User Manual

CS3E Series

EtherCAT Closed Loop Stepper Drive

Revision 1.0

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ETC Laboratory Conformance Test Passed

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

- **Thank you for purchasing Leadshine CS3E Series Products**
- **Please read this manual carefully before operating**
- **Please keep this manual appropriately**

Notice

Read this manual carefully before any assembling and using. Incorrect handling of products in this manual can result in injury and damage to persons and machinery. Strictly adhere to the technical information regarding installation requirements.

Record of Revisions

Reversion	Data	Description of Release	Signed
V1.00	20181017	Initial Release	Max

Preface

Thank you for choosing CS3E series EtherCAT closed loop stepper drive system of Leadshine Technology Co., Ltd. This manual gives required knowledge & precautions for using CS3E series closed loop 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 CS3E Series Include:

- <CS3E Series EtherCAT Closed Loop Stepper Drive User Manual >

  The user manual is about hardware, function description, EtherCAT communication protocol, object dictionary, etc.

  Please make sure to read carefully and refer to this specification after understanding the contents fully.

- <CS3E Series EtherCAT Stepper Drive Software Manual>, coming soon.

  The user manual is coming soon, includes how to connect with Leadshine PC software, operation steps and parameters configuration, etc. Customer also can configure object dictionary through master station PC software.

Please Pay Attention to The Following Reminders:

- Only technical personnel are allowed to install debug or maintain the product.
- Make sure wiring is correct before power-on test.
- Incorrect voltage or power polar connection can cause damage to drive or other accidents.
- Contents of this manual are subject to change without prior notice for functional improvement, change of specifications or use's better understandings.
- Leadshine will not undertake any responsibility in case of user's unauthorized product changes reconstruction, product warranty will also be invalid.

Content Table

1 Introduction

1.1 Product Introduction

The newly released CS3E 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 many brands of EtherCAT controller/PLC such as Beckhoff, Omron, Trio, Keneyce etc.

The CS3E series is highly reliable and affordable and performs excellently in many industrial applications such as solar equipment, textile, civil, robotics, power generation equipment, 3C, packaging...

1.2 Features

- No loss of step, No hunting, No torque reservation
- CANopen over EtherCAT (CoE) with full support of CiA402,100Mbps full-duplex.
- Support operation modes: Profile Position, Profile Velocity, Cyclic Synchronous Position, Homing
- 7 configurable digital inputs, 7 optically isolated digital outputs include brake output
- Low noise and vibration, smooth motion
- 20-50VDC supply voltage for CS3E-D503 and CS3E-D507, max 7A output current

  20-72VDC supply voltage for CS3E-D728, max 8A output current

  20-80VAC or 30-100VDC supply voltage for CS3E-D1008, max 8A output current
- USB port for parameters configuration
- Encoder resolution: 1000 / 2500 / 5000 line for NEMA11/17/23/24/ 34 CS motors,
- Two 7-segment display velocity or slave ID or operation mode or error code
- Protections for over voltage, over current and position following error, encoder cable error, etc.

1.3 EtherCAT Compare with Step/Direction

1.3.1 Stronger anti-disturbance ability

Traditional step/direction transmission cables have lower reliability for the reason of EMC interference, whereas EtherCAT communication with shielded cables have stronger anti-interference ability, and inbuilt error detection. Limit and handling mechanisms can also bring more reliable transmission and longer communication distance.

1.3.2 Enhanced performance

EtherCAT is the fastest industrial Ethernet technology by and large,and it also synchronizes with nanosecond accuracy. This is a huge benefit for all applications in which target system is controlled or measured via the bus system.

1.3.3 Simple wiring and long communication distance

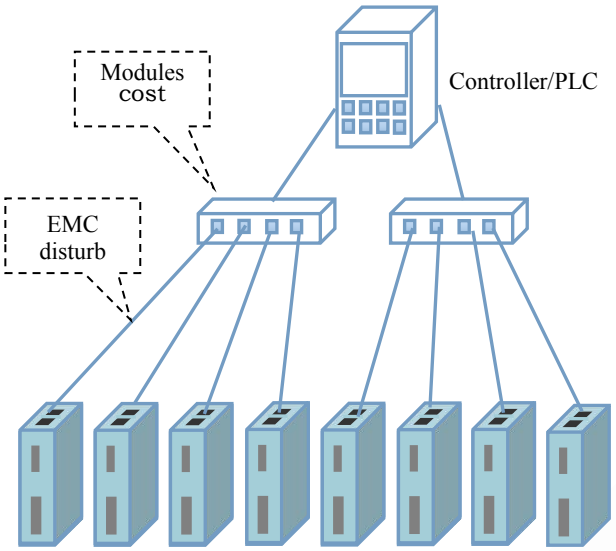
In step/direction control mode, the controller/PLC needs to connect with each drive to send control signals, which may lead to intensive signal cables and wiring complexity if many drives are required. While in EtherCAT applications, the controller/PLC just needs to connect with one of the drives and then line topology with others. Additionally, the EtherCAT communication allows longer distance up to 100 meters maximum.

1.3.4 Lower cost

EtherCAT delivery has 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, instead of some expensive interface cards or co-processors. 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 typologies are as below:

Step/direction Topology A (Controller/PLC)



Step/direction Topology B (Control Card)

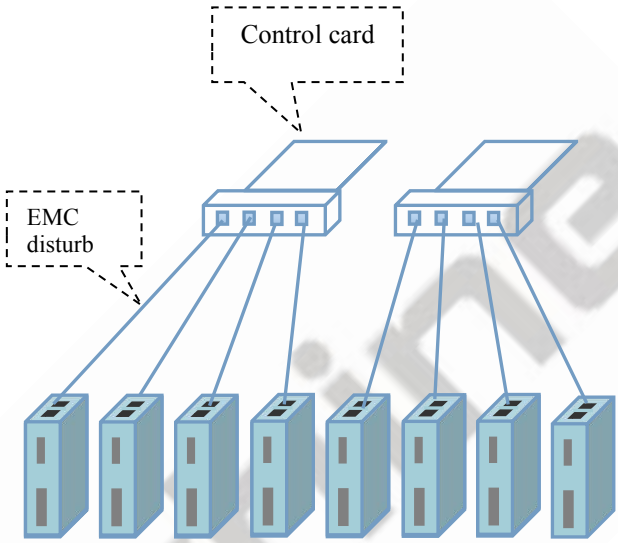


Figure 1.1: Step/direction Topology

EtherCAT Topology (Controller/PLC)

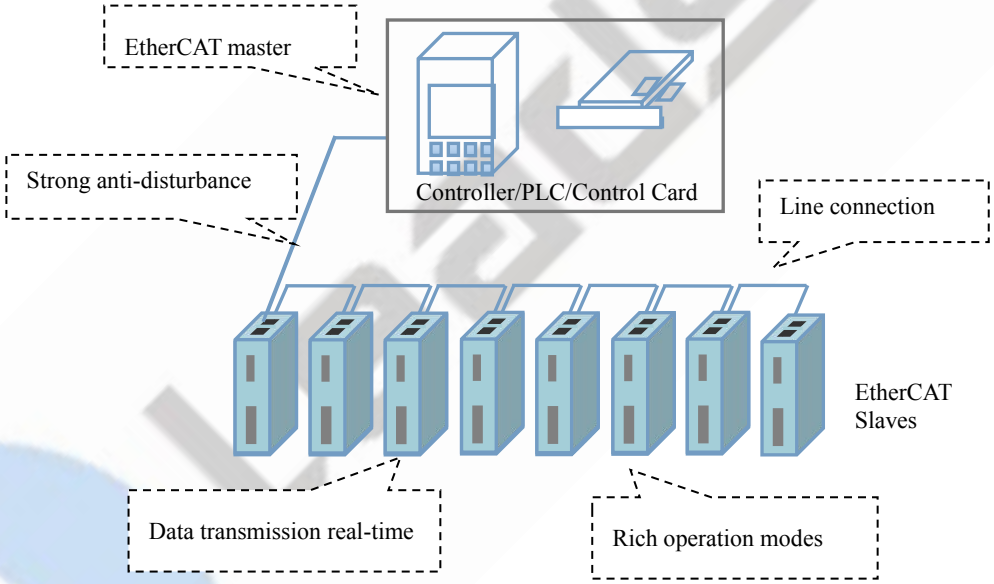


Figure 1.2: EtherCAT Topology

1.4 Check of Product

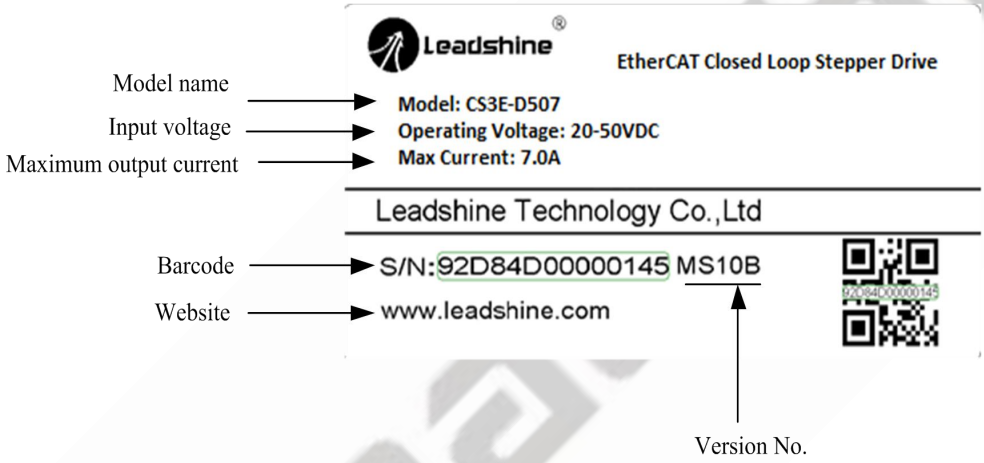
1.4.1 Arrival inspection

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

CAUTION

- Neither the damaged nor missing accessories of stepper system is allowed to install.
- Contact Leadshine or local distributor if any failure was found.

1.4.2 Nameplate information



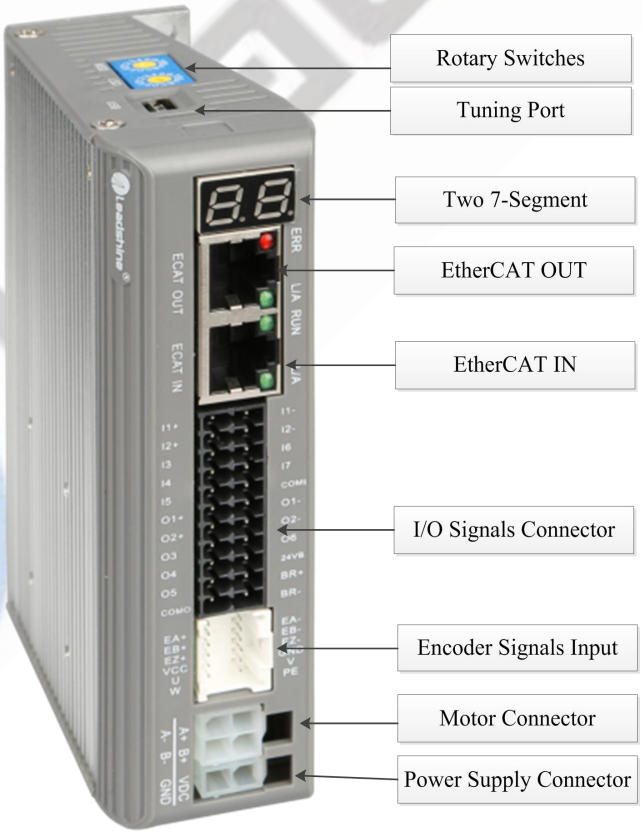
1.4.3 Part number

CS3E - D □ 50 7 - □

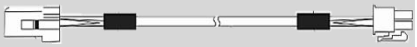
1 2 3 4 5 6 7

1. Series Name
   CS3: 3rd generation closed loop stepper drives
2. Communication Mode
   E: EtherCAT
3. Product Type
   D: Drive
4. AC or DC
   A: AC power voltage
   Blank: DC power voltage
5. Maximum Operating Voltage
   50: 50V
   100: 100V
6. Maximum Output Current
   7: 7.0A
   8: 8.0A
7. Customerized Code
   Blank: standard

1.4.4 Parts description



1.4.5 Accessories Information

Name	Necessary	Picture	Description	Need to cost extra
Power supply cable	Yes		Power supply cable with 1.5m length	No
Motor extension cable (CABLEM-RZ*M*)	Yes		Optional length: 1.5m,3m,5m,8m, 10m,12m,15m	Yes
Encoder extension cable (CABLEM-BM*M*)	Yes		Optional length: 1.5m, 3m, 5m,8m, 10m,12m,15m	Yes
I/O signal terminal	Yes		22-pin terminal	No
Tuning Cable	No, can use 3rd party cable		Micro-USB cable	Yes
Network cable	Yes, can use 3rd party cable		Optional length: 0.1m, 0.2m, 0.3m, 0.4m, 1m, 1.5m, 2m, 3m,5m,7m, 10m,15m, 20m	Yes

Note:

- Micro-USB cable is not necessary, you can also modify parameters by master station PC software. Leadshine ProTuner is coming soon.
- Network cable is necessary, but you can also buy shielded network cable through 3rd party.
- Power supply connector: 39012020, 39000038, Molex
- Motor extension cable connector: 39012040, 39000038, Molex
- Motor encoder cable connector: 513531200, 561349000, Molex

2 Installation

2.1 Storage and Installation Conditions

2.1.1 Storage condition

- Correctly packaged and store in a clean and dry environment where direct sunlight is avoided.
- Store within an ambient temperature ranging from -20℃ to +65℃.
- Store within a relative humidity ranging from 40% to 90% and non-condensed.
- Avoid any type of exposure to corrosive gases.

2.1.2 Operating ambience conditions

- Temperature ranging from 0℃ to 50℃. The ambient temperature of drive for long-term reliability should be under 40℃. Please install the drive in a well-ventilated area.
- Operation within a relative humidity ranging from 40% to 90% and non-condensed.
- Vibration lower than 0.15mm at a frequency of 10Hz-55Hz.

CAUTION

- DO NOT mount the drive and motor in a location subjected to corrosive or flammable gases, and combustibles.
- Please mount the drive and motor in an indoor electric control cabinet without liquid where direct sunlight is avoided.
- 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

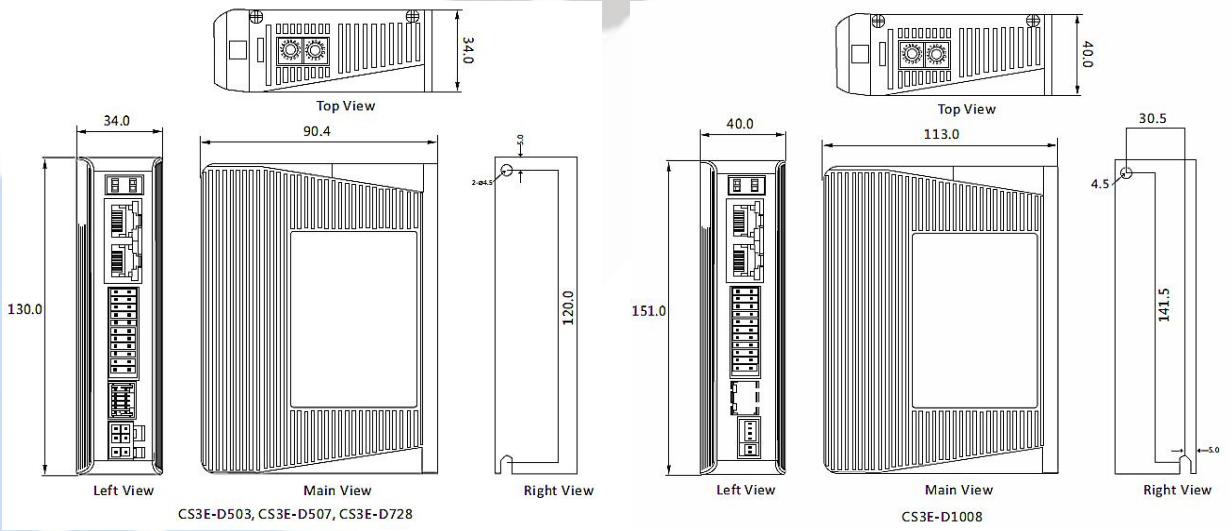


Figure 2.1: CS3E series mechanical drawing

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 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.

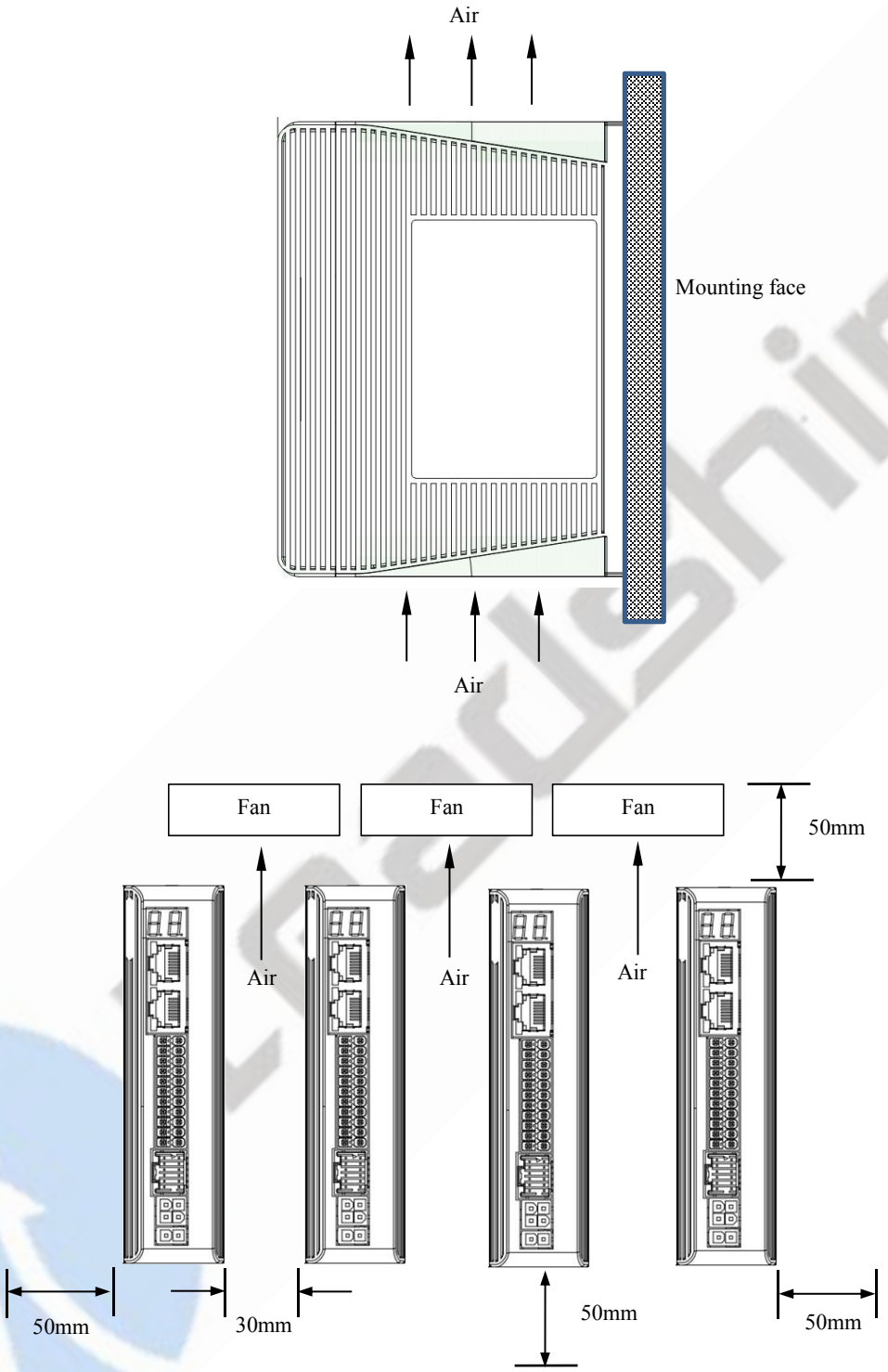


Figure 2.2: CS3E series installation drawing

3 Production Specifications

3.1 Electrical and Operating Specifications

3.1.1 EtherCAT Specifications

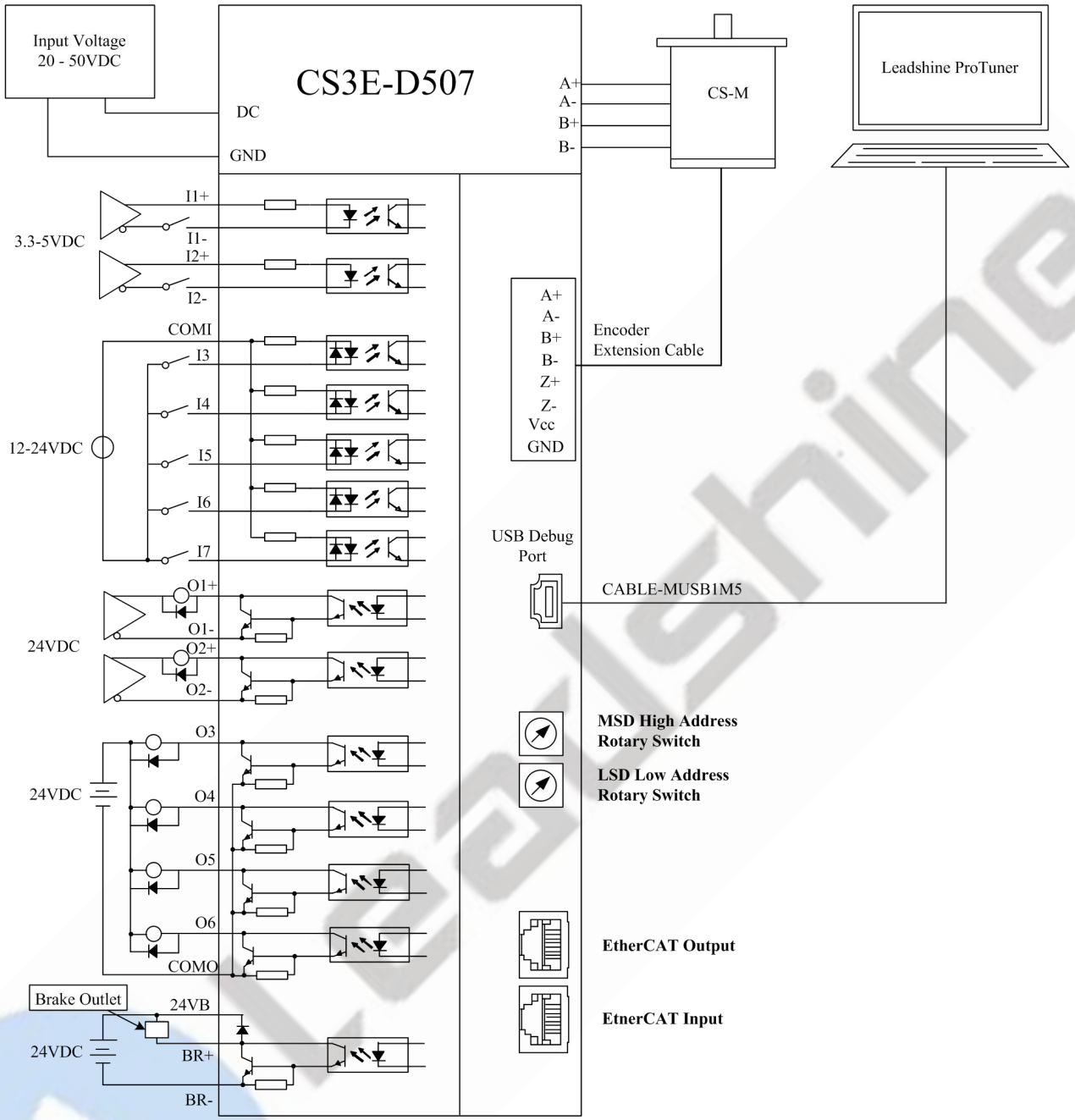
Name	Description
Physical Layer	Ethernet-100BASE-TX
Communication Connector	RJ45 (shielded) ECAT IN: EtherCAT Input ECAT OUT: EtherCAT Output
Topology	Line, Tree
Baud Rate	100Mbps (full-duplex-channel)
Frame Data Length	1484 bytes (Max)
Synchronization Manager	SM0：email received (from master station to slave station)slave SM1：email sent (from slave station to master station) SM2：process data output (from master station to slave station) SM3：process data input (from slave station to master station)
Supported Protocol	CoE：CANopen over EtherCAT
Synchronization mode	DC Synchronization (SYNC0) Free Run
Communication Event	SDO PDO EMCY
Application Layer Specifications	IEC61800-7 CiA402 Drive Profile
Supported Operation Mode	Cyclic Synchronous Position Mode Profile Position Mode Profile Velocity Mode Homing Mode
Cycle Time	500us, 750us, 1ms, 2ms, 3ms, 4ms, 5ms

