Y2SD2-S80E-N4

EtherCAT Bus Stepper Driver User Manual

Guangdong Kaifull Electronics Technology Co., Ltd.

Version 1.1

http://www.kaifull-motor.com/

Contents

1. Functional Features

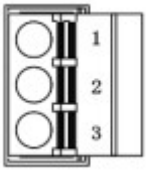
- Input power supply: DC24V~36V
- Output current (peak) of each axis motor: 0.4~3.0A
- Support control of up to 4 axes
- Suitable for open/closed-loop two-phase stepper motors
- EtherCAT communication control, supporting the control modes of PP, PV, HM, CSP
- Optoelectronic isolation input function
- Motor short circuit protection, undervoltage protection, overvoltage protection, and overcurrent protection functions

2 Technical Parameters

Driver model		Y2SD2-S80E-N4
Adaptive motor		Adapting to two-phase open/closed-loop incremental stepper motors, it can adapt to the current up to 3.0A (peak)
Power supply		DC12V~36V
Output current		0.4A~3.0A/phase (peak)
Drive mode		Full bridge bipolar PWM drive
Device initialization time		2s
Input signal	1 probe input	Optocoupler input voltage: H=24V, L=0-0.8V Conducting current 5~8mA
	3 general input signals	
Output signal	2 general output signals	Optoelectronic isolation output, maximum withstand voltage 30VDC, maximum saturation current 50mA
Dimensions		144×106×31 mm (excluding connectors)
Weight		Approximately 450g
Service environment	Scenario	Avoid dust, oil mist, and corrosive gases
	Humidity	<85%RH, without condensation
	Operating temperature	0°C~+40°C
	Storage temperature	-10°C~+75°C
	Heat dissipation	Installed in the ventilated environment

3 Schematic Diagrams and Interface Definitions

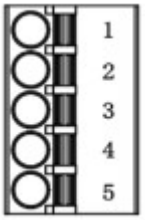
3.1 CN1 (Power Supply)

Terminal number	Diagram	Pin.	Signal name
CN1		1	Power supply V+DC12V~36V
		2	Power GND
		3	Ground FG

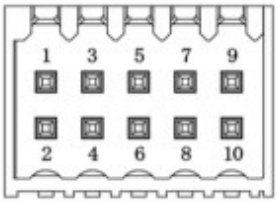
Pay attention to power polarity during wiring

Wire specification: AWG20~AWG16 (multi-strand wire)

3.2 CN2/CN5/CN8/CN11 (Axis 1/Axis 2/Axis 3/Axis 4 Motor Wiring)

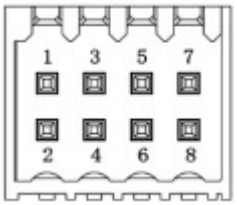
Terminal number	Diagram	Pin.	Signal name
CN2/CN5/CN8/CN11		1	Motor A+
		2	Motor A-
		3	Motor B+
		4	Motor B-
		5	NC

3.3 CN3/CN6/CN9/CN12 (Axis 1/Axis 2/Axis 3/Axis 4 Encoder Input)

Terminal number	Diagram	Pin	Signal name
CN3/CN6/CN9/CN12		1	FG
		2	FG
		3	+5V
		4	0V
		5	EZ+
		6	EZ-
		7	EB+
		8	EB-
		9	EA+
		10	EA-

***Note: The driver outputs 5V signal for the encoder, with a maximum current of 100mA**

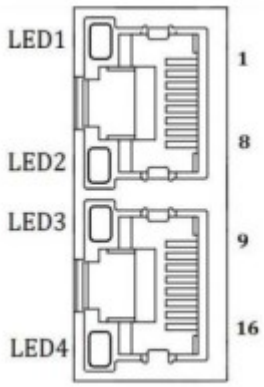
3.4 CN4/CN7/CN10/CN13 (Definitions of Axis 1/Axis 2/Axis 3/Axis 4 Input and Output Ports)

Terminal number	Diagram	Pin	Signal name	Description
CN4/CN7/CN10/CN13		1	COM_IN	Common terminal of single-end input signal; common cathode and common anode are compatible (24VDC)
		2	TP1	High-speed input port, maximum input frequency 100KHz
		3	COM_OUT	Output common-cathode common terminal (0V)
		4	IN1	General input port, valid at 18~24V, maximum input frequency 1KHz, signal definition configurable
		5	OUT1	Single-end output signal, common cathode connection method, maximum output current 50mA, maximum withstand voltage 30VDC. Output function configurable
		6	IN2	General input port, valid at 18~24V, maximum input frequency 1KHz, signal definition configurable
		7	BK	Band brake output, common cathode connection method, maximum output current 50mA, maximum withstand voltage 30VDC.
		8	IN3	General input port, valid at 18~24V, maximum input frequency 1KHz, signal definition configurable

3.5 CN14 MicroUSB B Debugging Interface

Note: The USB-to-MicroUSB B debugging cable should not exceed 2m

3.6 CN15 (OUT)/CN16 (IN) (EtherCAT Bus Interface)

Terminal number	Diagram	Pin	Signal name	Description
CN15/CN16		1,9	E_TX+	EtherCAT data transmission positive terminal
		2,10	E_TX-	EtherCAT data transmission negative terminal
		3,11	E_RX+	EtherCAT data receiving positive terminal
		4,12	-	-
		5,13	-	-
		6,14	E_RX-	EtherCAT data receiving negative terminal
		7,15	-	-
		8,16	-	-
		Connector shell	PE	Shield earthing

***Note: Description for definition of RJ45 network port lights**

LED identification	Name	Color	Status	Description
LED1	Link/Activity IN	Green	Off	Physical layer link is not established
			On	Physical layer link establishment
			Flash	Interactive data after link establishment
LED2	RUN	Green	Off	Initialization status
			Flash	Pre-operation status
			Single flash	Safe operation status
			On	Operation status
LED3	Link/Activity OUT	Green	Off	Physical layer link is not established
			On	Physical layer link establishment
			Flash	Interactive data after link establishment
LED4	ERR	Red	Off	No error
			Slow flash	Communication settings error
			Single flash	Synchronization error or communication data error
			Double flash	Watchdog request timeout
			Quick flashing	Guidance error
			On	Internal bus watchdog timeout

3.7 Address Allocation

The master allocates the address.

3.8 Indicator Lights

3.8.1 Status Indication

Status function	Communication code	Description
Stopping	2	Enable it, the motor phase will be locked but the motor will not run
Running	3	The driver is running
Enable disconnection	1	Enable disconnection, the motor can be free

3.8.2 Fault Indication

Alarm function	Communication code	Description
Motor overcurrent	10	Motor phase overcurrent or driver failure
Open phase of motor	11	Motor not connected
Overvoltage	14	Power input greater than 45V
Undervoltage	13	Power input less than 10V
Other alarm	Other	

4 Power Supply

4.1 Voltage

The chopped mode driver continuously changes the magnitude and direction of the motor winding terminal voltage while detecting the current to obtain accurate phase current. If both high efficiency and low noise are to be ensured, the supply voltage of the driver should be at least 5 times the rated phase voltage of the motor (i.e. the rated phase current of the motor multiplied by the phase resistance).

To make the motor provide better high-speed performance, you need to increase the supply voltage of the driver.

If a stabilized voltage supply is used, the supply voltage should not exceed 36V.

If a stabilized voltage supply is used, the voltage should not exceed 25V.

Because the rated current of a non-stabilized voltage supply is full-load current; when the load is light, e.g., the motor is not rotating, the actual voltage can reach 1.4 times the rated voltage of the power supply. If you want the motor to run smoothly and quietly, choose a low voltage.

4.2 Current

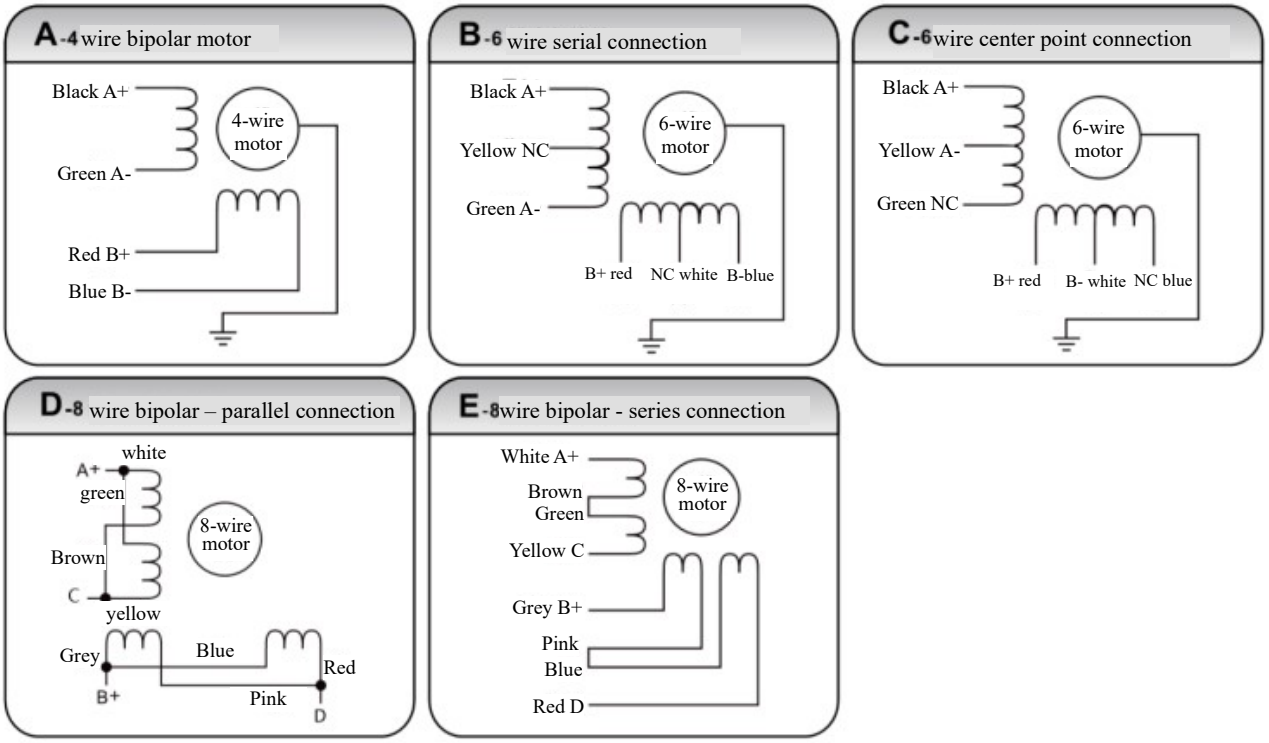
The maximum supply current should be the sum of the two-phase current. Generally, the current you need depends on the motor model, voltage, speed and load conditions. The actual power supply current value is significantly lower than this maximum current value because the driver uses a switching amplifier to convert high voltage and low current into low voltage and high current. The more the power supply voltage exceeds the motor voltage, the less supply current is required.

4.3 Regenerative Discharge

When the motor decelerates, it will convert the kinetic energy of the load into electrical energy like an electric generator. Some energy will be consumed by the driver and motor. If there is a large load running at high speed in your application, considerable kinetic energy will be converted into electrical energy. Usually, the simple linear power supply has a large capacitor to absorb the energy without causing damage to the system. The switching power supply will be turned off under overvoltage conditions, and the excess energy can be transmitted back to the driver, which may cause damage to the driver. Therefore, in this case, an external absorption resistor or capacitor should be connected.

5 Motor Connection

Warning: When connecting the motor to the driver, please confirm that the driver power has been turned off first. Confirm that the unused motor leads are not short-circuited to other objects. During the power-on period of the driver, the motor cannot be disconnected. Do not connect the motor leads to the ground or power supply.



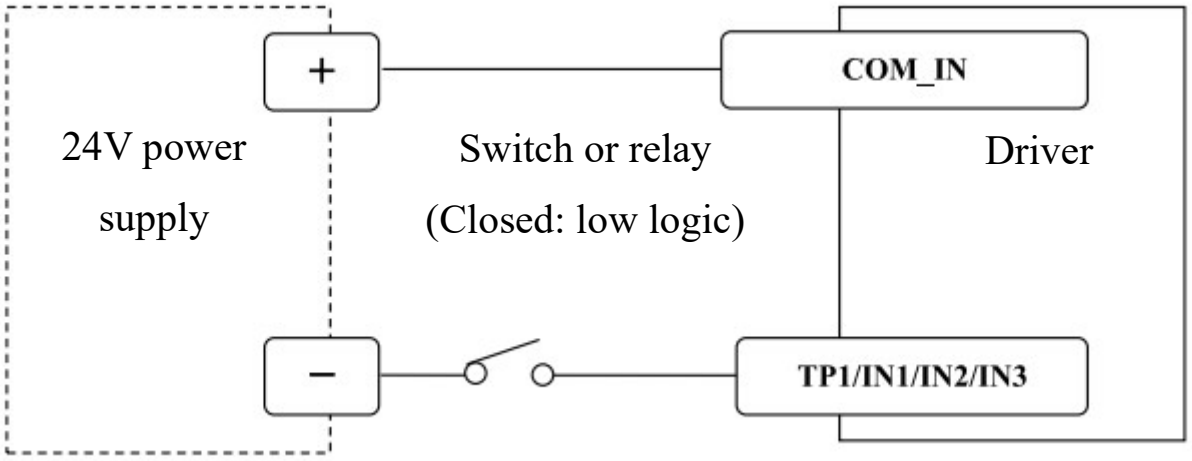
1) You can only use one method to connect the four-wire motor.
2) Six-wire motors can be connected in two methods: full set and half a set. In the full-set mode, the motor has a higher torque when operating at low speed, but not as fast as that in half-set mode. When operating in full set, the motor needs to operate at a current less than 30% of the current in the full-set connection mode to avoid overheating.
3) Eight-wire motors can be connected in two methods: series and parallel connection. The motor has a greater torque at the low speed and smaller torque at the high speed during the series connection mode. When operating in series, the motor needs to operate at a current which is equivalent to 50% of the current in the parallel connection mode to avoid overheating

Notes:

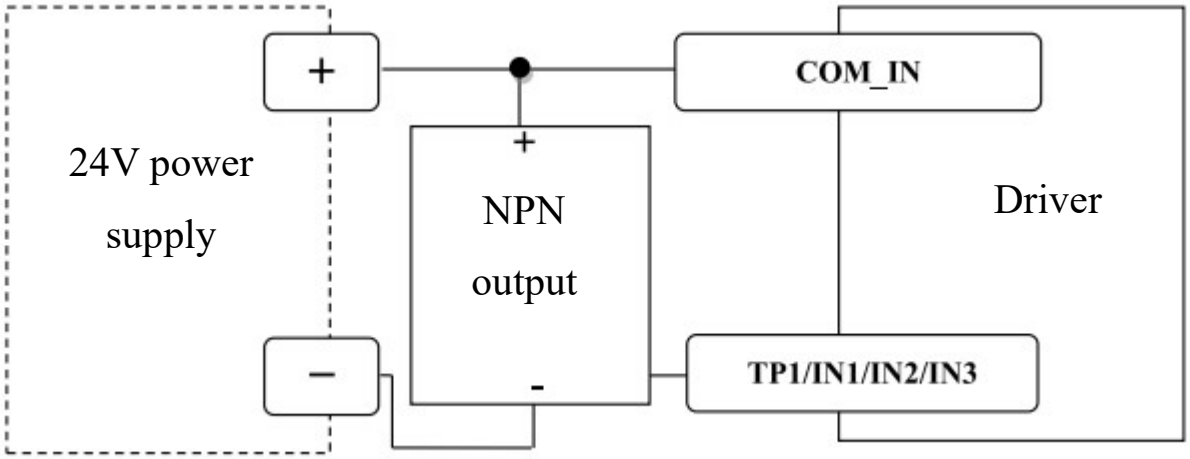
1) The color of different motor is different, which will be subject to the motor information during use.
2) The windings of different phases of the motor cannot be connected to the terminal of the same phase of the driver (A+ and A – are one phase, B+ and B – are the other phase). If the direction of rotation of the motor is different from the expected direction, only exchange the positions of A+ and A -.
3) The driver can only drive two-phase hybrid stepper motors and cannot drive three-phase and five-phase stepper motors.

