M6-L Series Servo System

User Manual

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Shenzhen Megmeet Electrical Co., Ltd. provides comprehensive technical support for our valued customers. Please contact your nearest Megmeet office or service center, or connect directly with Megmeet headquarters if any assistance is needed.

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Foreword

Thank you for choosing Megmeet M6-L Series Servo System.

M6-L series servo system is engineered on an innovative hardware-design platform, and adopts the latest generation of control algorithms. It delivers comprehensive functionality and superb performance based on a compact layout, and offers incomparable convenience in installation, commissioning, and maintenance, making this series highly cost-efficient for OEM and general-purpose servo drive markets. All models support EtherCAT communication protocol and multi-servo-system topology when coordinated with the host computer. Key functions, such as rigidity setting, inertia identification, and vibration suppression, further enhance the ease of use in industrial sectors that require fast and precise control of position, speed, and torque, including machine tool servo feed axis, printing machine, textile processing machine, cutting machine, manipulator, punching press, semiconductor welding machine, logistics, etc.

M6-L series is dedicated for applications with DDR and DDL motors where it excels due to faster response, higher precision and operation stability, and wider encoder compatibility, including multi-turn absolute encoder, incremental encoder, and sin/cos encoder.

This user manual provides instructions and precautions in the installation, wiring, parameter setting, and fault diagnosis/removal of the product. To ensure the correct installation and operation of the M6-L series servo system and maximize its capabilities, please read this manual thoroughly before installation. This manual shall be kept properly and delivered to the actual users of the product.

Unboxing inspection

When unboxing the product, please make sure to check the following:

- whether there is any damage to the product;
- Whether the rotating shaft of the servo motor rotates smoothly (except for the motor with brake);
- Whether the servo drive and the rated values on the nameplate are consistent with your order requirement;
- Whether there is any damage to the cables and wiring, and whether the cables and wiring can work properly.

Our company has implemented strict inspection on the product's manufacturing and packaging. If there is still any error, please contact us or the local distributor.

We are engaged in the continuous improvement of our servo drive products. The relevant manuals provided by us are subject to changes without notice.

Safety precautions

Indicates that failure to comply with the notice can result in death or severe personal injuries.

Indicates that failure to comply with the notice may result in moderate or minor personal injuries, or property damages.

- Install the product on incombustible materials such as metal. Failure to comply will result in a fire.
- Do not install the product near combustible objects. Failure to comply will result in a fire.
- Do not install the product in places with explosive gases. Failure to comply will result in explosion.
- The wiring work must be carried out by sufficiently qualified personnel. Otherwise, there is a risk of electric shock.
- Before wiring, make sure that the power supply input is completely cut off. Otherwise, there is a risk of electric shock.
- Make sure to reliably ground the servo drive. Otherwise, there is a risk of electric shock.
- Properly install the covers of the drive enclosure before power on. Otherwise, there is a risk of electric shock and explosion.
- When powering on a drive product that has been idle/stored for more than 2 years, employ a voltage regulator to gradually turn up the input voltage to the required level. Otherwise, there is a risk of electric shock or explosion.
- Do not touch any terminals with bare hands when the drive is powered on. Otherwise, there is a risk of electric shock.
- Do not operate the servo drive with wet hands. Otherwise, there is a risk of electric shock.
- Before maintenance, make sure the drive has been powered off for at least 10 minutes, and that the charging indicator is completely off or the bus negative/positive voltage is below 36 V. Failure to comply will result in an electric shock.
- Parts/Components replacement must be carried out by sufficiently qualified personnel. Do not leave any wire residue or foreign metal inside the drive. Failure to comply will result in a fire.
- The bare parts of the terminal lugs in the main circuit must be properly wrapped with insulation tapes. Otherwise, electric shock may occur.

⚠ WARNING

- Install the product on the place that can bear its weight. Failure to comply will result in personal injuries or equipment damage.
- Do not install the drive near water pipes or other places capable of water splashing. Otherwise, there is a risk of property damage.
- Do not allow screws, gaskets, metal bars, and the like to fall into the servo drive. Failure to comply may result in a fire or property damage.
- If the servo drive is damaged or lacks components, do not install or run the drive. Failure to comply may result in a fire or personal injuries.
- Do not install the product in places with direct sunlight exposure. Otherwise, there is a risk of property damage.
- Cable lugs must be firmly connected to the terminals of the main circuit. Otherwise, there is a risk of property damage.
- When handling the servo motor, do not drag the machine by pulling the cables or holding the rotating shaft. Otherwise, there is a risk of machine dropping that may cause personal injuries or property damage.
- Do not impact the shaft with direct striking or pounding as such actions may cause damage to the shaft and the encoder attached to the opposite side of the shaft. Failure to comply may result in property damage.
- Do not store the servo motor in the place with vibration beyond the limit in the requirement. Otherwise, there is a risk of property damage.

Content

Chapter 1 M6-L Series Model Selection

1.1 Servo drive models

1.1.1 Product model

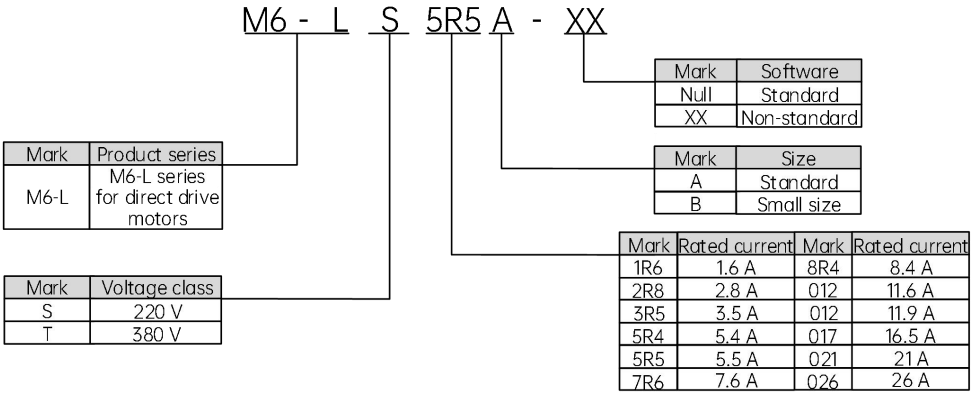


Figure 1-1 M6-L series servo drive model explanation

1.1.2 Product nameplate

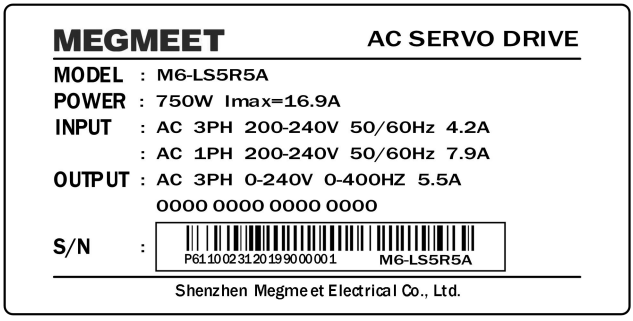
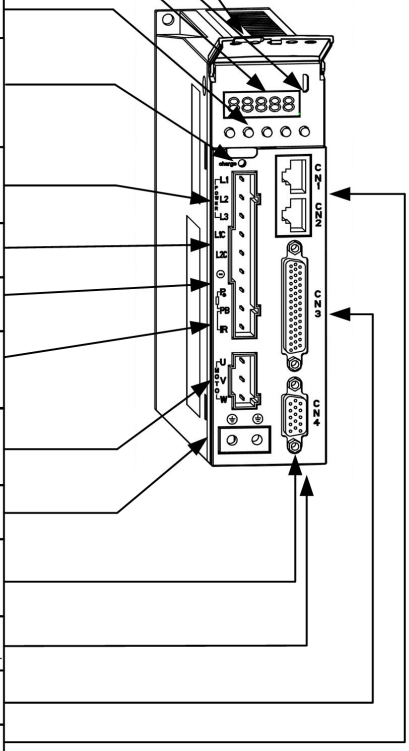


Figure 1-2 M6-L series servo drive nameplate

1.2 Names and descriptions of interface

Interface name	Interface description
CN7 STO safety function	General STO function, optional
CN5 Micro USB communication port	Used for the connection with the computer USB to facilitate the drive parameter setting and commissioning
LED digital tube	Five-digit eight-segment digital tube for status monitoring and parameter display & setting
Operating key	Five keys, used for parameter setting and display status switchover
CHARGE Bus power supply indicator	Used for indicating the status of the bus power supply. When the indicator is on, it indicates that the bus capacitor is charged; do not touch the power supply terminal in the circumstances even if the main power supply has been cut off; otherwise, there is a risk of electric shock.
L1, L2, L3 Main power supply input	Main power supply input, 220 V or 380 V, single-phase or three-phase. Refer to the section 2.1.1 for detailed specifications.
L1C, L2C Control power supply input	Single-phase 220 V control power supply input
⊖, P⊕ DC bus terminal	DC bus terminal, for connection under common bus
P⊕, PB, IR Braking resistor wiring terminal	Braking resistor wiring terminals. Please short-circuit PB and IR when an internal braking resistor is applied; when an external braking resistor is applied, install it between P⊕ and PB.
U, V, W Servo motor power terminals	Servo motor UVW power terminals
⏚ Ground terminal	Ground terminal. Please short-circuit to ground and the motor enclosure.
CN4 Main encoder interface	DB15 female connector for connecting motor encoder. Multi-turn absolute encoder, incremental encoder, and sin/cos encoder are supported.
CN6 Secondary encoder interface	DB15 female connector for connecting Hall-effect sensor, motor temperature detector, and the ABZ signal of the secondary encoder
CN3 Control I/O interface	DB44 female connector, control I/O interface, used for connecting with external I/O and host controller
CN1, CN2 Communication interface	Two RJ45 ports in parallel for EtherCAT Bus communication



Chapter 2 Servo System Specifications

2.1 Standard specifications of servo drives

2.1.1 Electrical specifications of servo drives

220 V class servo drive models and electrical specifications

Table 2-1 Models and electrical specifications of 220 V class servo drives

Voltage class	220 V					
Model	LS1R6A	LS2R8A	LS5R5A	LS7R6B	LS7R6A	LS012A
Power class	200 W	400 W	750 W	1 kW	1 kW	1.5 kW
Size	SIZE A				SIZE B	
Phase	Single-phase		Single-phase, three-phase	Three-phase		
Rated input current (A)	2.2	4	7.6/4.2	5.1	5.1	8
Rated output current (A)	1.6	2.8	5.5	7.6	7.6	11.6
Max. output current (A)	5.8	9.3	16.9	17	22	28
Main circuit power supply	200 to 240 V, -10% to +10%, 50/60 Hz			200 to 240 V, -15% to +10%, 50/60 Hz		
Control circuit power supply	Single-phase, 200 to 240 V, -15% to +10%, 50/60 Hz					
Braking resistor	No built-in braking resistor		Built-in braking resistor			

380 V class servo drive models and electrical specifications

Table 2-2 Models and electrical specifications of 380 V class servo drives

Voltage class	380 V						
Model	LT3R5A	LT5R4A	LT8R4A	LT012A	LT017A	LT021A	LT026A
Power class	0.85 kW	1.3 kW	2.0 kW	2.9 kW	4.4 kW	5.5 kW	7.5 kW

Size	SIZE B				SIZE C		
Phase	Three-phase						
Rated input current (A)	2.4	3.6	5.5	8	11.6	15	19.7
Rated output current (A)	3.5	5.4	8.4	11.9	16.5	20.8	25.7
Max. output current (A)	8.5	14	22	28	42	55	65
Main circuit power supply	Three-phase, 380 to 440 V, -15% to +10%, 50/60 Hz						
Control circuit power supply	Single-phase, 200 to 240 V, -15% to +10%, 50/60 Hz						
Braking resistor	Built-in braking resistor				No built-in braking resistor		