3.1.2 Electrical and Operating Specifications

Name	CS3E-D503	CS3E-D507	CS3E-D728	CS3E-D1008
Supply Voltage	20-50VDC	20-50VDC	20-72VDC	30-100VDC or 20-80VAC
Output Current (Peak)	0.5-2.5A	1.0-7.0A	1.0-8.0A	2.1-8.0A
Size (H*W*L mm)	130*90.4*34			151*113*30.5
Weight (kg)	0.65			0.85

Matched Motor	NEMA 11, 14, 17 NEMA 17, 23, 24 NEMA 24, 34 NEMA34	
Input Signals	Home Input, Positive Limit, Negative Limit, Touch Probe, GPIOs	
Output Signals	Brake, Alarm, In Position, GPIOs	
Protection Functions	Over Current, Over Voltage, Position Following Error, Encoder Cable Error, etc.	
PC Software	Leadshine ProTuner (coming soon)	
Operating Environment	Environment	Avoid dust, oil ,fog and corrosive gases
	Operating Temperature	0-50℃ (32 F – 122 F)
	Storage Temperature	-20℃-65℃ (-4 F – 149 F)
	Humidity	40-90%RH
	Vibration	10-55Hz/0.15mm
	Mount	Vertical or horizontal mounting

3.2 Wiring Instructions



Note:

- There are two EtherCAT communication ports above, one of them is input port which connects with master station or previous slave, and the other is output port which connects with the following slave.
- Single-end input I3, I4, I5, I6 and I7 connection types can be common-cathode and common-anode.
- Brake output on the drive can connect with brake outlet on the motor directly.
- Encoder extension cable with Z signal is named: CABLEM-BM*M*Z

3.2.1 Power Supply Cable & Motor Cable

- Wire diameter: +VDC, GND, A+, A-, B+, B- terminal wire diameter≥0.3mm^2 (AWG15-22)
- A noise filter which can improve anti-interference performance is recommended to be connected between power supply and drive.

3.2.2 I/O Signal Cable

- Wire diameter: I1 - I7, O1 - O6, COM, 24VB and COM terminal wires diameter≥0.12mm^2 (AWG24-26)

- Recommend to adopt shielded twisted pair cable with a length of less than 3 meters (the shorter the better).
- 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 use shielded Ethernet network cables that do not exceed 100 meters.

CAUTION

- DO NOT hot plug in and out.
- Be sure to turn off power and wait for at least 5 minutes when using CS3E-D728 and CS3E-D1008, and then you can transport, wiring and inspect the drives and motors.

3.3 Interface Specifications

3.3.1 Connectors Definition

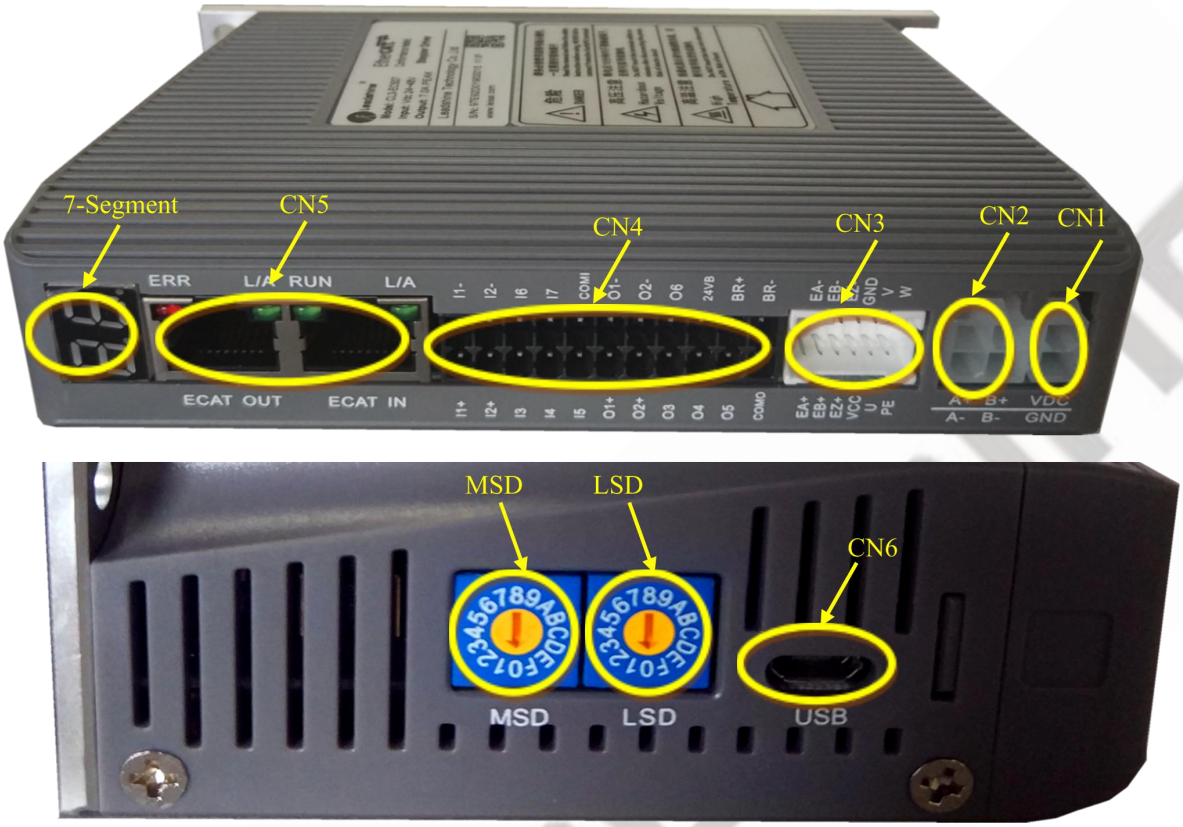
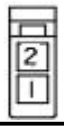


Figure 3.2: CS3E series connectors

Name	Description
CN1	Input power connector
CN2	Motor connector
CN3	Encoder input signals connector
CN4	Digital input and output connector
CN5	EtherCAT communication connector
CN6	Micro USB tuning connector
7-Segment	Two 7-Segment display slave ID, velocity, statue machine, operation mode and error code
MSD	Setting communication high address
LSD	Setting communication low address

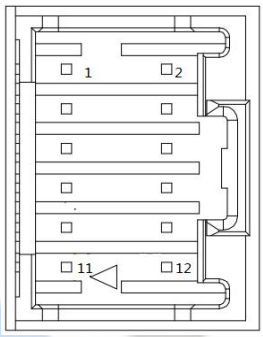
3.3.2 CN1-Input Power Connector

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

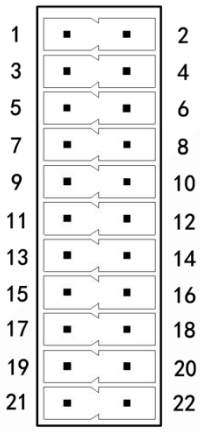
3.3.3 CN2-Motor Connector

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 CN3-Encoder Input Signals Connector

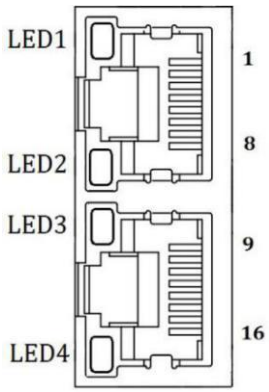
Name	Pic	PIN	Signal	Description
CN3		1	EA+	Encoder signal of phase A+
		2	EA-	Encoder signal of phase A-
		3	EB+	Encoder signal of phase B+
		4	EB-	Encoder signal of phase B-
		5	EZ+	Encoder Z+ signal
		6	EZ-	Encoder Z- signal
		7	VCC	Encoder +5V voltage
		8	GND	Encoder ground
		9	U	Reserved
		10	V	Reserved
		11	W	Reserved
		12	PE	Shield ground

3.3.5 CN4-I/O Signals Connector

Name	Pic	PIN	Signal	I/O	Description
CN4		1	I1+	I	Configurable Differential Digital Input I1, 3.3V - 5V, 500KHz, Touch Probe 1 (default)
		2	I1-	I	
		3	I2+	I	Configurable Differential Digital Input I2, 3.3V - 5V, 500KHz, Touch Probe 2 (default)
		4	I2-	I	
		5	I3	I	Configurable Single-ended Digital Inputs I3-I7, 12V - 24V, 10KHz, I3 is Origin Signal, I4 is Positive Limit, I5 is Negative Limit, I6 and I7 are GPIO
		6	I6	I	
		7	I4	I	
		8	I7	I	
		9	I5	I	
		10	COMI	I	Common connection of single-end input signals (common-cathode and common-anode)
		11	O1+	O	Configurable Differential Digital Output O1, Max. 30V/100mA. Alarm (default).
		12	O1-	O	
		13	O2+	O	Configurable Differential Digital Output O2, Max. 30V/100mA. In Position (default).
		14	O2-	O	
		15	O3	O	Configurable Single-ended Digital Outputs O3, O4, O6, Max. 30V/100mA. Default is GPIO
		16	O6	O	
		17	O4	O	
		19	O5	O	
		18	24VB	O	Used for brake signal, connect with +24 DC of external power supply, refer to chapter 4.2.5
		20	BR+	O	Brake + signal, Max. 24/500mA, connect with brake coil. It's shown as SO7 in Leadshine ProTuner and level cannot be modified
		21	COMO	O	Common connection of single-end output signals (common-cathode)
		22	BR-	O	Brake-signal, Max. 24/500mA, connect with brake coil. It's shown as SO7 in Leadshine ProTuner and level cannot be modified

Remark: I/O interface and corresponding parameter setting refer to chapter 4.1.3

3.3.6 CN5-EtherCAT Communication Connector

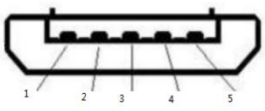
Name	Pic	PIN	Signal	Description
CN5		1, 9	E_TX+	EtherCAT TxD+
		2, 10	E_TX-	EtherCAT TxD-
		3, 11	E_RX+	EtherCAT RxD+
		4, 12	/	/
		5, 13	/	/
		6, 14	E_RX-	EtherCAT RxD-
		7, 15	/	/
		8, 16	/	/
		Cover	PE	Shield earthing
Note	(1) LED1 as'Link/Activity IN' indicator, green (2) LED3 as'Link/Activity OUT' indicator, green (3) LED2 as'RUN' indicator, green (4) LED4 as'ERR' indicator, red			

This LED informs EtherCAT communication status. RUN LED, ERROR LED positions at the front side of product and, Link/Activity LED individually positions at the top of right corner of EtherCAT ports..

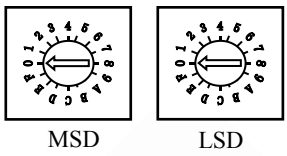
Name	Color	Statue	Description
LED1	Green	OFF	Link not established in physical layer
		ON	Link established in physical layer
		Flickering	In operation after establishing link
LED3	Green	OFF	Link not established in physical layer
		ON	Link established in physical layer
		Flickering	In operation after establishing link

Table 3.3 Link/Activity LED status

3.3.7 CN6-Micro USB Tuning Port

Name	Pic	PIN	Signal
CN6		1	GND
		2	Reserved
		3	Data+
		4	Data-
		5	V_Bus

3.3.8 Salve ID (Site Alias) Setting



The Salve ID (also called Site Alias) of CS3E series can be set by the following 3 methods:

- **Setting via Rotary Switches**

When Object (2151h) is set to value '0', user can set a value non-zero via the two rotary switches as the salve ID, activated after restarting the power supply. The specific definition is as below:

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

- **Setting via Reading ESC(EtherCAT Salve Controller)**

When Object (2151h) is set to value '2' and MSD, LSD rotary switches are set to 0, the EtherCAT master will configure site alias to the address of EEPROM 0004h of ESC automatically.

- **Setting via Object (2150h)**

When Object (2151h) is set to value '1', the value written in Object (2150h) is as the site alias, activated after saving parameter and restarting the power supply.

3.3.9 Two 7-Segment

There are two 7-Segment with two LED indicators on the front of CS3E-D507 (turn on when drive is enabled).The displayed content of after initialization can be set by Object (214b-00h):

- 2-Velocity
- 0-Statue machine / operation mode
- 1-Slave ID

When an error occurs, the 7-Segment displays only the alarm code, please refer to chapter 5.2

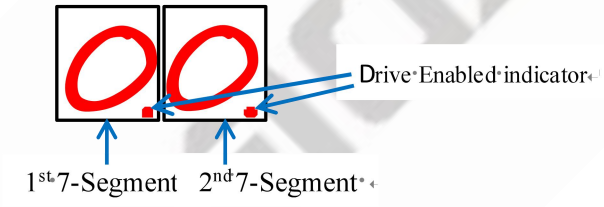


Figure 3.3: Two 7-Segment

3.4 I/O Interface and Corresponding Parameters Setting

3.4.1 Digital Input

- **Wiring**

There are two types of input signals: single-ended and differential.the connections are as below:

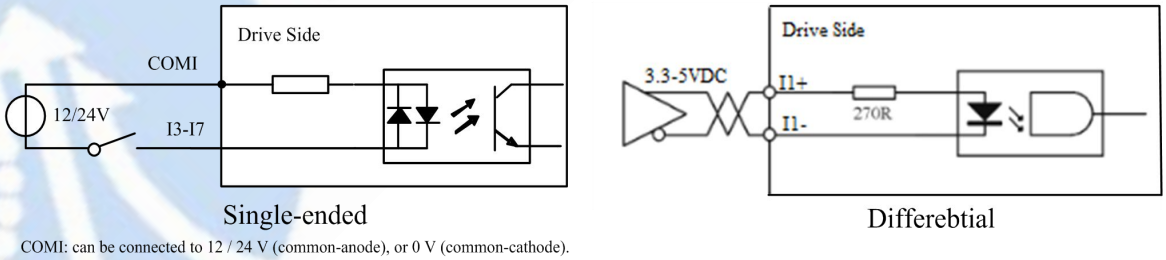


Figure 3.4: Input Interface Connection

Note:

(1) Controller/PLC/Control card should provide input DC power 12-24V, 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.

3.4.2 Digital Output

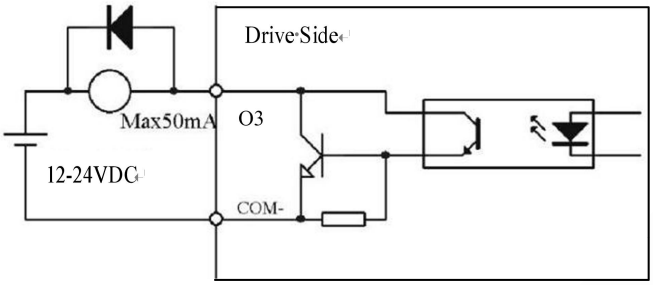


Figure 3.5: Output Interface Wiring

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 100mA/30V (recommended 50mA/25V), the provided power supply should be under 30V (recommended 24V), otherwise it will cause damage to the drive.

3.4.3 Brake Output

This driver has a special brake output, built-in a fly-wheel diode, driving current up to 500 mA, can directly drive the motor brake without relays. The connection is below:

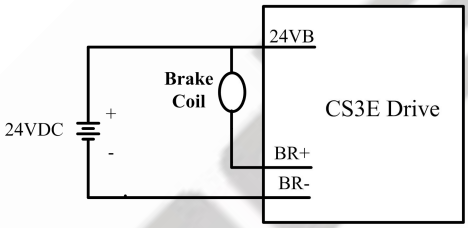


Figure 3.6: Brake output connection

4 EtherCAT Object Dictionary

4.1 Object Dictionary

The CS3E-D507 follows the EtherCAT standard protocol, can communicate with the master stations which also supports the EtherCAT standard protocol.

The parameters can be configured by master station's PC software or Leadshine ProTuner software (coming soon).

4.1.1 Communication Object

Index	Sub-index	Name	Access	Type	Range	Default Value	Unit	Remark
1000	0	Device type	R	UINT	0-32767	0x40912	-	Refer to CIA 402 profile
1001	0	Error register	R	USINT	0-255	0	--	Type of error generated from the controller
1008	0	Device name	R	UINT	0-32767	CS3E-D507	-	Product model
1009	0	Hardware version	R	UINT	0-32767	V1.0	-	Refer to product label
100A	0	Software version	R	UINT	0-32767	V1.0	-	Refer to object (3100h)
1010	00	Number of sub-index	R	UINT	0-32767	4	-	-
	01	Save all parameters	R/W	UDINT	0-0xFFFFFFFF	0	-	Need to write 0x65766173 or 1702257011 (decimal) into sub-index. It will return 1 if save successfully
	02	Save communication parameters	R/W	UDINT	0-0xFFFFFFFF	0	-	Need to write 0x65766173 or 1702257011 (decimal) into sub-index. It will return 1 if save successfully
	03	Save motion parameters	R/W	UDINT	0-0xFFFFFFFF	0	-	Need to write 0x65766173 or 1702257011 (decimal) into sub-index. It will return 1 if save successfully
	04	Save factory parameters	R/W	UDINT	0-0xFFFFFFFF	0	-	Need to write 0x65766173 or 1702257011 (decimal) into sub-index. It will return 1 if save successfully
1011	00	Number of sub-index	R	UINT	0-32767	4	-	-
	01	Restore all	R/W	UDIN	0-0xFFFFF	0	-	Need to write

		parameters to default setting		T	FFF			0x64616f6c or 1684107116 (decimal) into sub-index. It will return 1 if save successfully
	02	Restore communication parameters to default setting	R/W	UDINT	0-0xFFFFFFFF	0	-	Need to write 0x64616f6c or 1684107116 (decimal) into sub-index. It will return 1 if save successfully
	03	Restore motion parameters to default setting	R/W	UDINT	0-0xFFFFFFFF	0	-	Need to write 0x64616f6c or 1684107116 (decimal) into sub-index. It will return 1 if save successfully
	04	Restore user parameters to default setting	R/W	UDINT	0-0xFFFFFFFF	0	-	Need to write 0x64616f6c or 1684107116 (decimal) into sub-index. It will return 1 if save successfully
1018	00	Number of sub-index	R	UINT	0-32767	4	-	-
	01	Vendor ID	R	UINT	0-32767	4321	-	Leadshine code
	02	Product code	R	UINT	0-32767	100	-	-
	03	Revision number	R	UINT	0-32767	1	-	-
	04	Series number	R	UINT	0-32767	1	-	-
1600	0	Number of sub-index	R/W	UINT	0-32767	3	-	Default number of 1st mapping object
	01-08	1st RXPDO-Map object	R/W	UDINT	0-0xFFFFFFFF	-	-	Default number of 1st RXPDO-Map object
1601	0	Number of sub-index	R/W	UINT	0-32767	6	-	Default number of 2nd mapping object
	01-08	2nd RXPDO-Map object	R/W	UDINT	0-0xFFFFFFFF	-	-	Default number of 2nd RXPDO-Map object
1602	0	Number of sub-index	R/W	UINT	0-32767	5	-	Default number of 3rd mapping object
	01-08	2nd RXPDO-Map object	R/W	UDINT	0-0xFFFFFFFF	-	-	Default number of 3rd RXPDO-Map object
1603	0	Number of sub-index	R/W	UINT	0-32767	7	-	Default number of 4th mapping object
	01-08	3rd RXPDO-Map object	R/W	UDINT	0-0xFFFFFFFF	-	-	Default number of 4th RXPDO-Map object

1A00	0	Number of sub-index	R/W	UINT	0-32767	7	-	Default number of 1st mapping object
	01-08	1st TXPDO-Map object	R/W	UDINT	0-0xFFFFFFFF	-	-	Default number of 1st TXPDO-Map object
1A01	0	Number of sub-index	R/W	UINT	0-32767	0	-	Default number of 2nd mapping object
	01-08	2nd TXPDO-Map object	R/W	UDINT	0-0xFFFFFFFF	-	-	Default number of 2nd TXPDO-Map object
1C00	0	Number of sub-index	R	UINT	0-32767	4	-	-
	01	Output type of email	R	UINT	0-32767	1	-	-
	02	Input type of email	R	UINT	0-32767	2	-	-
	03	Output type of process data	R	UINT	0-32767	3	-	-
	04	Input type of process data	R	UINT	0-32767	4	-	-
1C12	0-04	RXPDO assign	R/W	UINT	0-32767	1600	-	-
1C13	0-02	TXPDO assign	R/W	UINT	0-32767	1A00	-	-
1C32	0-0A	RXPDO administrative parameters	R	UINT	0-32767	-	-	-
1C33	0-0A	TXPDO administrative parameters	R	UINT	0-32767	-	-	-

4.1.2 Manufacture Specific Object

Index	Name	Access	Type	Range	Default value	Unit	Remark
2150-00h	Salve ID	R/W/S	UINT	0-256	1	--	-
2151-00h	Salve ID resource	R/W/S	UINT	0-10	0	--	0: Rotary switch 1: Master setting
2000-00h	Peak current	R/W/S	UINT	0-80	60	0.1A	Drive's max output current.
2001-00h	Microstep resolution	R/W/S	UINT	200-51200	10000	Pulse	Required number of pulse to rotate 1 revolution of motor
2010-01h	Internal filtering time	R/W/S	UINT	1-2048	15	0.1ms	Internal smoothing time for control command.
2012-00h	Soft-starting time	R/W/S	UINT	1-60	1	100ms	Internal smoothing time for starting current.