6 Typical Connection Methods of Signals

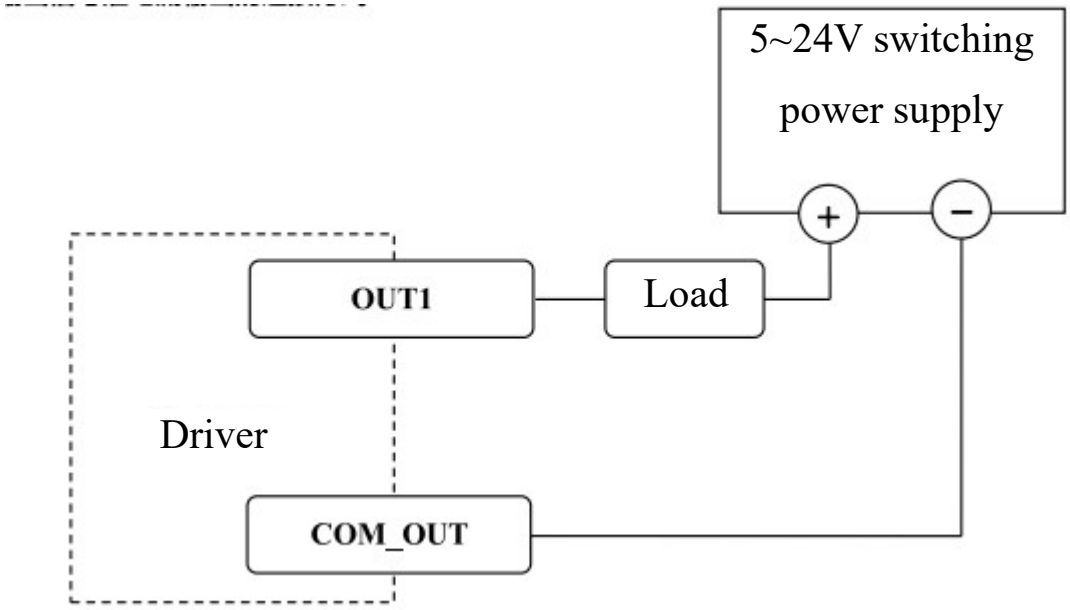
6.1 Connection Methods of Input Signal Using the Switch or Relay



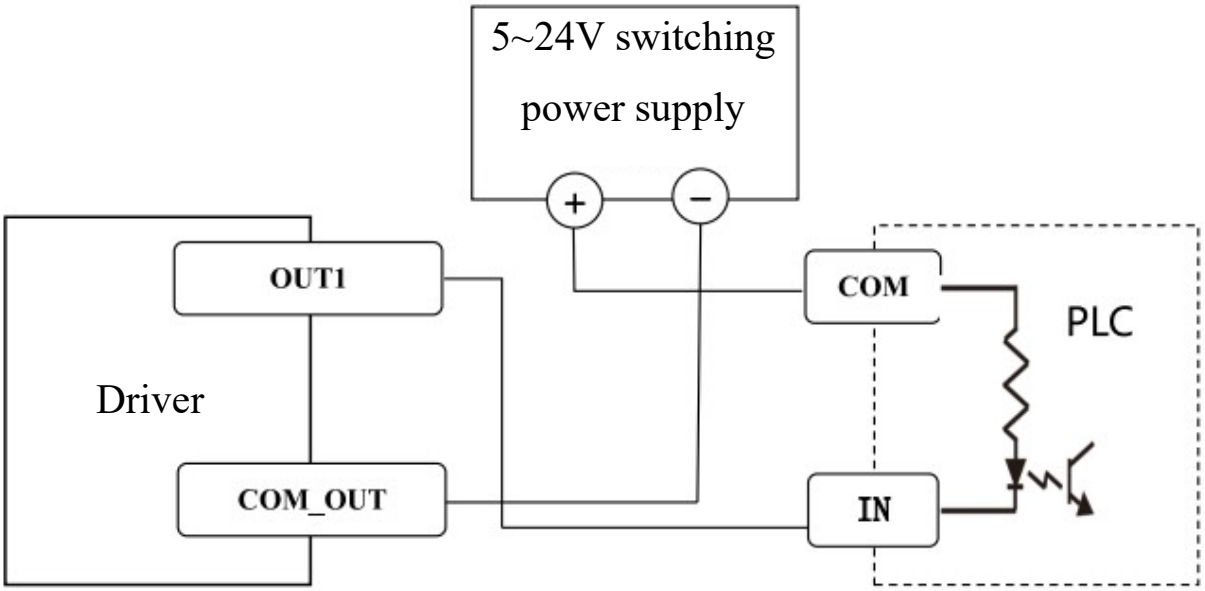
6.2 Connection between Input Signal and NPN Output



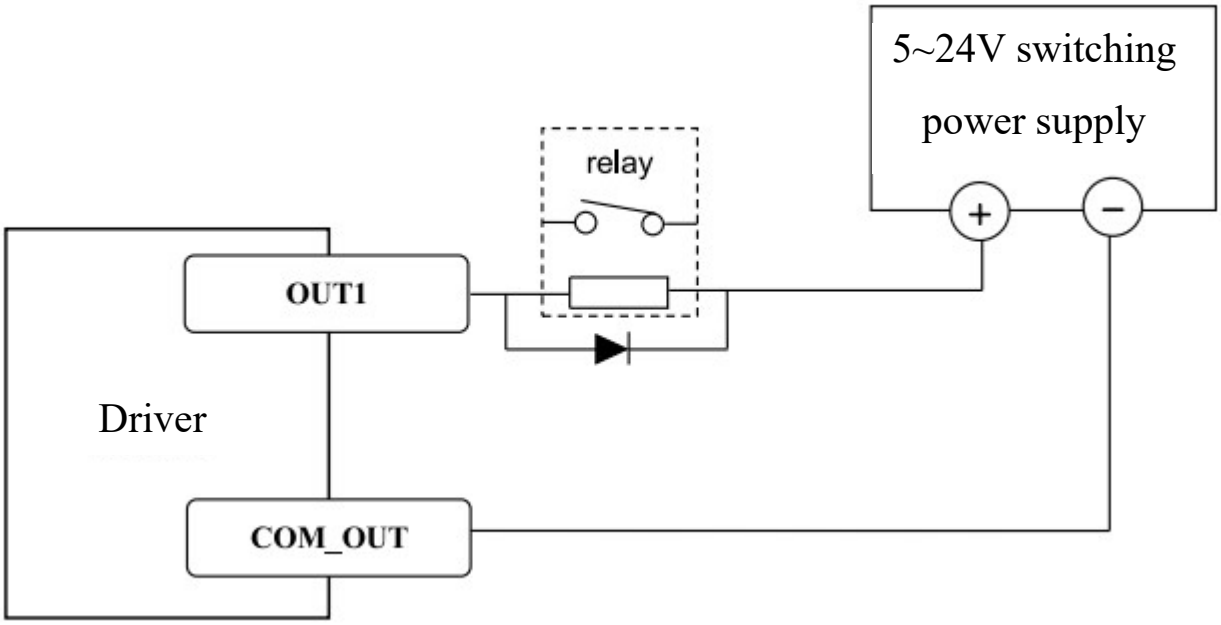
6.3 Connection Methods of Sinking Current Output of Output Signal



6.4 Connection Methods of Sinking Current Output of Output Signal and Connection of PLC Input



6.5 Connection between Output Signal and Relay



Warning: Do not connect the output end to a DC voltage above 30V, and the current flowing into the output end should not exceed 50mA

7 Wiring Requirements

1) To prevent interference with the driver, it is recommended to use shielded cables for control signals, and the shielding layer should be short circuited to the ground wire. Unless otherwise specified, the shielded wire of the control signal cable should be grounded at one end: the upper computer end of the shielded wire should be grounded, and the driver end of the shielded wire should be suspended. Grounding is only allowed at the same point within the same machine. If it is not a true grounding wire, it may cause serious interference, and the shielding layer is not connected at this time.

2)

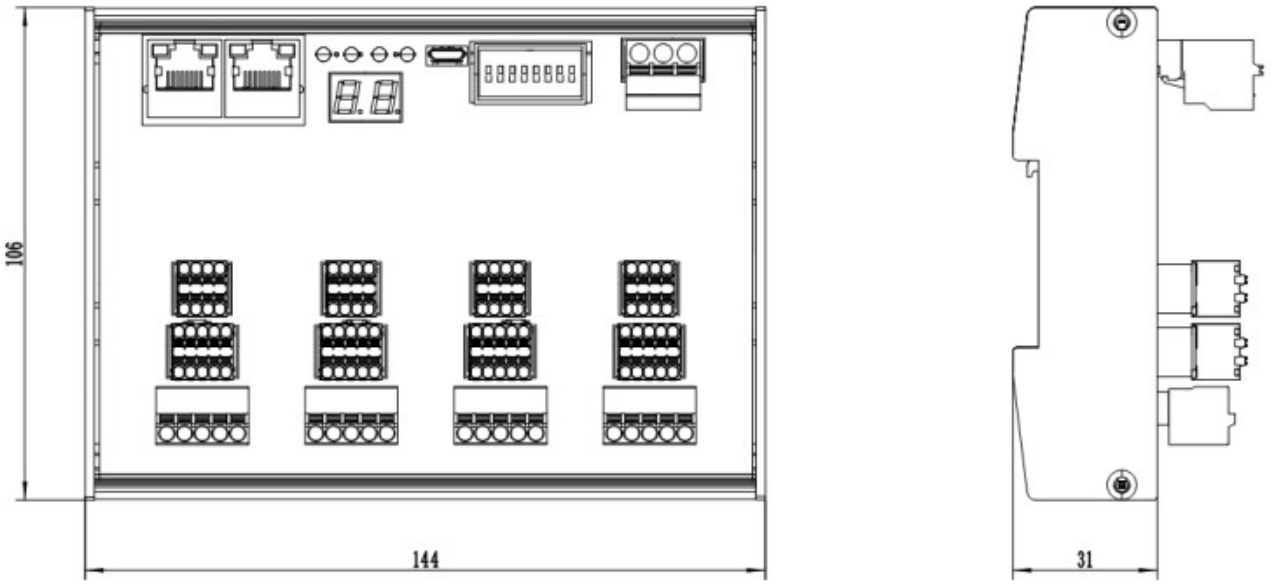
3) If a power supply supplies multiple drivers, parallel connection should be adopted at the power supply, and chain connection from one to another is not allowed.

4) It is strictly prohibited to plug and unplug the strong electric (motor and power) terminals of the driver with electricity. When the charged motor stops, there is still a large current flowing through the coil. You may cause a huge instantaneous induced electric potential to burn out the driver by plugging and unplugging the strong electric (motor and power) terminals.

5) It is strictly prohibited to solder the wire head and connect it to the wiring terminal. Otherwise, it may overheat and damage the terminal due to increased contact resistance.

6) The wiring terminal should not be exposed outside the terminal to prevent accidental short circuit and damage to the driver.

8 Installation Dimensions: (in mm)



Driver installation

Install with narrow edges and M4 screws through the holes on both sides. The power components of the driver will generate heat. If it operates continuously under high input voltage and high power conditions, the effective heat dissipation area should be expanded or forced cooling should be applied.

Do not use it in areas with poor air circulation or environments with temperatures exceeding 40℃; do not install the driver at a damp place or at a place with scrap metal.

9 Parameter Description and Settings

9.1 SDO Parameter List

The bus type closed-loop stepper driver is a standard EtherCAT slave device, which complies with the EtherCAT standard protocol, and can communicate with the standard master stations that support this protocol. The PC software interacts with the driver using the MODBUS protocol. The PC software can modify/read all parameters and alarm information of the driver, and control the driver for trial operation.

9.1.1 Configuration Parameters

The configuration parameter address consists of the base address and the axis number.
The starting number of each axis of the configuration parameters is calculated using the following formula.
Configuration parameter address=0x2000+(axis number -1) x 0x200

Axis number	Address
Axis 1	2000~21FF
Axis 2	2200~23FF
Axis 3	2400~25FF
Axis 4	2600~27FF

The following takes Axis 1 as an example:

Object Dictionary	Name	Attribute	Word	Range	Default value	Unit	Remark
2064	Rated current display	RO	1	0~65535	--		
2065	Bus voltage	RO	1	0~65535	--		
206C	Error code	RO	1	0~65535	--		
206D	Running status	RO	1	0~65535	--		
206E	Hardware version	RO	1	0~65535	--		
206F	Software version	RO	1	0~65535	--		
20C9	Rotation direction	RW	1	0~3	0		Select the motor running direction bit0=0: The running direction is not changed; bit0=1: The running direction is changed.
20CE	Control command	RW	1	0~5	0		
20D5	Idle current	RW	1	10~120	50		The stop current is a percentage of the running current.
20D9	Motor mode setting	RW	1	0~2	0		0: Open loop; 1: Closed loop.
20E0	Filter coefficient	RW	1	0~500	50		The lower the value, the smoother the motor runs, the higher the delay.
20F1	Current Setting	RW	1	0~3000	1000	0.1%A	
20F2	Resolution setting	RW	2	200~102400	10000	ppr	
20F5	Idle current time	RW	1	1~30000	200	ms	The delay time (ms) for the motor to enter the half-current state after it stops running.
20F6	Encoder resolution	RW	1	200~65535	4000		Resolution=the number of encoder lines x 4.
20F7	In-place range	RW	1	1~1000	5		
2102	Position out-of-tolerance threshold	RW	1	1~30000	1000		The value of position out-of-tolerance threshold is encoder resolution.

213D	Positive limit	RW	2	-2,000,000,000 ~2,000,000,000	2,000,000,000	pulse	
213F	Negative limit	RW	2	-2,000,000,000 ~2,000,000,000	-2,000,000,000	pulse	
2144	Memory control switch	RW	1	0~65535	0		bit0: Enable forward soft limit function. bit1: Enable reverse soft limit function.
2190	IN1 function selection	RW	1	0~23	0		
2191	IN2 function selection	RW	1	0~23	0		
2192	IN3 function selection	RW	1	0~23	0		
21A4	OUT1 function selection	RW	1	100~109	101		
21A5	OUT2 function selection	RW	1	100~109	101		
21AD	Input port logic	RW	1	0~65535	RW		
21AE	Output port logic	RW	1	0~256	RW		

9.1.2 Motion Parameters

The motion parameter address consists of the base address and the axis number.
The starting number of each axis of the motion parameters is calculated using the following formula.
Motion parameter address=0x6000+(axis number -1) x 0x800

Axis number	Address
Axis 1	6000~67FF
Axis 2	6800~6FFF
Axis 1	7000~77FF
Axis 2	7800~7FFF

The following takes Axis 1 as an example:

Object dictionary	Name	Attribute	Word	Range	Default value	Unit	Remark
603F	Error register	R	1	0~65535	0	--	
6040	Control word	R/W	1	0~65535	0	--	
6041	Status word	R	1	0~65535	0	--	
6060	Operation Mode	R/W	1	0-255	1	--	1-PP, 3-PV, 4-TQ, 6-HOME, 8-CSV, 9-CSV,
6061	Operation mode display	R	1	0-255	0	--	
6064	Actual position	R	2	-2147483647~2147483647	0	pulse	
606C	Actual speed	R	2	-2147483647~2147483647	0	0.01rps	
607A	Target position	R/W	2	-2147483647~2147483647	0	pulse	pp mode 1 target position instruction
607C	Origin offset	R/W	2	-2147483647~2147483647	0	pulse	
6081	Trapezoidal speed	R/W	2	1~5000	100	0.01rps	pp mode 1 maximum speed
6083	Acceleration	R/W	2	1~5000	50	rps^2	pp, PV mode 1, 3 acceleration
6084	Deceleration	R/W	2	1~5000	50	rps^2	pp, PV mode 1, 3 deceleration
6098	Origin method	R/W	1	0~100	21	-	
6099+1	Origin approach velocity	R/W	2	1~5000	200	0.01rps	
6099+2	Home position creep speed	R/W	2	1~5000	100	0.01rps	
609A	Acceleration and deceleration of returning to zero	R/W	2	5~10000	50	rps^2	
60B8	Probe control word	R/W	1	0~65535	0	None	Set probe function
60B9	Probe status word	R	1	0~65535	0	None	Probe action status
60BA	Probe data 1	R	2	-2147483647~2147483647	0	P	Probe1 rising edge capture data
60BB	Probe data 2	R	2	-2147483647~2147483647	0	P	Probe1 falling edge capture data
60FD	Input port status	R	2	0~4294967296	0	--	Bit0:: Negative limit Bit1: Positive

							limit bit2: Origin; bit16~18: Corresponding to IN1-IN3 status
60FE+1	General output	R/W	2	0~4294967296	0	--	
60FE+2	Matching bit	R/W	2	0~4294967296	0	--	
60FF	Target speed	R/W	0	-5000~5000	0	--	CSV mode target speed

10 Common Functions

10.1 Control Words and Operation Mode

In synchronous motion mode, the master station performs trajectory planning and outputs cycle instructions. The driver receives the planning instructions from the master station according to the synchronization cycle, making it suitable for multi-axis synchronous motion. The synchronous motion mode of the product supports cyclic synchronous position mode (CSP). In the cyclic synchronous position mode (CSP), trajectory planning is completed at the master station. The product receives the position information sent by the master station based on the synchronization cycle, and the position information is immediately transmitted to the driver when the synchronization signal arrives. The product supports the synchronization cycles of 1000us, 2000us, 4000us.