2.1.2 Technical specifications of servo drives

Table 2-3 Technical specifications of servo drives

Item			Specifications
Basic specifications	Control mode		IGBT, PWM control, and sine wave current drive mode
	Encoder	Incremental encoder	4 MHz bandwidth; it can be multiplied to 16 MHz.
		Sin/Cos encoder	1 Vp-p, 200 kHz bandwidth
		Absolute encoder	BiSS-C, EnDat, and NRZ protocols
		Hall-effect encoder	Open-collector and differential inputs
Control I/O	DI	Various functions defined by parameters	Nine channels of general input, optocoupler isolation, NPN and PNP inputs for selection, input voltage ranging from 20 to 30 V, input impedance of 3.9 K

Item			Specifications
	DO	Various functions defined by parameters	Five channels of general output, optocoupler isolation, NPN and PNP outputs for selection
			Operating voltage up to 30 V, current up to 100 mA
Communication	EtherCAT		CoE communication protocol (in compliance with CiA 402 profile)
	USB port		For connection between computer and servo drive to facilitate commissioning and tuning
Other terminals	Button		Five buttons
	LED display		Five 8-segment LEDs
	Power indication		CHARGE indicator
	Safety function		General STO function
General functions	Automatic adjustment		The host computer outputs an action command to run the motor, during which the load's moment of inertia ratio is estimated in real time and the rigidity level is automatically set.
	Control mode		Position mode; speed mode; torque mode; position/speed mode switchover; speed/torque mode switchover; position/torque mode switchover
	Protection function		Overvoltage, undervoltage, overcurrent, overspeed, stall, overheat, overload, encoder abnormality, input phase loss, excessive position deviation
	High-frequency vibration suppression		Four sets of notch filters for the suppression of vibration between 0 and 4000 Hz; one set of speed reference filter for the suppression of vibration between 0 and 1000 Hz
	End vibration suppression		Two sets of filters for the suppression of low-frequency end vibration between 1 and 100 Hz
	Homing mode		Multiple homing modes
	Gantry control		Gantry synchronization
	Reverse clearance compensation		Used to minimize the response delay when the traveling direction of the machine is reversed

Item		Specifications			
	Mechanical analyzer	Used for analyzing the frequency characteristics of the mechanical system via the host computer software			
	Inertia identification	Offline and online identification of system inertia			
	Torque observer	Load torque observation and compensation			
	Friction compensation	System friction compensation			
Position control	Control input	Deviation counter reset, electronic gear switchover, etc.			
	Control output	Positioning completed			
	Position reference	Pulse reference	Pulse mode	1. Pulse + Sign; 2. A/B orthogonal; 3. CW/CCW	
			Input mode	Differential input	
			Pulse frequency	High speed pulse terminal	Differential input; speed up to 4 Mpps; bandwidth no less than 0.125 microseconds
			Pulse filter	First-order command smoothing filter or FIR notch filter	
		EtherCAT	CoE communication protocol (in compliance with CiA 402 profile)		
		Electronic gear	4 sets of electronic gear ratio; online		
Speed control	Performance	Speed variation rate	Load variation rate	0 to 100% load: Below 0.5% (at the rated speed)	
			Voltage variation rate	Rated voltage ±10%: 0.5% (at the rated speed)	
			Temperature variation rate	25 ±25℃: below 0.5% (at the rated speed)	
		Speed control range	1 to 6000		

Item		Specifications	
		Speed-loop response characteristics	2.6 kHz
	Control input	Internal speed command selection 1/2/3/4, zero speed clamp, etc.	
	Control output	Speed arrival, etc.	
Torque control	Performance	Torque control precision	±1%
		Frequency characteristics	3 kHz
	Control input	Zero speed clamp, torque command symbol input, etc.	
	Control output	Speed arrival, etc.	
	Speed limit function	Set the speed limit according to parameters.	

2.2 Servo drive outline & dimensions

1. SIZE A (Applicable for drive models: LS1R6A, LS2R8A, LS5R5A, and LS7R6B)

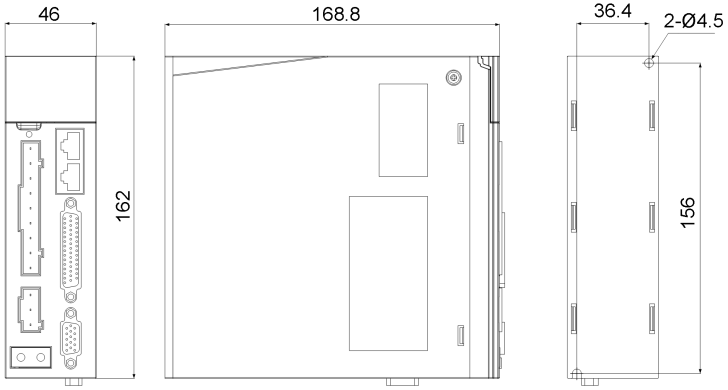


Figure 2-1 SIZE A outline & dimensions

2. SIZE B (Applicable for drive models: LS7R6A, LS012A, LT3R5A, LT5R4A, LT8R4A, and LT012A)

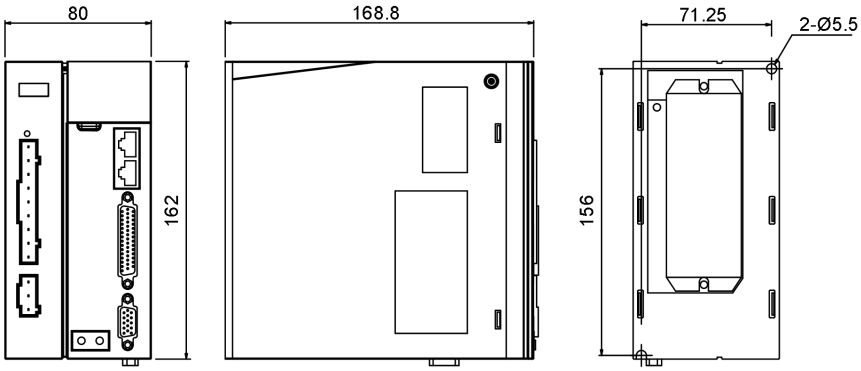


Figure 2-2 SIZE B outline & dimensions

3. SIZE C (Applicable for drive models: LT017A, LT021A, and LT026A)

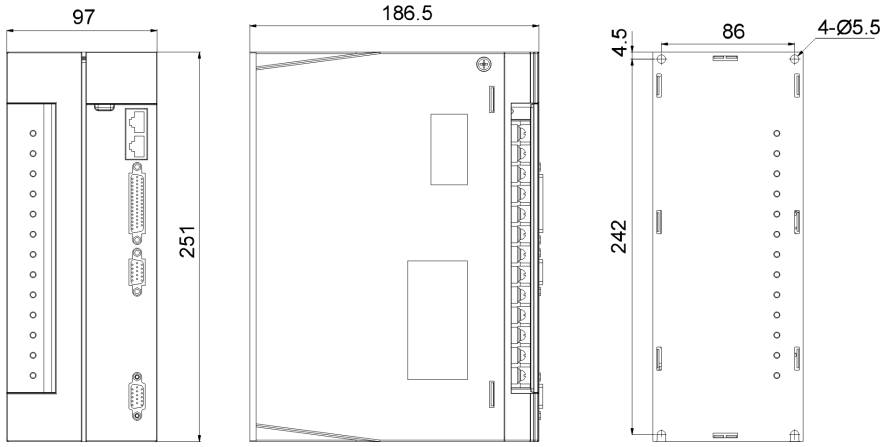


Figure 2-3 SIZE C outline & dimensions

Chapter 3 Installation Instruction

3.1 Servo drive installation

3.1.1 Place for installation

- The product shall be installed inside a cabinet shielded from direct sunlight exposure, rain, and water dropping;
- Do not install the product in places with high temperature, high humidity, or excessive exposure to dust or metal powder.
- Do not install the product in places with corrosive, explosive, or flammable gases.
- The place for installation shall be without vibration.

3.1.2 Environmental requirements for installation

Table 3-1 Environmental requirements for M6-L servo drive installation

Item		Requirements
Operating conditions	Place for installation	Vertical mounting on a solid and stable indoor base; at least 5 cm spacing for air inlet and outlet; at least 4 cm spacing for the right and left sides of the enclosure; air cooling
	Ambient temperature	0 to +45℃; temperature change rate less than 0.5℃/min; derated use above 45℃ with adequate ventilation; max. working temperature at 55℃ (operation allowed with less than 25% load)
	Humidity	Relative humidity <90% (non-condensing)
	Other climate conditions	Non-condensing, non-freezing, and no rain, snow, hail, etc.; solar radiation less than 700 W/m^2; air pressure ranging from 70 to 106 kPa
	Salt and corrosive gas content	Pollution degree 2
	Dust and solid particle content	Pollution degree 2
	IP rating	IP20

Item		Requirements
	Altitude	Normal use below 1000 m; derated use above 1000 m; derated by 6% for each increase of 1000 m
	Vibration resistance	Below 4.9 m/s^2
	Impact resistance	Below 19.6 m/s^2

3.1.3 Installation precautions

This servo drive product shall be properly installed at an adequately-ventilated indoor location. Installation inside a cabinet is preferred. It shall adopt a vertical mounting method, and be secured to the mounting surface via the two fixing holes of the drive.

1. Installation drawing

- SIZE A installation requirements

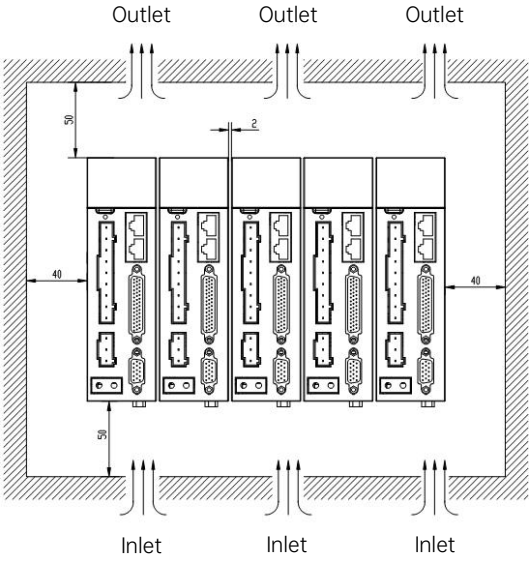


Figure 3-1 SIZE A installation drawing

- SIZE B/C installation requirements

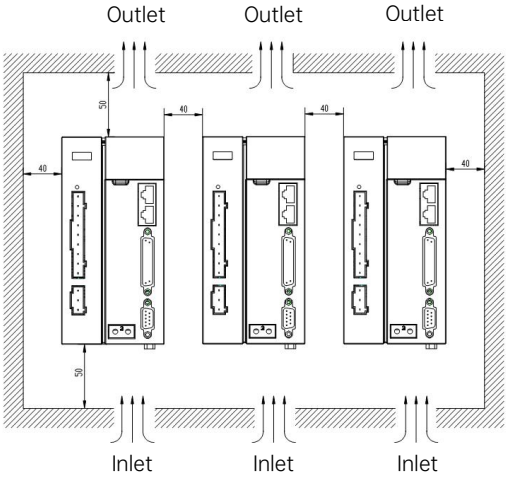


Figure 3-2 SIZE B/C installation drawing

2. Side-by-side installation

As shown in the two drawings above, different group installation methods shall be adopted to suit the cooling methods of different enclosures. When installed side by side, there is no need for spacing between two SIZE A models, while at least 40 mm spacing shall be applied between two SIZE B/C models.

3. Convection cooling

To ensure effective cooling via natural convection and drive fans, it is required to place the air inlets on the lower cover and the air outlets on the upper cover of the cabinet inside which the drive is installed, and the exhaust fans shall be applied at the top of the cabinet. The drive models installed inside the cabinet shall be kept at least 50 mm away from the upper and lower covers.