2013-00h	Auto-tuning at power on	R/W/S	UINT	0-1	1	--	1: Yes. 0: No
201A-01h	Locking current percentage of power on	R/W/S	UINT	0-100	100	%	Usually keep the default value.
201A-02h	Open loop output current percentage	R/W/S	UINT	0-100	50	%	Percentage of peak current; also output current in open loop mode. Only available when "control mode" is set to open loop
201A-03h	Closed loop holding current percentage	R/W/S	UINT	0-100	50	%	Percentage of peak current; also idle current in closed loop mode. Only available when "control mode" is set to closed loop
201B-00h	Locking duration time	R/W/S	UINT	0-1500	200	ms	Appropriately reduce this value if you want to shorten the time of locking shaft.
201C-00h	Max time to close brake	R/W/S	UINT	100-10000	1000	ms	Usually keep the default value
201D-00h	Zero speed point	R/W/S	UINT	0-500	10	0.1r/s	
2024-00h	Control mode	R/W/S	UINT	0-10	2		0: open loop, 2: closed loop
2029-00h	Encoder resolution	R/W/S	UINT	200-51200	4000	Pulse	4 times of encoder lines
2030-00h	Allowed max position error counts	R/W/S	UINT	0-32767	4000	Pulse	It will occur position error when exceeds the setting value.
2032-00h	Distance to output "in position" signal	R/W/S	UINT	0-1000	4	Pulse	Configures this value to determine if the motor is in position (dynamic).
2033-00h	Delay of output signal of in position	R/W/S	UINT	0-1000	3	ms	
2047-00h	Over voltage point	R/W/S	UINT	0-1000	90	V	
2048-00h	Bus-voltage	R	UINT	0-65535		V	
2090-05h	Acceleration feed-forward	R/W/S	UINT	0-10000	0	--	
2091-01h	Velocity loop Kp	R/W/S	UINT	0-10000	30	--	
2091-02h	Velocity loop Ki	R/W/S	UINT	0-10000	3	--	

2092-01h	Position loop Kp	R/W/S	UINT	0-100	25	--	
214A-00h	Digital display address	R	UINT	0-255	--	--	Setting by rotary switch
214B-00h	LED initial status setting	R/W/S	UINT	0-100	0	--	0: state machine / operating mode 1: slave ID 2: speed
2203-00h	Velocity loop integral limit	R/W/S	UINT	0-100	0	--	
2203-02h	Reset factory	R/W	UINT	0-1	0	--	All parameters reset to factory default values
2206-01h	Save parameters	R/W	UINT	0-1	0	--	
3100-01h	Drive software version	R	UINT			--	
3100-02h	FPGA software version	R	UINT			--	
3100-03h	EtherCAT protocol version	R	UINT			--	
4003-01h	Delay of closing brake	R/W/S	UINT	0-1500	250	ms	
4003-02h	Delay of loosening brake	R/W/S	UINT	0-1500	250	ms	
4003-03h	Max speed to close brake	R/W/S	UINT	0-500	10	0.1r/s	

4.1.3 I/O Configuration Object

Index	Name	Access	Type	Range	Default value	Unit	Remark
2155-00h	Digital input status	R	UINT	0—65535	0	--	
2152-01h	Input port 1	R/W/S	UINT	0-65535	0x17	--	Touch probe input signal 1
2152-02h	Input port 2	R/W/S	UINT	0-65535	0x18	--	Touch probe input signal 2
2152-03h	Input port 3	R/W/S	UINT	0-65535	0x16	--	Origin point
2152-04h	Input port 4	R/W/S	UINT	0-65535	0x01	--	Positive limit
2152-05h	Input port 5	R/W/S	UINT	0-65535	0x02	--	Negative limit
2152-06h	Input port 6	R/W/S	UINT	0-65535	0x19	--	User defined
2152-07h	Input port 7	R/W/S	UINT	0-65535	0x19	--	User defined
2156-01h	Output port 1	R/W/S	UINT	0-65535	0x01	--	Alarm
2156-02h	Output port 2	R/W/S	UINT	0-65535	0x04	--	In position
2156-03h	Output port 3	R/W/S	UINT	0-65535	0x05	--	User defined

2156-04h	Output port 4	R/W/S	UINT	0-65535	0x05	--	User defined
2156-05h	Output port 5	R/W/S	UINT	0-65535	0x05	-	User defined
2156-06h	Output port 6	R/W/S	UINT	0-65535	0x05	--	User defined
2156-07h	Output port 7	R	UINT	0-65535	0x03	--	Brake
2056-00h	Fault detection	R/W/S	UINT	0-65535	65535	--	bit0: over current, bit1: over voltage bit2: position error, bit4: break wire detection

4.1.4 Motion Objects

Index	Name	Access	Type	Range	Default value	Unit	Remark
603F	Error code	R	UINT	0-65535	0	--	Refer to chapter 5.2
6040	Control word	R/W	UINT	0-65535	0	--	Refer to chapter 6.1
6041	Status word	R	UINT	0-65535	0	--	Refer to chapter 6.1
605A	Quick stop option code	R/W	UINT	0-65535	5	--	5: decelerated stop, others: invalid
6060	Operation mode	R/W	USINT	0-255	8	--	1: PP mode, 3: PV mode, 6: Home mode, 8: CSP mode
6061	Displayed operation mode	R	USINT	0-255	8	--	-
6062	Position demand value	R	DINT	-2147483648 -2147483647	0	P	P: pulse
6064	Position actual value	R	DINT	-2147483648 -2147483647	0	P	P: pulse
606B	Velocity demand value	R	DINT	-2147483648 -2147483647	0	P/s	-
606C	Velocity actual value	R	DINT	-2147483648 -2147483647	0	P/S	-
607A	Target position	R/W	DINT	-2147483648 -2147483647	0	P	Target position under PP mode
60FF	Target velocity	R/W	DINT	-2147483648 -2147483647	0	P/S	Profile velocity under PV mode
6081	Max profile velocity	R/W/S	DINT	-2147483648 -2147483647	50000	--	Max. Allowable velocity under PP mode
6082	Start velocity	R/W/S	DINT	-2147483648 -2147483647	0	--	Start velocity under PP mode
6083	Profile acceleration	R/W/S	DINT	-2147483648 -2147483647	4000	P/S^2	Acceleration under PP and PV mode

6084	Profile deceleration	R/W/S	DINT	-2147483648 -2147483647	4000	P/S^2	Deceleration under PP and PV mode
6085	Quick stop deceleration	R/W/S	DINT	-2147483648 -2147483647	400000 000	P/S^2	Deceleration of quick stop under PP, PV and Home mode
6098	Homing method	R/W/S	USINT	1-100	19	-	Methods of searching origin under homing mode, refer to Appendix A
6099-01h	Fast homing velocity	R/W/S	DINT	-2147483648 -2147483647	50000	P/S	Speed during search for switch under Home mode
6099-02h	Slow homing velocity	R/W/S	DINT	-2147483648 -2147483647	25000	P/S	Speed during search for zero under Home mode
607C	Home offset	R/W/S	DINT	-2147483648 -2147483647	0	P	The value of difference between senor origin position and mechanical origin position under Home mode
609A	Homing acceleration	R/W/S	USINT	-2147483648 -2147483647	25000	P/S^2	Acc / Dec velocity under Home mode
60B8	Touch probe control word	R/W	UINT	0-65535	0	-	Set touch probe function, refer to chapter 6.3
60B9	Touch probe statue word	R	UINT	0-65535	0	-	Status of touch probe 1/2, refer to chapter 6.3
60BA	Touch probe 1 positive value	R	DINT	-2147483648 -2147483647	0	P	Data value sensed by touch probe 1 at rising edge
60BB	Touch probe 1 negative value	R	DINT	-2147483648 -2147483647	0	P	Data value sensed by touch probe 1 at falling edge
60BC	Touch probe 2 positive value	R	DINT	-2147483648 -2147483647	0	P	Data value sensed by touch probe 2 at rising edge
60BD	Touch probe 2 negative value	R	DINT	-2147483648 -2147483647	0	P	Data value sensed by touch probe 2 at falling edge
60C2-01h	Interpolation time period value	R/W	USINT	0-255	2	--	Only for internal tuning.
60C2-02h	Interpolation time unit	R/W	SINT	-128-127	0	--	
60D5	Touch probe 1 rising edge counter	R	UINT	0-65535	0	--	Frequency for capture of touch probe 1 rising edge
60D6	Touch probe 1 falling edge counter	R	UINT	0-65535	0	--	Frequency for capture of touch probe 1 falling edge
60D7	Touch probe2 rising	R	UINT	0-65535	0	--	Frequency for capture of touch probe 2 rising edge

	edge counter						
60D8	Touch probe 2 falling edge counter	R	UINT	0-65535	0	--	Frequency for capture of touch probe 2 falling edge
60FD	Digital input statue	R	UDINT	0-4294967296	0	--	Statue of digital input signals, refer to chapter 4.2.3
60FE-01h	Open physical output	R/W/S	UDINT	0-4294967296	0	--	Able to control user output through this object, refer to chapter 4.2
60FE-02h	Enable physical output	R/W/S	UDINT	0-4294967296	0	--	
6502	Supported operation mode	R	UDINT	0-4294967296	165	--	Operation modes the drive supported

4.2 I/O Configuration

After setting the functions of input and output, it is necessary to save and restart the drive. If the two input functions configurations repeated, the smaller input port is valid, the other input port will back to default input function.

For example, input port 5 (I5) and input port 6 (I6) are both set to negative limit, after saving the restating, the I5 type is negative limit, while the I6 type is still by default for user defined.

4.2.1 Input Function Setting

Bit	11-8	7-6	5-0
Name	Filtering time	Input level setting	Input function setting

Table 4.1: Input setting

Bit 15-12 are reserved，

Bit 11-8 values correspond to the meaning:

Bit 11-8 value	Filtering time
0	1ms
1	2ms
2	3ms
3	4ms
4	5ms
5	6ms
6	8ms
7	10ms
8	15ms
9	20ms
10	30ms
11	40ms
12	50ms

13	100ms
14	200ms
15	500ms

Bit 7-0 values correspond to the meaning (the input level is set by bit 7):

Value when bit 7 is set to 0	Value when bit 7 is set to 1	Input function name
0x01	0x81	Positive limit (POT)
0x02	0x82	Negative limit (NOT)
0x03	0x83	Reserved
0x04	0x84	Reserved
0x14	0x94	Quick stop (EMG)
0x16	0x96	Origin point (ORG)
0x17	0x97	**Touch probe 1 (only I1 or I2 valid)**
0x18	0x98	**Touch probe 2 (only I1 or I2 valid)**
0x19	0x99	User defined (GPIO function)

For example, input port 1 is set to positive limit (POT) with 30ms filtering time and bit 7 =0, the Object (2151-01h) will be the value in below table:

		bit15-bit12	bit11-bit8	bit7-bit4	bit3-bit0
Index 2152-01h	binary	0000	1010	0000	0001
	hexadecimal	0	A	0	1

4.2.2 Output Signals

Bit	7-6	5-0
Name	Output level setting	Output function setting

Bit 15-8 are reserved

Bit 7-0 values correspond to the meaning (the input level is set by bit 7):

Value when bit 7 is set to 0	Value when bit 7 is set to 1	Output function name
0x01	0x81	Alarm
0x04	0x84	In position
0x05	0x85	User defined (GPIO function)

For example, output port 3 is set to in position with bit 7 =0, the Object (2156-03h) will be the value in below table:

		bit15-bit12	bit11-bit8	bit7-bit4	bit3-bit0
Index 2156-03h	binary	0000	0000	0000	0100
	hexadecimal	0	0	0	4

4.2.3 Input Signals

Name	Mark	Default port	Index	I/O status 60FD

			2152 (01h-05h)	
Negative limit	NOT	I5	0x02	bit0
Positive limit	POT	I4	0x01	bit1
Origin point	HOME	I3	0x16	bit2
Quick stop	EMG		0x14	bit16
Touch Probe 1	Probe 1	I1	0x17	bit26
Touch Probe 2	Probe 2	I2	0x18	bit27

4.2.4 User Defined Output Function

Name	Index	Output level		Open physical output (60FE+01)	Enable physical output (60FE+02)
		Bit 7 =0	Bit 7 =1		
OUT1	2156+01	0x05	0x85	bit16 (0x10000)	bit16 (0x10000)
OUT2	2156+02	0x05	0x85	bit17 (0x20000)	bit17 (0x20000)
OUT3	2156+03	0x05	0x85	bit18 (0x40000)	bit18 (0x40000)
OUT4	2156+04	0x05	0x85	bit19 (0x80000)	bit19 (0x80000)
OUT5	2156+05	0x05	0x85	Bit20 (0x100000)	Bit20 (0x100000)
OUT6	2156+06	0x05	0x85	Bit21 (0x200000)	Bit21 (0x200000)

For example, when OUT2 is set to user defined output function with bit 7 = 0, the operation steps are as below:

- Set Object (2156+02h) to value 0x05 to user defined output function;
- Set both 60FE+01 and 60FE+02 to value ox20000, then OUT2 is available

4.3 EtherCAT Slave Information

EtherCAT Slave Information file (XML File or ESI file) is needed to connect controller with EtherCAT Master.

This file is provided by Leadshine, described slave device information as XML format based on EtherCAT specifications. Please follow the EtherCAT Master software manual for importing method.

Some master stations require files in a specific format and do not recognize XML format, please contact the master technical engineer of master station.

5 Two7-Segment and Error Code

5.1 Two 7-Segment

CS3E-D507 has two 7-Segment with a LED indicate respectively (the right LED will be on when the drive is enabled), and the contents displayed are different in the initialization status and operational status.

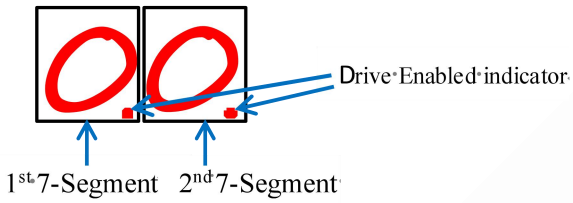


Figure 5.1: Two 7-Segment display

5.1.1 Initialization Status

After the drive is powered on, the two 7-Segment displays are fully lit by 0.5s, followed by a number (max FF) in hex showing the actual node address of the drive. Then the displayed number will be flashing for 5S.

If the node address of the drive is changed during initialization status or running status, the segment displays will be flashing and back to the former status after 5s.

5.1.2 Operational Status

The drive goes into operational status after initialization, and the contents displayed on the 7-Segment are configurable, can be set to three types and set by Object (214b-00h).

Index	Value	Name	Description
214b-00h	2	Velocity	Unit: rps
	0	Status Machine & Operation Mode	(1) 1st 7-Segment displays the information of status machine in hex • 1: Initialization • 2: Pre-operation • 4: Safe Operation • 8: Operation (2) 2nd 7-Segment displays the information of operation mode in hex • 1: PP (Profile Position) • 3: PV (Profile Velocity) • 6: HM (Homing) • 8: CSP (Cyclic Synchronous Position)
	1	Salve ID	The Salve ID will be displayed always

Note: If change the node address through rotary switches MSD and LSD during the status of operation, the 7-Segment tube will blinking display the new node address in the time of 5S, then restore the information it had displayed.

5.2 Error Codes

Once error generates at drive during operational status,changed to ‘fault reaction active’ status, and types of error code will be blinking displayed on the two 7-Segment.

For example, if “E 180” is occurred at the drive , the error will be displayed as below, until to clear the error.

Error Code

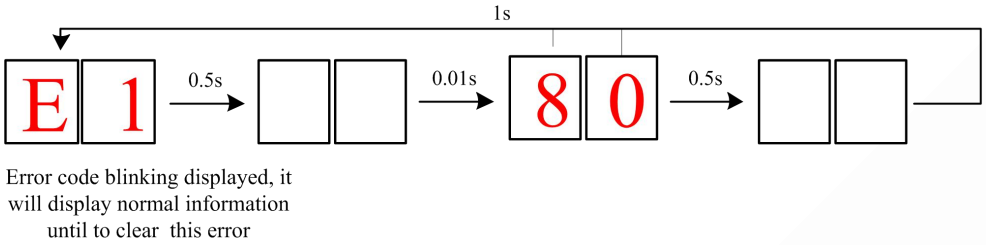


Figure 5.2: Error code displayed process

Displayed Error Code	Error Name	Description	Object (603Fh)
E0e0	Over Current Error	The current through power devices in inverter exceeds the limit value.	0x2211
E0c0	Over Voltage Error		0x3211
E100	Overload Error	The motor is continuously operated more than 5 second under a load exceeding the Max. torque of motor	
E120	Regenerative Discharge Circuit Overload Error		
E121	Regenerative Resistance Error		
E150	Encoder Connection Error	Abnormal connection between drive and encoder.	
E151	Encoder Communication Error		
E152	Initialize Encoder Position Error		
E170	Encoder Data Error		
E190	Excessive Vibration Error		
E1a0	Over Speed Error		Motor speed exceed 3000[rpm].
E1a1	Speed Out of Control Error		
E1b0	Position instruction frequency it too large		
E1b1	electronic gear setup error		
E180	Position following error		0x8611
E240	EEPROM parameters saving error		0x5530
E241	Saving module hardware error		0x5531
E242	Error / diagnosis record keeping error		0x5532

E243	Saving signals error		0x5533
E244	Communication parameters saving error		0x5534
E245	Motion parameters saving error		0x5535
E260	Overtravel Positive / Negative input is valid		0x7329
E828	Synchronizing mode is not supported		0x8728
E82d	Asynchronous error		0x872D
E81a	synchronizing error		0xFF02
E82e	synchronizing cycle is too short		0x872E
E836	Invalid DC synchronizing cycle		0x8736
E832	DC phase-locked Loop failure		0x8732
E81b	Watchdog Time-Out of Synchronization Manager 2		0x821B
E818	Invalid input data		0x8211
E819	Invalid output data		0x8212
E82c	Fatal synchronization error		0x872C
E813	Boot Status main-page-reqprotection		0x8213
E850	EEPROM reading error		0x5550
E851	EEPROM error		0x5551
E801	ESM State Machine Conversion Failed		0x8201
E81c	Invalid Type of Synchronization Manager		0x821C
E811	Invalid ESM Conversion request		0xA001
E812	Unknown ESM Conversion request		0xA002
E816	Invalid pre-operation mailbox configuration		0x8216
E815	Invalid boot Status mailbox configuration		0x8215
E81d	Invalid output configuration		0x821D
E81e	Invalid input configuration		0x821E
E821	Waiting for the status of ESM initialization		0xA003
E822	Waiting for the status of ESM pre-operation		0xA004
E823	Waiting for the status of		0xA005

	ESM safe operation		
E824	Invalid input data mapping		0x8224
E825	Invalid output data mapping		0x8225
E82b	Input and Output is invalid		0x8210
E830	DC synchronization configuration is invalid		0x8730
E802	Out of memory		0x5510
E852	Hardware is not ready		0x5552
E870	Mode not support		0x5201
E871	The operation condition of this mode is not satisfied.		0x5202

6 Common Functions

6.1 Saving Parameters and Resetting Drive

To save all storable parameters into EEPROM through Object (1010h), need to write "0x65766173" into sub-index 01h. To reset the drive to default parameters through Object (1011h), need to write "0x64616f6c" into sub-index 01h. After writing the save command, do not turn off the power immediately, wait around 10s to ensure that all parameters have been saved successfully. The below table is the description of Object (1010h) and Object (1011h).

Table 6.1: Object (1010h) and Object (1011h)

Action	Sub-index	Write Command (hex)	Return Value	Description
Save Objects (2000h-5000h)	1010:04	0x65766173	Return 1	Save Manufacture Specific Objects
Save Objects (6000h)	1010:03	0x65766173	Return 1	Save Motion Objects
Save Object (1000)	1010:02	0x65766173	Return 1	Save Communication Objects
Save all Objects	1010:01	0x65766173	Return 1	Save all Objects
Restore Objects (2000h-5000h)	1011:04	0x64616F6C	Return 1	Reset Manufacture Specific Objects
Restore Objects (6000h)	1011:03	0x64616F6C	Return 1	Save Motion Objects
Restore Objects (1000h)	1011:02	0x64616F6C	Return 1	Reset Communication Objects
Restore all Objects	1011:01	0x64616F6C	Return 1	Reset all Objects

6.2 Control Word and Operation Modes

CS3E supports both synchronous mode and asynchronous mode. In the synchronous mode, master station processes trajectory planning and outputs cyclical instructions. Drives follow the planning instructions given by master station in synchronous cycle, making it suitable for synchronous motion of multiple axes. CS3E synchronous motion mode supports CSP mode. In CSP mode, master station completes trajectory planning and sends it to CS3E. The drive will execution the synchronous cyclic position instructions immediately once they has arrived. CS3E supports following synchronous cycles: 500 us, 750us, 1000 us, 2000 us, 4000 us.

In asynchronous motion mode, master station is only responsible for sending motion parameters and control commands. CS3E drives will process trajectory planning according to the motion parameters after receives control command from master station and the movements between each axis are asynchronous. CS3E asynchronous mode includes Profile Position mode(PP), Profile Velocity mode(PV)and Homing mode(HM).

In both control modes, EtherCAT data transmission between master and slave station is achieved through object dictionary. The transmission types contain PDO and SDO and only one can be chosen in general cases. According to control needs, it is classified in three levels by data transmission real time capability and importance:

Must> Recommend > Can.

- "Must" indicates under this mode, the object dictionary has to be PDO mode;
- "Recommend" indicates under the set mode, the object dictionary is suggested to be configured as PDO mode to achieve real-time capability but SDO transmission can be allowed if the controlling is not quite demanding;
- "Can" indicates under this mode, object dictionary data transmission is generally through SDO mode and PDO communication mode won't be necessary.