The master station is only responsible for sending motion parameters and control commands; after receiving the motion start command from the master station, the closed-loop stepper driver of this product will perform trajectory planning according to the motion parameters sent by the master station; in non-synchronous motion mode, the motion between each motor axis is asynchronous. The asynchronous motion modes of the product include Protocol Position Mode (PP), Protocol Velocity Mode (PV), and Home Mode (HM).

No matter in which control mode, the data exchange between EtherCAT bus master and slave stations is achieved through the object dictionary. There are two data transmission modes of PDO and SDO, and generally only one can be chosen. According to the real-time requirements and importance of data transmission, it can be divided into three levels based on the control needs: must > recommend > can. "Must" means that in this mode, the corresponding object dictionary must be configured as PDO transmission mode. "Recommend" means that in this mode, the corresponding object dictionary is recommended to be configured as PDO transmission mode to ensure real-time data and obtain better control requirements; if the control requirements are not high, data transmission can also be carried out through SDO communication. "Can" means that in this mode, the corresponding object dictionary generally transmits data through SDO communication and does not need to be configured as PDO. The object dictionaries associated with each control mode are shown in the table below.

Object dictionary associated with each control mode

Control Mode	Index + Sub-index	Name	Data type	Access type	Unit	PDO configuration	SDO communication
CSP mode (8)	6040-00h	Control word	U16	RW	—	Must	-
	607A-00h	Target position	I32	RW	pulse	Must	-
	6041-00h	Status word	U16	RO	—	Must	-
	6064-00h	Actual position	I32	RO	pulse	Must	-
	606C-00h	Actual speed	I32	RO	0.01rps	Can	Can
pp mode (1)	607A-00h	Target position	I32	RW	pulse	Recommended	Can
	6081-00h	Maximum speed	U32	RW	0.01rps	Can	Can
Shared by PV mode (3), PP mode (1) and PV mode (3)	6040-00h	Control word	U16	RW	—	Recommended	Can
	6083-00h	Acceleration	I32	RW	rps^2	Can	Can
	6084-00h	Deceleration	U32	RW	rps^2	Can	Can
HOME mode (6)	6040-00h	Control word	U16	RW	—	Recommended	Can
	6098-00h	Zeroing method	18	RW	—	Can	Can
	6099-01h	Home position fast	U32	RW	0.01rps	Can	Can
	6099-02h	Home position slow	U32	RW	0.01rps	Can	Can
	609A-00h	Home position acceleration	U32	RW	rps^2	Can	Can
	607C-00h	Home position offset	U32	RW	pulse	Can	Can
Shared by PP, PV and HOME modes	6041-00h	Status word	U16	RO	—	Recommended	Can
	6064-00h	Actual position	I32	RO	pulse	Recommended	Can
	606C-00h	Actual speed	I32	RO	0.01rps	Can	Can
Shared by all modes	60B8-00h	Probe function	U16	RW	—	Recommended	Can
	60B9-00h	Probe status	U16	RO	—	Recommended	Can
	60BA-00h	Probe 1 captured value	I32	RO	P	Can	Can
	60FD-00h	Digital input	U32	RO	—	Recommended	Can
	603F-00h	Latest error code	U16	RO	P	Recommended	Can
Other associated parameters	6060-00h	Operation Mode	I8	RW	—	Can	Can
	60B0-00h	Position offset	I32	RW	—	Can	Can

	6082-00h	Jump speed	U32	RW	0.01rps	Can	Can
	6085-00h	Emergency stop deceleration	U32	RW	rps^2	Can	Can
	6061-00h	Operation mode display	I8	RO	—	Can	Can

No matter which control mode is used to implement drive control of the actuator, it cannot be separated from the reading and writing of the two object dictionaries of control word 6040h and status word 6041h. The master and slave stations use these two object dictionaries as media to issue instructions and monitor the status. The following focuses on the definitions of each bit in these two object dictionaries.

The definition of the control word (6040h) is shown in the table below. The left half of the table describes bit4~6 and bit8, their meanings depend on the operating mode and they mainly control the operation execution or stopping of each mode; the right half of the table describes bit0~3 and bit7, which together manage the state transition changes of the 402 state machine to meet complex and diverse control requirements. The definition of the status word (6041h) is shown in the definition table of the status word (6041h) bits. Bit0~bit7 mainly displays the transition state of the 402 state machine, while bit8~bit15 mainly displays the motion execution or stop status in various control modes.

The enabled typical state transitions are as follows:

Initial (00h) - Power on (06h) - Start (07h) - Enable (0fh) - Execute running or pause (depending on the operating mode, issue relevant control instructions in combination with bit4~6 and bit8). The state transitions that trigger the operational control in each control mode are shown in the state transition table for control operation of each mode.

Definitions of control word (6040h) bits												
Mode/Bit	**15~9**	**8**	**6**	**5**	**4**	**7**	**3**	**2**	**1**	**0**	**Typical value**	**Action result**
Shared	-	Pause	Depending on the operating mode			Error reset	Operation	Quick stop	Voltage output	Start		
CSP mode 8	-	Invalid	Invalid	Invalid	Invalid	0	0(x)	1	1	0	06h	Powered on
PP mode 1	-	Slow down and stop	Absolute/ Relative	Immediately trigger	New location point	0	0	1	1	1	07h	Start
PV mode 3	-	Slow down and stop	Invalid	Invalid	Invalid	0	0(x)	0	1	0(x)	02h	Quick stop
HM mode 6	-	Slow down and stop	Invalid	Invalid	Start movement	0	1	1	1	1	0fh	Enabling
None						1	0(x)	0(x)	0(x)	0(x)	80h	Clear errors
None						0	0	0	0	0	0	Initial

Additional description for other bits:

Bit 2 quick stop trigger is valid when logic is 0; please distinguish it from other triggered logic areas.

Bit 7 error reset trigger selection is the rising edge is valid.

Bit 5 immediate trigger logic is the rising edge is valid.

Definition of status word (6041h) bit								
Mode/Low 8 bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Shared	hold	Not started	Quick stop	Power on	Error	Allow operation	Start	Ready to start
Mode/High 8 bits	**15**	**14**	**13**	**12**	**10**	**8**	**11**	**9**
Shared	Depending on the operating mode						Limit is valid	Remote
CSP mode 8	Invalid	Invalid	Invalid	Following is valid	Invalid	Abnormal stop	It will be set when hardware limit is valid	0 below PreOP
PP mode 1	Can trigger the response	The parameter has 0	Invalid	New location point response	The position reached	Abnormal stop		
PV mode 3	Invalid	The parameter has 0	Invalid	The speed is 0	The speed reached	Quick stop		
HM mode 6	Can trigger the	The parameter	Origin error	Origin completed	The position	Abnormal stop		

	response	has 0			reached			

Additional description for other bits:
When the drive is powered on, Bit 4 will be set.
Bit 5 quick stop activation is valid when logic is 0, which is opposite to the logic of other bits.
Bit 9 remote displays the status of the communication state machine, which is 0 below ProOP. At this time, the command of the control word (6040h) cannot be executed.
Bit 11 limit is set only when the hardware limit is valid.
Bit 8 abnormal stop is generally valid when the hardware limit, slow-down and stop, and fast stop are triggered.
Bit 12 following the master station is set to 0 when in CSP, the driver is not enabled or no longer follows the master station's instructions.

State transition of control operation of each mode										
	Step	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Mode	Action	Preparatory work	Initial	Powered on	Start	Enabling	Start operation	Displacement	Stop	Fault
CSP mode 8	6040	Establish communication OP status and activate the NC axis	00h	06h	07h	0fh	1fh master station sends instructions	Master station control	Master station stop position command	-
	6041		250h	231h	233h	1237h	1237h	1237h	1237h	238h
PP mode 1	6040	Establish communication OP status and set the motion parameters	00h	06h	07h	0fh	-	2fh->3fh	10fh	-
	6041		250h	231h	233h	8237h	1237h	1637h->1237h	1737h	1238h
PV mode 3	6040	Establish OP status and set the motion parameters	00h	06h	07h	0fh	Run immediately after enabled	Change the speed	10fh	-
	6041		250h	231h	233h	1637h	1637h	1637h	1737h	1638h
HM mode 6	6040	Establish OP status and set the motion parameters	00h	06h	07h	0fh	1fh	Invalid	10fh	-
	6041		250h	231h	233h	8337h	237h	237h	737h	238h

Additional description for other bits:
When the position in PP mode is changed, the rising edge should be given to the bit5 of the control word in order to start a new position motion.

10.2 Probe Capture Function

The probe function is to use the input signals with probe function to capture the actual position of the motor and record it. The driver has two input IO signals to support the probe function and they can be enabled simultaneously. The object dictionary related to the probe functions is shown in the table below.

Object dictionary related to probe function						
Object Dictionary	**Meaning of bit or object dictionary**					
60B8h	7~6	5	4	3~2	1	0
	-	Probe 1 falling edge trigger	Probe 1 rising edge trigger	-	Probe 1 mode	Probe 1 enable
	15~14	13	12	11-10	9	8
	-	Probe 2 falling edge trigger	Probe 2 rising edge trigger	-	Probe 2 mode	Probe 2 enable
60B9h	7	6	5~3	2	1	0
	Actual level of Probe 2	Actual level of Probe 1		Probe 1 falling edge trigger completed	Probe 1 rising edge trigger completed	Probe 1 in action
	15~11			10	9	8
	-			Probe 2 falling edge trigger completed	Probe 2 rising edge trigger completed	Probe 2 in action
60BAh	**Probe 1 rising edge capture data value register**					
60BBh	**Probe 1 falling edge capture data value register**					
60BCh	**Probe 2 rising edge capture data value register**					
60BDh	**Probe 2 falling edge capture data value register**					
60FDh	**The status of bit26 is AND logic of bit1 and bit2 of 60B9, and the status of bit27 is AND logic of bit9 and bit10 of 60B9**					
2152h	**Its sub-indexes 01h and 02h can be written to 17 or 18 to be configured as functions of Probe 1 or Probe 2**					

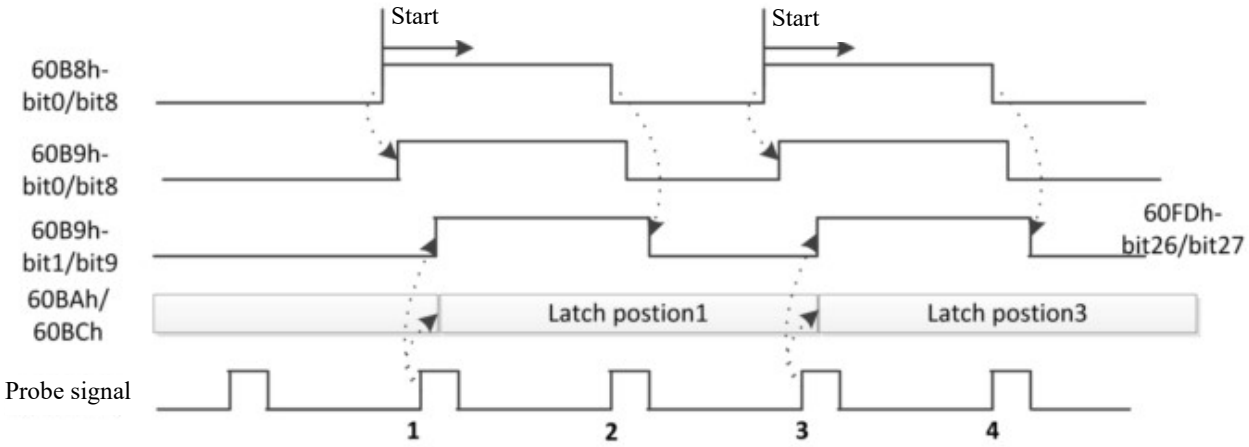
Additional description for other bits:

Bit0 and bit8 of 60B8h are the enable and stop control bit for Probe 1 and Probe 2, respectively, and the rising edge is valid.

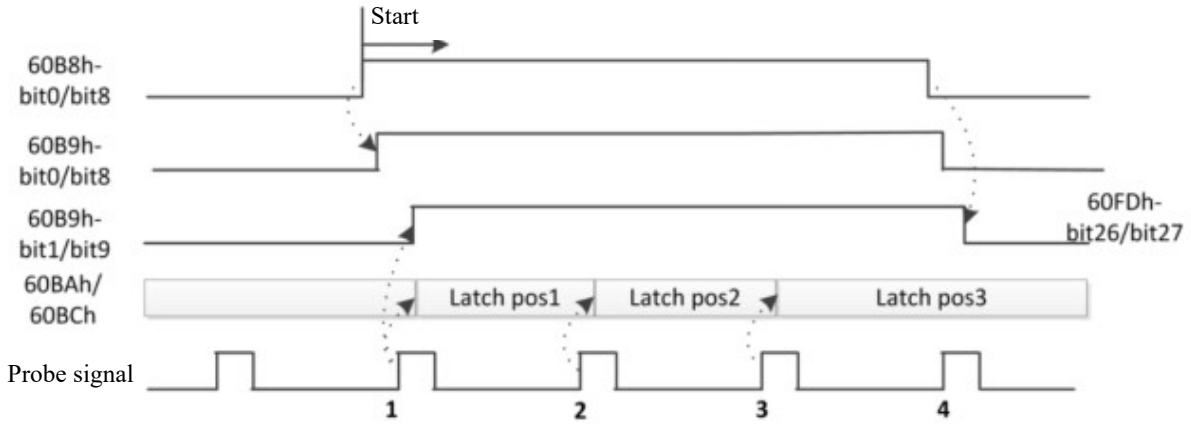
Bit1 and bit9 of 60B8h: The probe mode is single mode and continuous mode respectively

Single mode: After the probe is started, it only captures under the first trigger signal. In order to capture the new position value again, a rising edge signal must be given to bit0/bit8 of the 60B8 object to restart the probe action.

Continuous mode: After the probe is started, it performs capture action is performed under each trigger signal.



Single-mode rising edge trigger situation



Continuous-mode rising edge trigger situation

10.3 Encoder Resolution

The encoder resolution of this driver is 10000, and it matches the 2500-wire encoder motor by default. If the user uses a 5000-wire encoder motor, the encoder resolution needs to be changed to 20000 (4 times the frequency).

The encoder resolution can be set through the object dictionary of the master station PLC, which is 0x20F6. It can also be set through the debugging software of upper computer, as shown below:

Object Dictionary	Name	Attribute	Word	Range	Default value	Unit	Remark
20F6	Encoder resolution	RW	1	200~4096	4000		Resolution=the number of encoder lines x 4.