4. Grounding requirements

To ensure optimal EMC performance and prevent electric shock, the drive and motor shall be reliably grounded, and the GND terminals of both the drive and the motor shall be directly short-circuited.

3.2 System wiring diagram

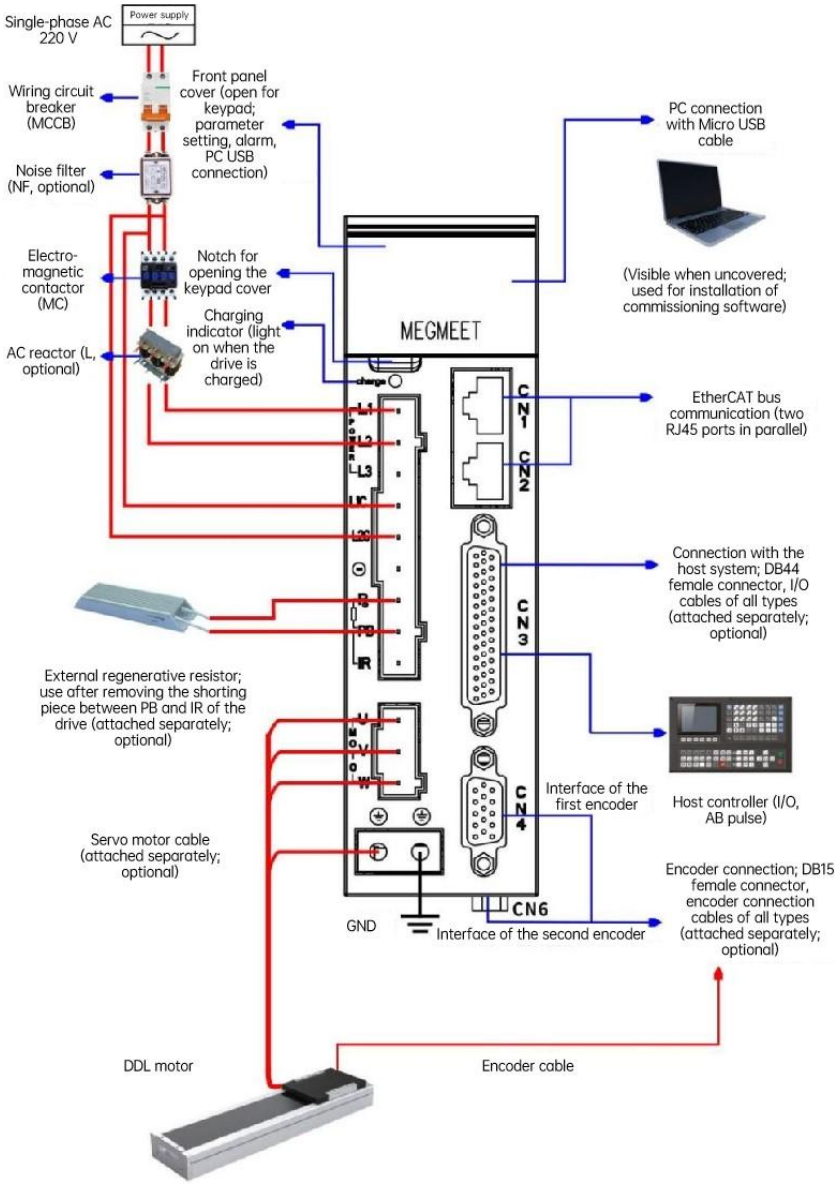


Figure 3-3 220 V single-phase servo system wiring

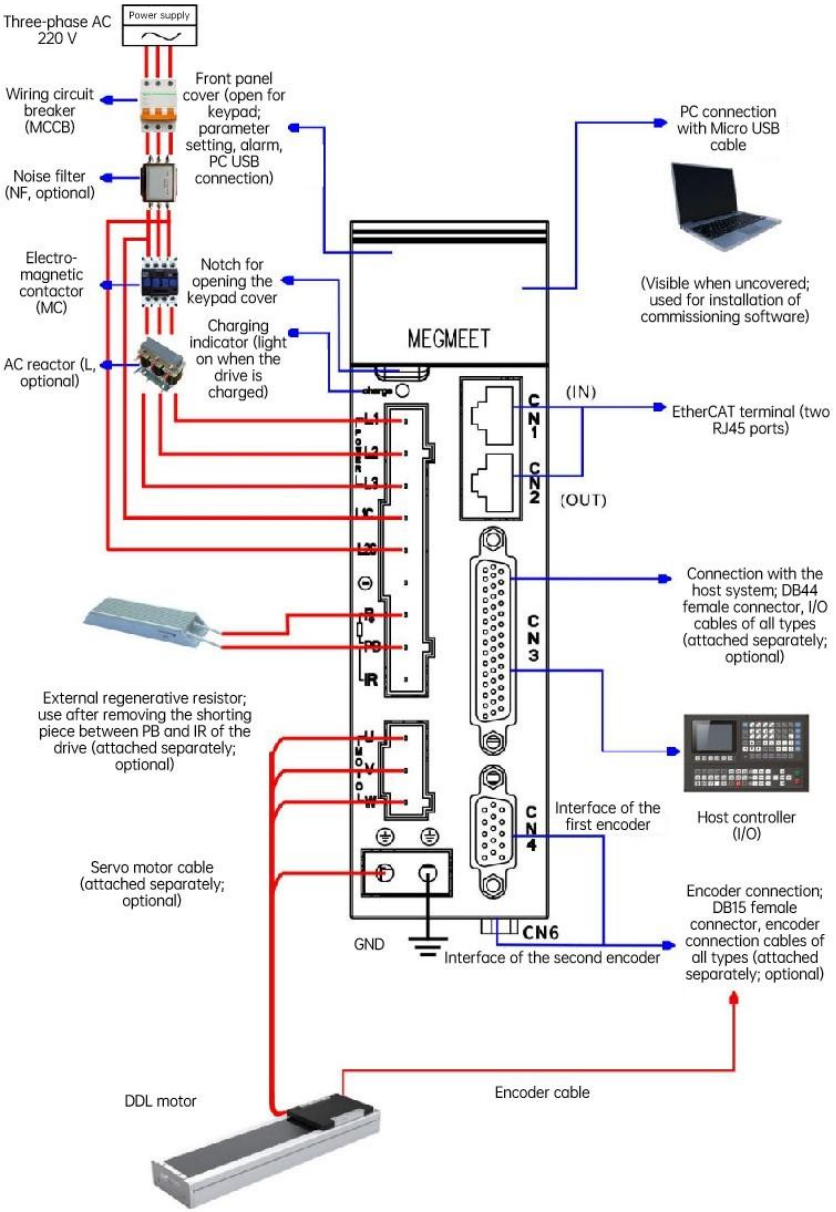


Figure 3-4 220 V three-phase servo system wiring

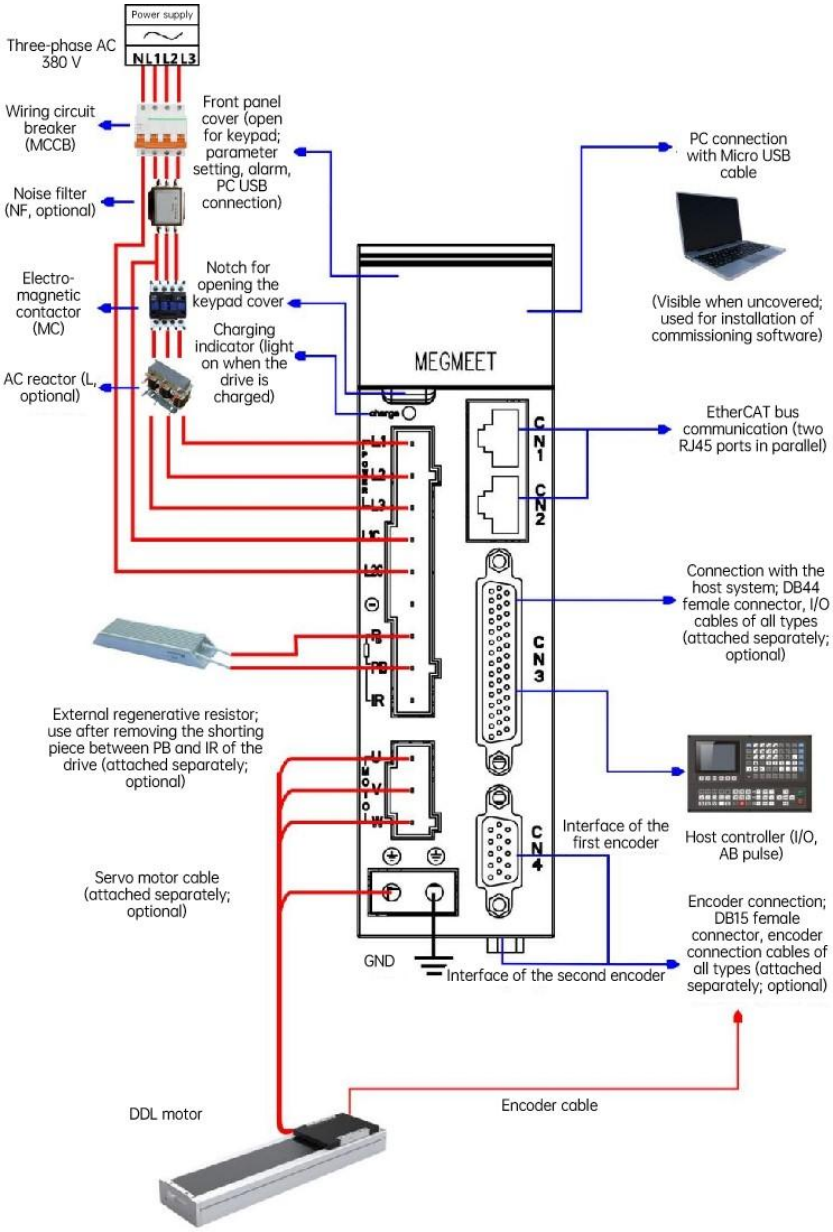


Figure 3-5 380 V three-phase servo system wiring

Note:

The 220 V single-phase system wiring method is applicable only for LS5R5A and other 220 V models with a lower power class; the 220 V three-phase system wiring method is applicable only for LS5R5A and other 220 V models with a higher power class.

During system wiring, pay attention to the followings (applicable for models with 220 V control power supply):

- Make sure the power supply specifications and wiring of L1, L2, L3, L1C, and L2C are correct to avoid damage to the drive (pay special attention to the requirement that L1C and L2C of all models shall be connected to 220 V);
- Make sure the motor output U, V, W phase sequence is correct during wiring; otherwise, it may cause abnormal motor rotation;
- When using an external braking resistor, it is required to remove the shorting piece between PB and IR, and install the resistor between P and PB; if an internal braking resistor is used, directly short-circuit PB and IR;
- To protect the drive system and prevent cross-device electric shock, please use a circuit breaker or fuse at the power supply input side. The recommended specifications of the circuit breaker and fuse are shown in Table 3-2;
- The drive does not have a built-in grounding protection circuit; please use a leakage circuit breaker dedicated for both overload and short circuit protection, or a leakage circuit breaker dedicated for grounding protection;
- It is strictly forbidden to directly use the electromagnetic contactor for the operation and shutdown of the motor. The motor is a large-inductance device, and the instantaneous high voltage generated may break down the contactor and other components;
- To ensure reliable operation of the system and reduce interference to the power grid system, it is recommended to add a filter at the input side.