The object dictionary of each control mode are shown as below:

Table 6.2: Control word

Operation Modes	Index + Sub-index	Name	Data Type	Access	Unit	PDO Configuration	SDO Configuration
CSP Mode (8)	6040-00h	Control Word	U16	RW	—	Must	-
	607A-00h	Target Position	I32	RW	P	Must	-
	6041-00h	Status Word	U16	RO	—	Must	-
	6064-00h	Actual Position	I32	RO	P	Must	-
	606C-00h	Actual Velocity	I32	RO	P /S	Can	Can
PP Mode (1)	607A-00h	Target Position	I32	RW	P	Recommend	Can
	6081-00h	Max Profile Velocity	U32	RW	P	Can	Can
PV Mode (3)	60FF-00h	Target Velocity	I32	RW	P	Recommend	Can
PP Mode (1) And PV Mode (3) shared	6040-00h	Control Word	U16	RW	—	Recommend	Can
	6083-00h	Profile Acceleration	I32	RW	P/S^2	Can	Can
	6084-00h	Profile Deceleration	U32	RW	P/S^2	Can	Can
Homing Mode (6)	6040-00h	Control Word	U16	RW	—	Recommend	Can
	6098-00h	Homing Method	I8	RW	—	Can	Can
	6099-01h	Fast Homing Velocity	U32	RW	P /S	Can	Can
	6099-02h	Slow Homing Velocity	U32	RW	P /S	Can	Can
	609A-00h	Homing Acceleration	U32	RW	P/S^2	Can	Can
	607C-00h	Home Offset	U32	RW	P	Can	Can
PP, PV and HOME Mode shared	6041-00h	Status Word	U16	RO	—	Recommend	Can
	6064-00h	Actual Position	I32	RO	P	Recommend	Can
	606C-00h	Actual Velocity	I32	RO	P /S	Can	Can
All operation modes shared	60B8-00h	Touch Probe Control Word	U16	RW	—	Recommend	Can
	60B9-00h	Touch Probe Status Word	U16	RO	—	Recommend	Can
	60BA-00h	Touch Probe 1 Positive Value	I32	RO	P	Can	Can
	60FD-00h	Digital Input Status	U32	RO	—	Recommend	Can

	603F-00h	Latest Error Code	U16	RO	P	Recommend	Can
Other Related	6060-00h	Operation Mode	I8	RW	—	Can	Can
	60B0-00h	Position Offset	I32	RW	—	Can	Can
	6082-00h	Start Velocity	U32	RW	P /S	Can	Can
	6085-00h	Quick Stop Deceleration	U32	RW	P/S^2	Can	Can
	6061-00h	Displayed Operation Mode	I8	RO	—	Can	Can

No matter using which operation mode, it can not be separated from the reading and writing of Control Word (6040h) and Status Word (6041h). Master and slave stations use these two object dictionaries as a medium to send instructions and monitor status. Following contents will highlight the definitions of each bit of the two object dictionaries.

The bit definition of Control Word (6040 h) is as shown in Table 6.3. The table A is about bit4, bit5, bit6 and bit8, whose definition depend on the operation mode, and mainly cover the execution, stop, etc. of each operation mode. The table B is about bit0-3 and bit7, which manages the state transition of the 402 state machine. The definition of. Status Word (6041h) is as shown in Table 6.4. The bit0 -7 mainly show the state machine transition state, while the bit8-15 mainly shows the status of execution or stop in each operation mode. The typical state transition of enable is as follows:

Initiation (00h) -> power-on (06h) -> start (07h) -> enable (0fh) -> execute or pause (depending on operation mode to send related control instructions of bit4-6 and bit8). The state transition that triggers the running control in each control mode is shown in Table 6.5.

Table 6.3A: Control Word (6040h) Bit Definition

Bit / Mode	15-9	8	6	5	4
Shared	-	Pause	Depending on the operation mode		
CSP mode (8)	-	Invalid	Invalid	Invalid	Invalid
PP mode (1)	-	Deceleration stop	Absolute / Relative	Immediate trigger	New position point
PV mode (3)	-	Deceleration stop	Invalid	Invalid	Invalid
HM mode (6)	-	Deceleration stop	Invalid	Invalid	Starting motion

Table 6.3B: Control Word (6040h) Bit Definition

Bit / Mode	7	3	2	1	0	Type value	Action
Shared	Wrong reset	Permitted operation	Quick stop	Voltage output	Start		
CSP mode (8)	0	0(x)	1	1	0	06h	Get power
PP mode (1)	0	0	1	1	1	07h	Start

PV mode (3)	0	0(x)	0	1	0(x)	02h	Quick
HM mode (6)	0	1	1	1	1	0fh	Enable
-	1	0(x)	0(x)	0(x)	0(x)	80h	Clear error
-	0	0	0	0	0	0	Initiation

Additional information on other bits:

- Bit 2 is quick stop, trigger logic is 0 effective, notice to separate from other trigger logic.
- Bit 7 is error reset, trigger logic is rising edge effective.
- Bit 5 is immediate trigger, trigger logic is rising edge effective.

Table 6.4 Status Word(6041h) Bit Definition

Low 8 bits / Mode	7	6	5	4	3	2	1	0
Shared	Reserved	Not started	Quick stop	Power on	Error	Permitted operation	Start	Ready to start
Mode / high 8 bits	15	14	13	12	10	8	11	9
Shared	Depending on the operation mode						Limit validity	Distance
CSP mode (8)	Invalid	Invalid	Invalid	Following effective	Invalid	Emergency stop	It will be set when the hardware limit effective	0 below PreOP status
PP mode (1)	Trigger response	Parameter has 0	Invalid	New position point response	Position arrival	Emergency stop		
PV mode (3)	Invalid	Parameter has 0	Invalid	Speed is 0	Velocity arrival	Quick stop		
HM mode (6)	Trigger response	Parameter has 0	Origin error	Origin completion	Position arrival	Emergency stop		

Additional information on other bits:

- When the drive is put into power, the bit 4 will be set.
- Bit 5 quickly stops activation, which is valid under logic 0, contrary to the logic of other bits.
- Bit 9 remote, showing the state of the communication state, 0 below ProOP, at this time the control word (6040 h) command will not be executed.
- Bit 11 limit is set only, when the hardware limit is valid.
- Bit 8 abnormal stop is generally valid in hardware limit, deceleration stop and fast stop trigger state.
- Bit 12 follows the master station, if the driver does not enable or no longer follow instructions from the master station under CSP, this position is 0.

Table 6.5: State transition of each mode control operation

Mode \ Action		PreOP	Initialization	Get power	Start	Enable	Start operation	Change position	Stop	Error
CSP mode (8)	6040	Create a communication OP state and activate the NC axis	00h	06h	07h	0fh	1fh Master station send instruction	Master station control	Master station stop position instruction	-
	6041		250h	231h	233h	1237h	1237h	1237h	1237h	238h
PP mode (1)	6040	Create a communication OP state, setting motion parameters	00h	06h	07h	0fh	-	2fh->3fh	10fh	-
	6041		250h	231h	233h	8237h	1237h	1637h->1237h	1737h	1238h
PV mode (3)	6040	Create a communication OP state, setting motion parameters	00h	06h	07h	0fh	Immediate operation after enabling	Change the speed	10fh	-
	6041		250h	231h	233h	1637h	1637h	1637h	1737h	1638h
HM mode (6)	6040	Create a communication OP state, setting motion parameters	00h	06h	07h	0fh	1fh	-	10fh	-
	6041		250h	231h	233h	8337h	237h	237h	737h	238

Additional information on other bits:

- When the PP mode changes the position, it needs to give the bit5 rising edge of the control word to start the new position motion.

6.3 Touch Probe

Touch probe function is to capture and record the actual position of the motor by using the input signal with the touch probe function. The CS3E driver has two input I/O signals to support the probe function and can be enabled at the same time. The probe function related object dictionaries are shown in Table 6.6.

Table 6.6： Related Object Dictionaries of Touch Probe

<table>
<tr><td>Object</td><td colspan="8">Bit Definition</td></tr>
<tr><td rowspan="4">60B8h</td><td>7-6</td><td colspan="2">5</td><td colspan="2">4</td><td>3-2</td><td>1</td><td>0</td></tr>
<tr><td>-</td><td colspan="2">Touch Probe 1 falling edge trigger</td><td colspan="2">Touch Probe 1 rising edge trigger</td><td>-</td><td>Touch Probe 1 mode</td><td>Touch Probe 1 enable</td></tr>
<tr><td>15-14</td><td colspan="2">13</td><td colspan="2">12</td><td>11-10</td><td>9</td><td>8</td></tr>
<tr><td>-</td><td colspan="2">Touch Probe 2 falling edge trigger</td><td colspan="2">Touch Probe 2 rising edge trigger</td><td>-</td><td>Touch Probe 2 mode</td><td>Touch Probe 2 enable</td></tr>
<tr><td colspan="9"></td></tr>
<tr><td rowspan="4">60B9h</td><td>7</td><td>6</td><td>5-3</td><td colspan="2">2</td><td colspan="2">1</td><td>0</td></tr>
<tr><td>Actual level of touch probe 2</td><td>Actual level of Touch Probe 1</td><td></td><td colspan="2">Touch Probe 1 falling edge trigger complete</td><td colspan="2">Touch Probe 1 rising edge trigger complete</td><td>Touch Probe 1 action</td></tr>
<tr><td colspan="3">15-11</td><td colspan="2">10</td><td colspan="2">9</td><td>8</td></tr>
<tr><td colspan="3">-</td><td colspan="2">Touch Probe 2 falling edge trigger complete</td><td colspan="2">Touch Probe 2 rising edge trigger complete</td><td>Touch Probe 2 action</td></tr>
<tr><td>60BAh</td><td colspan="8">Touch Probe 1 rising edge capture data value register</td></tr>
<tr><td>60BBh</td><td colspan="8">Touch Probe 1 falling edge capture data value register</td></tr>
<tr><td>60BCh</td><td colspan="8">Touch Probe 2 rising edge capture data value register</td></tr>
<tr><td>60BDh</td><td colspan="8">Touch Probe 2 falling edge capture data value register</td></tr>
<tr><td>60FDh</td><td colspan="8">The state of bit26 is bit 1 and bit 2 AND logic of Object (60B9h); The state of bit27 is bit 9 and bit 10 AND logic of Object (60B9h)</td></tr>
<tr><td>2152h</td><td colspan="8">It can be configured as probe 1 or probe 2 by writing its sub-indexes 01h and 02h to 17 or 18.</td></tr>
</table>

Additional information on other bits:

- The bit0 and bit8 of Object (60B8h): start/stop control bit of Touch Probe 1 and Touch Probe 2 respectively, and the rising edge is effective.
- The bit1 and bit9 of Object (60Bh): Touch Probe modes are divided into single mode and continuous mode.
  - Single mode: After a Touch Probe is activated, it is captured only under the first trigger signal. In order to capture the new position value again, the bit0 /bit8 of the Object (60B8h) must be given a rising edge signal to restart the probe action.
  - Continuous mode: After a Touch Probe is activated, the capture action is carried out under each trigger signal.

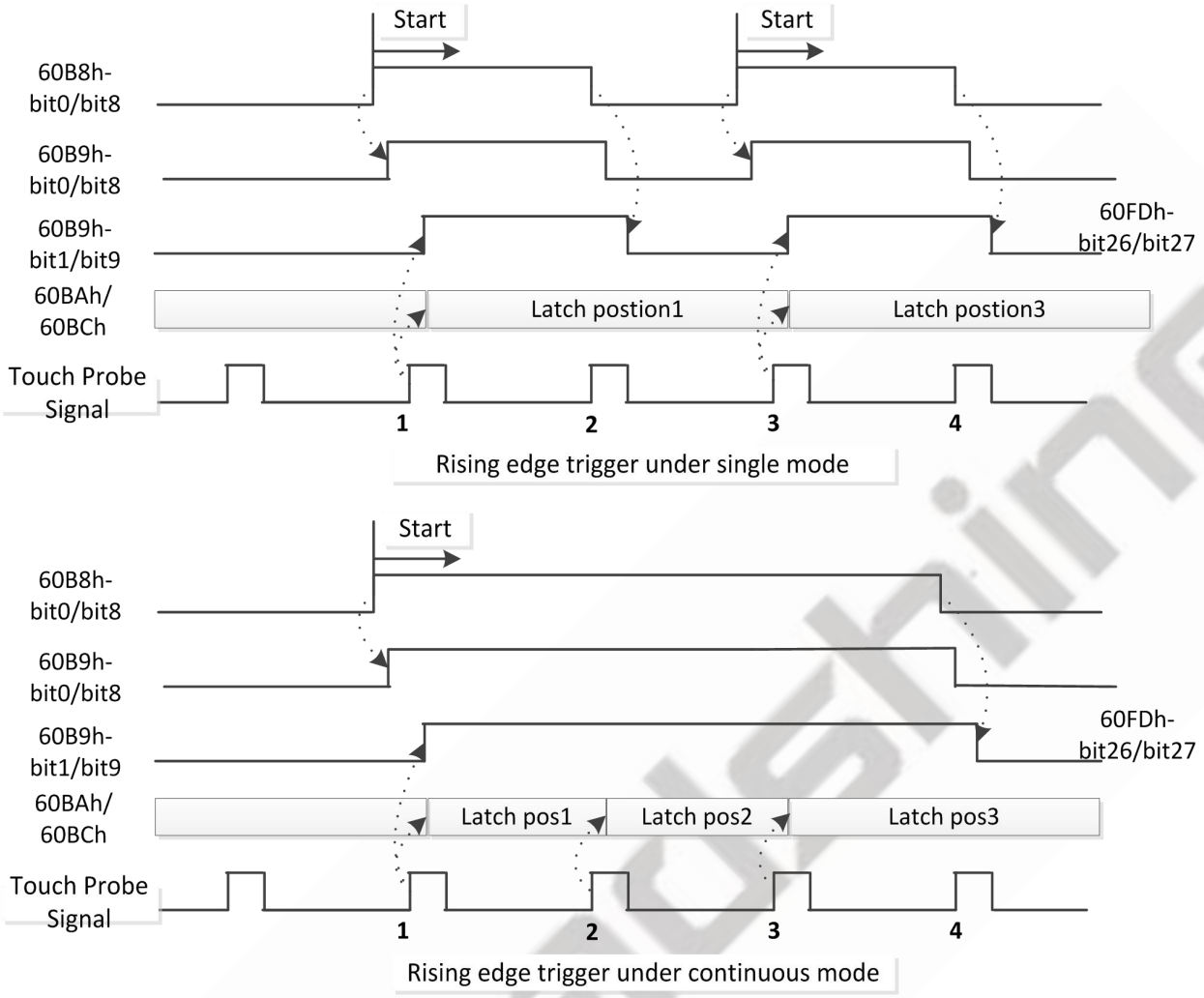


Figure 6.1: Touch Probe Mode

Appendix A: Homing Methods

The CS3E series drives support homing method 1-14 (with Z signal), method 17-34, and method 35 / 37. Specific definition and the process of homing methods described below.

Note: If you need to use Z signal for homing, you need to order the matching motor and encoder extension cable which are with Z signal.

Method 1:

- If the motor starting point is not at the Negative Limit position like Situation A, it will move toward negative direction at Fast Homing Velocity (6099-01h) until the Negative Limit goes ON, then the motor stops quickly and starts to move toward positive direction at Low Homing Velocity (6099-02h). The motion stops at the first effective Z signal after leaving the Negative Limit Switch, as shown in Figure 7-1.
- If the motor starting point is at the Negative Limit position like Situation B, it will move toward positive direction at Low Homing Velocity and stop when st first effective Z signal after leaving the Negative Limit Switch.
- If the Positive Limit signal goes ON during homing motion, bit 13 of Status Word (6041h) will be valid, it indicates an error in the homing motion, and the motor will stop immediately.

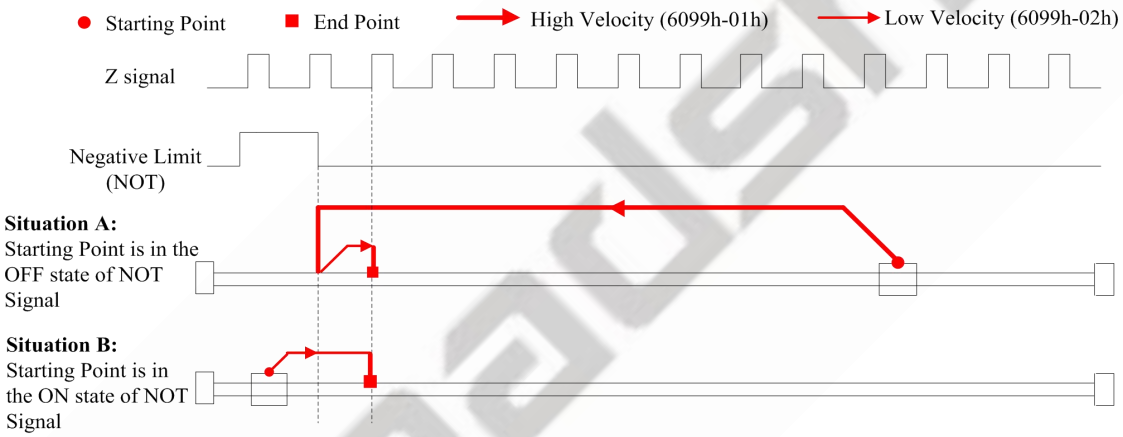


Figure **7-1 Method 1**

Method 2:

- If the motor starting point is not at the Positive Limit position like Situation A, it will move toward positive direction at Fast Homing Velocity (6099-01h) until the Positive Limit goes ON, then the motor stops quickly and starts to move toward negative direction at Low Homing Velocity (6099-02h). The motion stops at the first effective Z signal after leaving the Positive Limit Switch, as shown in Figure 7-2.
- If the motor starting point is at the Positive Limit position, it will move toward negative direction at Low Homing Velocity and stop at the first effective Z signal after leaving the Positive Limit Switch.
- If the Negative Limit signal goes ON during homing motion, bit 13 of Status Word (6041h) will be set, it indicates an error in the homing motion.and the motor will stop immediately.

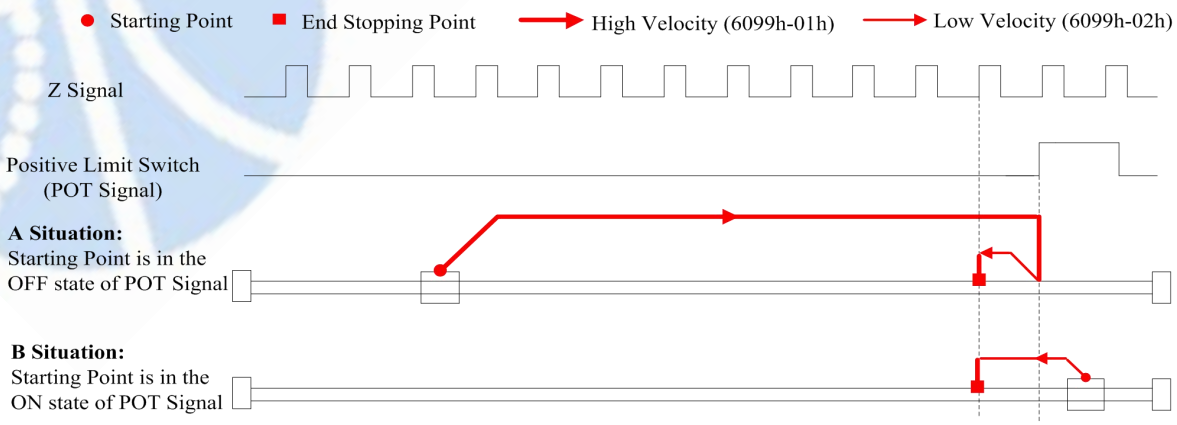


Figure 7-2: Method 2

Method 3:

- If the motor starting point is not at the HOME-SWITCH position like Situation A, it will move toward positive direction at Fast Homing Velocity (6099-01h) until the HOME-SWITCH goes ON, then the motor stops quickly and starts to move toward negative direction at Low Homing Velocity (6099-02h). The motion stops at the first effective Z signal after leaving the HOME-SWITCH, as shown in Figure 7-3.
- If the motor starting point is at the HOME-SWITCH position, it will move toward negative direction at Low Homing Velocity and stop at the first effective Z signal after leaving the HOME-SWITCH.
- If the Negative or Positive Limit signal goes ON during homing motion, bit 13 of Status Word (6041h) will be set, it indicates an error in the homing motion.and the motor will stop immediately.

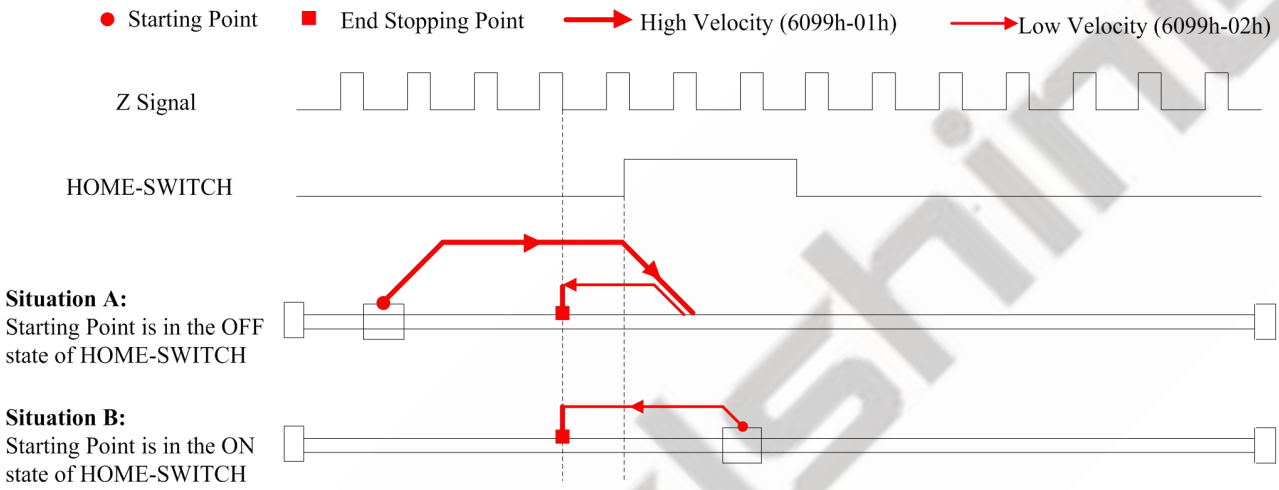


Figure 7-3: Method 3

Method 4:

- If the motor starting point is in the OFF state of HOME-SWITCH like Situation A, it will move toward positive direction at Low Homing Velocity (6099-02h) and stop at the first effective Z signal after leaving the HOME-SWITCH, as shown in Figure 7-4.
- If the motor starting point is in the ON state of HOME-SWITCH like Situation B,it will move toward negative direction at Fast Homing Velocity (6099-01h) until the Positive Limit goes ON, then the motor stops quickly and starts to move toward negative direction at Low Homing Velocity. Stop the motion at the first effective Z signal after leaving the HOME-SWITCH.
- If the Negative or Positive Limit signal goes ON during homing motion, bit 13 of Status Word (6041h) will be set, it indicates an error in the homing motion.and the motor will stop immediately.