10.4 Output Peak Current

If it matches the motors of the base of 42 and below, before connecting the motor for the first time, be sure to modify the peak output current of the driver to prevent from burning the motor due to excessive output current.

The peak output current can be modified by setting the object dictionary of the master station PLC, which is 0x20F1. It can also be modified through the debugging software of the upper computer, as shown below

Object Dictionary	Name	Attribute	Word	Range	Default value	Unit	Remark
20F1	Current Setting	RW	1	0~3000	1000	0.1%A	

10.5 603F Fault Codes

Fault description

603F object	Meaning
0x2211	Overcurrent fault
0x7120	Motor open circuit
0x3220	Undervoltage
0x3210	Overvoltage
0x8611	Error of too large position error
0xFF23	Emergency stop
0xFF19	Position following error
0xFF18	Motor overspeed
0xFF32	Communication is unstable

Appendix 1: Methods of Returning to Home Position

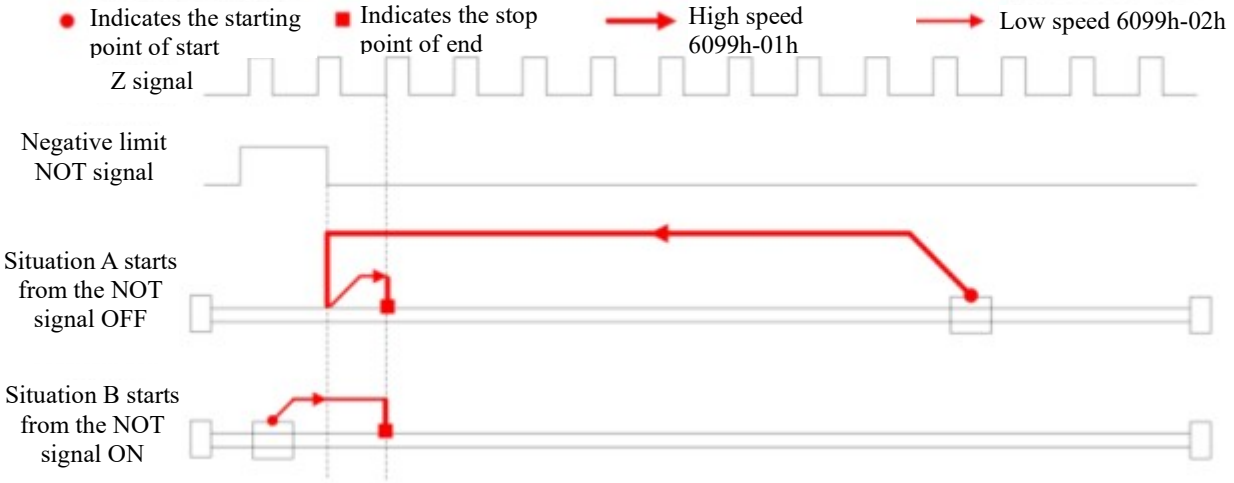
This drive product supports the method of Z signal returning to the home position 1~14, 17~34, 35. The specific definitions and process of returning to the home position are described below.

Method 1:

If the negative limit is invalid, the motor will make home-position high-speed movement in the negative direction until the negative limit switch signal is valid, the motor will stop and start the home-position low-speed movement in the positive direction. It will stop movement when the first encoder Z signal is valid after leaving the negative limit switch, as shown in Figure A.

If the motor already stops at the negative limit position when it starts the home-position movement, the motor will make home-position low-speed movement in the positive direction and stop when the first encoder Z signal is valid after leaving the negative limit switch.

If the positive limit signal is valid during the movement, Bit 13 of the status word (6041h) will be valid, indicating an error in the home-position movement, and the motor will immediately stop.



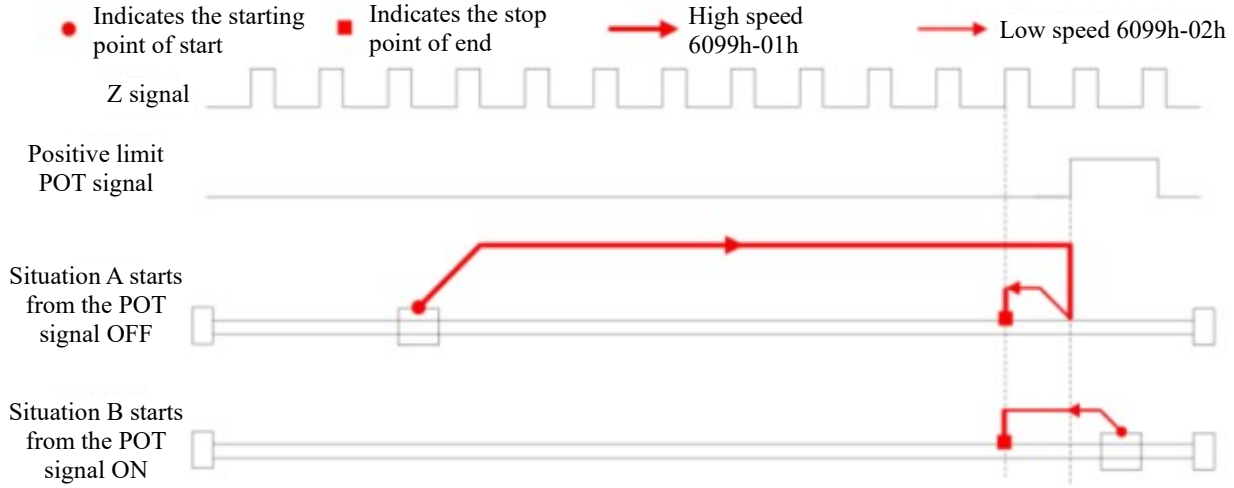
Method 1 Diagram

Method 2:

If the positive limit is invalid, the motor will make home-position high-speed movement in the positive direction until the positive limit switch signal is valid, the motor will stop and start the home-position low-speed movement in the negative direction. It will stop movement when the first encoder Z signal is valid after leaving the negative limit switch, as shown in Figure A.

If the motor already stops at the positive limit position when it starts the home-position movement, the motor will make home-position low-speed movement in the negative direction and stop when the first Z signal is valid after leaving the positive limit switch.

If the negative limit signal is valid during the movement, Bit 13 of the status word (6041h) will be valid, indicating an error in the home position movement, and the motor will immediately stop.



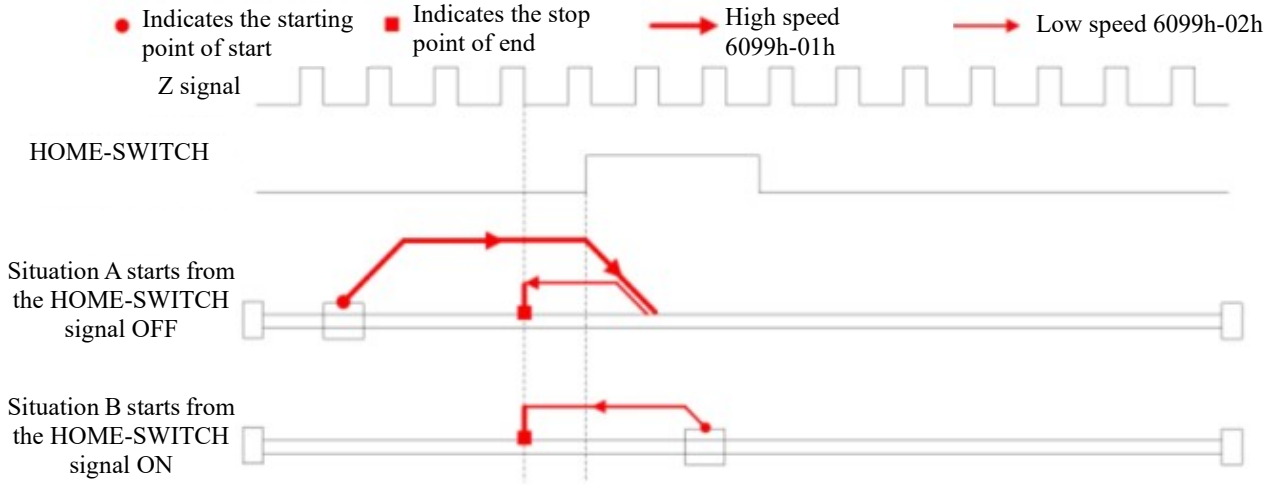
Method 2 Diagram

Method 3:

If the home position signal is invalid, the motor will make home-position high-speed movement in the positive direction until the home position signal is valid, the motor will stop and start the home-position low-speed movement in the negative direction. It will stop movement when the first encoder Z signal is valid after leaving the home position switch, as shown in Situation A in the figure.

If the motor already stops at the home position signal switch position when it starts the home-position movement, the motor will make home-position low-speed movement in the negative direction and stop when the first Z signal is valid after leaving the home position switch.

If the limit signal is valid during the movement, Bit 13 of the status word (6041h) will be valid, indicating an error in the home position movement, and the motor will immediately stop.



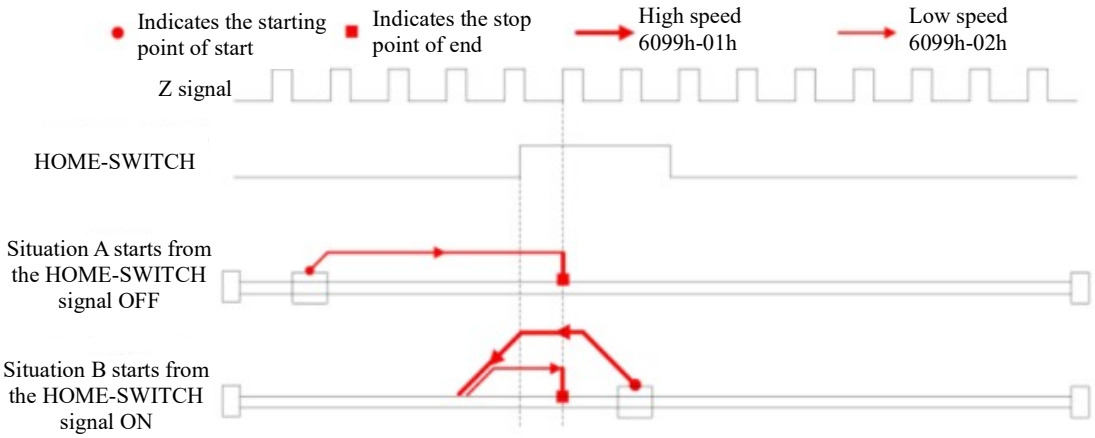
Method 3 Diagram

Method 4:

If the home position signal is invalid, the motor will make home-position low-speed movement in the positive direction, and stop when the first encoder Z signal is valid after the home position signal is valid, as shown in Figure 7-4.

If the motor already stops at the home-position signal switch position when it starts the home-position movement, the motor will make the home-position high-speed movement in the negative direction, and when the home position signal is invalid, the motor will slow down and stop, make the home-position low-speed movement in the positive direction, and stop the movement when the first encoder Z signal is valid after the home position signal is valid, as shown in Situation B in the figure.

If the limit signal is valid during the movement, Bit 13 of the status word (6041h) will be valid, indicating an error in the home position movement, and the motor will immediately stop.



Method 4 Diagram

Method 5:

If the home position signal is invalid, the motor will make home-position high-speed movement in the negative direction until the home position signal is valid, the motor will slow down and stop and then start the home-position low-speed movement in the positive direction. It will stop movement when the first encoder Z signal is valid after leaving the home position signal switch, as shown in Situation A in the figure.

If the motor already stops at the home position signal switch position when it starts the home-position movement, the motor will make home-position low-speed movement in the positive direction and stop when the first Z signal is valid after leaving the home position signal switch, as shown in Situation B in the figure.
If the limit signal is valid during the movement, Bit 13 of the status word (6041h) will be valid, indicating an error in the home position movement, and the motor will immediately stop.

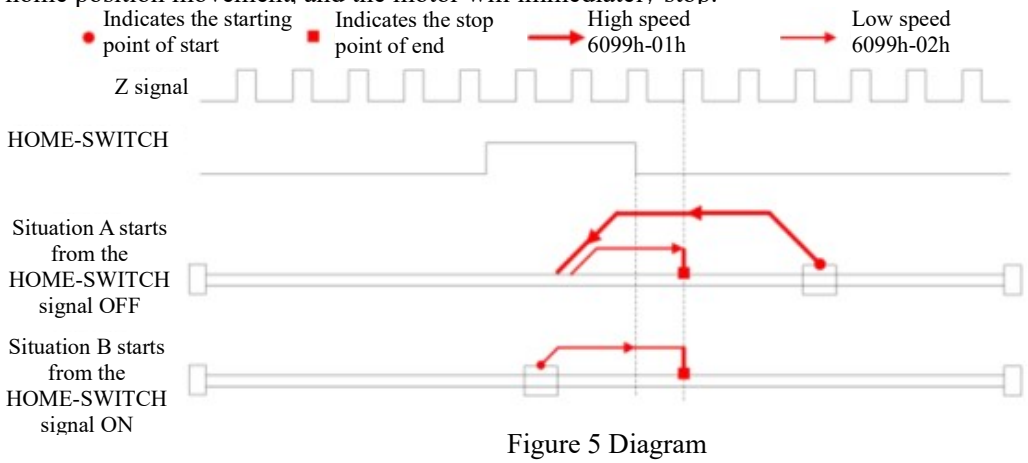
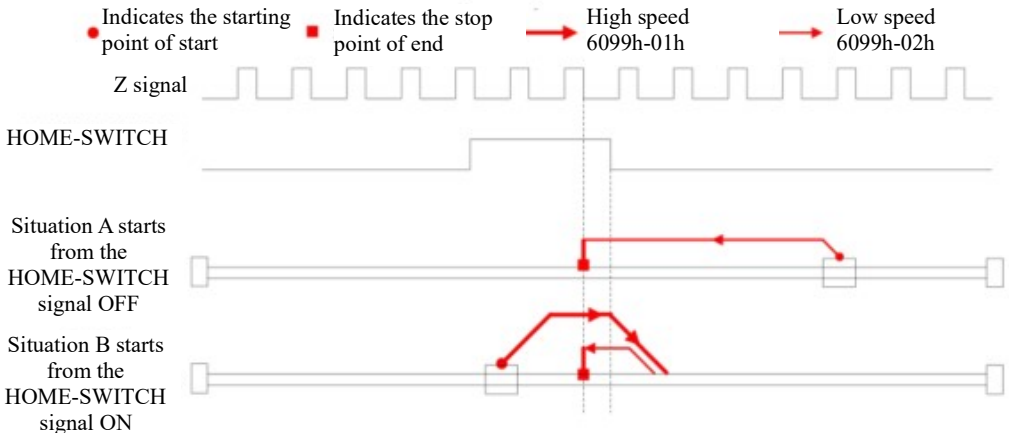


Figure 5 Diagram

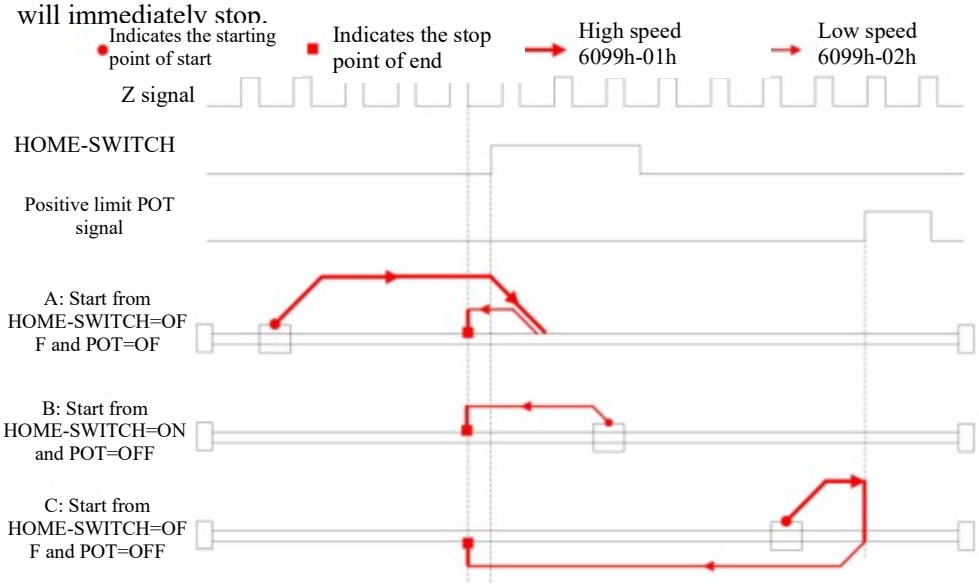
Method 6:
If the home position signal is invalid, the motor will make home-position low-speed movement in the negative direction, and stop movement when the first encoder Z signal is valid after the home position signal is valid, as shown in Situation A in the figure.
If the motor already stops at the home-position signal switch position when it starts the home-position movement, the motor will make home-position high-speed movement in positive direction, and when leaving the home-position signal switch, it will slow down and stop, then make the home-position low-speed movement in the negative direction, and stop until the first Z signal is valid when the home-position signal is valid, as shown in Situation B in the figure.
If the limit signal is valid during the movement, Bit 13 of the status word (6041h) will be valid, indicating an error in the home position movement, and the motor will immediately stop.