3.3 Recommended specifications for circuit breakers and fuses

Table 3-2 Recommended specifications for circuit breakers and fuses

Drive model	Circuit breaker	Fuse
M6-LS1R6A	4 A	10 A
M6-LS2R8A	10 A	15 A
M6-LS5R5A	16 A / 6 A	20 A / 10 A
M6-LS7R6B	10 A	20 A
M6-LS7R6A	10 A	25 A

Drive model	Circuit breaker	Fuse
M6-LS012A	16 A	35 A
M6-LT3R5A	4 A	15 A
M6-LT5R4A	6 A	20 A
M6-LT8R4A	10 A	20 A
M6-LT012A	16 A	35 A
M6-LT017A	20 A	50 A
M6-LT021A	25 A	70 A
M6-LT026A	32 A	100 A

3.4 Specifications of braking resistors

The specifications of braking resistors are shown in the table below.

Table 3-3 Specifications of braking resistors

Servo drive model M6-[][][][][][]		Built-in braking resistor specification		Min. allowable resistance of external braking resistor (Ω)	Max. braking energy absorbed by capacitor (J)
		Resistance (Ω)	Capacity (W)		
Single-phase 220 V	LS1R6A	—	—	45	11
	LS2R8A	—	—	45	22
Single-phase or three-phase 220 V	LS5R5A	50	50	45	31
Three-phase 220 V	LS7R6B	50	50	45	31
	LS7R6A	25	80	20	47
	LS012A	25	80	20	64
Three-phase 380 V	LT3R5A	50	80	45	26
	LT5R4A	50	80	45	53
	LT8R4A	50	80	35	53
	LT012A	50	80	35	106

Servo drive model M6-[][][][][][][]		Built-in braking resistor specification		Min. allowable resistance of external braking resistor (Ω)	Max. braking energy absorbed by capacitor (J)
		Resistance (Ω)	Capacity (W)		
	LT017A	—	—	25	106
	LT021A	—	—	25	128
	LT026A	—	—	25	128

Note:

1. The drive operates with PB and IR short-circuited by default; the internal braking resistor is applied under the circumstances.
2. In case the internal braking resistor can not deliver adequate capacity, please disconnect PB and IR, and install an external braking resistor between PB and P.
3. For external braking resistors, please contact us for technical support.
4. The symbol "—" in the table above indicates that there is no built-in braking resistor for the corresponding model.

Chapter 4 Wiring of Servo System

This chapter provides the wiring instructions for the servo drive and the related precautions.

DANGER

- Do not open the drive cover until the power supply of the drive has been completely cut off for at least 10 minutes.
- Even if the power supply is cut off, high voltage may remain inside the servo drive. To prevent electric shock, do not touch the power terminals. After discharging is completed, the CHARGE indicator will turn off. Make sure that the wiring and inspection be conducted only when the CHARGE indicator is off.
- Only the well-trained and authorized personnel are allowed to perform the internal wiring of the servo drive.
- Check the wiring carefully when connecting the emergency stop or safety circuit.
- Check the voltage class of the servo drive before powering on; otherwise, personal injury, death, or equipment damage may occur.

WARNING

- Check carefully whether the rated input voltage of the servo drive is consistent with the AC power voltage before powering on.
- The servo drive has passed the dielectric withstand test before leaving the factory. Do not conduct this test again.
- Do not connect AC power supply to the U, V, or W phase.
- The diameter of the copper core used in the grounding cables shall be larger than 3.5 mm, and the grounding resistance shall be less than 10 Ω.
- There is leakage current inside the servo drive and the value of the leakage current depends on the operating conditions. To ensure safety, the drive and the motor must be grounded and a Residual Current Detector (i.e. RCD) is required. The type-B RCD is recommended. The permissible value of the leakage current is 300 mA.
- To provide the over-current protection for the input side and facilitate the power-off maintenance, the servo drive shall be connected to the AC power supply through an air switch or a fuse.

4.1 Servo drive main circuit connection

4.1.1 Main circuit specifications

The names and functions of the servo drive main circuit terminals are as shown in Table 4-1, and the cable specifications are shown in Table 4-2.

Table 4-1 Terminal names and functions of the M6-L series servo drive main circuit

Terminal name	Terminal symbol	Drive model M6-Lxxxxx	Terminal function
Main circuit power supply input terminals	L1, L2	LS1R6A, LS2R8A	Main circuit single-phase 220 V power supply input
	L1, L2, L3	LS5R5A, LS7R6B, LS7R6A, LS012A	Main circuit three-phase 220 V power supply input
		LT3R5A, LT5R4A, LT8R4A, LT012A, LT017A, LT021A, LT026A	Main circuit three-phase 380 V power supply input
Control circuit input terminal	L1C, L2C	Control power supply input, single-phase AC 220 V input	
DC bus terminals	P, ⊖	Servo DC bus terminal, used for multi-device common-bus connection	
Braking resistor connection terminals	P, PB, IR	LS1R6A, LS2R8A, LT017A, LT021A, LT026A	In case the braking resistor can not deliver adequate capacity, please install an external braking resistor between PB and P. Please refer to the recommendations for specifications of the external braking resistor.
		LS5R5A, LS7R6B, LS7R6A, LS012A, LT3R5A, LT5R4A, LT8R4A, LT012A	Terminals PB and IR are short-circuited by default, and the built-in braking resistor is applied under the circumstances; In case the braking resistor can not deliver adequate capacity, please disconnect PB and IR, and install an external braking resistor between P

Terminal name	Terminal symbol	Drive model M6-Lxxxxx	Terminal function
			and PB. Please refer to the recommendations for specifications of the external braking resistor.
Servo motor connection terminals	U, V, W	Used for connection with servo motor.	
Grounding terminals (two)	PE	For connection with the power supply grounding terminal and the servo motor grounding terminal for grounding	

Note:

For models with the built-in braking resistor, terminals PB and IR are short-circuited by default.

4.1.2 Main circuit cable dimensions

Recommended main circuit cable dimensions for servo drives are shown in the table below.

Table 4-2 Recommended main circuit cable specifications for M6-L series drives

Drive model M6-L[][][][][][]		Power supply input L1、L2、L3	Control power supply input L1C、L2C	Power output U、V、W	Grounding PE	Braking resistor PB、P
SIZE A	LS1R6A	18AWG (0.75 mm^2)	20AWG (0.5 mm^2)	18AWG (0.75 mm^2)	18AWG (0.75 mm^2)	18AWG (0.75 mm^2)
	LS2R8A	18AWG (0.75 mm^2)	20AWG (0.5 mm^2)	18AWG (0.75 mm^2)	18AWG (0.75 mm^2)	18AWG (0.75 mm^2)
	LS5R5A	18AWG (0.75 mm^2)	20AWG (0.5 mm^2)	18AWG (0.75 mm^2)	18AWG (0.75 mm^2)	18AWG (0.75 mm^2)
	LS7R6B	18AWG (0.75 mm^2)	20AWG (0.5 mm^2)	18AWG (0.75 mm^2)	18AWG (0.75 mm^2)	18AWG (0.75 mm^2)
SIZE B	LS7R6A	15AWG (1.5 mm^2)	20AWG (0.5 mm^2)	15AWG (1.5 mm^2)	15AWG (1.5 mm^2)	15AWG (1.5 mm^2)
	LS012A	15AWG (1.5 mm^2)	20AWG (0.5 mm^2)	15AWG (1.5 mm^2)	15AWG (1.5 mm^2)	15AWG (1.5 mm^2)

Drive model M6-L[][][][][][]		Power supply input L1、L2、L3	Control power supply input L1C、L2C	Power output U、V、W	Grounding PE	Braking resistor PB、P
	LT3R5A	15AWG (1.5 mm^2)	20AWG (0.5 mm^2)	15AWG (1.5 mm^2)	15AWG (1.5 mm^2)	15AWG (1.5 mm^2)
	LT5R4A	15AWG (1.5 mm^2)	20AWG (0.5 mm^2)	15AWG (1.5 mm^2)	15AWG (1.5 mm^2)	15AWG (1.5 mm^2)
	LT8R4A	15AWG (1.5 mm^2)	18AWG (0.75 mm^2)	15AWG (1.5 mm^2)	15AWG (1.5 mm^2)	15AWG (1.5 mm^2)
	LT012A	15AWG (1.5 mm^2)	20AWG (0.5 mm^2)	15AWG (1.5 mm^2)	15AWG (1.5 mm^2)	15AWG (1.5 mm^2)
SIZE C	LT017A	15AWG (1.5 mm^2)	20AWG (0.5 mm^2)	15AWG (1.5 mm^2)	15AWG (1.5 mm^2)	15AWG (1.5 mm^2)
	LT021A	13AWG (2.5 mm^2)	20AWG (0.5 mm^2)	13AWG (2.5 mm^2)	13AWG (2.5 mm^2)	13AWG (2.5 mm^2)
	LT026A	13AWG (2.5 mm^2)	20AWG (0.5 mm^2)	13AWG (2.5 mm^2)	13AWG (2.5 mm^2)	13AWG (2.5 mm^2)

4.2 Signal description of the first encoder (CN4)

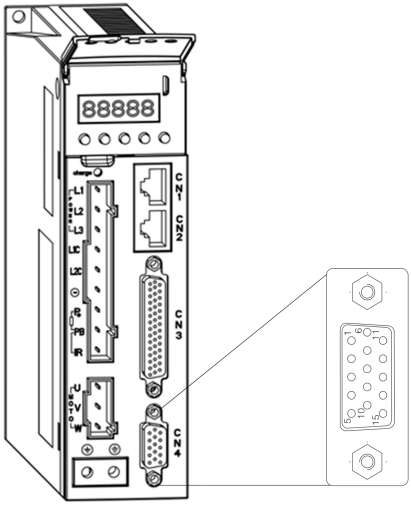


Figure 4-1 Servo motor encoder signal connection (CN4)

The interface of the first encoder for the M6-L series servo drive supports connection with multi-turn absolute encoders, incremental encoders, and sin/cos encoders. The interface functions for the above encoder types are integrated into a single DB15 port, and the interface signals are defined in the table below.

Table 4-3 First encoder interface definition

Connection port: CN4, DB15 three-row female connector		
Pin	Signal name	Signal description
1	A+	Incremental differential A+ signal
	SLO+	BiSS-C communication SLO+ signal
2	B+	Incremental differential B+ signal
3	Z+	Incremental differential Z+ signal
	MA+	BiSS-C communication MA+ signal
	DA+	Incremental DA+ signal

Connection port: CN4, DB15 three-row female connector		
Pin	Signal name	Signal description
4	COS+	Sin/Cos COS+ signal
5	SIN+	Sin/Cos SIN+ signal
6	A-	Incremental differential A- signal
	SLO-	BiSS-C communication SLO- signal
7	B-	Incremental differential B- signal
8	Z-	Incremental differential Z- signal
	MA-	BiSS-C communication MA- signal
	DA-	Incremental DA- signal
9	COS-	Sin/Cos COS- signal
10	SIN-	Sin/Cos SIN- signal
11	REF+	Sin/Cos REF+ signal
12	REF-	Sin/Cos REF- signal
13	NC	Null
14	GND	Power supply grounding
15	5 V	Power supply +5 V
Enclosure	PE	Shield layer

4.3 Signal description of the second encoder (CN6)

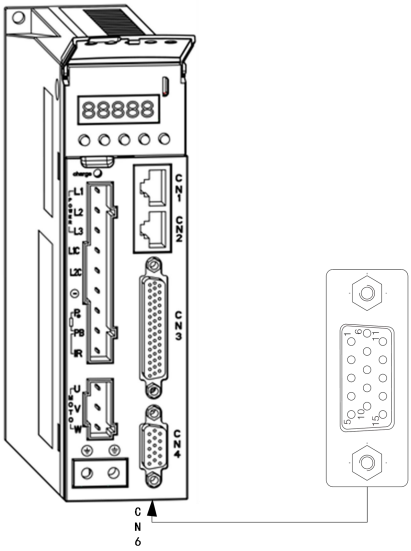


Figure 4-2 Servo motor encoder signal connection (CN6)

The interface of the second encoder for the M6-L series servo drive is used for connection with Hall-effect sensors, motor temperature detection signals, and the second encoder ABZ signals. The signal communication of the above types is integrated into a single DB15 port, and the interface signals are defined in the table below.