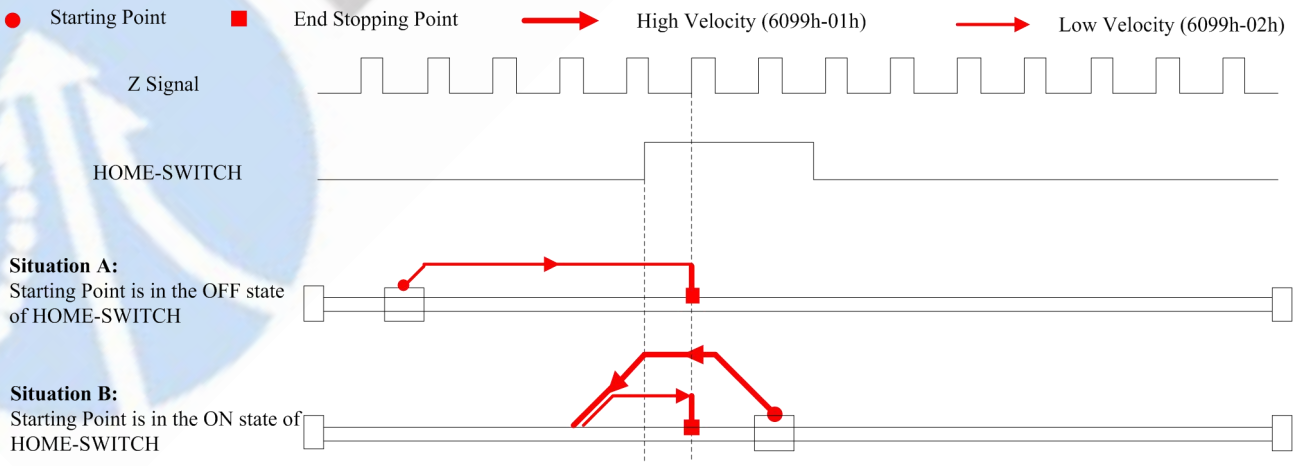


Figure 7-4: Method 4

Method 5:

- If the motor starting point is in the OFF state of HOME-SWITCH like Situation A,it will move toward negative direction at Fast Homing Velocity (6099-01h) until the HOME-SWITCH goes ON, then the motor has a deceleration stop and starts to move toward positive direction at Low Homing Velocity (6099-02h). Stop the motion at the first effective Z signal during the OFF state of HOME-SWITCH, as shown in Figure 7-5.
- If the motor starting point is in the ON state of HOME-SWITCH like Situation B, it will move toward positive direction at Low Homing Velocity and stop at the first effective Z signal after leaving the HOME-SWITCH.
- If the Negative or Positive Limit signal goes ON during homing motion, bit 13 of Status Word (6041h) will be set, it indicates an error in the homing motion.and the motor will stop immediately.

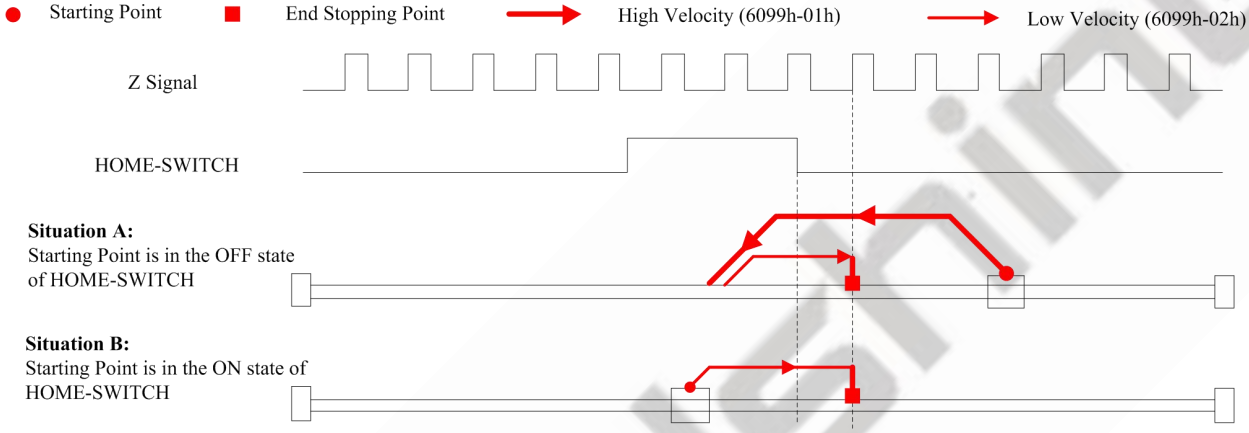


Figure 7-5: Method 5

Method 6:

- If the motor starting point is in the OFF state of HOME-SWITCH like Situation A,it will move toward negative direction at Low Homing Velocity (6099-02h) until the HOME-SWITCH goes ON, then stops at the first effective Z signal.
- If the motor starting point is in the ON state of HOME-SWITCH like Situation B, it will move toward positive direction at Fast Homing Velocity (6099-01h), then the motor has a deceleration stop and starts to move toward negative direction at Low Homing Velocity. Stop the motion at the first effective Z signal during the ON state of HOME-SWITCH, as shown in Figure 7-6.
- If the Negative or Positive Limit signal goes ON during homing motion, bit 13 of Status Word (6041h) will be set, it indicates an error in the homing motion.and the motor will stop immediately.

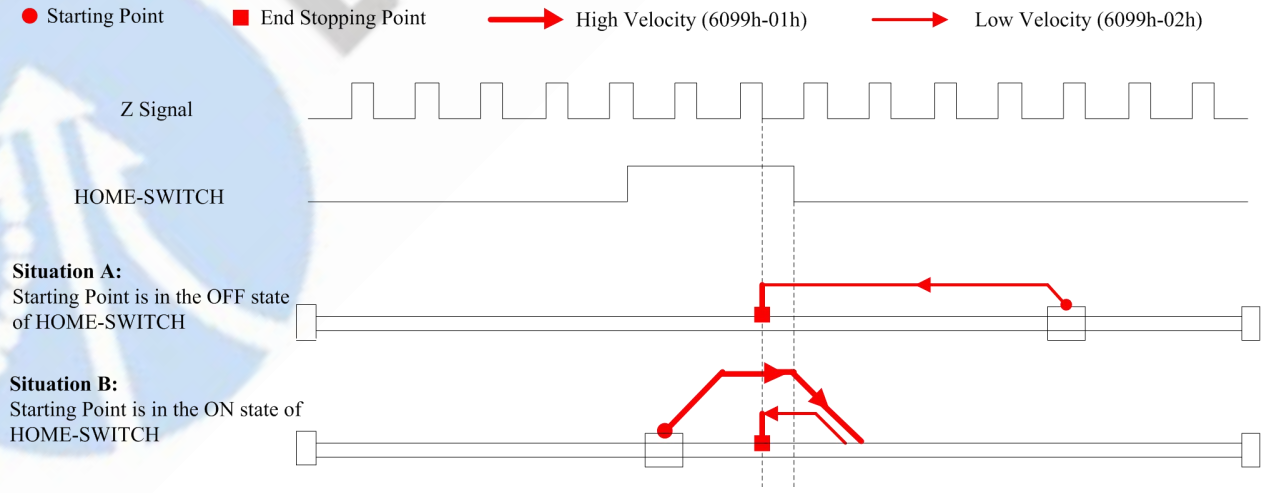


Figure7-6: Method 6

Method 7:

- If the motor starting point is in the OFF state of HOME-SWITCH and Positive Limit like Situation A, it will move toward positive direction at Fast Homing Velocity (6099-01h) until the HOME-SWITCH goes ON to have a deceleration stop, then moves toward negative direction at Low Homing Velocity (6099-02h) and stops at the first effective Z signal after leaving the HOME-SWITCH, as shown in Figure 7-7.
- If the motor starting point is in the ON state of HOME-SWITCH and OFF state of Positive Limit like Situation B, it will move toward negative direction at Low Homing Velocity (6099-02h), then the motor stops at the first effective Z signal after leaving the HOME-SWITCH.
- If the motor starting point is in the OFF state of HOME-SWITCH and Positive Limit like Situation C, it will move toward positive direction at Fast Homing Velocity (6099-01h) until the Positive Limit goes ON to have a quick stop, then moves toward negative direction at Low Homing Velocity and stops at the first effective Z signal after leaving the HOME-SWITCH.
- If the Negative Limit signal goes ON during homing motion, bit 13 of Status Word (6041h) will be set, it indicates an error in the homing motion.and the motor will stop immediately.

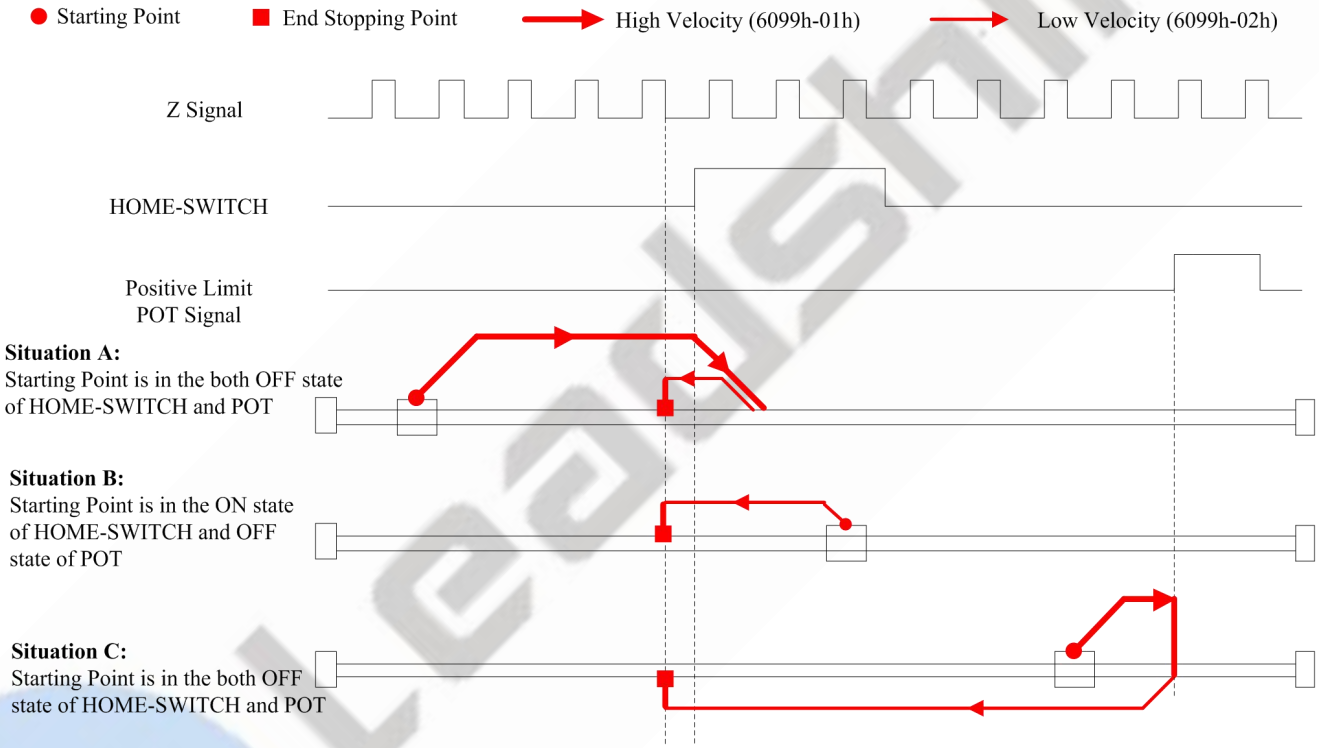


Figure 7-7 Method 7

Method 8:

- If the motor starting point is in the OFF state of HOME-SWITCH and Positive Limit like Situation A, it will move toward positive direction at Low Homing Velocity (6099-02h), it will stop at the first effective Z signal during the ON state of HOME-SWITCH, as shown in Figure 7-8.
- If the motor starting point is in the ON state of HOME-SWITCH and OFF state of Positive Limit like Situation B, it will move toward negative direction at Fast Homing Velocity (6099-01h), and have a deceleration stop after leaving HOME-SWITCH, then move toward positive direction as Low Homing Velocity, the motor stops at the first effective Z signal during the ON state of HOME-SWITCH.
- If the motor starting point is in the OFF state of HOME-SWITCH and Positive Limit like Situation C, it will move toward positive direction at Low Homing Velocity (6099-02h) until the Positive Limit goes ON to have a quick stop, then moves toward negative direction at Fast Homing Velocity and have a deceleration stop when leaving the HOME-SWITCH, then moves toward positive direction at Low Homing Velocity and stops at the first effective Z signal during the ON state of HOME-SWITCH.
- If the Negative Limit signal goes ON during homing motion, bit 13 of Status Word (6041h) will be set, it indicates an error in the homing motion.and the motor will stop immediately.

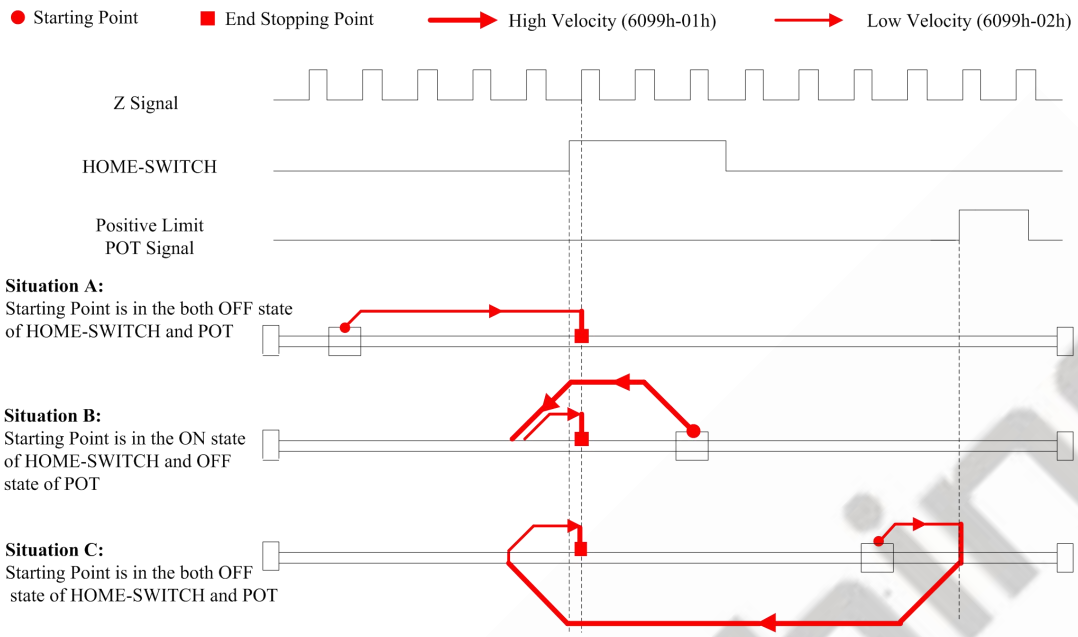


Figure 7-8 Method 8

Method 9:

- If the motor starting point is in the OFF state of HOME-SWITCH and Positive Limit , it will move toward positive direction at Fast Homing Velocity (6099-01h), and have a deceleration stop after leaving HOME-SWITCH, then move toward negative direction at Low Homing Velocity (6099-02h) and motion stops at the first effective Z signal during the ON state of HOME-SWITCH, as shown in Situation A of Figure 7-9.
- If the motor starting point is in the ON state of HOME-SWITCH and OFF state of Positive Limit, it will move toward positive direction at Fast Homing Velocity, and have a deceleration stop after leaving HOME-SWITCH, then move toward negative direction at Low Homing Velocity, the motion stops at the first effective Z signal during the ON state of HOME-SWITCH, as shown in Situation B of Figure 7-9.
- If the motor starting point is in the OFF state of HOME-SWITCH and Positive Limit, it will move toward positive direction at Fast Homing Velocity until the Positive Limit goes ON to have a quick stop, then moves toward negative direction at Low Homing Velocity and motion stops at the first effective Z signal during the ON state of HOME-SWITCH, as shown in Situation C of Figure 7-9.
- If the Negative Limit signal goes ON during homing motion, bit 13 of Status Word (6041h) will be set, it indicates an error in the homing motion.and the motor will stop immediately.

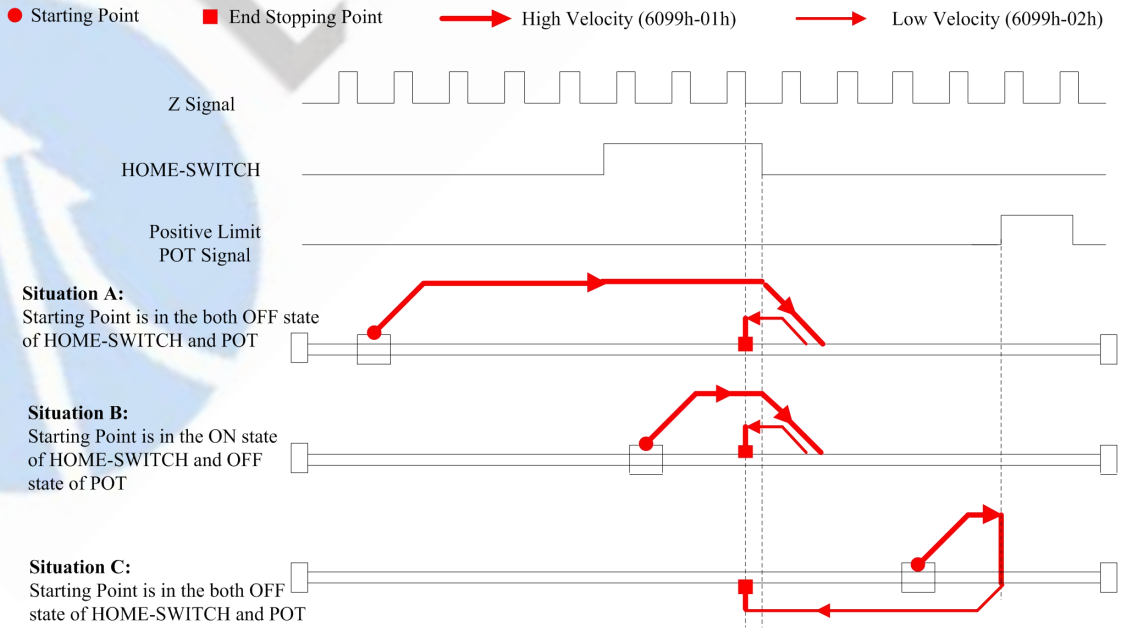


Figure 7-9 Method 9

Method 10：

- If the motor starting point is in the OFF state of HOME-SWITCH and Positive Limit, it will move toward positive direction at Low Homing Velocity (6099-02h), it will stop at the first effective Z signal during the OFF state of HOME-SWITCH, as shown in Situation A of Figure 7-10.
- If the motor starting point is in the ON state of HOME-SWITCH and OFF state of Positive Limit, it will move toward positive direction at Low Homing Velocity (6099-02h), it will stop at the first effective Z signal during the OFF state of HOME-SWITCH, as shown in Situation B of Figure 7-10.
- If the motor starting point is in the OFF state of HOME-SWITCH and Positive Limit, it will move toward positive direction at Low Homing Velocity (6099-02h) until the Positive Limit goes ON to have a quick stop, then moves toward negative direction at Fast Homing Velocity and have a deceleration stop when HOME-SWITCH goes ON, then moves toward positive direction at Low Homing Velocity and stops at the first effective Z signal during the OFF state of HOME-SWITCH, as shown in Situation C of Figure 7-10.
- If the Negative Limit signal goes ON during homing motion, bit 13 of Status Word (6041h) will be set, it indicates an error in the homing motion.and the motor will stop immediately.

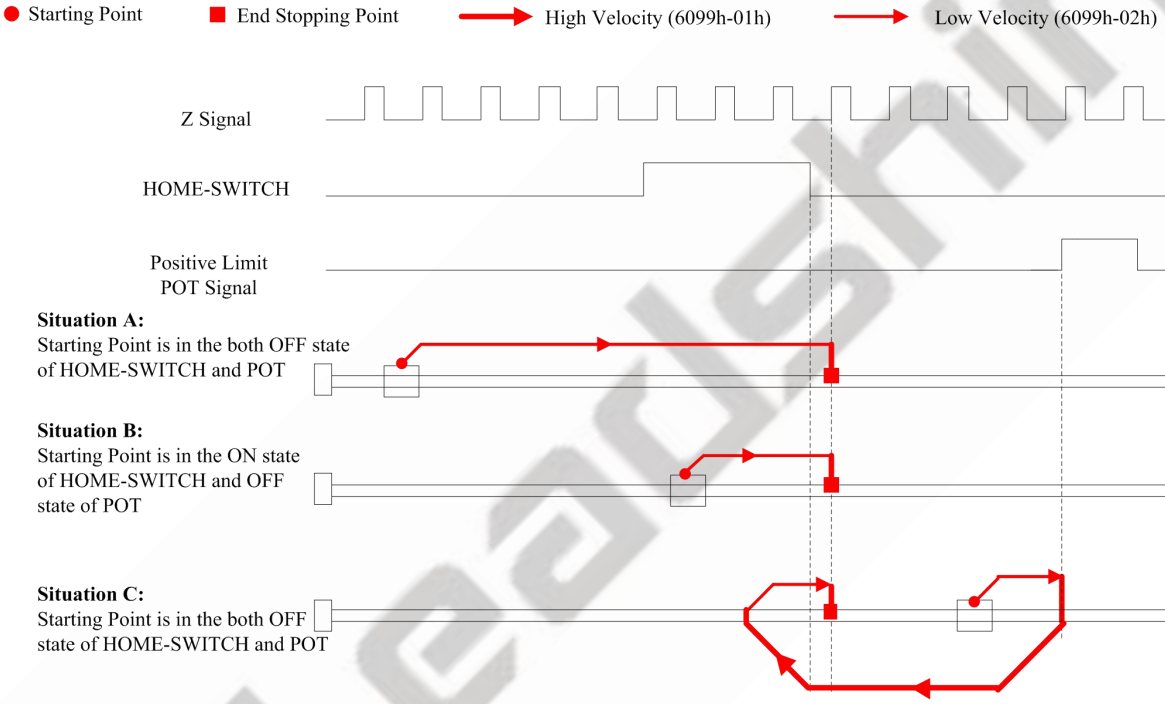


Figure 7-10 Method 10

Method 11

- If the motor starting point is in the OFF state of HOME-SWITCH and Negative Limit , it will move toward negative direction at Fast Homing Velocity (6099-01h), and have a deceleration stop when HOME- SWITCH goes ON, then move toward positive direction at Low Homing Velocity (6099-02h) and motion stops when the first Z signal after leaving HOME-SWITCH goes ON, as shown in Situation A of Figure 7-11.
- If the motor starting point is in the ON state of HOME-SWITCH and OFF state of Negative Limit, it will move toward positive direction at Low Homing Velocity, and the motion stops when the first Z signal after leaving HOME-SWITCH goes ON, as shown in Situation B of Figure 7-11.
- If the motor starting point is in the OFF state of HOME-SWITCH and Negative Limit, it will move toward negative direction at Fast Homing Velocity until the Negative Limit goes ON to have a quick stop, then moves toward positive direction at Low Homing Velocity and motion stops at the first effective Z signal after leaving HOME-SWITCH, as shown in Situation C of Figure 7-11.
- If the Positive Limit signal goes ON during homing motion, bit 13 of Status Word (6041h) will be set, it indicates an error in the homing motion.and the motor will stop immediately.