Method 6 Diagram

Method 7:
If both the home position signal and the positive limit signal are invalid, the motor will make home-position high-speed movement in the positive direction until the home position signal is valid, the motor will slow down, stop and make the home-position low-speed movement in the negative direction. It will stop movement when the first encoder Z signal is valid after leaving the home position signal switch, as shown in Situation A in the figure.
If the positive limit is invalid, and the motor already stops at the home position signal switch position when it starts the home-position movement, the motor will make home-position low-speed movement in the negative direction and stop when the first Z signal is valid after leaving the home position signal switch, as shown in Situation B in the figure.
If both the home position signal and the positive limit signal are invalid, the motor will make home-position high-speed movement in the positive direction until the positive limit signal is valid, the motor will stop and make the home-position low-speed movement in the negative direction. When the home-position signal is valid, the motor will continue to move, and will stop movement when the first encoder Z signal is valid after leaving the home

position signal switch, as shown in Situation C in the figure. If the negative limit signal is valid during the movement, Bit 13 of the status word (6041h) will be valid, indicating an error in the home position movement, and the motor will immediately stop.



Method 7 Diagram

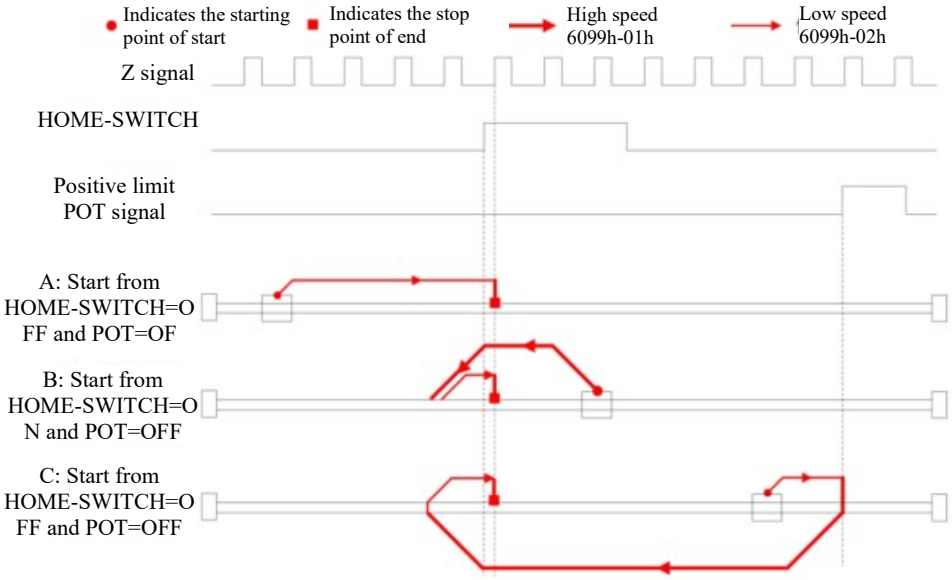
Method 8:

If both the home position signal and the positive limit signal are invalid, the motor will make home-position low-speed movement in the positive direction, and stop movement when the first encoder Z signal is valid after the home position signal is valid, as shown in Situation A in the figure.

If the positive limit is invalid an the motor already stops at the home-position signal switch position when it starts the home-position movement, the motor will make home-position high-speed movement in negative direction, and after leaving the home-position signal switch, it will slow down and stop, then make the home-position low-speed movement in the positive direction, and stop until the first Z signal is valid when the home-position signal is valid, as shown in Situation B in the figure.

If both the home position signal and the positive limit signal are invalid, the motor will make home-position low-speed movement in the positive direction until the positive limit signal is valid, the motor will stop and make the home-position high-speed movement in the negative direction. When the home-position signal is valid, the motor will continue to move, and after leaving he home-position signal switch, the motor will slow down, stop, then make the home-position low-speed movement in the positive direction, and stop the movement when the first encoder Z signal is valid after the home-position signal is valid, as shown in Situation C in the figure.

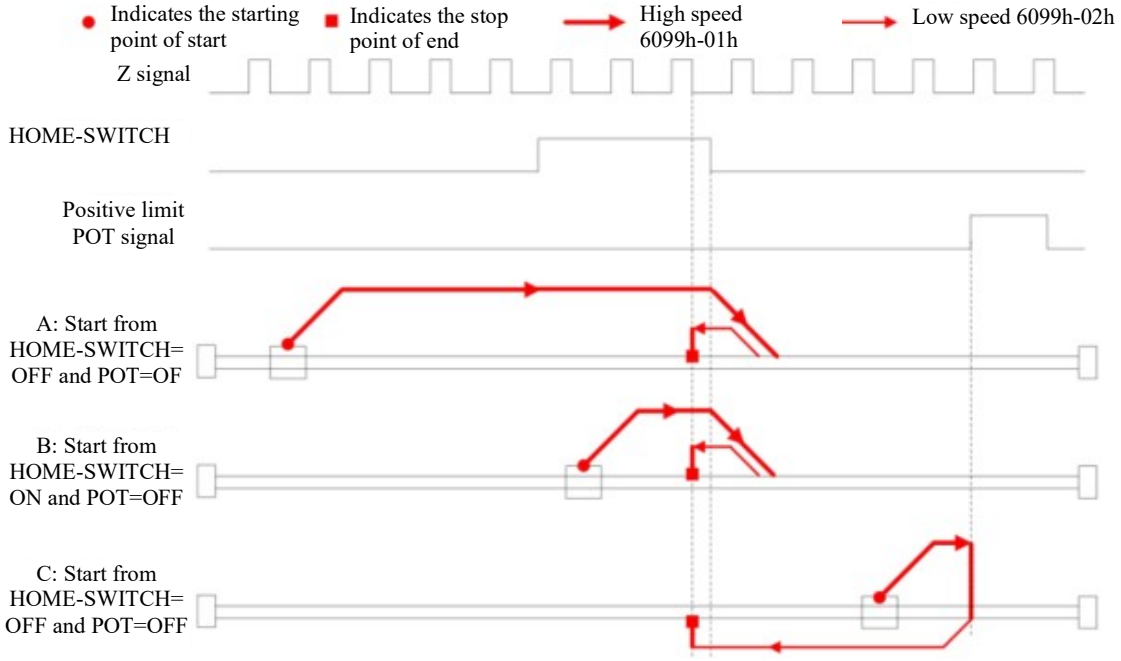
If the negative limit signal is valid during the movement, Bit 13 of the status word (6041h) will be valid, indicating an error in the home position movement, and the motor will immediately stop.



Method 8 Diagram

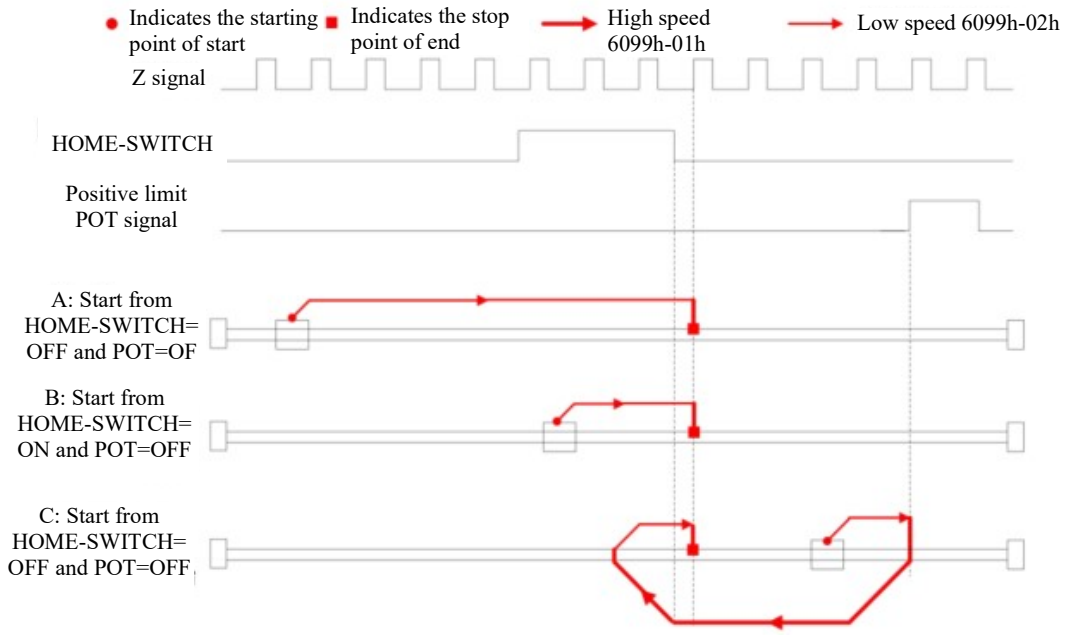
Method 9:

If both the home position signal and the positive limit signal are invalid, the motor will make home-position high-speed movement in the positive direction. When the home position signal is valid, the motor will continue to move. When leaving the home-position signal switch, the motor will slow down and stop, then make the home-position low-speed movement in the negative direction, and stop the movement when the first encoder Z signal is valid after the home position signal is valid, as shown in Situation A in the figure.
If the positive limit is invalid an the motor already stops at the home-position signal switch position when it starts the home-position movement, the motor will make home-position high-speed movement in positive direction, and after leaving the home-position signal switch, it will slow down and stop, then make the home-position low-speed movement in the negative direction, and stop until the first Z signal is valid when the home-position signal is valid, as shown in Situation B in the figure.
If both the home position signal and the positive limit signal are invalid, the motor will make home-position high-speed movement in the positive direction until the positive limit signal is valid, the motor will stop and make the home-position low-speed movement in the negative direction. The motor will stop movement when the first encoder Z signal is valid after the home position signal is valid, as shown in Situation C in the figure.
If the negative limit signal is valid during the movement, Bit 13 of the status word (6041h) will be valid, indicating an error in the home position movement, and the motor will immediately stop.



Method 9 Diagram

Method 10:
If both the home position signal and the positive limit signal are invalid, the motor will make home-position low-speed movement in the positive direction. When the home-position signal is valid, it will continue to move, and stop the movement when the first encoder Z signal is valid after the home position signal is invalid, as shown in Situation A in the figure.
If the positive limit is invalid, and the motor already stops at the home position signal switch position when it starts the home-position movement, the motor will make home-position low-speed movement in the positive direction and stop when the first Z signal is valid after the home position signal is invalid, as shown in Situation B in the figure.
If both the home position signal and the positive limit signal are invalid, the motor will make home-position low-speed movement in the positive direction until the positive limit signal is valid, the motor will stop and make the home-position high-speed movement in the negative direction. When the home-position signal is valid, the motor will slow down, stop, then make the home-position low-speed movement in the positive direction, and stop the movement when the first encoder Z signal is valid after the home-position signal is invalid, as shown in Situation C in the figure.
If the negative limit signal is valid during the movement, Bit 13 of the status word (6041h) will be valid, indicating an error in the home position movement, and the motor will immediately stop.



Method 10 Diagram

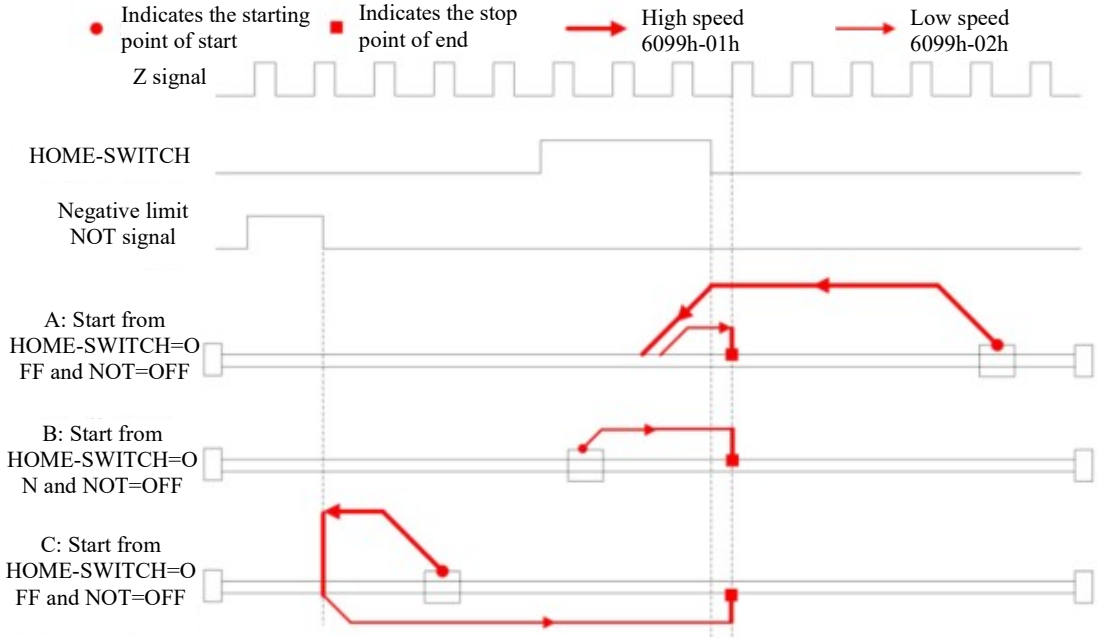
Method 11

If both the home position signal and the negative limit signal are invalid, the motor will make home-position high-speed movement in the negative direction until the home position signal is valid, the motor will slow down, stop and make the home-position low-speed movement in the positive direction. It will stop movement when the first encoder Z signal is valid after leaving the home position signal switch, as shown in Situation A in the figure.

If the negative limit is invalid, and the motor already stops at the home position signal switch position when it starts the home-position movement, the motor will make home-position low-speed movement in the positive direction and stop when the first Z signal is valid after leaving the home position signal switch, as shown in Situation B in the figure.

If both the home position signal and the negative limit signal are invalid, the motor will make home-position high-speed movement in the negative direction until the negative limit signal is valid, the motor will stop and make the home-position low-speed movement in the positive direction. When the home-position signal is valid, the motor will continue to move, and will stop movement when the first encoder Z signal is valid after leaving the home position signal switch, as shown in Situation C in the figure.

If the positive limit signal is valid during the movement, Bit 13 of the status word (6041h) will be valid, indicating an error in the home-position movement, and the motor will immediately stop.