Table 4-4 Second encoder interface definition

Connection port: CN6, DB15 three-row female connector		
Pin	Signal name	Signal description
1	HALU+	Hall-effect differential U+ signal
	SA+	Second encoder incremental A+ signal
2	HALV+	Hall-effect differential V+ signal
	SB+	Second encoder incremental B+ signal
3	HALW+	Hall-effect differential W+ signal
	SZ+	Second encoder incremental Z+ signal

Connection port: CN6, DB15 three-row female connector		
Pin	Signal name	Signal description
4	KTY+	Motor temperature detection + signal
5	KTY-	Motor temperature detection - signal
6	HALU-	Hall-effect differential U- signal
	SA-	Second encoder incremental A- signal
7	HALV-	Hall-effect differential V- signal
	SB-	Second encoder incremental B- signal
8	HALW-	Hall-effect differential W- signal
	SZ-	Second encoder incremental Z- signal
9	GND	Power supply grounding
10	5V	Power supply +5V
11	HALU	Hall-effect single-ended U signal
12	HALV	Hall-effect single-ended V signal
13	HALW	Hall-effect single-ended W signal
14	GND	Power supply grounding
15	5 V	Power supply +5 V
Enclosure	PE	Shield layer

4.4 Encoder signal connection mode

When connecting different types of motor encoders, the connection mode of the first and second encoder interfaces are described in the tables below.

1. ABZ encoder without Hall-effect sensor

Interface definition for ABZ encoder connection (no Hall-effect sensor)			
Port	Pin	Signal name	Signal description
CN4	1	A+	Incremental differential A+ signal
	2	B+	Incremental differential B+ signal

Interface definition for ABZ encoder connection (no Hall-effect sensor)			
Port	Pin	Signal name	Signal description
	3	Z+	Incremental differential Z+ signal
	6	A-	Incremental differential A- signal
	7	B-	Incremental differential B- signal
	8	Z-	Incremental differential Z- signal
	14	GND	Power supply grounding
	15	5 V	Power supply +5 V

2. ABZ encoder with single-ended Hall-effect sensor

Interface definition for connection with ABZ encoder and open-collector single-ended Hall-effect sensor			
Port	Pin	Signal name	Signal description
CN4	1	A+	Incremental differential A+ signal
	2	B+	Incremental differential B+ signal
	3	Z+	Incremental differential Z+ signal
	6	A-	Incremental differential A- signal
	7	B-	Incremental differential B- signal
	8	Z-	Incremental differential Z- signal
	14	GND	Power supply grounding
	15	5 V	Power supply +5 V
CN6	11	HALU	Single-ended Hall-effect U signal
	12	HALV	Single-ended Hall-effect V signal
	13	HALW	Single-ended Hall-effect W signal
	14	GND	Power supply grounding
	15	5 V	Power supply +5 V

3. ABZ encoder and differential Hall-effect sensor

Interface definition for connection with ABZ encoder and differential Hall-effect sensor			
Port	Pin	Signal name	Signal description
CN4	1	A+	Incremental differential A+ signal
	2	B+	Incremental differential B+ signal
	3	Z+	Incremental differential Z+ signal
	6	A-	Incremental differential A- signal
	7	B-	Incremental differential B- signal
	8	Z-	Incremental differential Z- signal
	14	GND	Power supply grounding
	15	5 V	Power supply +5 V
CN6	1	HALU+	Differential Hall-effect U+ signal
	2	HALV+	Differential Hall-effect V+ signal
	3	HALW+	Differential Hall-effect W+ signal
	6	HALU-	Differential Hall-effect U- signal
	7	HALV-	Differential Hall-effect V- signal
	8	HALW-	Differential Hall-effect W- signal
	14	GND	Power supply grounding
	15	5 V	Power supply +5 V

4. Tamagawa / HIPERFACE DSL

Interface definition for Tamagawa / HIPERFACE DSL connection			
Port	Pin	Signal name	Signal description
CN4	3	DA+	Absolute DA+ signal
	8	DA-	Absolute DA- signal
	14	GND	Power supply grounding
	15	5 V	Power supply +5 V

5. BiSS-C

Interface definition for BiSS-C connection			
Port	Pin	Signal name	Signal description
CN4	1	SLO+	BiSS-C communication SLO+ signal
	3	MA+	BiSS-C communication MA+ signal
	6	SLO-	BiSS-C communication SLO- signal
	8	MA-	BiSS-C communication MA- signal
	14	GND	Power supply grounding
	15	5 V	Power supply +5 V

6. Hiperface sin/cos encoder

Interface definition for connection with Hiperface sin/cos encoder			
Port	Pin	Signal name	Signal description
CN4	3	DA+	Hiperface communication DA+ signal
	4	COS+	Sin/Cos COS+ signal
	5	SIN+	Sin/Cos SIN+ signal
	8	DA-	Hiperface communication DA- signal
	9	COS-	Sin/Cos COS- signal
	10	SIN-	Sin/Cos SIN- signal
	14	GND	Power supply grounding
	15	5 V	Power supply +5 V

7. REF sin/cos encoder

Interface definition for connection with REF sin/cos encoder			
Port	Pin	Signal name	Signal description
CN4	4	COS+	Sin/Cos COS+ signal
	5	SIN+	Sin/Cos SIN+ signal
	9	COS-	Sin/Cos COS- signal
	10	SIN-	Sin/Cos SIN- signal
	11	REF+	Sin/Cos REF+ signal

Interface definition for connection with REF sin/cos encoder			
Port	Pin	Signal name	Signal description
	12	REF-	Sin/Cos REF- signal
	14	GND	Power supply grounding
	15	5 V	Power supply +5 V

8. Second encoder of incremental type (incompatible with differential Hall-effect sensor)

Interface definition for connection with second encoder of incremental type			
Port	Pin	Signal name	Signal description
CN6	1	SA+	Second encoder incremental A+ signal
	2	SB+	Second encoder incremental B+ signal
	3	SZ+	Second encoder incremental Z+ signal
	6	SA-	Second encoder incremental A- signal
	7	SB-	Second encoder incremental B- signal
	8	SZ-	Second encoder incremental Z- signal
	14	GND	Power supply grounding
	15	5 V	Power supply +5 V

4.5 Control signal interface definition

Control signal consists of digital input and output. The connection mode is DB44, with its female connector at the drive end.

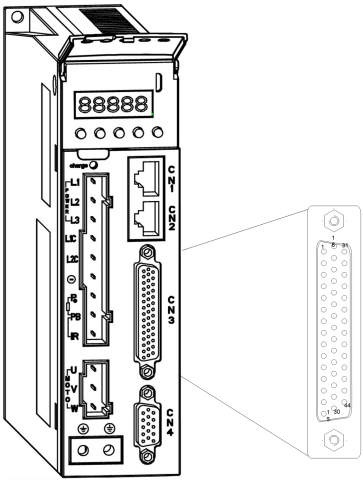


Figure 4-3 Control signal terminal diagram

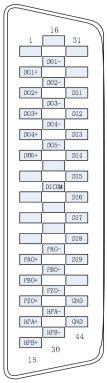


Figure 4-4 Control signal interface definition

The interface definition for the control signal is shown in the table below.

Table 4-5 Control signal interface definition

Pin	Signal name	Pin	Signal name	Pin	Signal name
1	-	16	-	31	-
2	DO1+	17	DO1-	32	-
3	DO2+	18	DO2-	33	DI1
4	DO3+	19	DO3-	34	DI2
5	DO4+	20	DO4-	35	DI3

Pin	Signal name	Pin	Signal name	Pin	Signal name
6	DO5+	21	DO5-	36	DI4
7	-	22	-	37	DI5
8	-	23	DICOM	38	DI6
9	-	24	-	39	DI7
10	-	25	-	40	DI8
11	PAO+	26	PAO-	41	DI9
12	PBO+	27	PBO-	42	-
13	PZO+	28	PZO-	43	GND
14	HSIGN+	29	HSIGN-	44	GND
15	HPULS+	30	HPULS-		

4.5.1 Digital input/output signal

Digital input and output signals are described in the table below.

Table 4-6 Digital input/output signal description

Signal name		Default function	Pin	Function description
General	DI1	/SON	33	Servo enable
	DI2	/ARST	34	Fault reset
	DI3	/SPD1	35	Multi-segment running reference 1
	DI4	/SPD2	36	Multi-segment running reference 2
	DI5	/GSEL	37	Gain switchover
	DI6	/MSEL1	38	Operation mode switchover 1
	DI7	/MSEL2	39	Operation mode switchover 2
	DI8	/P-OT	40	Positive over-travel limit switch
	DI9	/N-OT	41	Negative over-travel limit switch
	DICOM	DI common end	23	DI common end (for connection with power supply or power supply grounding)

Signal name		Default function	Pin	Function description
	DO1+	/SRDY	2	Servo ready
	DO1-		17	
	DO2+	/ALM	3	Fault output
	DO2-		18	
	DO3+	/BRK	4	Brake output
	DO3-		19	
	DO4+	/SRCH	5	Speed reach
	DO4-		20	
	DO5+	/T-LT	6	Torque limiting
	DO5-		21	

4.5.1.1 Digital input circuit

M6-L series servo has nine DI terminals in total. The DI common terminal can be connected to power supply or ground, and supports dry contact input, NPN input, and PNP input.

M6-L series servo does not provide 24 power supply to the outside, and the connection of DI uses external power supply.

The following example is based on DI1, and the same method applies to the interface circuits of DI1 to DI9.

(1) Dry contact mode

The dry contact wiring method is shown in Figure 4-5.

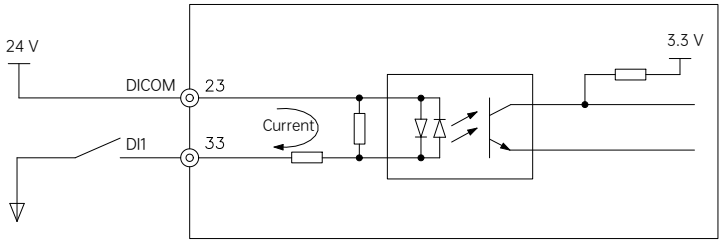


Figure 4-5 DI terminal dry contact connection mode

(2) NPN (Sinking) mode

The external controller adopts the NPN common emitter output. The wiring method is shown in Figure 4-6.

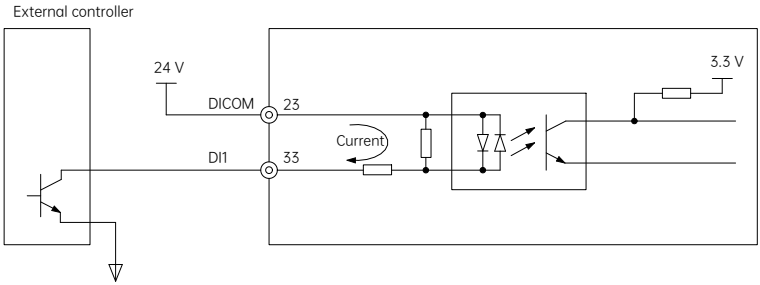


Figure 4-6 DI terminal NPN connection mode

(3) PNP (Sourcing) mode

The external controller adopts the PNP common emitter output. The wiring method is shown in Figure 4-7.

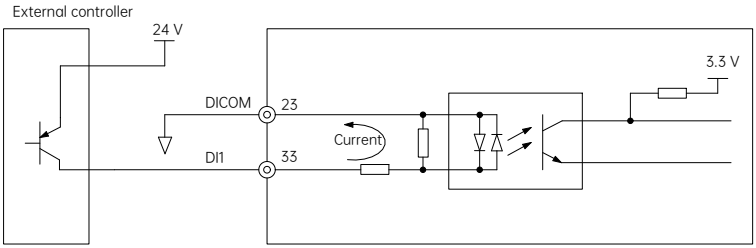


Figure 4-7 DI terminal PNP connection mode

Note:

Do not mix NPN and PNP modes on the DI terminals of the same drive.

