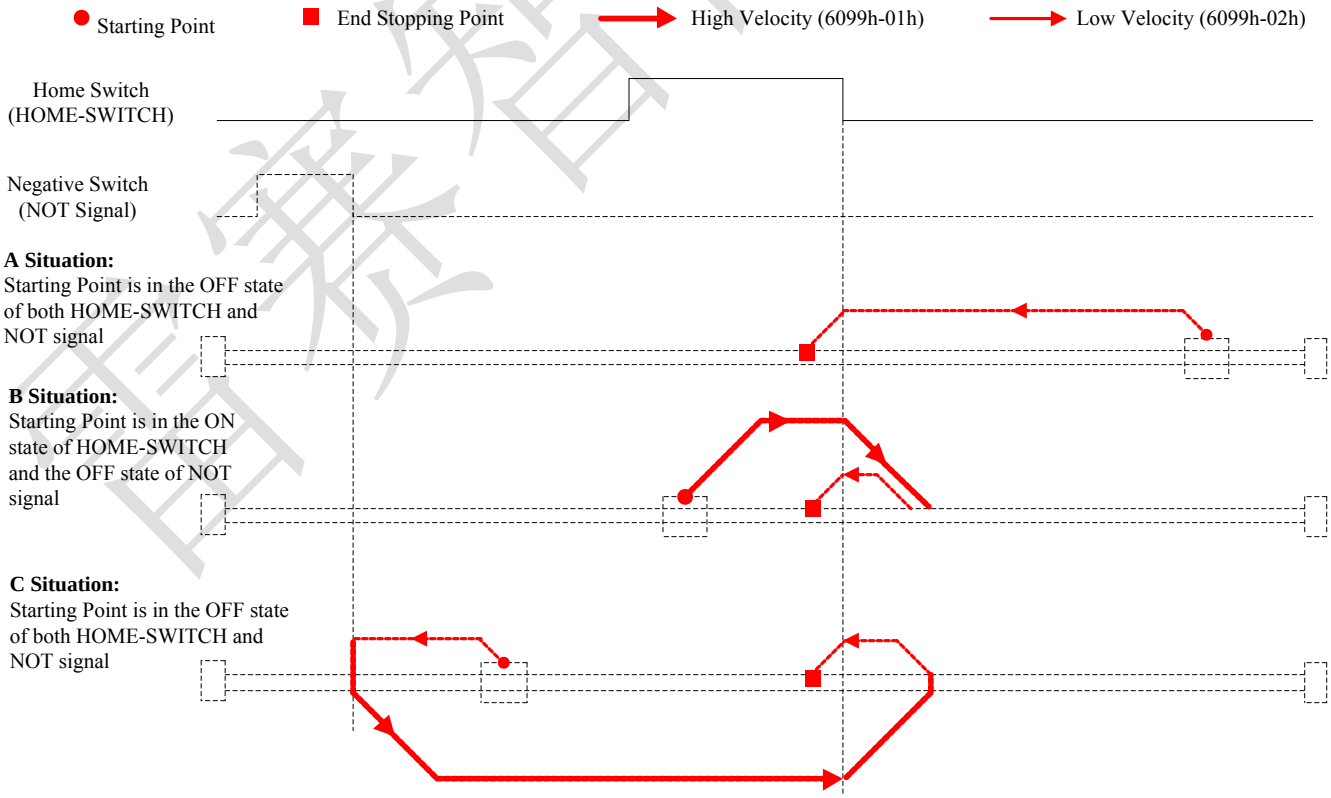


Figure 8.12 No.28 homing method

No. 29:

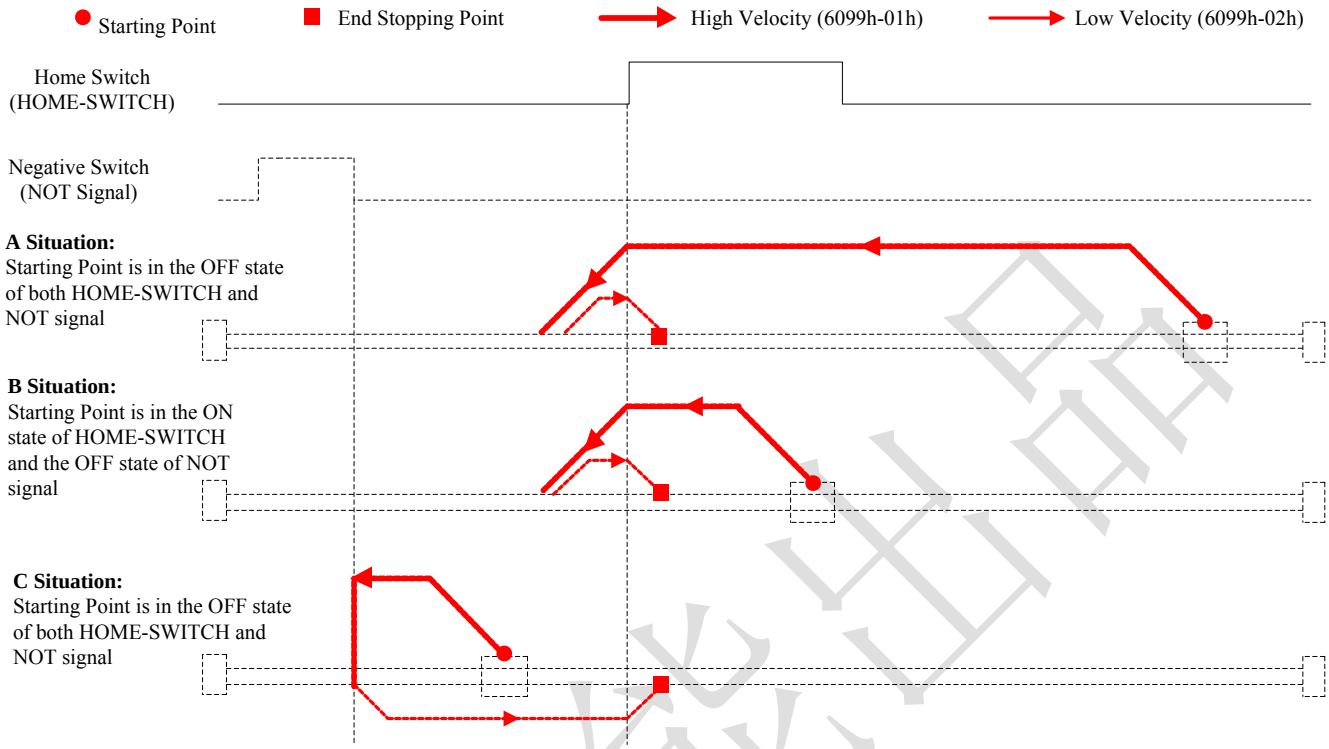


Figure 8.13 No.29 homing method

No. 30:

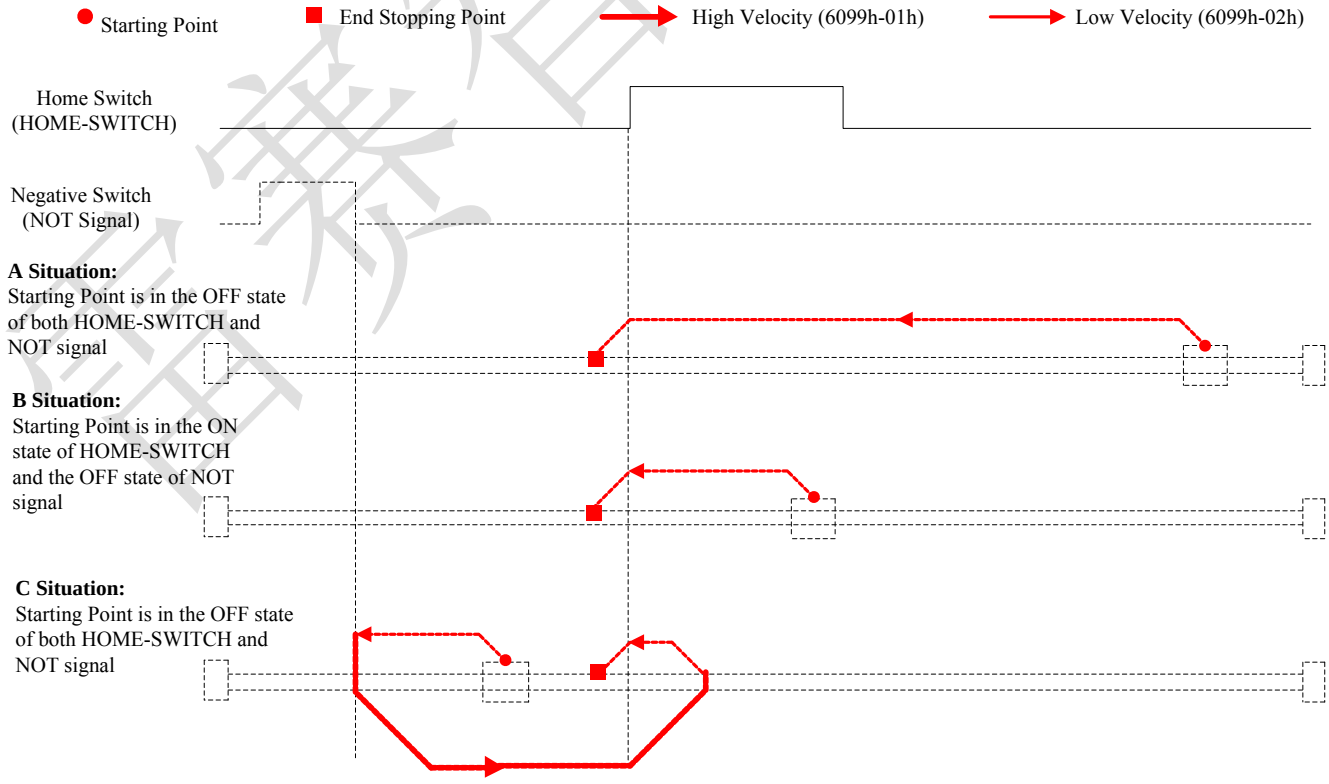


Figure 8.14 No.30 homing method

No. 35/37:

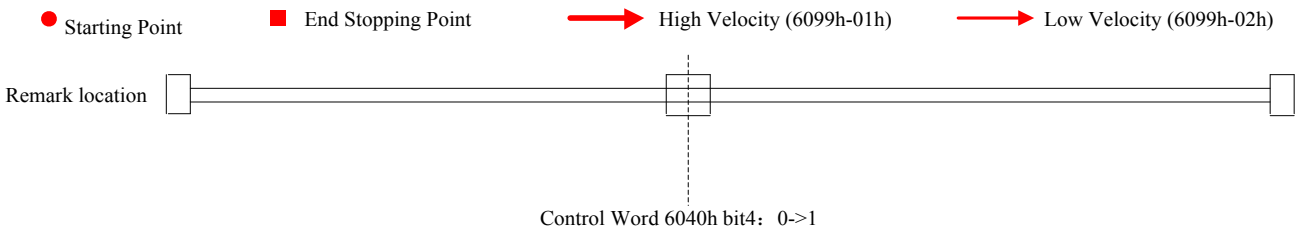


Figure 8.15 No.35/37 homing method

Warranty

Twelve Month Warranty

Leadshine Technology Co., Ltd. warrants its products against defects in materials and workmanship for a period of 12 months from shipment out of factory. During the warranty period, Leadshine will either, at its option, repair or replace products which proved to be defective.

Exclusions

The above warranty does not extend to any product damaged by reasons of improper or inadequate handlings by customer, improper or inadequate customer wirings, unauthorized modification or misuse, or operation beyond the electrical specifications of the product and/or operation beyond environmental specifications for the product.

Obtaining Warranty Service

To obtain warranty service, please contact your seller to obtain a returned material authorization number (RMA) before returning product for service.

Shipping Failed Products

If your product fail during the warranty period, please contact your seller for how and where to ship the failed product for warranty or repair services first, you can also e-mail customer service at tech@leadshine.com to obtain a returned material authorization number (RMA) before returning product for service. Please include a written description of the problem along with contact name and address.

Contact Us

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