Method 11 Diagram

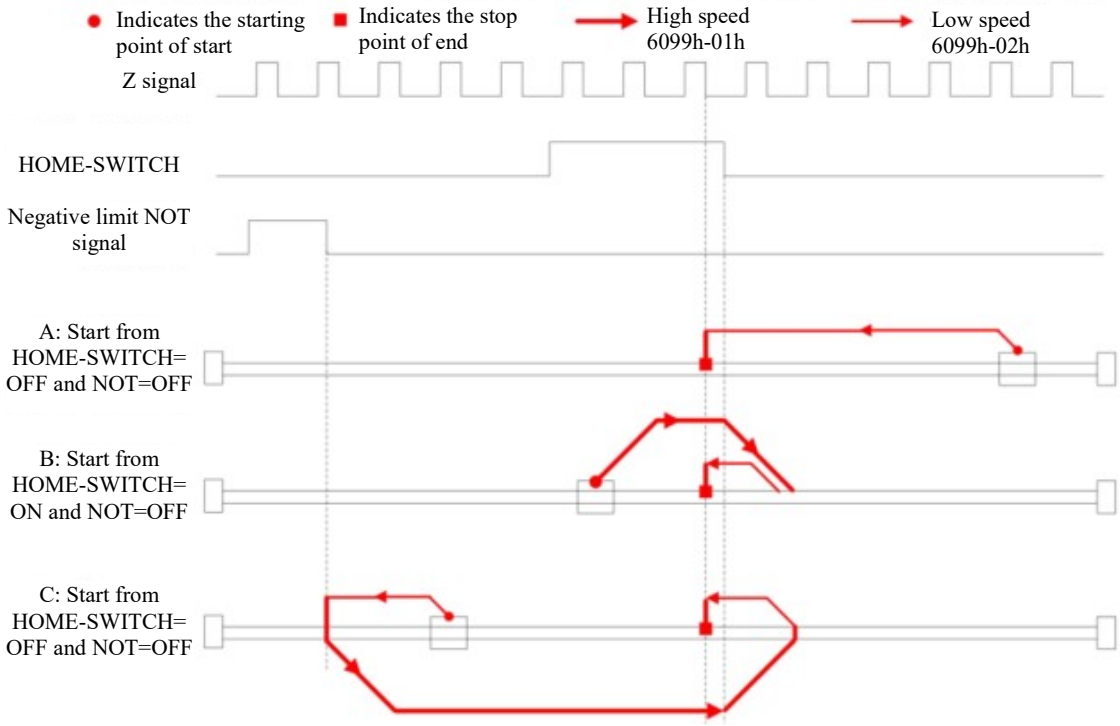
Method 12:

If both the home position signal and the negative limit signal are invalid, the motor will make home-position low-speed movement in the negative direction, and stop movement when the first encoder Z signal is valid after the home position signal is valid, as shown in Situation A in the figure.

If the negative limit is invalid an the motor already stops at the home-position signal switch position when it starts the home-position movement, the motor will make home-position high-speed movement in positive direction, and after leaving the home-position signal switch, it will slow down and stop, then make the home-position low-speed movement in the negative direction, and stop until the first Z signal is valid when the home-position signal is valid, as shown in Situation B in the figure.

If both the home position signal and the negative limit signal are invalid, the motor will make home-position low-speed movement in the negative direction until the negative limit signal is valid, the motor will stop and make the home-position high-speed movement in the positive direction. When the home-position signal is valid, the motor will continue to move, and after leaving he home-position signal switch, the motor will slow down, stop, then make the home-position low-speed movement in the negative direction, and stop the movement when the first encoder Z signal is valid after the home-position signal is valid, as shown in Situation C in the figure.

If the positive limit signal is valid during the movement, Bit 13 of the status word (6041h) will be valid, indicating an error in the home-position movement, and the motor will immediately stop.



Method 12 Diagram

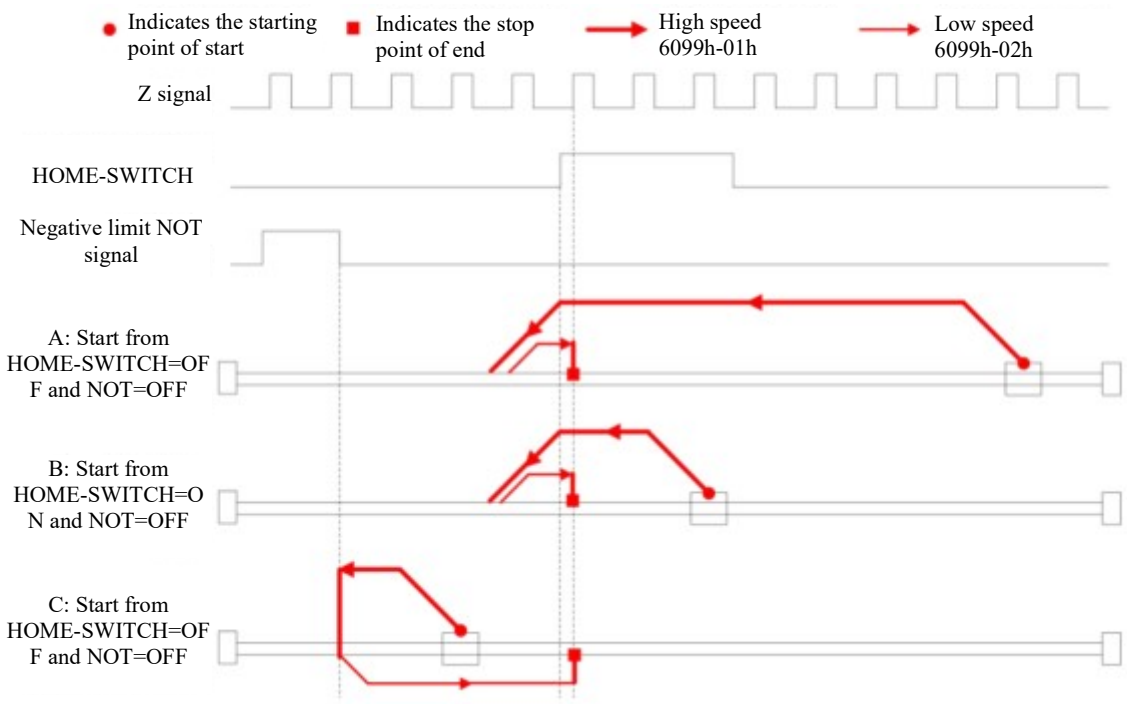
Method 13:

If both the home position signal and the negative limit signal are invalid, the motor will make home-position high-speed movement in the negative direction. When the home position signal is valid, the motor will continue to move. When leaving the home-position signal switch, the motor will slow down and stop, then make the home-position low-speed movement in the positive direction, and stop the movement when the first encoder Z signal is valid after the home position signal is valid, as shown in Situation A in the figure.

If the negative limit is invalid an the motor already stops at the home-position signal switch position when it starts the home-position movement, the motor will make home-position high-speed movement in negative direction, and after leaving the home-position signal switch, it will slow down and stop, then make the home-position low-speed movement in the positive direction, and stop until the first Z signal is valid when the home-position signal is valid, as shown in Situation B in the figure.

If both the home position signal and the negative limit signal are invalid, the motor will make home-position high-speed movement in the negative direction until the negative limit signal is valid, the motor will stop and make the home-position low-speed movement in the positive direction. The motor will stop movement when the first encoder Z signal is valid after the home position signal is valid, as shown in Situation C in the figure.

If the negative limit signal is valid during the movement, Bit 13 of the status word (6041h) will be valid, indicating an error in the home position movement, and the motor will immediately stop.



Method 13 Diagram

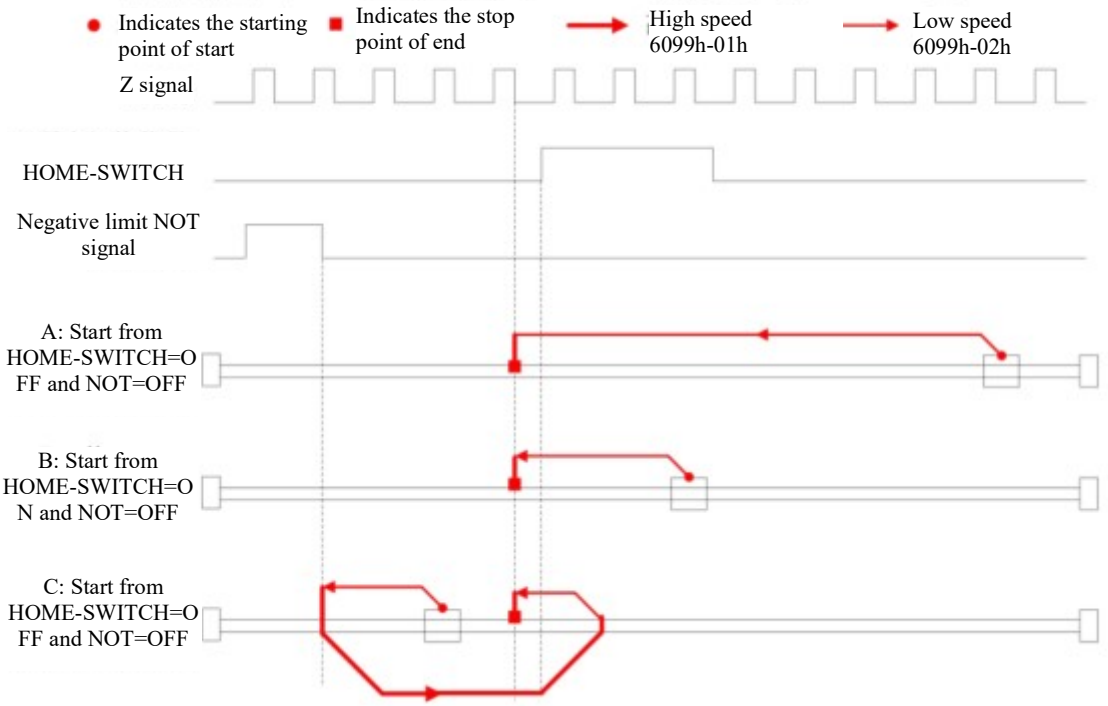
Method 14:

If both the home position signal and the negative limit signal are invalid, the motor will make home-position low-speed movement in the negative direction. When the home-position signal is valid, it will continue to move, and stop the movement when the first encoder Z signal is valid after the home position signal is invalid, as shown in Situation A in the figure.

If the negative limit is invalid, and the motor already stops at the home position signal switch position when it starts the home-position movement, the motor will make home-position low-speed movement in the negative direction and stop when the first Z signal is valid after the home position signal is invalid, as shown in Situation B in the figure.

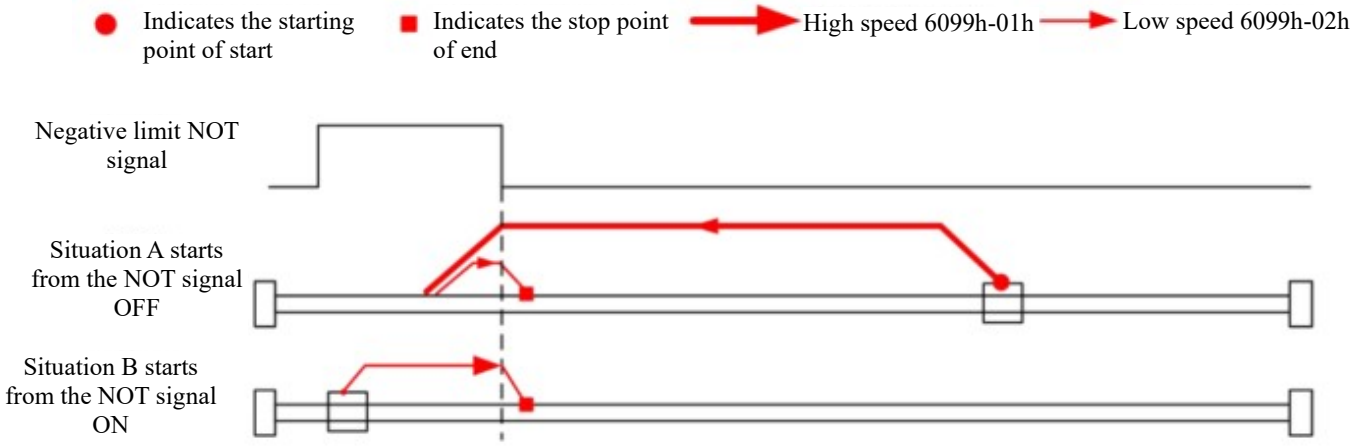
If both the home position signal and the negative limit signal are invalid, the motor will make home-position low-speed movement in the negative direction until the negative limit signal is valid, the motor will stop and make the home-position high-speed movement in the positive direction. When the home-position signal is valid, the motor will slow down, stop, then make the home-position low-speed movement in the negative direction, and stop the movement when the first encoder Z signal is valid after the home-position signal is invalid, as shown in Situation C in the figure.

If the negative limit signal is valid during the movement, Bit 13 of the status word (6041h) will be valid, indicating an error in the home position movement, and the motor will immediately stop.



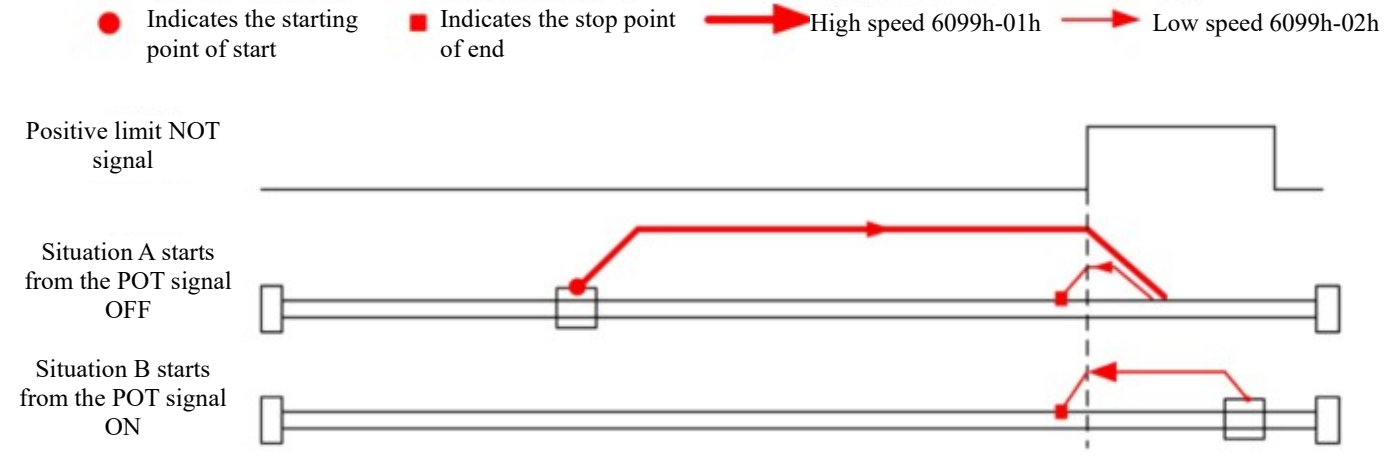
Method 14 Diagram

Method 17:



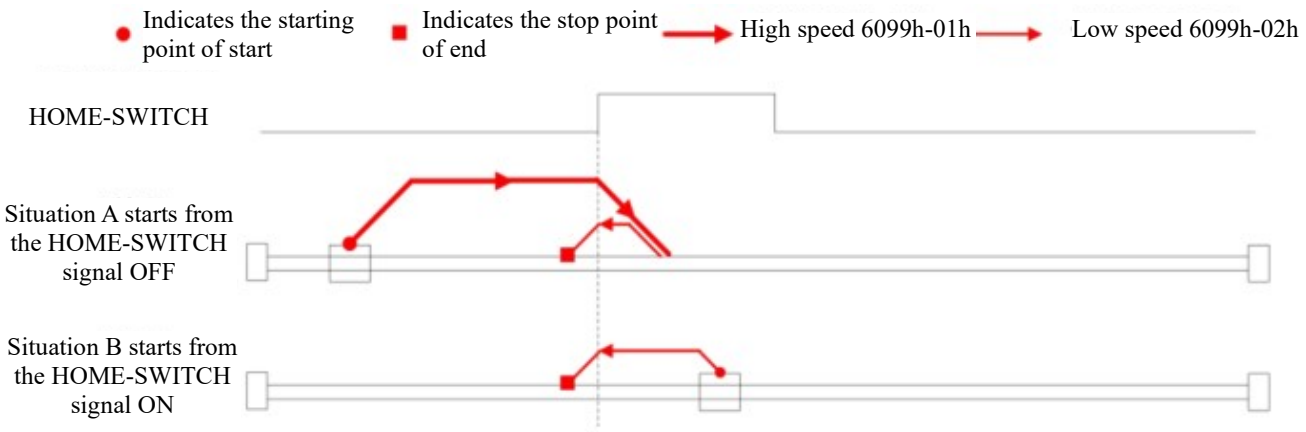
Method 17 Diagram

Method 18:



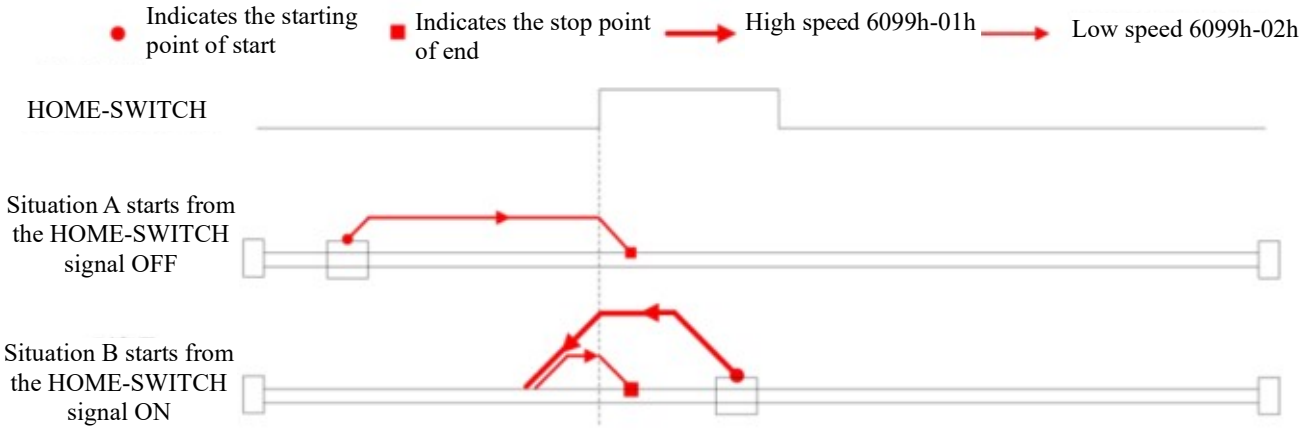
Method 18 Diagram

Method 19:



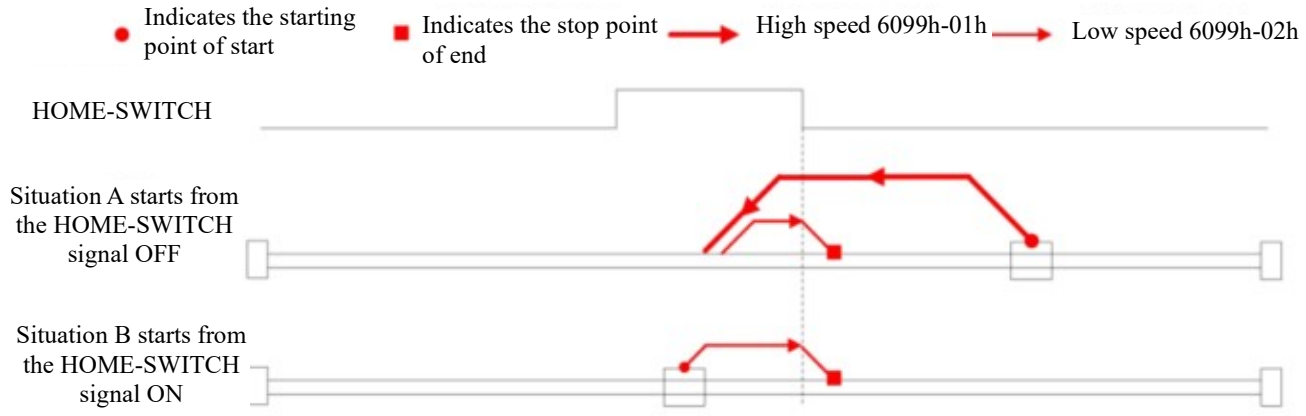
Method 19 Diagram

Method 20:



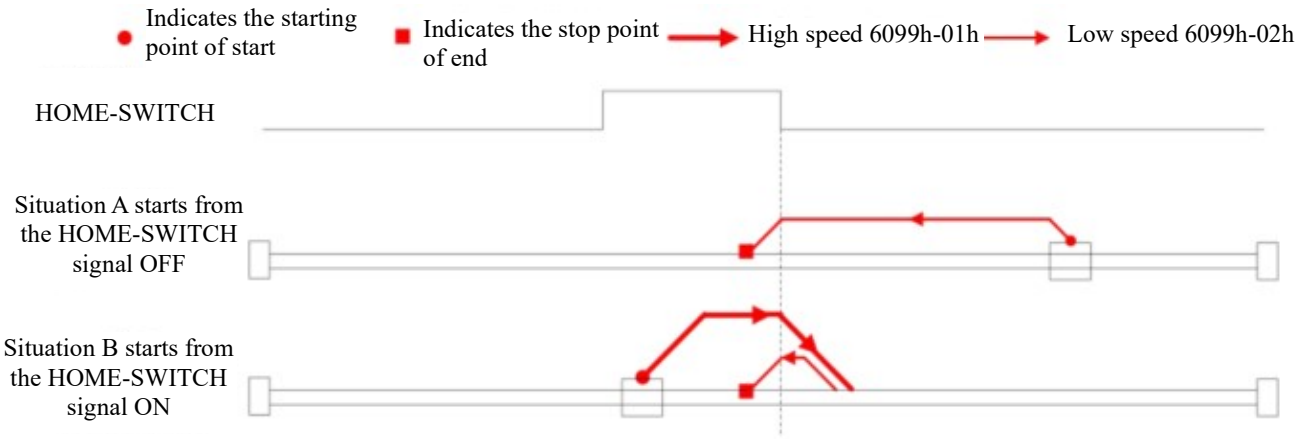
Method 20 Diagram

Method 21:



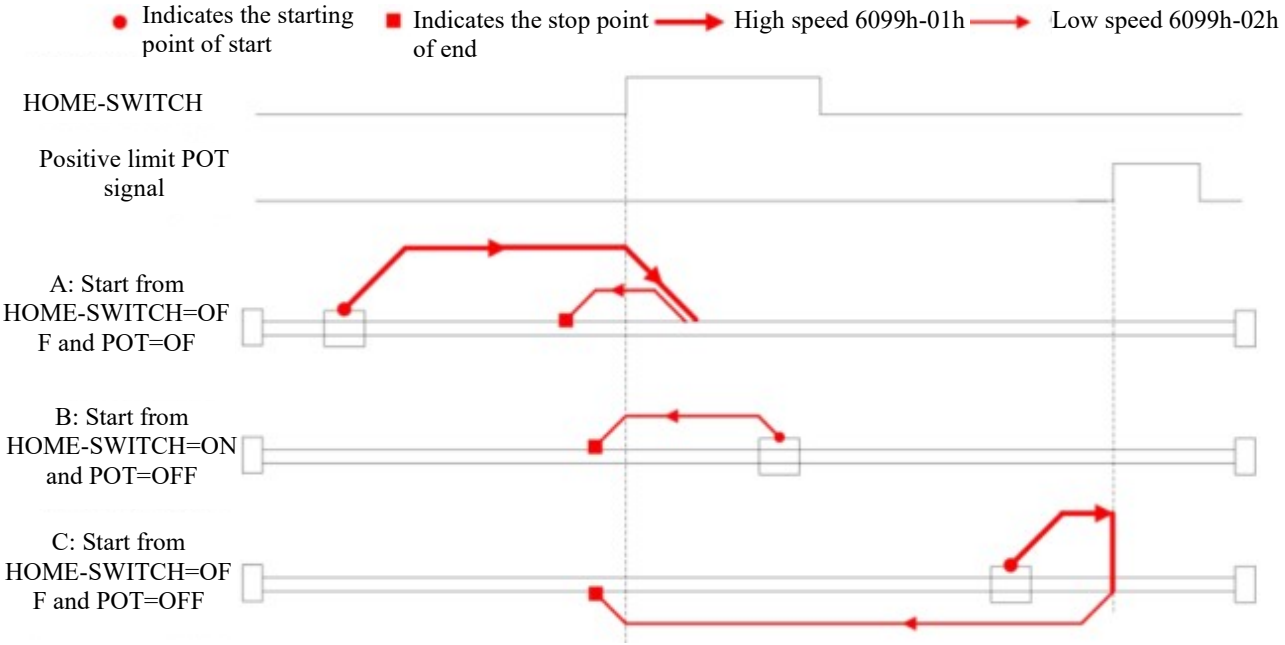
Method 21 Diagram

Method 22:



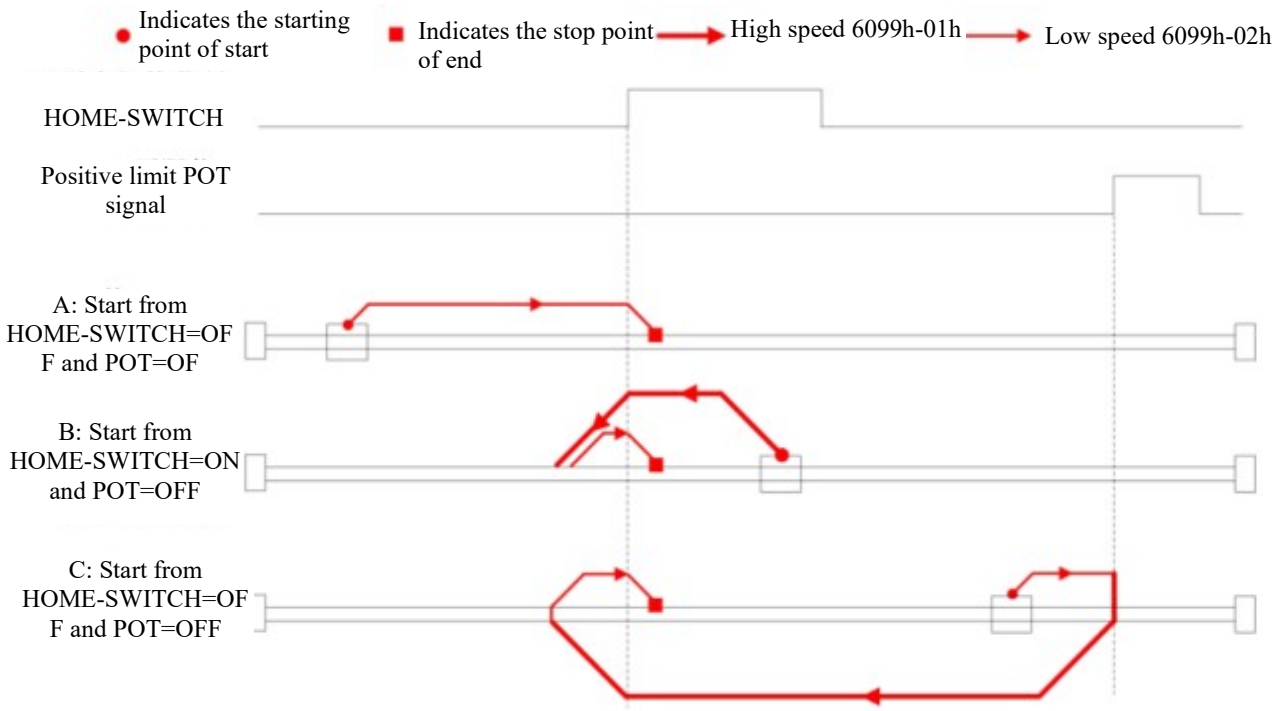
Method 22 Diagram

Method 23:



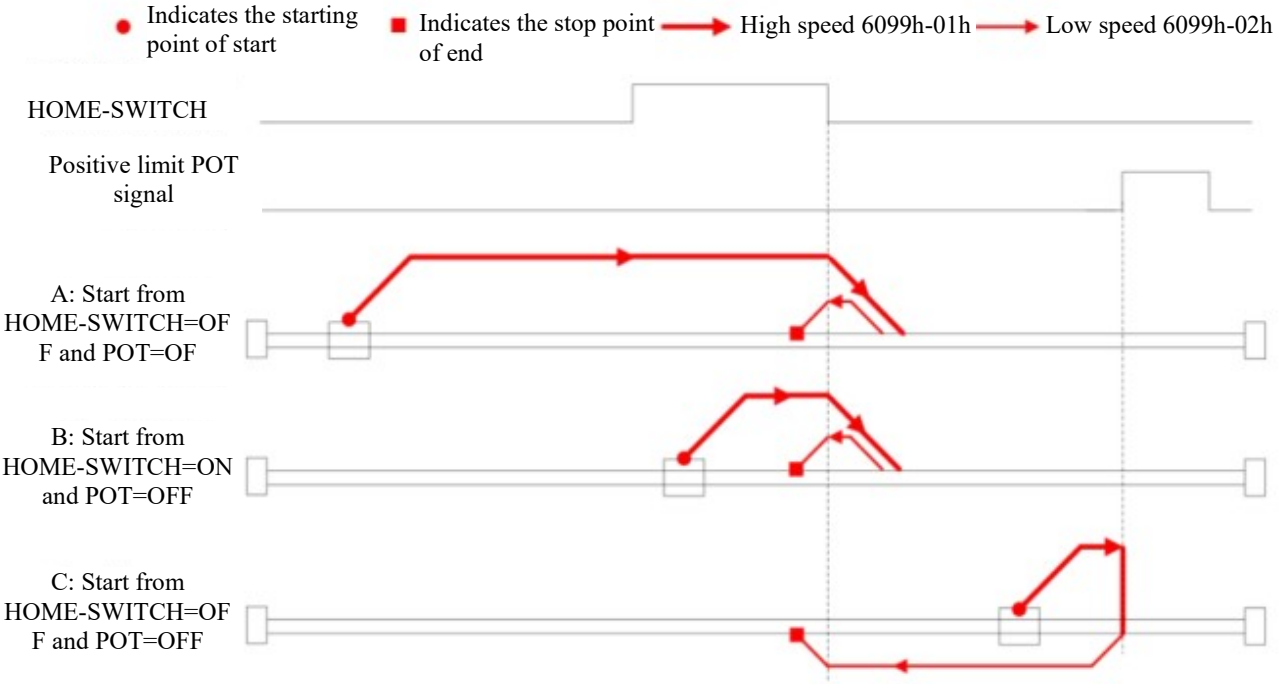
Method 23 Diagram

Method 24:



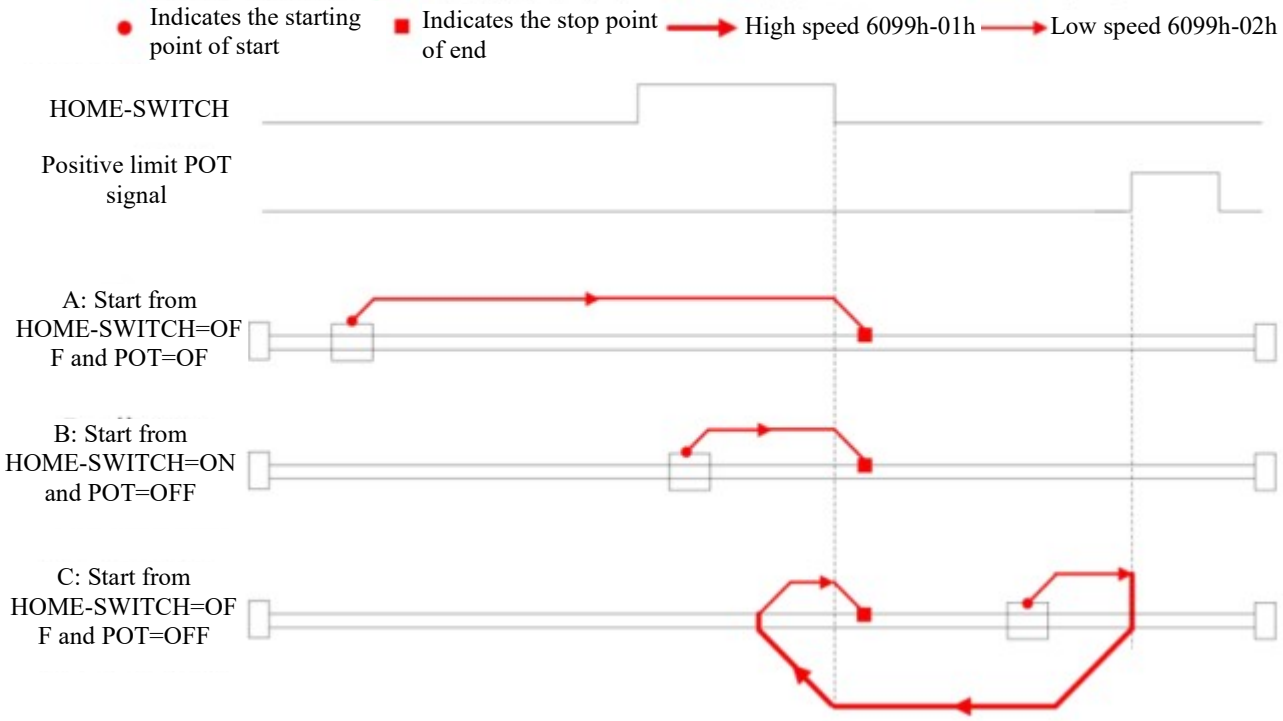
Method 24 Diagram

Method 25:



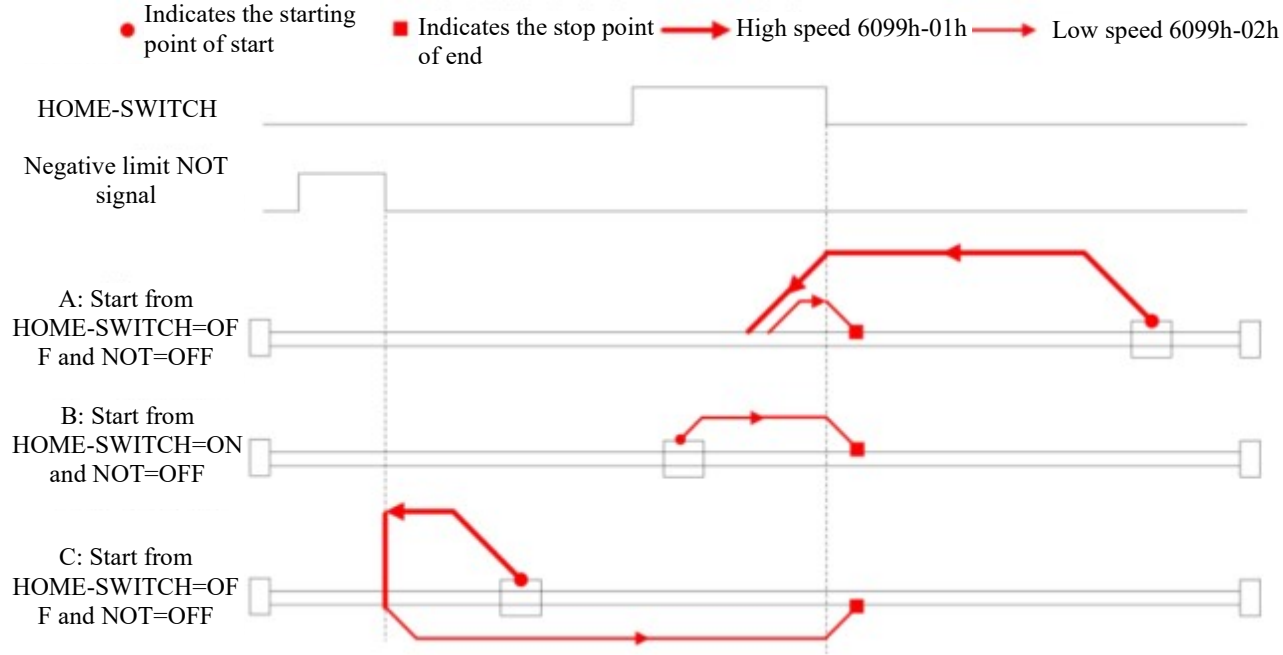
Method 25 Diagram

Method 26:



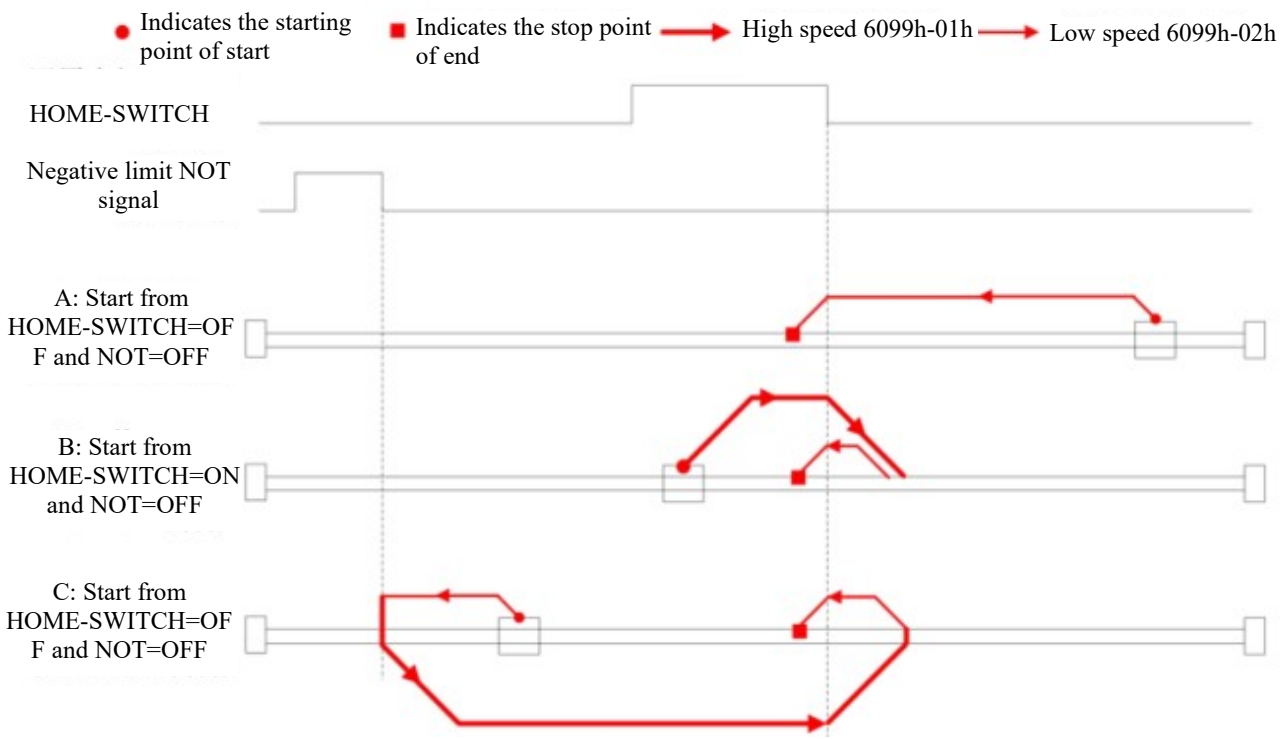
Method 26 Diagram

Method 27:



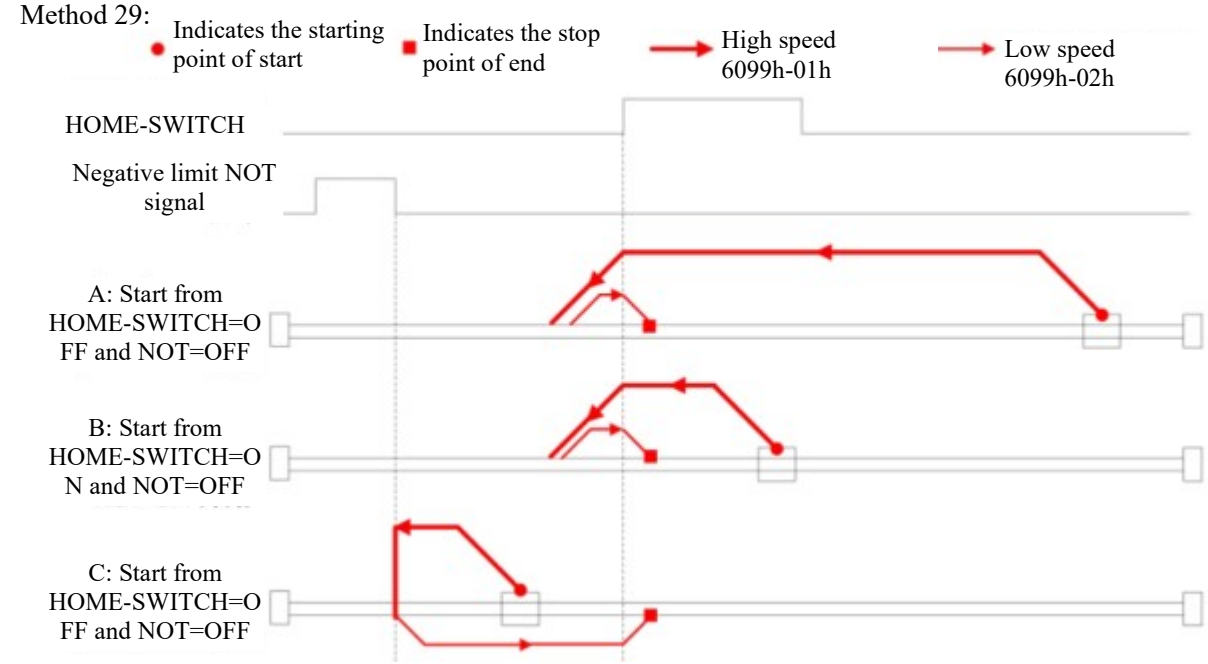
Method 27 Diagram

Method 28:



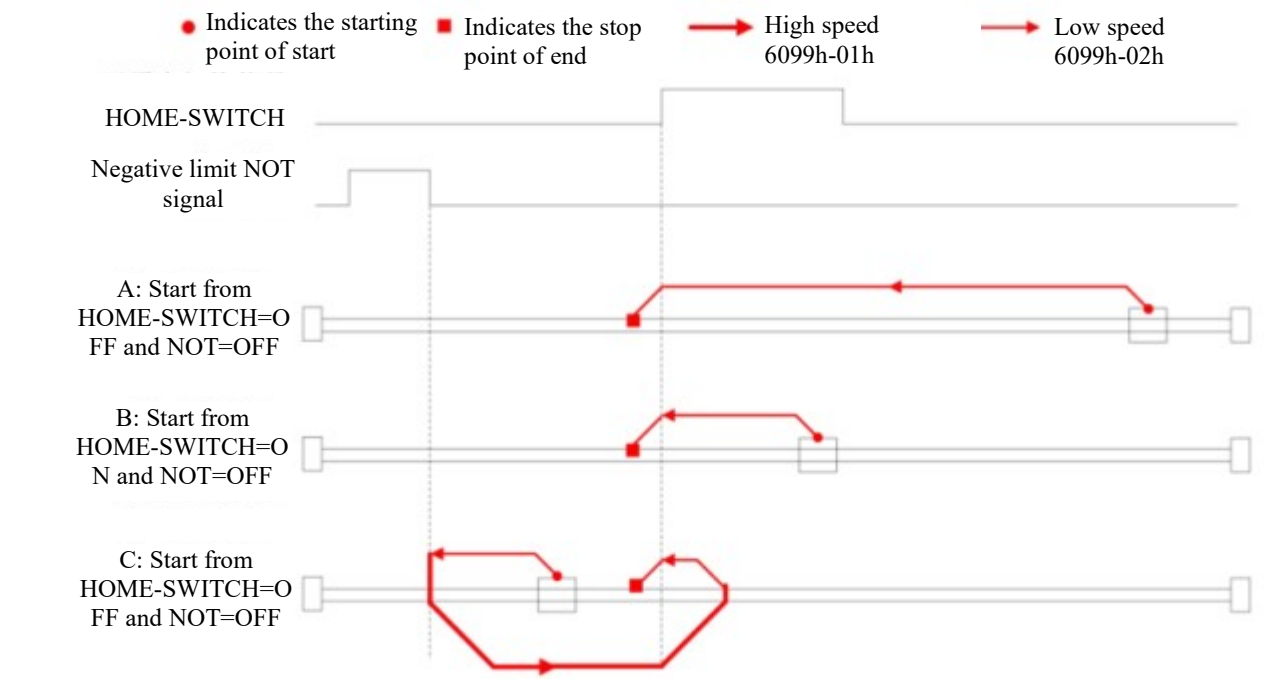
Method 28 Diagram

Method 29:



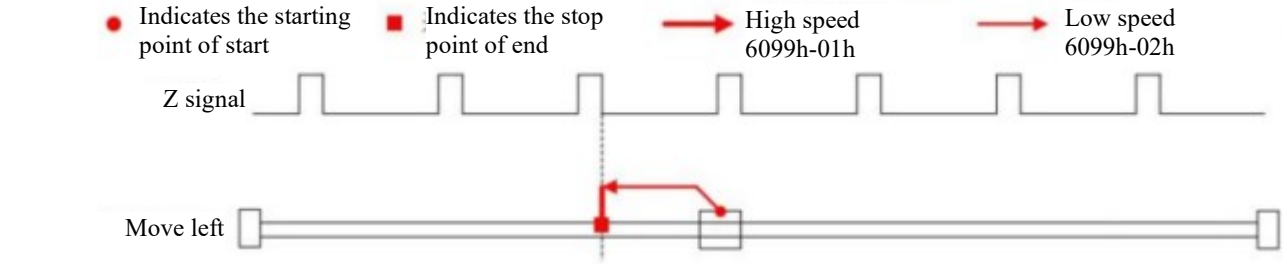
Method 29 Diagram

Method 30:



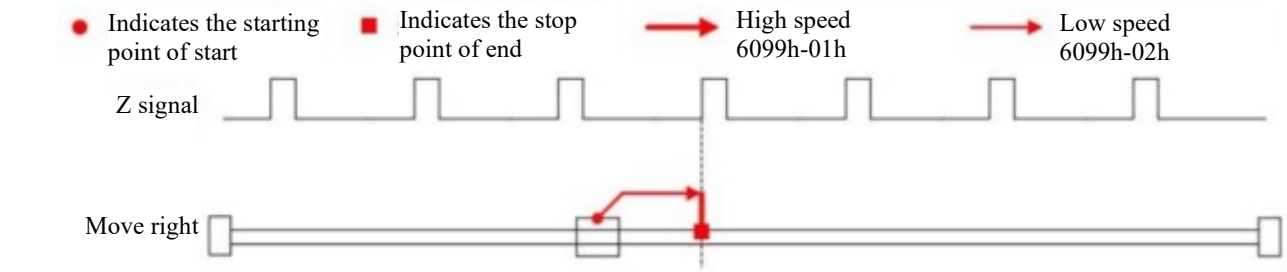
Method 30 Diagram

Method 33:



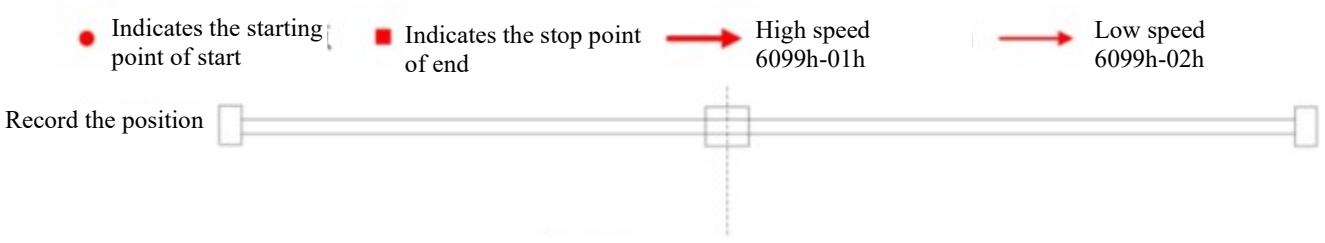
Method 33 Diagram

Method 34:



Method 34 Diagram

Method 35:



Method 35 Diagram

Appendix 2: Change History

No.	Version	Change date	Description
1	V1.0	May 29, 2023	First edition