4.5.1.2 Digital output circuit

The DO terminal adopts double-ended output and multiple output modes. It is required to use external power supply since no internal power supply is offered. The following example is based on DO1, and the same method applies to the interface circuits of DO1 to DO5.

(1) The host device is relay input

When the external device adopts relay input, the wiring method is shown in Figure 4-8.

Warning:

The inductive load (such as relay) shall be anti-parallel with the fly-wheel diode!

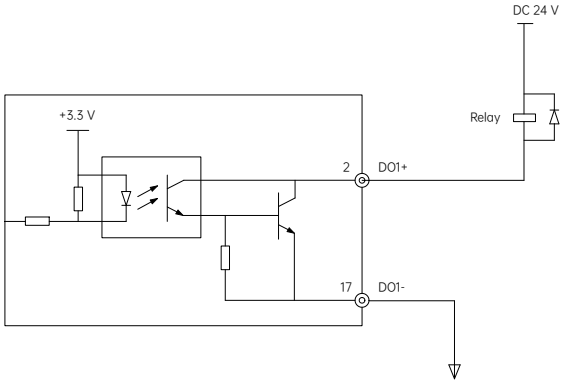


Figure 4-8 Wiring mode for connection between DO terminal and relay

(2) Sink (NPN) output

When the controller adopts sink input, the wiring method is shown in Figure 4-9.

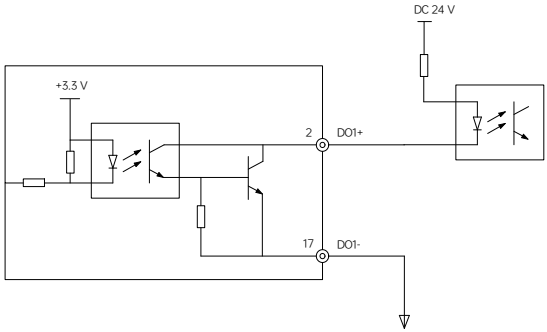


Figure 4-9 DO terminal sink (NPN) output wiring mode

(3) Source (PNP) output

When the controller adopts source input, the wiring method is shown in Figure 4-10.

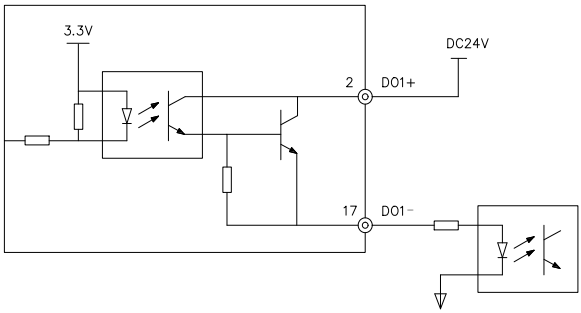


Figure 4-10 DO terminal source (PNP) output wiring mode

4.5.2 Position command input signal

Table 4-7 Position command input signal

Signal name		Pin	Function	
Position command	HPULS+	15	High-speed pulse command Differential input	Pulse input modes: Pulse + Sign CW/CCW A/B phase orthogonal
	HPULS-	30		
	HSIGN+	14		
	HSIGN-	29		
	GND	44	Differential input pulse signal ground	

The pulse command input takes the form of high-speed pulse command input, and supports differential input mode. The maximum input frequency and the minimum pulse width are described in the table below.

Table 4-8 Pulse input requirements

Pulse channel	Input mode	Max. input frequency	Min. pulse width	Voltage	Current consumption
High-speed pulse input	Differential input	4 Mpps	0.125 μs	5 V	< 5 mA

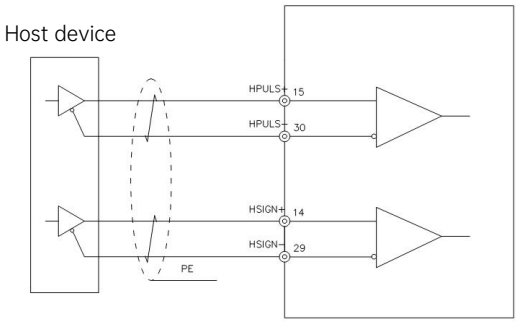


Figure 4-11 High-speed pulse input wiring diagram

4.5.3 Encoder frequency-division output circuit

Table 4-9 Encoder frequency-division output signal

Signal name		Pin	Function	
General	PAO+ PAO-	11 26	A phase frequency-division output signal	A/B orthogonal pulse frequency-division output
	PBO+ PBO-	12 27	B phase frequency-division output signal	
	PZO+ PZO-	13 28	Z phase frequency-division output signal	Homing signal
	GND	44	Pulse signal ground	

The encoder frequency-division output wiring is shown in Figure 4-12 and Figure 4-13.

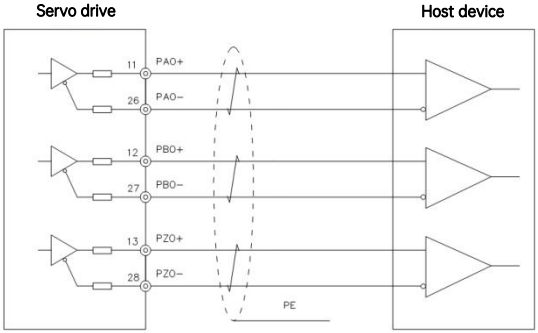


Figure 4-12 Encoder frequency-division output wiring 1

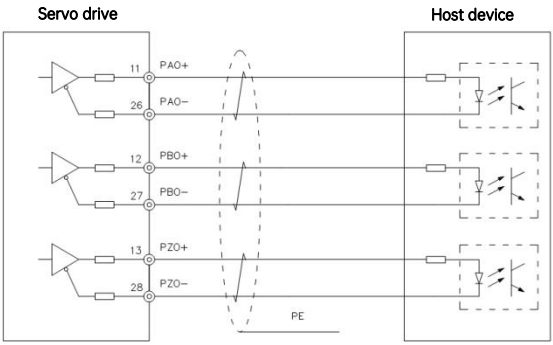


Figure 4-13 Encoder frequency-division output wiring 2

4.6 Communication interface wiring

M6-L series servo supports EtherCAT communication. The communication ports are CN1 and CN2. CN1(IN) is used to connect with the master station communication port, and CN2(OUT) is used to connect with the next slave station in the sequence.

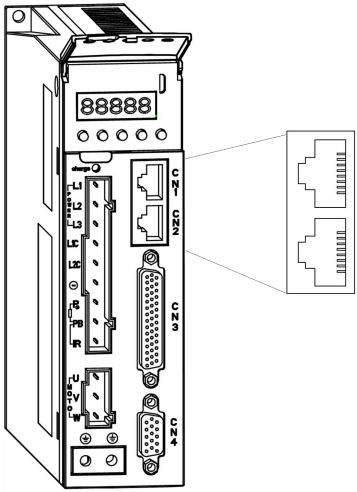


Figure 4-14 Communication interface wiring

Table 4-10 Communication interface signal definition

Pin	Definition	Description
1	TX+	Data transmit +

Pin	Definition	Description
2	TX-	Data transmit -
3	RX+	Data receive +
6	RX-	Data receive -
Enclosure	PE	Shield
4/5/7/8	Undefined	

4.7 STO terminal wiring

M6-L series provides STO function. The interface is CN7. After receiving the input signal from STO, the drive cuts off the control over the motor which terminates its operation.

4.7.1 Layout and definition of the terminal

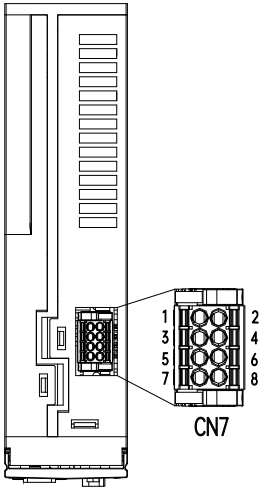


Figure 4-15 STO terminal diagram

Tabel 4-11 STO terminal signal definition

Pin	Definition	Description
1	-12 V	Drive internal -12 V power supply

Pin	Definition	Description
2	+12 V	Drive internal +12 V power supply
3	STO1+	Control input STO1+
4	STO1-	Control input STO1-
5	STO2+	Control input STO2+
6	STO2-	Control input STO2-
7	SFBK+	STO fault monitoring output +
8	SFBK-	STO fault monitoring output -

4.7.2 Principle and connection of STO input

The STO function controls the drive current output via two hardware circuit inputs. Its principle and wiring are explained as below.

(1) STO terminal function principle

Tabel 4-12 STO terminal function

Signal		Status of input and output			
STO	STO1+ STO1-	ON	ON	OFF	OFF
	STO2+ STO2-	ON	OFF	ON	OFF
STO fault monitoring output	SFBK+ SFBK-	OFF	ON	ON	ON
Drive output status		Ready	Stop	Stop	Stop
Fault alarm		Null	Er.074	Er.074	Er.074

(2) External 24 V connection example

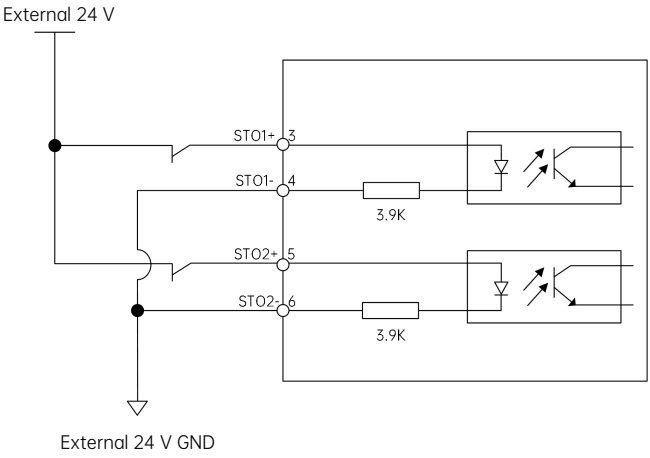


Figure 4-16 STO external 24 V input connection

(3) Internal 12 V connection example

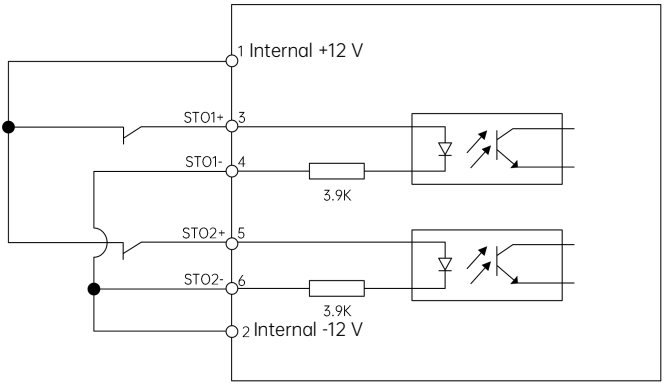


Figure 4-17 STO internal 12 V input connection

(4) Example of STO short circuit when STO is disabled

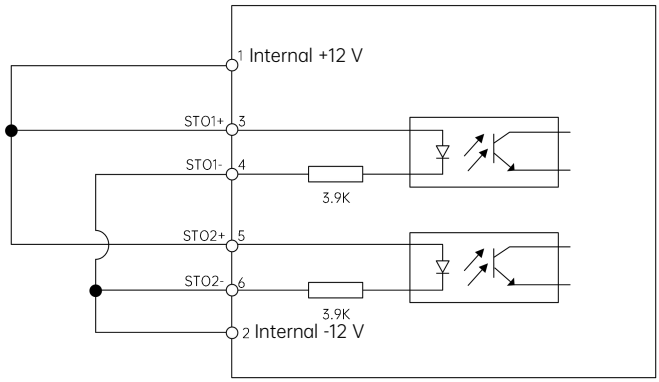


Figure 4-18 Short circuit of STO input

Note:

1. When the STO function is not in use, it is required to connect STO1+ and STO2+ to +12 V, and connect STO1- and STO2- to -12 V, as shown in the figure above. The servo would work normally only under such circumstances.