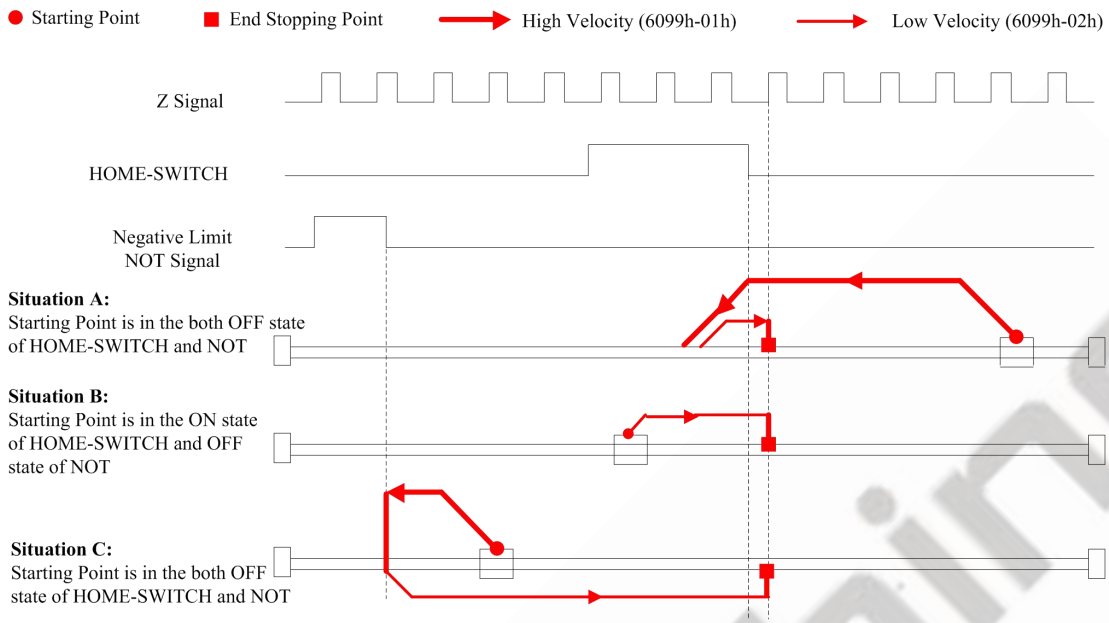


Figure 7-11 Method 11

Method 12：

- If the motor starting point is in the OFF state of HOME-SWITCH and Negative Limit, it will move toward negative direction at Low Homing Velocity (6099-02h), and the motion stops at the first effective Z signal during the ON state of HOME-SWITCH, as shown in Situation A of Figure 7-12.
- If the motor starting point is in the ON state of HOME-SWITCH and OFF state of Negative Limit, it will move toward positive direction at Fast Homing Velocity (6099-01h) and have a deceleration stop after leaving HOME-SWITCH, then move toward negative direction at Low Homing Velocity, the motion stops at the first effective Z signal during the ON state of HOME-SWITCH, as shown in Situation B of Figure 7-12.
- If the motor starting point is in the OFF state of HOME-SWITCH and Negative Limit, it will move toward negative direction at Low Homing Velocity (6099-02h) until the Negative Limit goes ON to have a quick stop, then moves toward positive direction at Fast Homing Velocity and have a deceleration stop after leaving HOME-SWITCH, then move toward negative direction at Low Homing Velocity, the motion stops at the first effective Z signal during the ON state of HOME-SWITCH, as shown in Situation C of Figure 7-10.
- If the Positive Limit signal goes ON during homing motion, bit 13 of Status Word (6041h) will be set, it indicates an error in the homing motion.and the motor will stop immediately.

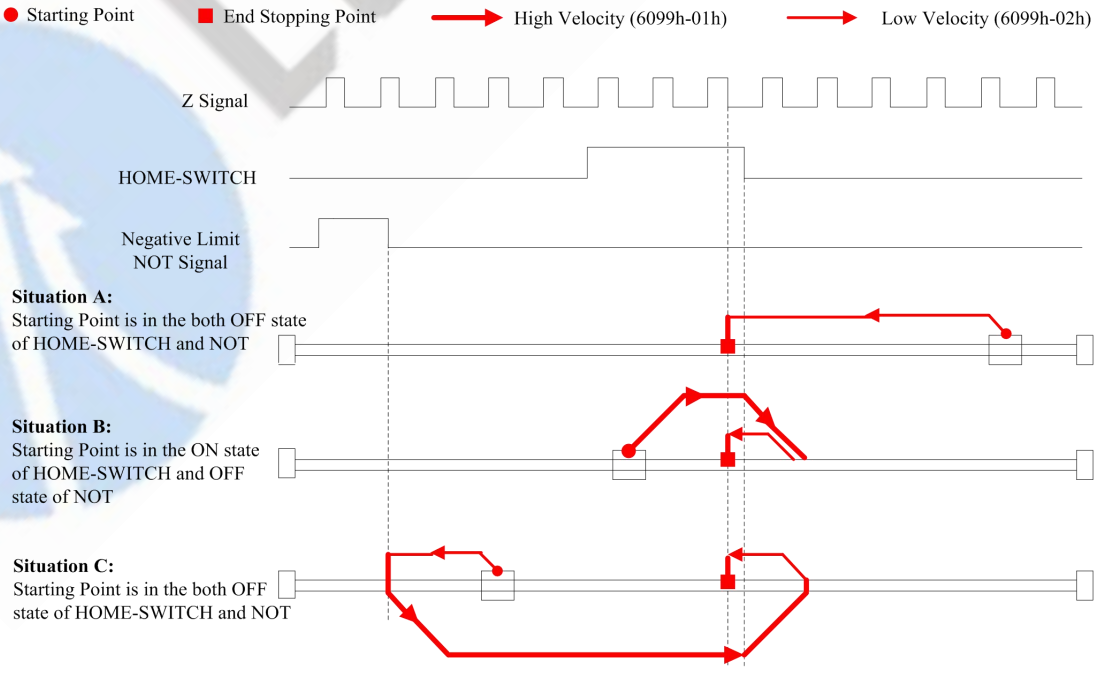


Figure 7-12 Method 12

Method 13：

- If the motor starting point is in the OFF state of HOME-SWITCH and Negative Limit, it will move toward negative direction at Fast Homing Velocity (6099-01h), and has a deceleration when leaving HOME-SWITCH , then moves toward positive direction at Low Homing Velocity , the motion stops at the first effective Z signal during the ON state of HOME-SWITCH, as shown in Situation A of Figure 7-13.
- If the motor starting point is in the ON state of HOME-SWITCH and OFF state of Negative Limit, it will move toward negative direction at Fast Homing Velocity (6099-01h) and have a deceleration stop after leaving HOME-SWITCH, then move toward positive direction at Low Homing Velocity, the motion stops at the first effective Z signal during the ON state of HOME-SWITCH, as shown in Situation B of Figure 7-12.
- If the motor starting point is in the OFF state of HOME-SWITCH and Negative Limit, it will move toward negative direction at Fast Homing Velocity (6099-01h) until the Negative Limit goes ON to have a quick stop, then moves toward positive direction at Low Homing Velocity, the motion stops at the first effective Z signal during the ON state of HOME-SWITCH, as shown in Situation C of Figure 7-13.
- If the Positive Limit signal goes ON during homing motion, bit 13 of Status Word (6041h) will be set, it indicates an error in the homing motion.and the motor will stop immediately.

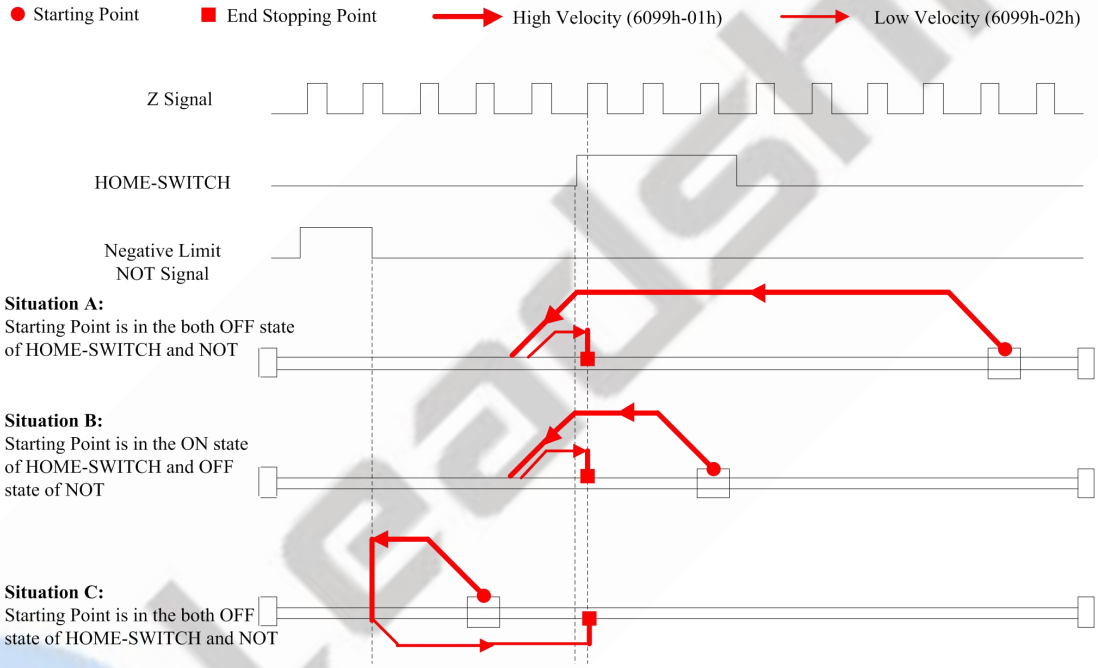


Figure 7-13 Method 13

Method 14：

- If the motor starting point is in the OFF state of HOME-SWITCH and Negative Limit, it will move toward negative direction at Low Homing Velocity (6099-02h), and the motion stops at the first effective Z signal during the OFF state of HOME-SWITCH, as shown in Situation A of Figure 7-14.
- If the motor starting point is in the ON state of HOME-SWITCH and OFF state of Negative Limit, it will move toward negative direction at Low Homing Velocity (6099-02h) and the motion stops at the first effective Z signal during the OFF state of HOME-SWITCH, as shown in Situation B of Figure 7-12.
- If the motor starting point is in the OFF state of HOME-SWITCH and Negative Limit, it will move toward negative direction at Low Homing Velocity (6099-02h) until the Negative Limit goes ON to have a quick stop, then moves toward positive direction at Fast Homing Velocity and have a deceleration stop when HOME-SWITCH goes ON, then move toward negative direction at Low Homing Velocity, the motion stops at the first effective Z signal during the OFF state of HOME-SWITCH, as shown in Situation C of Figure 7-14.
- If the Positive Limit signal goes ON during homing motion, bit 13 of Status Word (6041h) will be set, it indicates an error in the homing motion.and the motor will stop immediately.

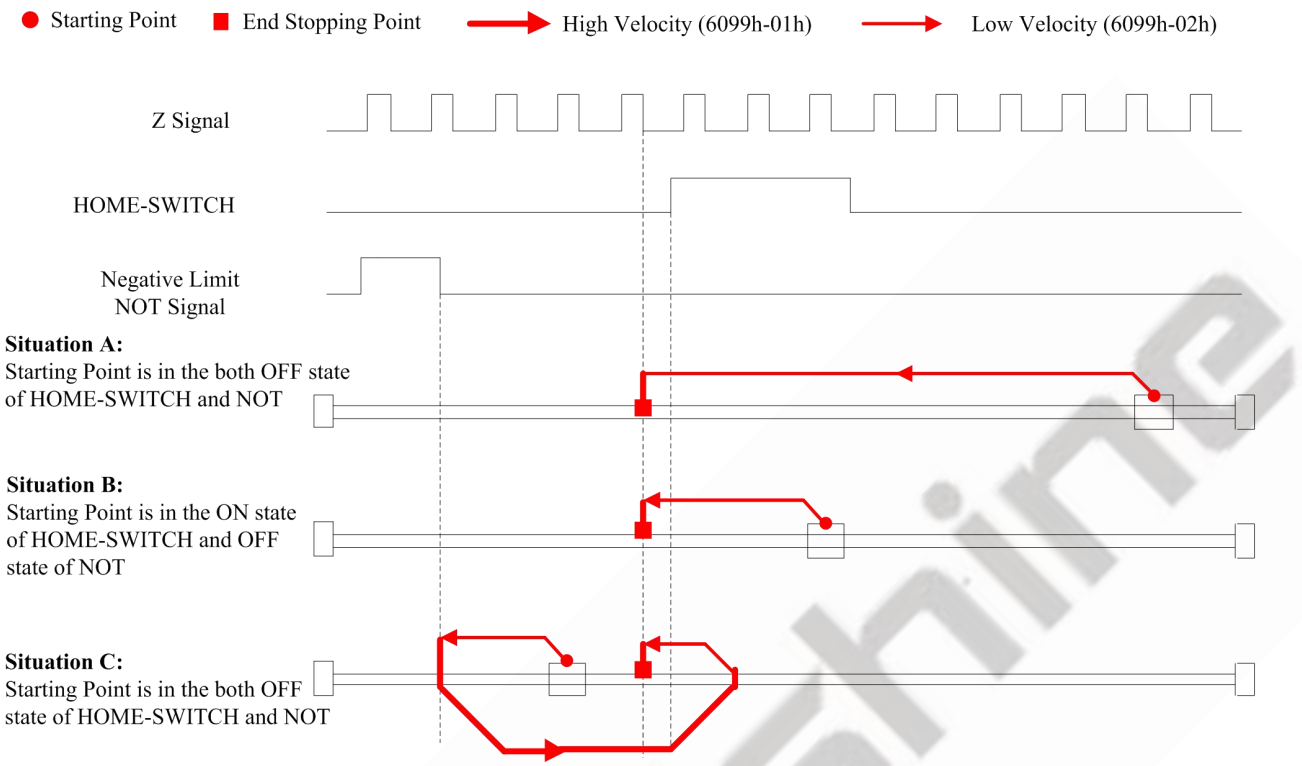


Figure 7-14 Method 14

Method 17:

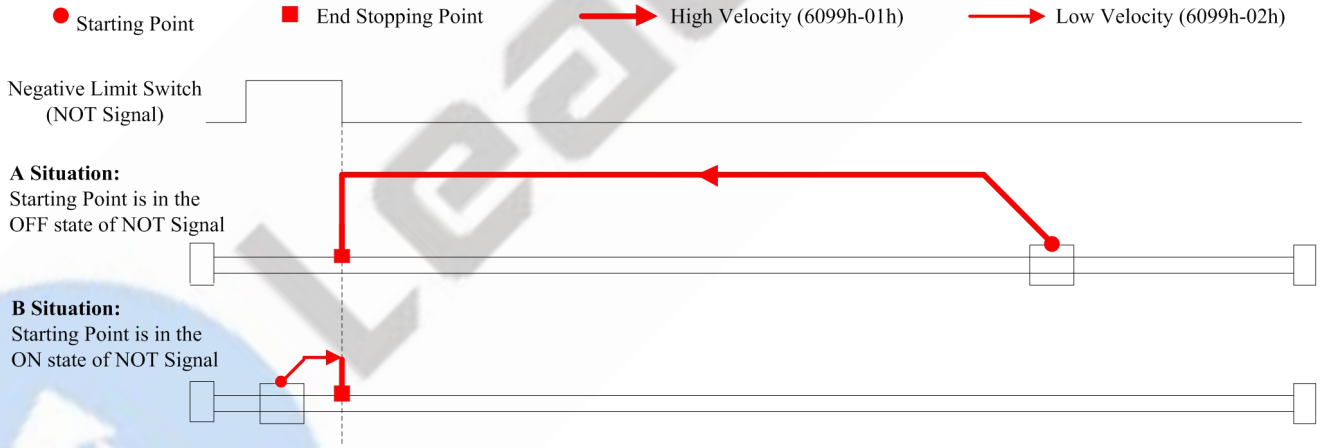


Figure 7-15 Method 17

Method 18:

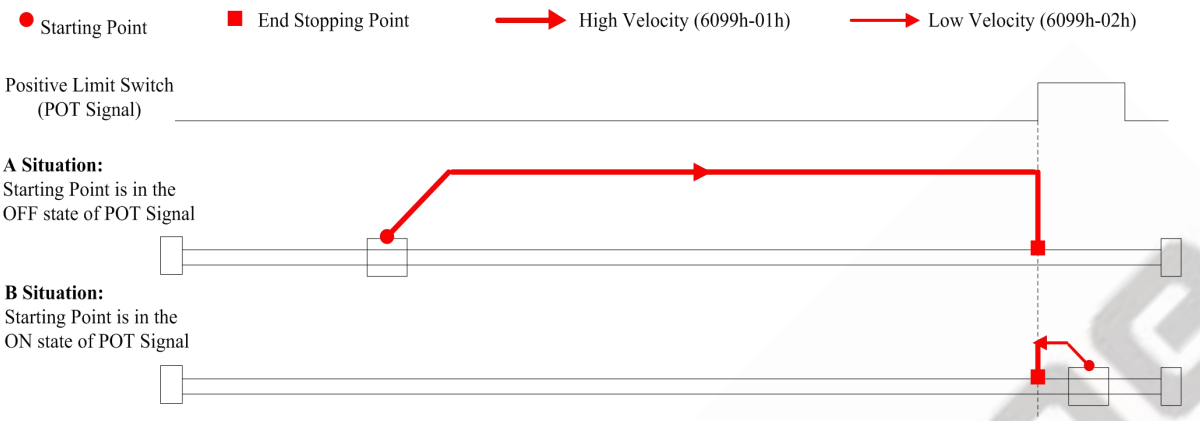


Figure 7-16: Method 18

Method 19:

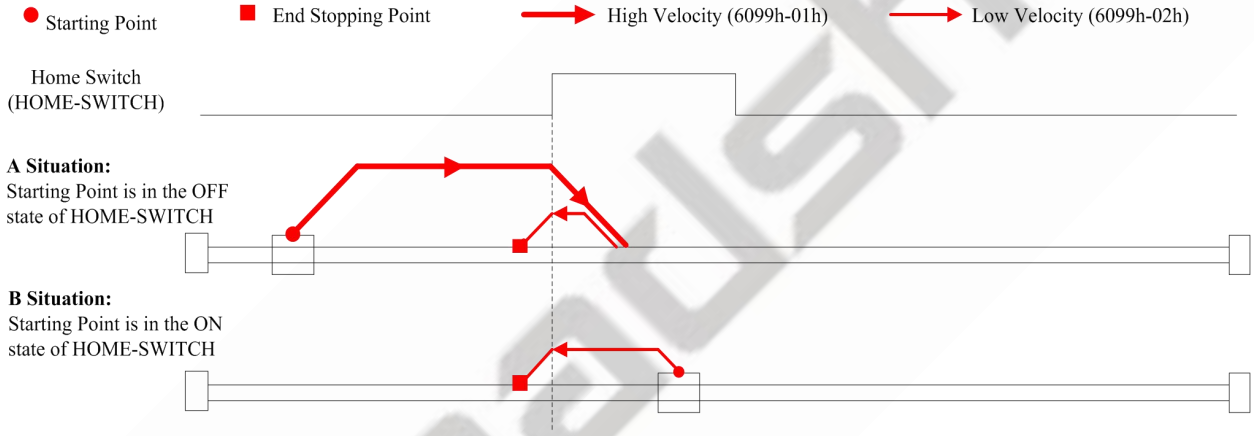


Figure 7-17 Method 19

Method 20:

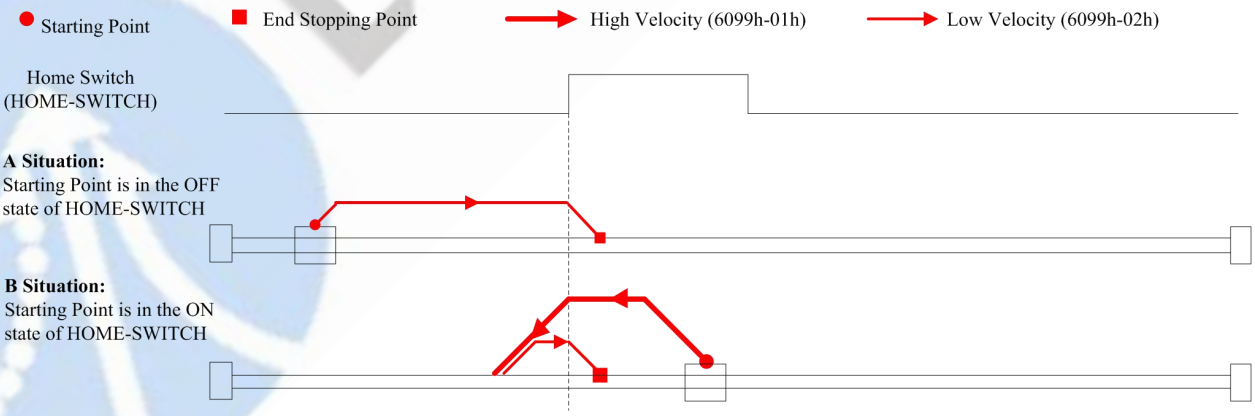


Figure 7-18 Method 20

Method 21:

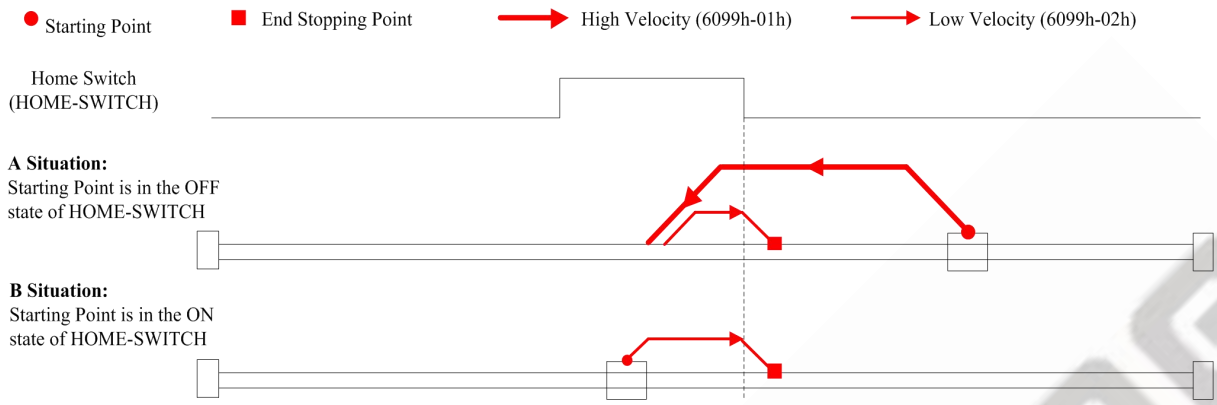


Figure 7-19 Method 21

Method 22:

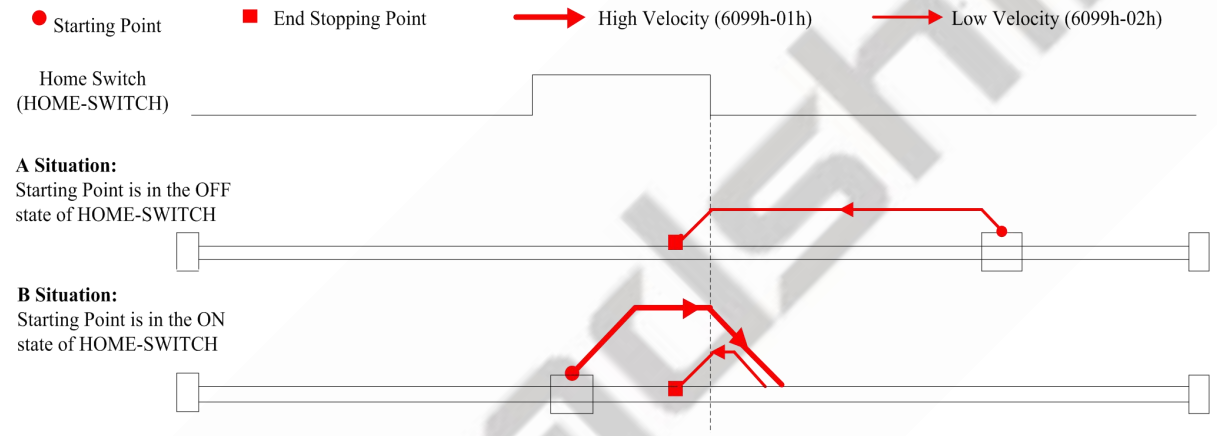


Figure 7-20 Method 22

Method 23:

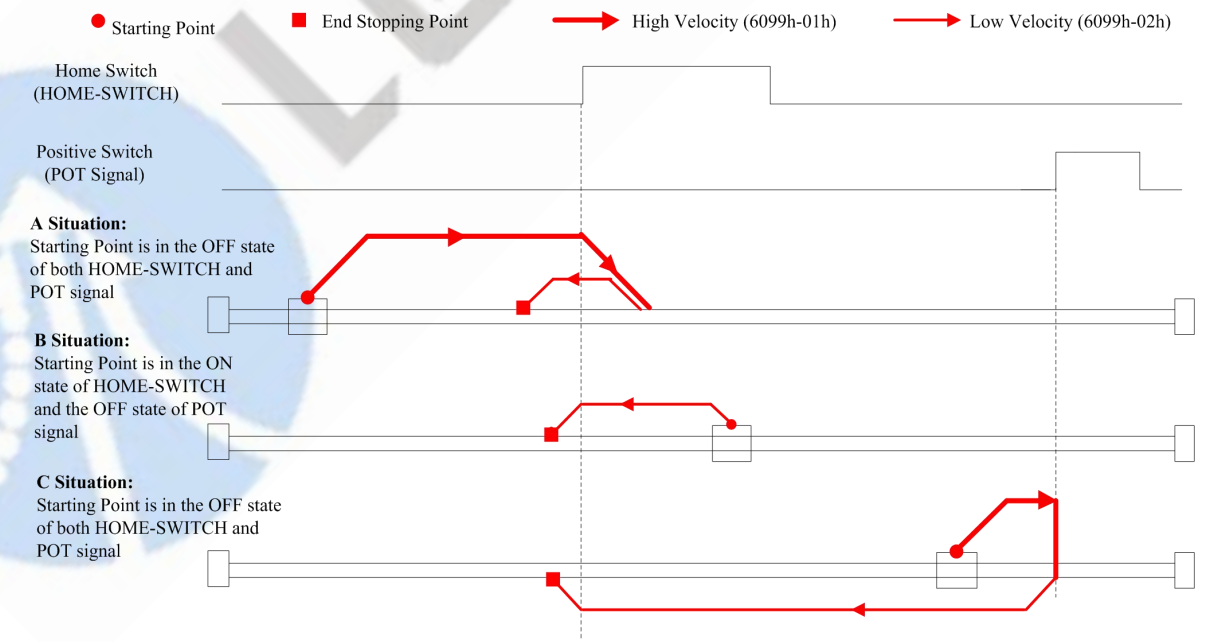


Figure 7-21 Method 23

Method 24:

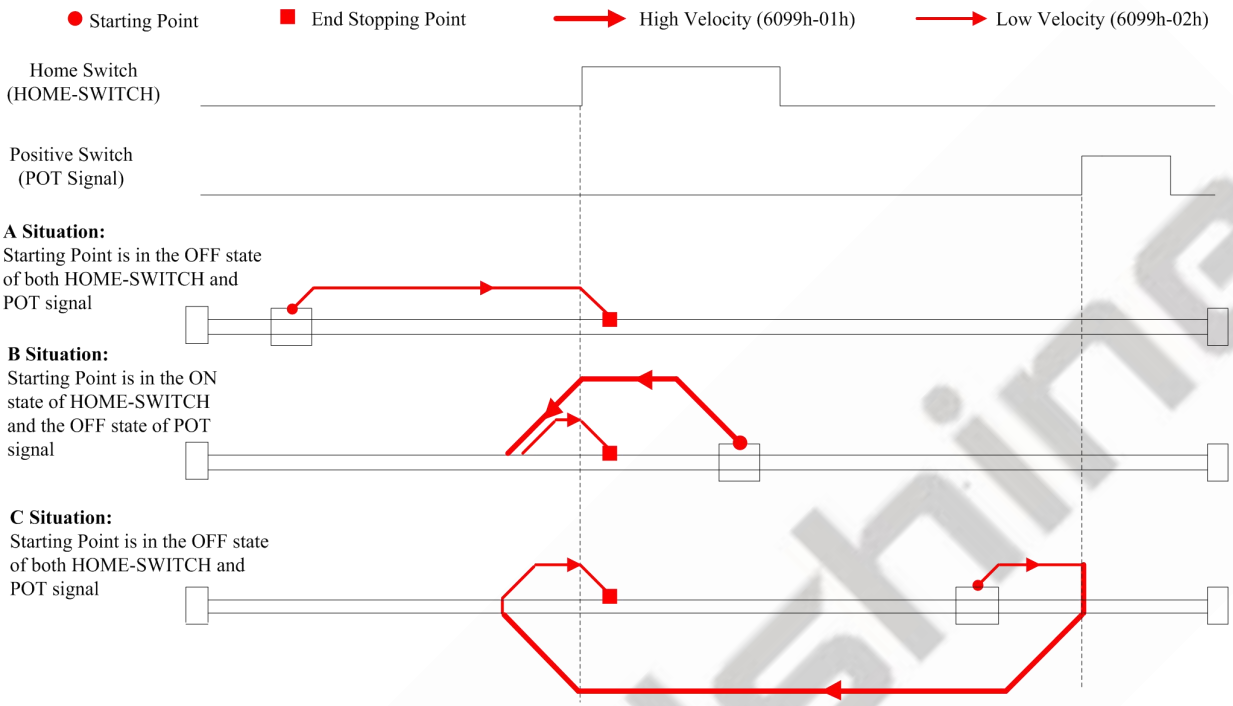


Figure 7-22 Method 24

Method 25:

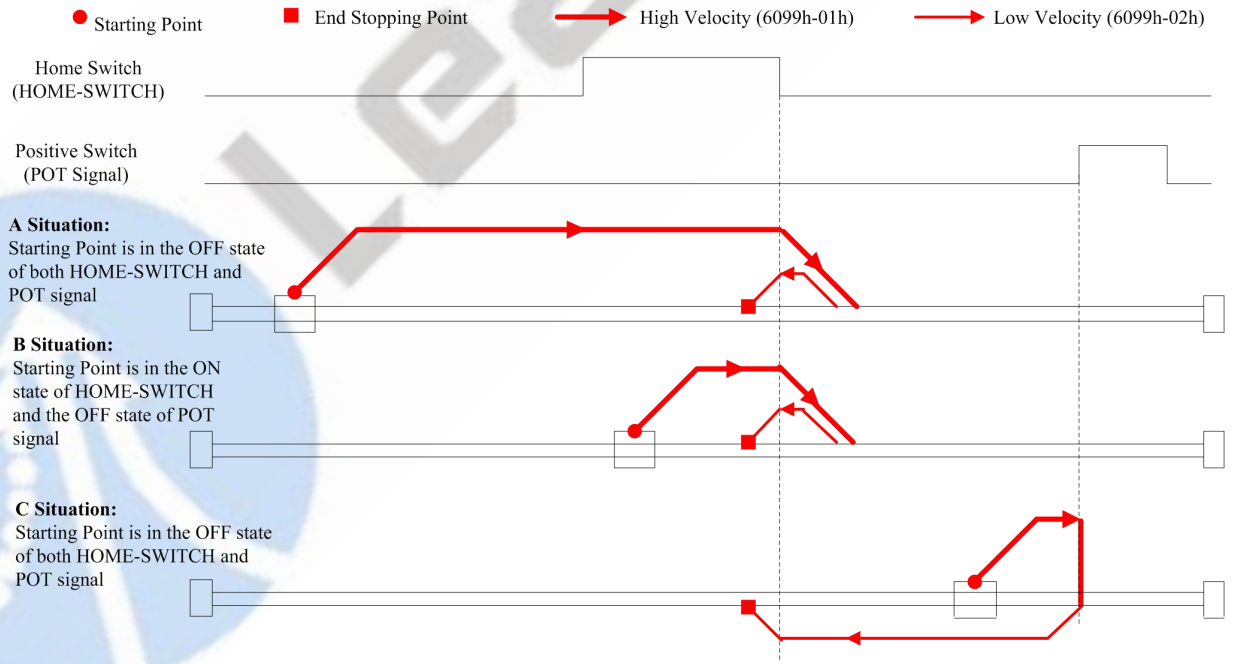


Figure 7-23 Method 25

Method 26:

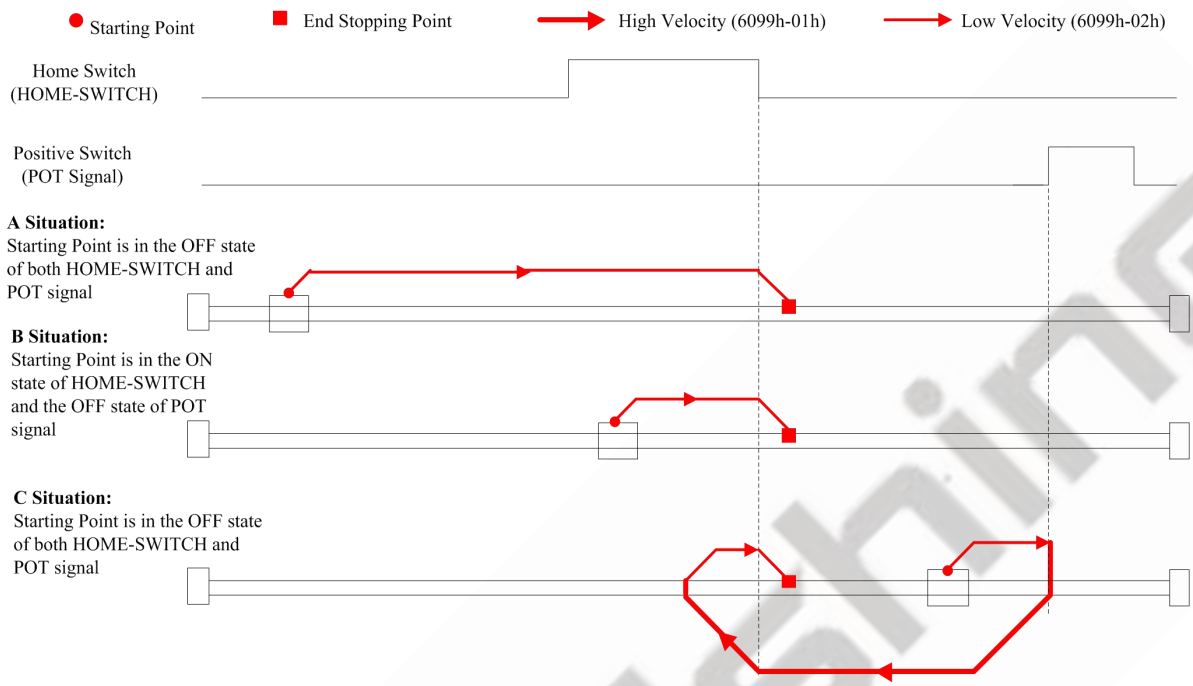


Figure 7-24 Method 26

Method 27:

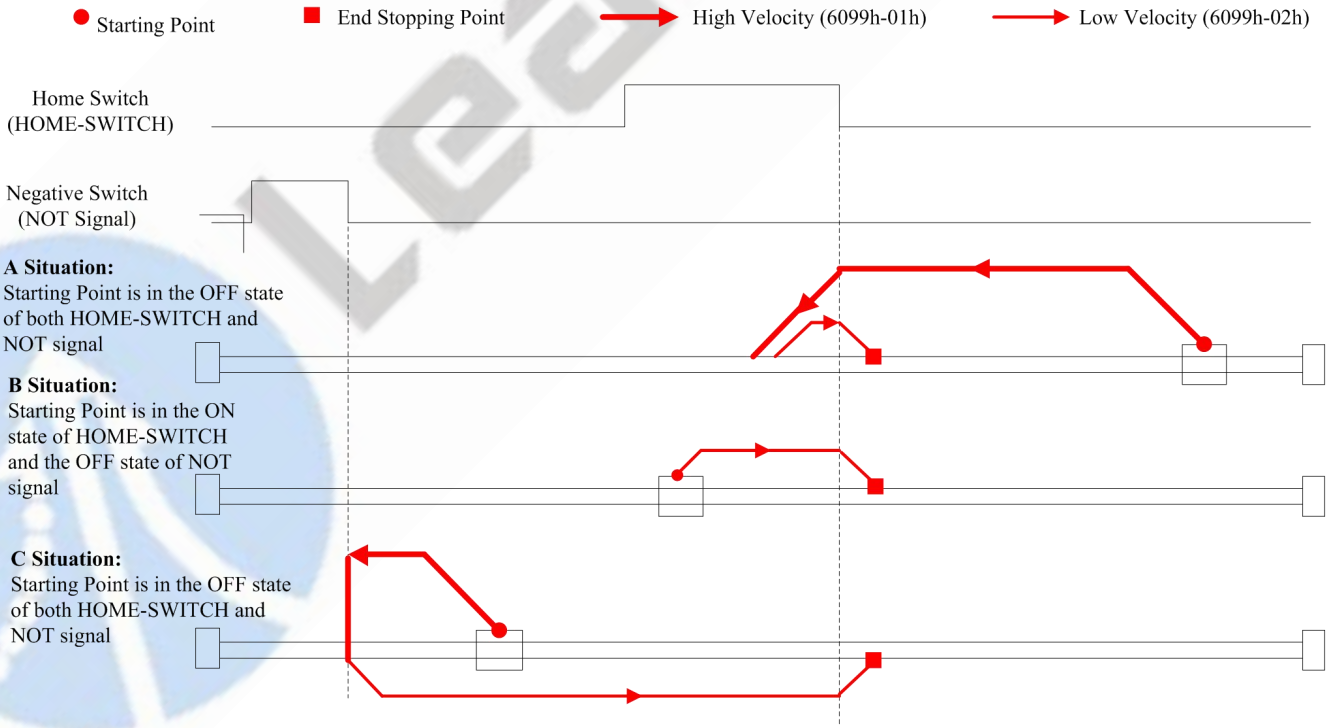


Figure 7-25 Method 27

Method 28:

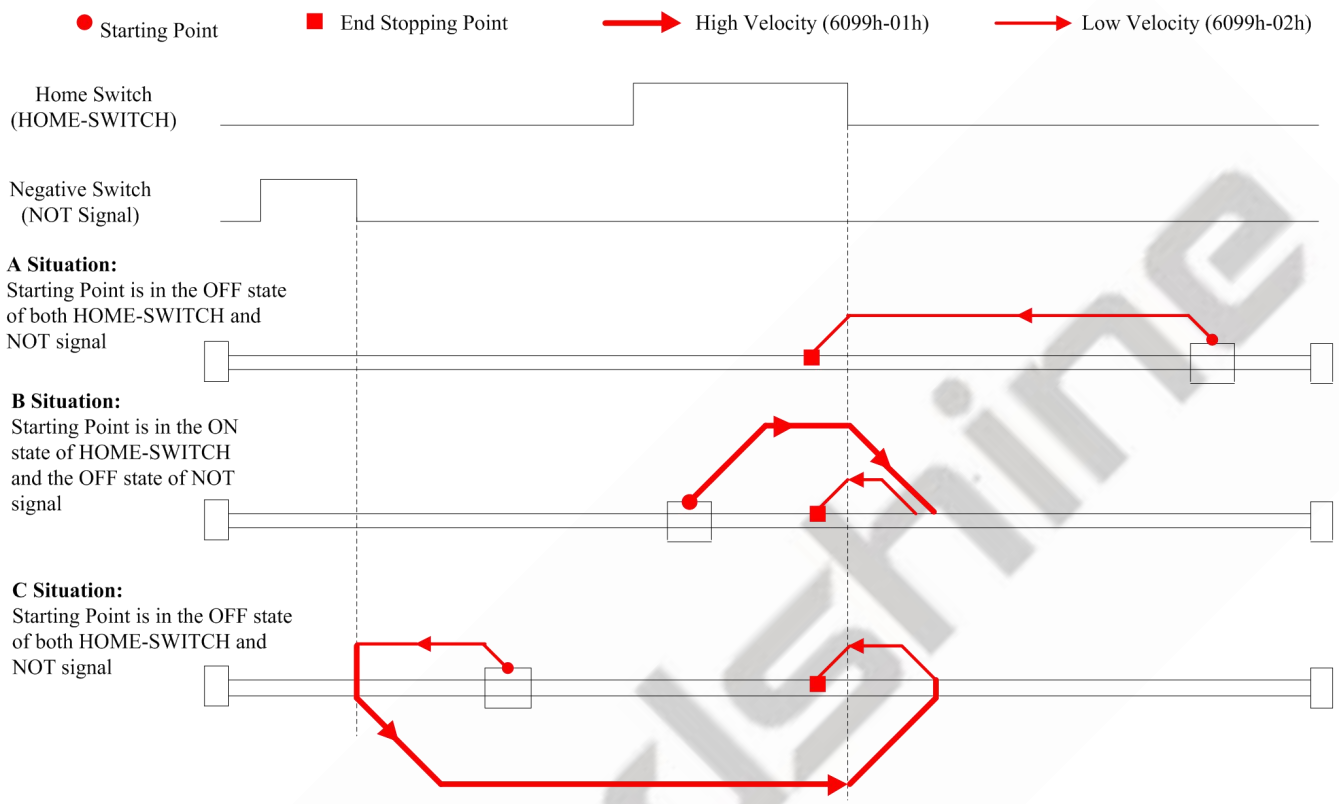


Figure 7-26 Method 28

Method 29:

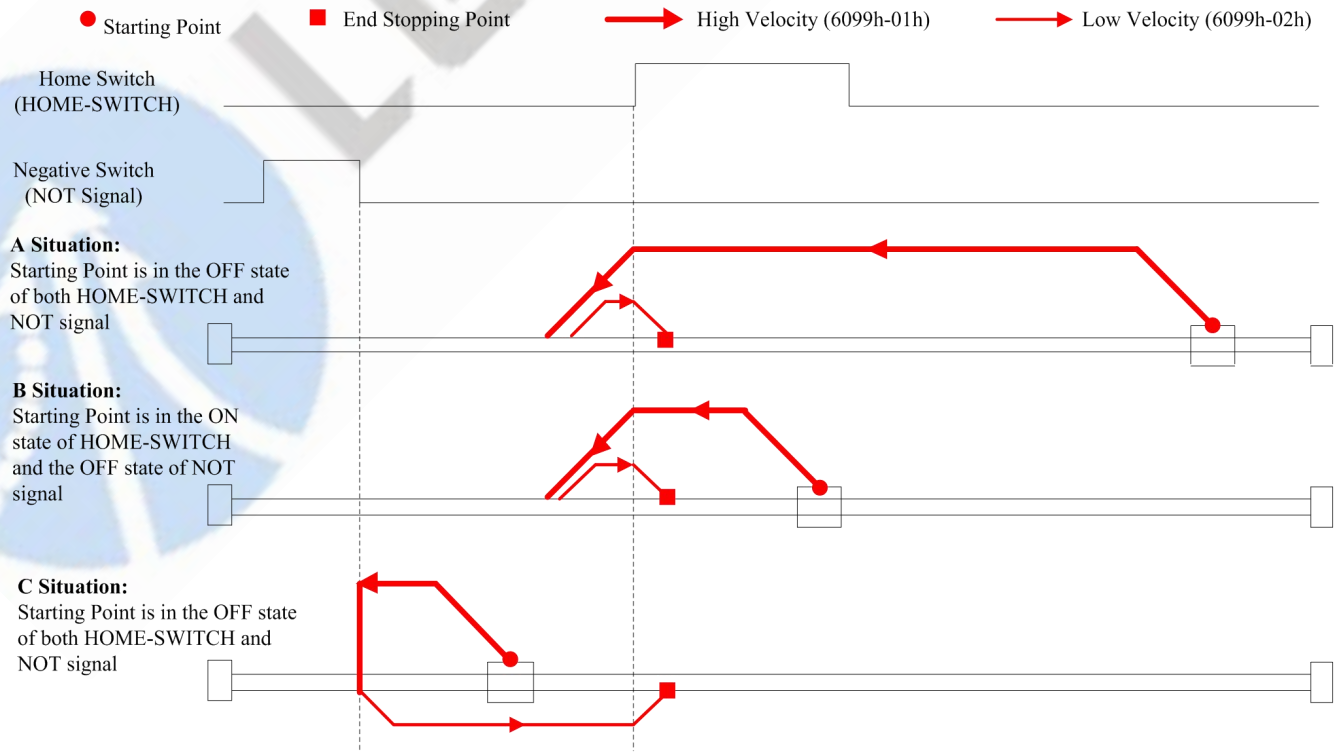


Figure 7-27 Method 29

Method 30:

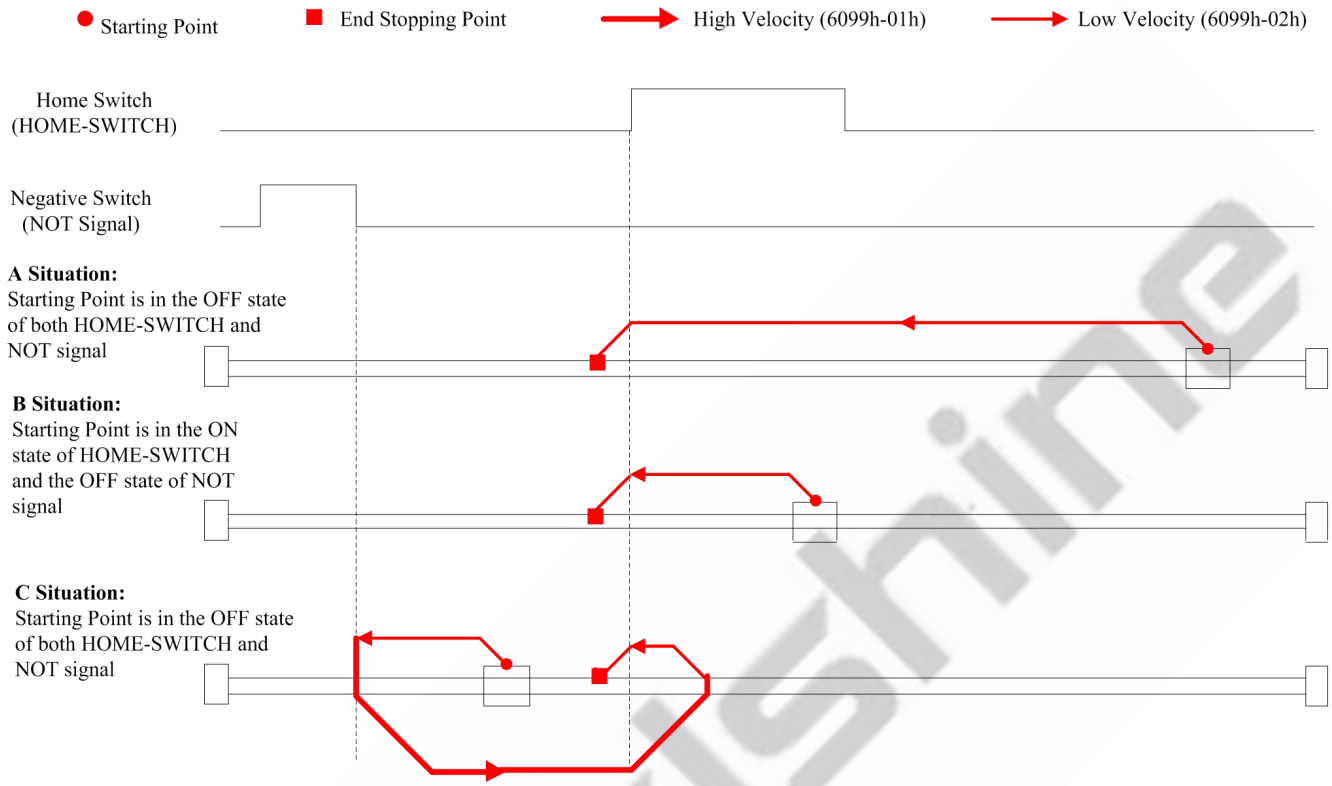


Figure 7-28 Method 30

Method 35/37:

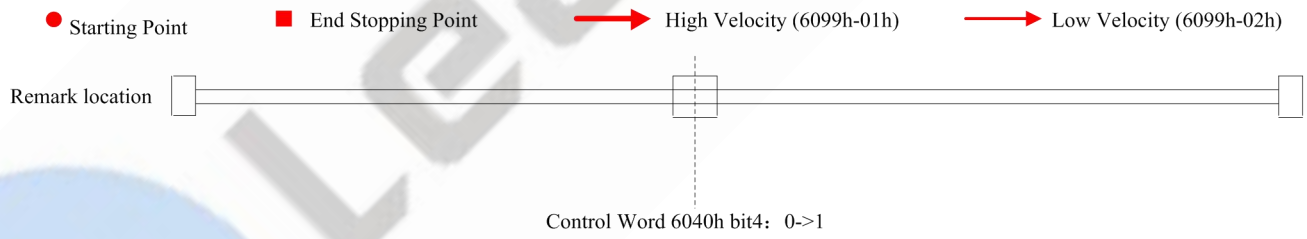


Figure 7-29 Method 35/37

Appendix B: Object Dictionary

Index	Sub-index	Name	Access	Type	Range	Default Value	Unit	Remark
1000	0	Device type	R	UINT	0-32767	0x40912	-	Refer to CIA 402 profile
1001	0	Error register	R	USINT	0-255	0	--	Type of error generated from the controller
1008	0	Device name	R	UINT	0-32767	CS3E-D507	-	Product model
1009	0	Hardware version	R	UINT	0-32767	V1.0	-	Refer to product label
100A	0	Software version	R	UINT	0-32767	V1.0	-	Refer to object (3100h)
1010	00	Number of sub-index	R	UINT	0-32767	4	-	-
	01	Save all parameters	R/W	UDINT	0-0xFFFFFFFF	0	-	Need to write 0x65766173 or 1702257011 (decimal) into sub-index. It will return 1 if save successfully
	02	Save communication parameters	R/W	UDINT	0-0xFFFFFFFF	0	-	Need to write 0x65766173 or 1702257011 (decimal) into sub-index. It will return 1 if save successfully
	03	Save motion parameters	R/W	UDINT	0-0xFFFFFFFF	0	-	Need to write 0x65766173 or 1702257011 (decimal) into sub-index. It will return 1 if save successfully
	04	Save factory parameters	R/W	UDINT	0-0xFFFFFFFF	0	-	Need to write 0x65766173 or 1702257011 (decimal) into sub-index. It will return 1 if save successfully
1011	00	Number of sub-index	R	UINT	0-32767	4	-	-
	01	Restore all parameters to default setting	R/W	UDINT	0-0xFFFFFFFF	0	-	Need to write 0x64616f6c or 1684107116 (decimal) into sub-index. It will return 1 if save

								successfully
	02	Restore communication parameters to default setting	R/W	UDINT	0-0xFFFFFFFF	0	-	Need to write 0x64616f6c or 1684107116 (decimal) into sub-index. It will return 1 if save successfully
	03	Restore motion parameters to default setting	R/W	UDINT	0-0xFFFFFFFF	0	-	Need to write 0x64616f6c or 1684107116 (decimal) into sub-index. It will return 1 if save successfully
	04	Restore user parameters to default setting	R/W	UDINT	0-0xFFFFFFFF	0	-	Need to write 0x64616f6c or 1684107116 (decimal) into sub-index. It will return 1 if save successfully
1018	00	Number of sub-index	R	UINT	0-32767	4	-	-
	01	Vendor ID	R	UINT	0-32767	4321	-	Leadshine code
	02	Product code	R	UINT	0-32767	100	-	-
	03	Revision number	R	UINT	0-32767	1	-	-
	04	Series number	R	UINT	0-32767	1	-	-
1600	0	Number of sub-index	R/W	UINT	0-32767	3	-	Default number of 1st mapping object
	01-08	1st RXPDO-Map object	R/W	UDINT	0-0xFFFFFFFF	-	-	Default number of 1st RXPDO-Map object
1601	0	Number of sub-index	R/W	UINT	0-32767	6	-	Default number of 2nd mapping object
	01-08	2nd RXPDO-Map object	R/W	UDINT	0-0xFFFFFFFF	-	-	Default number of 2nd RXPDO-Map object
1602	0	Number of sub-index	R/W	UINT	0-32767	5	-	Default number of 3rd mapping object
	01-08	2nd RXPDO-Map object	R/W	UDINT	0-0xFFFFFFFF	-	-	Default number of 3rd RXPDO-Map object
1603	0	Number of sub-index	R/W	UINT	0-32767	7	-	Default number of 4th mapping object
	01-08	3rd RXPDO-Map object	R/W	UDINT	0-0xFFFFFFFF	-	-	Default number of 4th RXPDO-Map object
1A00	0	Number of sub-index	R/W	UINT	0-32767	7	-	Default number of 1st mapping object

	01-08	1st TXPDO-Map object	R/W	UDINT	0-0xFFFFFFFF	-	-	Default number of 1st TXPDO-Map object
1A01	0	Number of sub-index	R/W	UINT	0-32767	0	-	Default number of 2nd mapping object
	01-08	2nd TXPDO-Map object	R/W	UDINT	0-0xFFFFFFFF	-	-	Default number of 2nd TXPDO-Map object
1C00	0	Number of sub-index	R	UINT	0-32767	4	-	-
	01	Output type of email	R	UINT	0-32767	1	-	-
	02	Input type of email	R	UINT	0-32767	2	-	-
	03	Output type of process data	R	UINT	0-32767	3	-	-
	04	Input type of process data	R	UINT	0-32767	4	-	-
1C12	0-04	RXPDO assign	R/W	UINT	0-32767	1600	-	-
1C13	0-02	TXPDO assign	R/W	UINT	0-32767	1A00	-	-
1C32	0-0A	RXPDO administrative parameters	R	UINT	0-32767	-	-	-
1C33	0-0A	TXPDO administrative parameters	R	UINT	0-32767	-	-	-
2150	00	Salve ID	R/W/S	UINT	0-256	1	--	-
2151	00	Salve ID resource	R/W/S	UINT	0-10	0	--	0: Rotary switch 1: Master setting
2000	00	Peak current	R/W/S	UINT	0-80	60	0.1A	Drive's max output current.
2001	00	Microstep resolution	R/W/S	UINT	200-51200	10000	Pulse	Required number of pulse to rotate one revolution of motor
2010	01	Internal filtering time	R/W/S	UINT	1-2048	15	0.1ms	Internal smoothing time for control command.
2012	00	Soft-starting time	R/W/S	UINT	1-60	1	100 ms	Internal smoothing time for starting current.
2013	00	Auto-tuning at power on	R/W/S	UINT	0-1	1	--	1: Yes. 0: No

201A	01	Locking current percentage qt power on	R/W/S	UINT	0-100	100	%	Usually keep the default value.
	02	Open loop output current percentage	R/W/S	UINT	0-100	50	%	Percentage of peak current; also output current in open loop mode. Only available when "control mode" is set to open loop
	03	Closed loop holding current percentage	R/W/S	UINT	0-100	50	%	Percentage of peak current; also idle current in closed loop mode. Only available when "control mode" is set to closed loop
201B	00	Locking duration time	R/W/S	UINT	0-1500	200	ms	Appropriately reduce this value if you want to shorten the time of locking shaft.
201C	00	Max time to close brake	R/W/S	UINT	100-10000	1000	ms	Usually keep the default value
201D	00	Zero speed point	R/W/S	UINT	0-500	10	0.1r/s	
2024	00	Control mode	R/W/S	UINT	0-10	2		0: open loop, 2: closed loop
2029	00	Encoder resolution	R/W/S	UINT	200-51200	4000	Pulse	4 times of encoder lines
2030	00	Allowed max position error counts	R/W/S	UINT	0-32767	4000	Pulse	It will occur position error when exceeds the setting value.
2032	00	Distance to output "in position" signal	R/W/S	UINT	0-1000	4	Pulse	Configures this value to determine if the motor is in position (dynamic).
2033	00	Delay of output signal of in position	R/W/S	UINT	0-1000	3	ms	
2047	00	Over voltage point	R/W/S	UINT	0-1000	90	V	
2048	00	Bus-voltage	R	UINT	0-65535		V	
2090	05	Acceleration feed-forward	R/W/S	UINT	0-10000	0	--	
2091	01	Velocity loop Kp	R/W/S	UINT	0-10000	30	--	
2091	02	Velocity loop Ki	R/W/S	UINT	0-10000	3	--	
2092	01	Position loop Kp	R/W/S	UINT	0-100	25	--	

214A	00	Digital display address	R	UINT	0-255	--	--	Setting by rotary switch
214B	00	LED initial status setting	R/W/S	UINT	0-100	0	--	0: state machine / operating mode 1: slave ID 2: speed
2203	00	Velocity loop integral limit	R/W/S	UINT	0-100	0	--	
	02	Reset factory	R/W	UINT	0-1	0	--	All parameters reset to factory default values
2206	01	Save parameters	R/W	UINT	0-1	0	--	
3100	01	Drive software version	R	UINT			--	
	02	FPGA software version	R	UINT			--	
	03	EtherCAT protocol version	R	UINT			--	
4003	01	Delay of closing brake	R/W/S	UINT	0-1500	250	ms	
	02	Delay of loosening brake	R/W/S	UINT	0-1500	250	ms	
	03	Max speed to close brake	R/W/S	UINT	0-500	10	0.1r/s	
2155	00	Digital input status	R	UINT	0—65535	0	--	
2152	01	Input port 1	R/W/S	UINT	0-65535	0x17	--	Touch probe input signal 1
	02	Input port 2	R/W/S	UINT	0-65535	0x18	--	Touch probe input signal 2
	03	Input port 3	R/W/S	UINT	0-65535	0x16	--	Origin point
	04	Input port 4	R/W/S	UINT	0-65535	0x01	--	Positive limit
	05	Input port 5	R/W/S	UINT	0-65535	0x02	--	Negative limit
	06	Input port 6	R/W/S	UINT	0-65535	0x19	--	User defined
	07	Input port 7	R/W/S	UINT	0-65535	0x19	--	User defined
2156	01	Output port 1	R/W/S	UINT	0-65535	0x01	--	Alarm
	02	Output port 2	R/W/S	UINT	0-65535	0x04	--	In position
	03	Output port 3	R/W/S	UINT	0-65535	0x05	--	User defined
	04	Output port 4	R/W/S	UINT	0-65535	0x05	--	User defined
	05	Output port 5	R/W/S	UINT	0-65535	0x05	-	User defined
	06	Output port 6	R/W/S	UINT	0-65535	0x05	--	User defined

	07	Output port 7	R	UINT	0-65535	0x03	--	Brake
2056	00	Fault detection	R/W/S	UINT	0-65535	65535	--	bit0: over current, bit1: over voltage bit2: position error, bit4: break wire detection
603F		Error code	R	UINT	0-65535	0	--	Refer to chapter 5.2
6040		Control word	R/W	UINT	0-65535	0	--	Refer to chapter 6.1
6041		Status word	R	UINT	0-65535	0	--	Refer to chapter 6.1
605A		Quick stop option code	R/W	UINT	0-65535	5	--	5: decelerated stop, others: invalid
6060		Operation mode	R/W	USINT	0-255	8	--	1: PP mode, 3: PV mode, 6: Home mode, 8: CSP mode
6061		Displayed operation mode	R	USINT	0-255	8	--	-
6062		Position demand value	R	DINT	-2147483648 -2147483647	0	P	P: pulse
6064		Position actual value	R	DINT	-2147483648 -2147483647	0	P	P: pulse
606B		Velocity demand value	R	DINT	-2147483648 -2147483647	0	P/s	-
606C		Velocity actual value	R	DINT	-2147483648 -2147483647	0	P/S	-
607A		Target position	R/W	DINT	-2147483648 -2147483647	0	P	Target position under PP mode
60FF		Target velocity	R/W	DINT	-2147483648 -2147483647	0	P/S	Profile velocity under PV mode
6081		Max profile velocity	R/W/S	DINT	-2147483648 -2147483647	50000	--	Max. Allowable velocity under PP mode

6082		Start velocity	R/W/S	DINT	-2147483648 -2147483647	0	--	Start velocity under PP mode
6083		Profile acceleration	R/W/S	DINT	-2147483648 -2147483647	4000	P/S^2	Acceleration under PP and PV mode
6084		Profile deceleration	R/W/S	DINT	-2147483648 -2147483647	4000	P/S^2	Deceleration under PP and PV mode
6085		Quick stop deceleration	R/W/S	DINT	-2147483648 -2147483647	400000000	P/S^2	Deceleration of quick stop under PP, PV and Home mode
6098		Homing method	R/W/S	USINT	1-100	19	-	Methods of searching origin under homing mode, refer to Appendix A
6099	01	Fast homing velocity	R/W/S	DINT	-2147483648 -2147483647	50000	P/S	Speed during search for switch under Home mode
	02	Slow homing velocity	R/W/S	DINT	-2147483648 -2147483647	25000	P/S	Speed during search for zero under Home mode
607C		Home offset	R/W/S	DINT	-2147483648 -2147483647	0	P	The value of difference between senor origin position and mechanical origin position under Home mode
609A		Homing acceleration	R/W/S	USINT	-2147483648 -2147483647	25000	P/S^2	Acc / Dec velocity under Home mode
60B8		Touch probe control word	R/W	UINT	0-65535	0	-	Set touch probe function, refer to chapter 6.3
60B9		Touch probe statue word	R	UINT	0-65535	0	-	Status of touch probe 1/2, refer to chapter 6.3
60BA		Touch probe 1 positive value	R	DINT	-2147483648 -2147483647	0	P	Data value sensed by touch probe 1 at rising edge
60BB		Touch probe 1 negative value	R	DINT	-2147483648	0	P	Data value sensed by touch probe 1 at

					-2147483647			falling edge
60BC		Touch probe 2 positive value	R	DINT	-2147483648 -2147483647	0	P	Data value sensed by touch probe 2 at rising edge
60BD		Touch probe 2 negative value	R	DINT	-2147483648 -2147483647	0	P	Data value sensed by touch probe 2 at falling edge
60C2	01	Interpolation time period value	R/W	USINT	0-255	2	--	Only for internal tuning.
	02	Interpolation time unit	R/W	SINT	-128-127	0	--	
60D5		Touch probe 1 rising edge counter	R	UINT	0-65535	0	--	Frequency for capture of touch probe 1 rising edge
60D6		Touch probe 1 falling edge counter	R	UINT	0-65535	0	--	Frequency for capture of touch probe 1 falling edge
60D7		Touch probe2 rising edge counter	R	UINT	0-65535	0	--	Frequency for capture of touch probe 2 rising edge
60D8		Touch probe 2 falling edge counter	R	UINT	0-65535	0	--	Frequency for capture of touch probe 2 falling edge
60FD		Digital input statue	R	UDINT	0-4294967296	0	--	Statue of digital input signals, refer to chapter 4.2.3
60FE	01	Open physical output	R/W/S	UDINT	0-4294967296	0	--	Able to control user output through this object, refer to chapter 4.2
	02	Enable physical output	R/W/S	UDINT	0-4294967296	0	--	
6502		Supported operation mode	R	UDINT	0-4294967296	165	--	Operation modes the drive supported

Appendix C. Leadshine Compatible Closed Loop Stepper Motors

The following Leadshine stepper motors with 1000-line encoders have been tested working with the CS3E closed loop stepper drive in link.

Model	Frame Size (NEMA)	Torque (N.m / Oz-In)	Drive	Length (mm / inch)	Notes
CS-M21702	17	0.2 / 28	CS3E-D503	56/2.20	-
CS-M21704		0.4 / 57		63/2.48	-
CS-M21706		0.6 / 85		70/2.76	-
CS-M21708		0.8 / 113		83/3.27	-
CS-M22306	23	0.6 / 85	CS3E-D507	62/2.44	-
CS-M22313		1.3 / 184		77/3.03	-
CS-M22323		2.3 / 326		97/3.82	-
CS-M22323-S		2.3 / 326		97/3.82	0.25-inch (6.35-mm) shaft
CS-M22326		2.6 / 368		105/4.13	-
CS-M22326-S		2.6 / 368		105/4.13	0.25-inch (6.35-mm) shaft
CS-M22321-L		2.1 / 368		88/3.46	-
CS-M22331-L		3.1 / 439		109/4.29	-
CS-M22331-L-S		3.1 / 439		109/4.29	-
CS-M22313B		1.3 / 184		109/4.29	24VDC brake integrated
CS-M22323B		2.3 / 326		131/5.15	24VDC brake integrated
CS-M22313WP		1.2 / 184		95/3.74	IP67 rated
CS-M22323WP		2.0 / 283		114/4.49	IP67 rated
CS-M22422	24	2.2 / 368		89 / 3.50	-
CS-M22430		3.0 / 439		107 / 4.21	-
CS-M22430B		3.0 / 439		143 / 5.63	24VDC brake integrated
CS-M23435	34	3.5 / 495	CS3E-D728/ CS3E-D1008	95 / 2.20	-
CS-M23435-S		3.5 / 495		95 / 2.48	0.50-inch (12.7-mm) shaft
CS-M23445		4.5 / 637		109 / 2.76	-
CS-M23445-S		4.5 / 637		109 / 3.27	0.50-inch (12.7-mm) shaft
CS-M23445B		4.5 / 637	CS3E-D1008	135 / 2.44	24VDC brake integrated
CS-M23445WP		4.5 / 637		115 / 2.08	IP67 rated
CS-M23480		8.0 / 1132		127 / 3.03	-
CS-M23480-S		8.0 / 1132		127 / 3.82	0.50-inch (12.7-mm) shaft
CS-M23480B		8.0 / 1132		173 / 3.82	24VDC brake integrated

CS-M23480WP		8.0 / 1132		133 / 2.94	IP67 rated
CS-M23485		8.5 / 1202		147 / 4.13	-
CS-M23485-S		8.5 / 1202		147 / 4.13	0.50-inch (12.7-mm) shaft
CS-M23485B		8.5 / 1202		173 / 3.46	24VDC brake integrated
CS-M23485WP		8.5 / 1202		154 / 3.08	IP67 rated
CS-M234120		12.0 / 1698		158 / 4.29	-
CS-M234120B		12.0 / 1698		184 / 4.29	24VDC brake integrated
CS-M234120WP		12.0 / 1698		164 / 3.82	IP67 rated

Note: all above stepper motors are mounted with 1000-line incremental encoders, also can contact with Leadshine for stepper motors with 2500-line, 5000-line encoders and other NEMA08, 11, 16 motors.

Appendix D. Leadshine Compatible Power Supplies

It is highly suggested to use the following Leadshine power supplies to power CS3E drives to get optimized performance. Those power supply are specially designed for stepper and servo controls.

Model	Output Voltage (VDC)	Series Model	Continuous Current (A)	Max Current (A)	Input Voltage (VAC)
RPS2410(V3.0)	24	RPS	10	30	85-132 / 176-264
RPS3611(V3.0)	36		11	33	85-132 / 176-264
RPS488(V3.0)	48		8.3	24.9	85-132 / 176-264
RPS4810(V3.0)	48		10.5	31.5	85-132 / 176-264
RPS608(V3.0)	60		8.5	10.5	85-132 / 176-264
SPS407	42	SPS	7.0	9.0	180-240
SPS407-L	42		4.7	9.0	90-130
SPS487	48		7.0	9.0	180-240
SPS487-L	48		3.0	9.0	90-130
SPS705	68		5.0	7.0	180-240
SPS705-L	68		3.0	7.0	90-130