2. The STO terminal +12 V and -12 V are the internal power supply dedicated for STO function use only. Do not use them for other purposes.

3. The maximum distance between the STO input and the operation contact point is 30 m.

Chapter 5 Operation Panel

5.1 Interface introduction

M6-L series servo drive offers an operation panel that consists of five LED digital tubes and 5 keys for operational status display and parameter setting.

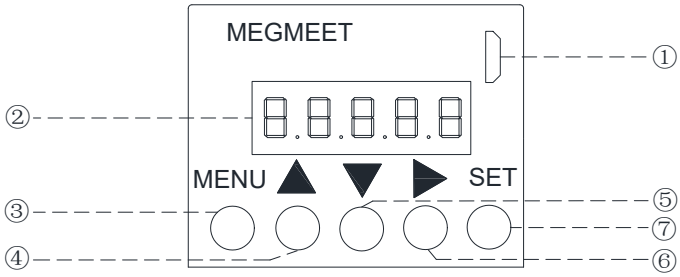


Figure 5-1 Appearance of the panel interface

Panel key functions are described in the table below.

Table 5-1 Panel key function

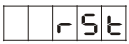
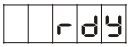
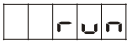
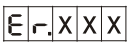
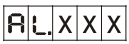
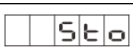
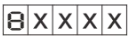
Key	Key name	Function
MENU	Menu/Exit key	When the interface is in the operational status display mode or monitoring parameter menu mode, this key serves as the switchover between the operational status display and the parameter setting level 1 menu, or between the monitoring parameter menu and the parameter setting level 1 menu. When the interface is in the parameter setting level 2 menu, this key serves as the return key to the upper-level menu.
▶	Switch/Shift/Page key	When the interface is in the operational status display mode, this key serves as the switchover between the operational status display and the monitoring parameter menu. When the interface is in the parameter setting mode, this key serves to shift to the next blinking digit on the left. When the parameter value is greater than 5 digits and unmodifiable, this key serves to scroll the parameter value display.
▲	Increase key	When the interface is in the monitoring parameter menu mode, this key serves to select the specific monitoring parameter.

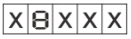
Key	Key name	Function
		When the interface is in the parameter setting mode, this key serves to increase the value of the blinking digit (hold the key for faster increase).
▼	Decrease key	When the interface is in the monitoring parameter menu mode, this key serves to select the specific monitoring parameter. When the interface is in the parameter setting mode, this key serves to decrease the value of the blinking digit (hold the key for faster decrease).
SET	Enter/Confirm/Reset key	When the interface is in the parameter setting mode, this key serves to enter the lower-level menu, or to confirm the setting of the parameter value and return to the upper-level menu. When the interface is in the fault status display mode, this key serves to reset the fault.

5.2 Operational status display

M6-L series servo drive offers display of the following operational status.

Table 5-2 Servo drive function status and display

Graphics in LED display	Symbol	Status description
	"rst"	State of initialization upon power-on, indicating the system is in the state of start or reset.
	"nrd"	Indicating the start or reset is completed and that the servo is not ready.
	"rdy"	Indicating the servo system is in the normal state through self-inspection and ready for the command from the host device.
	"run"	State of servo running
	"Er.xxx"	State of servo error
	"AL..xxx"	State of servo alarm
	"sto"	State of servo Safe Torque Off (STO)
	"8xxxx"	When the drive enters the OP state, the following control

Graphics in LED display	Symbol	Status description
		modes (P02.0) will be displayed: 0: Speed mode 1: Position mode 2: Torque mode 3: Speed mode ←→ Position mode 4: Torque mode ←→ Position mode 5: Speed mode ←→ Torque mode 6: Speed mode ←→ Torque mode ←→ Position mode 8: EtherCAT mode
	"x8xxx"	When the drive enters the op state, the following bus operation modes (6061h) will be displayed: 1: Profile position mode 3: Profile velocity mode 4: Profile torque mode 6: Homing mode 8: Cyclic synchronous position mode 9: Cyclic synchronous velocity mode A: Cyclic synchronous torque mode

5.3 Operational status display & parameter setting flowchart

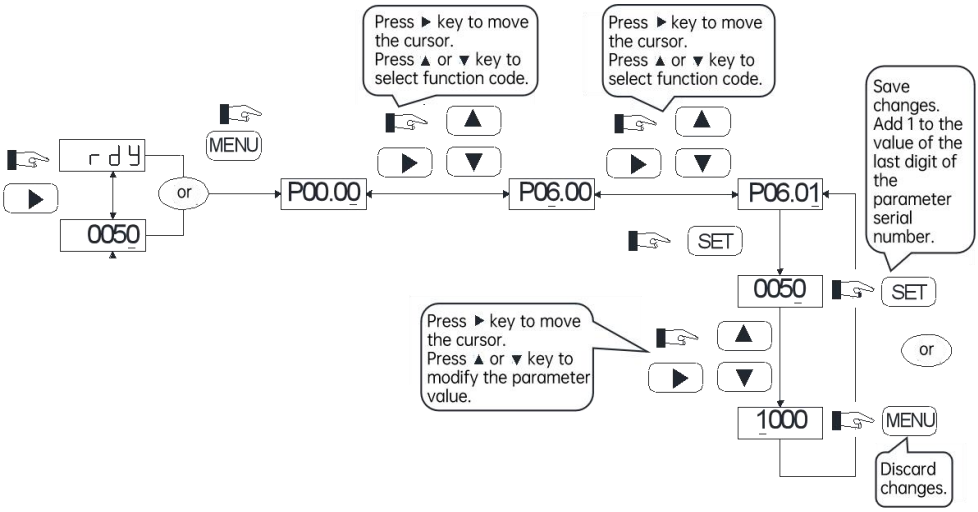


Figure 5-2 Flowchart of operational status display and parameter setting

1. When the servo drive initialization upon power-on is completed, the panel enters the operational status display mode by default. If the system is determined to be normal by self-inspection, the LED will display "rdy".
2. When the interface is in the operational status display mode, press ▶ key to switch between the operational status display mode and the monitoring parameter menu mode.
3. When the interface is in the monitoring parameter menu mode, press ▼/▲ key to select the monitoring parameter.
4. When the interface is in the operational status display mode or monitoring parameter menu mode, press MENU key to switch between the present mode and the parameter setting level 1 menu.
5. When the interface is in the parameter setting level 1 menu, press ▶ key to move the cursor to the parameter group or the parameter serial number.
6. When the interface is in the parameter setting level 1 menu, press ▼/▲ key to select the parameter group and the parameter serial number required.
7. When the interface is in the parameter setting level 1 menu, press SET key to enter the parameter setting level 2 menu and display the present value of the selected parameter. If the value is currently open for modification, the last digit will blink.
8. When the interface is in the parameter setting level 2 menu, press ▶ key to select the digit requiring modification, and press ▼/▲ key to increase or decrease the value.

9. When the value is modified, press SET key to save the changes and return to the upper-level menu, or press MENU key to discard changes and return to the upper-level menu.

5.4 Parameter value display

1. Display of parameter values of 5 digits and below

The parameter value which ranges from -9999 to 99999 can be displayed/edited on the same page.

2. Display of parameter values above 5 digits

When the parameter value is beyond the range from -9999 to 99999, it is required to turn the page for value display and editing. This system supports value display up to three pages. The following figure illustrates the page display logic. For example, the parameter value -21474836.48 can be displayed in three pages, with the value divided into [-21], [4748], and [36.48] on each page, as shown in the figure below.

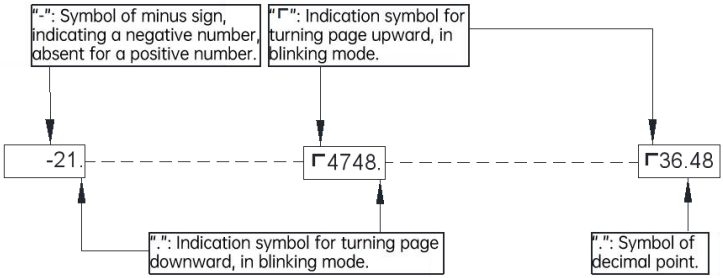


Figure 5-3 Page display logic for parameter values

If the parameter value is currently open for modification, press ▶ key to shift and select the digit requiring modification. If modification of values is not available, the ▶ key serves only for page turning.

Chapter 6 Instruction on Commissioning

6.1 Inspection before operation

Disconnect the servo motor from its load, and remove the coupling and its related components from the connected shaft of the servo motor. Check whether the servo motor operates normally without load. To prevent potential risks, load the servo motor again only when the no-load operation is determined to be normal.

Before operation, check and make sure:

(1) There is no obvious damage on the exterior of the servo drive;

(2) The wiring terminals have been insulated;

(3) There are no conductive objects, such as screws or metal pieces, or combustible objects inside the servo drive, and there are no conductive foreign objects around the wiring terminals;

(4) The servo drive and external braking resistor are not placed on combustible objects.

(5) The wiring is completed fully and correctly:

- Power cables, auxiliary power cables, and grounding cables of the servo drive are properly wired;
- All control signal cables are properly and reliably wired;
- Limit switches and protection signals are properly connected.

(6) The servo drive enable switch is in OFF state.

(7) The power circuit is cut off, and the emergency stop circuit is ON.

(8) And that the external voltage reference of the servo drive is correct.

Power on the servo drive when no operation command is sent by the controller.

Check and make sure:

(1) The servo motor works properly without vibration or excessive noise.

(2) All parameters are correctly set. Unexpected actions may occur due to different mechanical characteristics. Please do not set the parameters to extreme values

(3) The bus voltage indicator and the digital display work normally.

6.2 Commissioning

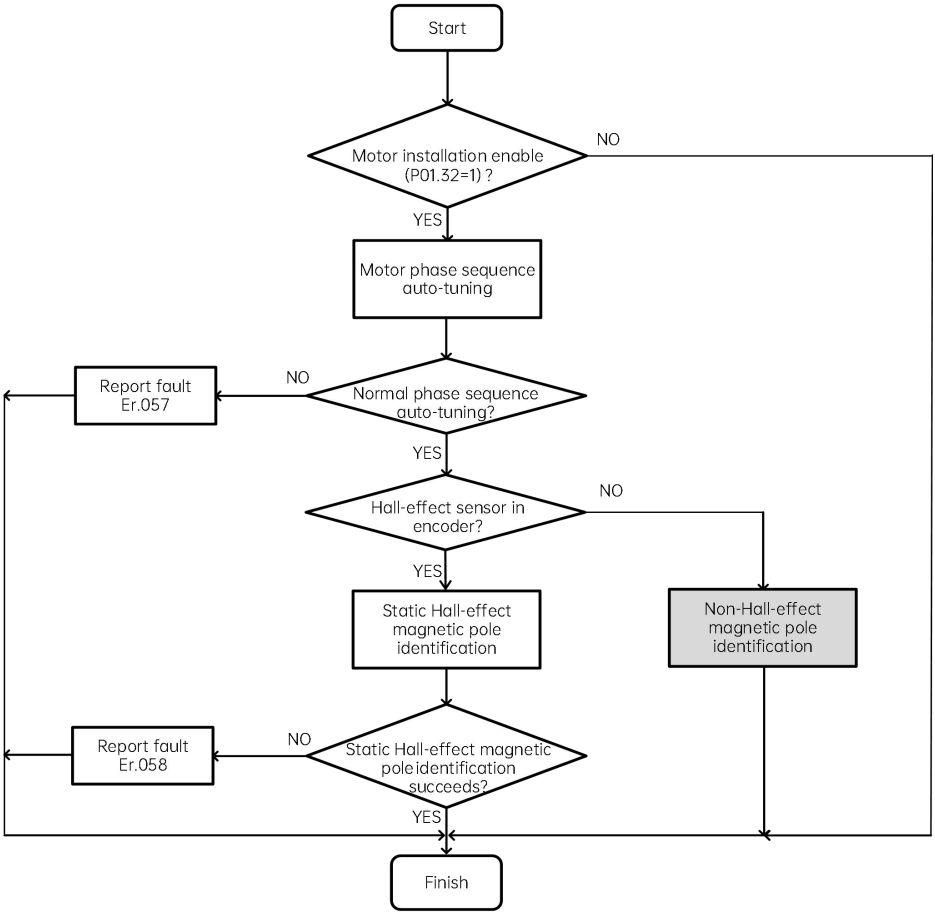
6.2.1 Motor installation

After the motor is correctly wired, set the related parameters, such as motor type, motor parameter,

encoder type, Hall-effect sensor selection, temperature detector, pole pitch, encoder resolution, etc.

Start motor installation. If the motor is equipped with a Hall-effect sensor, the motor installation process will include phase sequence auto-tuning and static Hall-effect magnetic pole identification which proceeds automatically afterwards. If the motor is not equipped with a Hall-effect sensor, the motor installation process will include phase sequence auto-tuning and non-Hall-effect magnetic pole identification.

The process is illustrated in the diagram below.



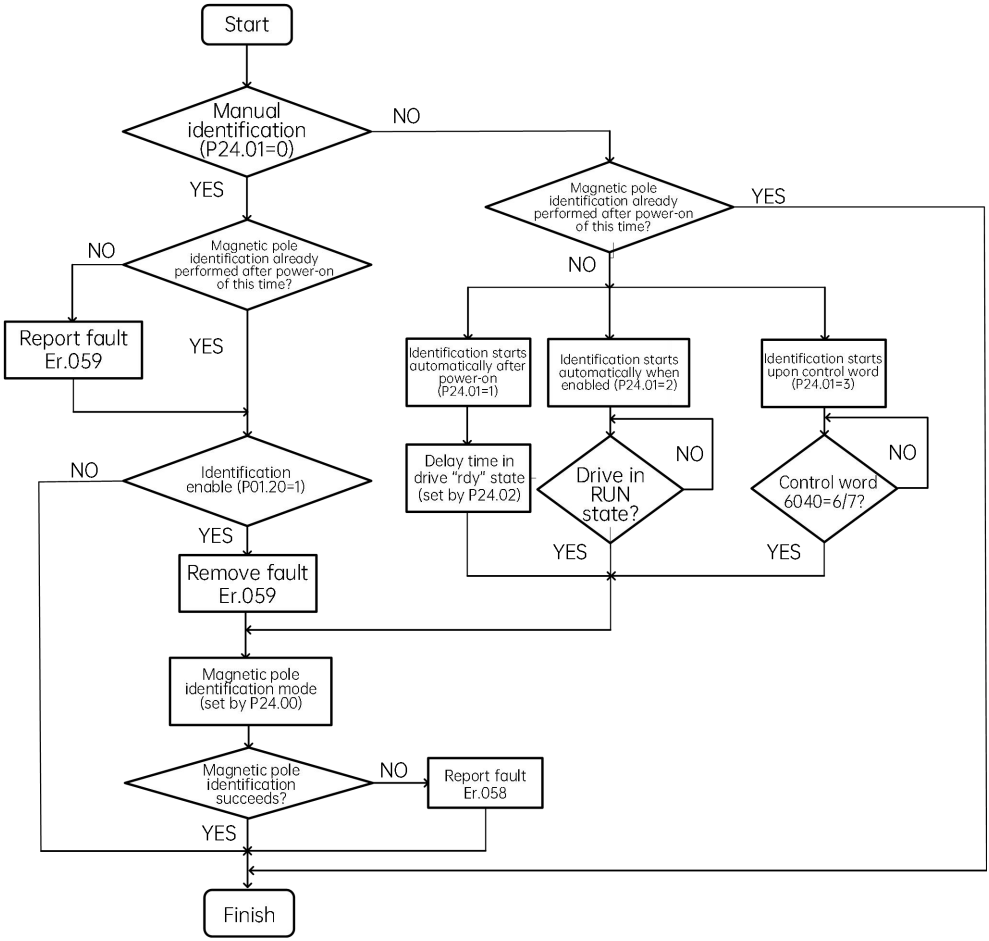
6.2.2 Magnetic pole identification

To ensure normal operation of the motor, it is required to perform magnetic pole identification (i.e. initial rotor position identification) before the running of the controlled motor.

As indicated in section 6.2.1, if the motor is equipped with a Hall-effect sensor, static Hall-effect magnetic pole identification will be performed automatically during the motor installation process. If no Hall-effect sensor is equipped, it is required to perform non-Hall-effect magnetic pole identification.

There are two methods for non-Hall-effect magnetic pole identification: pre-positioning, and micro-motion.

The magnetic pole identification flowchart is shown below.



Magnetic pole identification adopts manual and automatic modes. Set P24.01 to 0 to select manual mode, under which it is required to set P01.20 to 1 after power-on and perform manual identification once. Otherwise, fault Er.059 will be reported. Set P24.01 to a non-0 value to select automatic mode which offers three methods: automatic identification after power-on, automatic identification when enabled, and identification upon control word. Set P24.01 to select the method.

6.2.3 Jog commissioning

After the wiring is completed, perform jog commissioning to check whether the servo motor can operate normally and whether there is abnormal vibration or noise when rotating. Jog commissioning can be conducted via the panel or two external DI terminals, and the rotation speed is set by P06.05.

a. Jog commissioning via panel

Select P02.00 on the panel for control mode selection and set the function code to 0. Select P06.05 to set the jog running rotation speed. Afterward, select P06.06 and press SET key to display the present speed. Choose forward/reverse jog running via the ▼/▲ key. Press SET/MENU key to exit the jog running mode.

b. Jog commissioning via DI terminal

Configure two external DI terminals and set them to FunIN.17 and FunIN.18 functions respectively. After setting the jog running speed via P06.05, choose forward/reverse jog running through adjusting the DI terminal state.

6.3 Electronic gear

With the electronic gear function enabled, the movement amount of the workpiece corresponding to a single command pulse can be designated to an arbitrary value, and there is no need to consider the mechanical reduction ratio or the encoder pulses during system control.

6.3.1 Procedure of electronic gear ratio setting

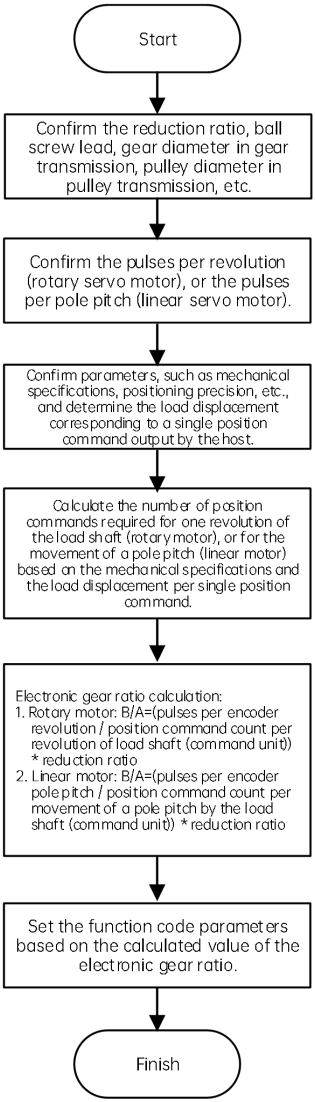


Figure 6-1 Procedure of electronic gear ratio setting

The parameter function of the electronic gear ratio is illustrated as below:

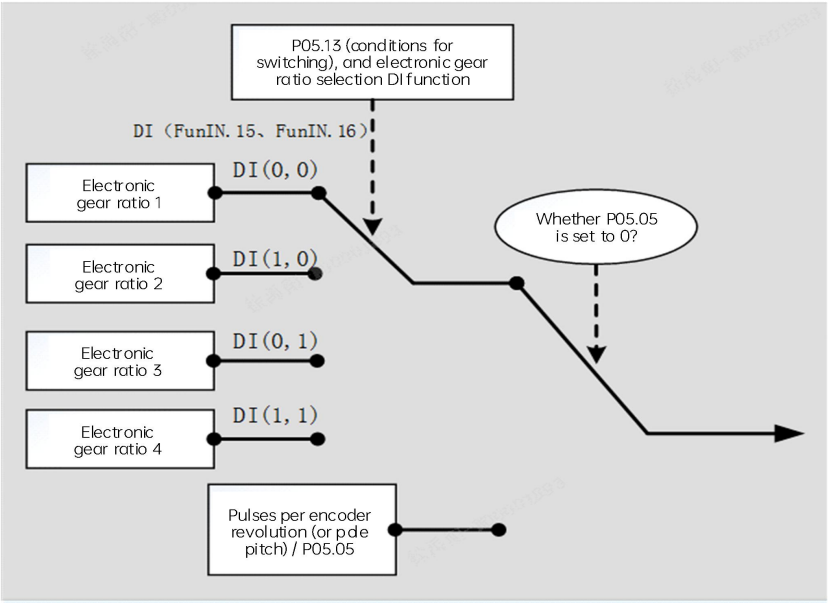


Figure 6-2 Electronic gear ratio function diagram

When P05.05 is set to a non-0 value, the electronic gear ratio formula is

$$\frac{B}{A} = \frac{\text{Pulses per encoder revolution (or pole pitch)}}{P05.05}.$$

The electronic gear ratio 1 to 4 are invalid under such circumstances.

6.3.2 Pulses per encoder revolution (pole pitch)

When working with a rotary motor, the electronic gear ratio is calculated using the pulses per encoder revolution; when working with a linear motor, the electronic gear ratio is calculated using the pulses per encoder pole pitch.

Different methods shall be adopted to calculate the pulses due to specific types of encoder, as shown in the table below.

	Pulses per revolution (rotary motor)	Pulses per pole pitch (linear motor)
Serial absolute encoder	P01.19 * 4	Pole pitch / encoder resolution
Incremental	P01.19 * 4	Pole pitch / encoder resolution

	Pulses per revolution (rotary motor)	Pulses per pole pitch (linear motor)
encoder		
Sin/Cos encoder	Number of sin/cos encoder lines* 2^n (n refers to sin/cos encoder interpolation bits) or P01.19 * 4 **Note:** P01.19 refers to the number of sin/cos encoder lines after interpolation.	Number of sin/cos encoder lines* 2^n (n refers to sin/cos encoder interpolation bits)

In the above table, P01.19 defines the number of encoder lines. For rotary motors, it refers to the number of lines per revolution; for linear motors, it refers to the number of lines per pole pitch.

When the linear motor works with an absolute or incremental encoder, the pulses and the number of lines per pole pitch are both calculated using the pole pitch and the encoder resolution, and the calculation formulas are as below:

Pulses per pole pitch = Pole pitch / Encoder resolution

Number of encoder lines = Pole pitch / (Encoder resolution * 4)

When the linear motor works with a sin/cos encoder, the pulses and the number of lines per pole pitch are both calculated using the pole pitch and the encoder resolution, and the calculation formulas are as below:

Pulses per pole pitch = Number of sin/cos encoder lines * $2^{\text{Sin/Cos encoder interpolation bits}}$

Number of encoder lines = Number of sin/cos encoder lines * $2^{\text{Sin/Cos encoder interpolation bits}}$ / 4

Calculation examples of the pulses and the number of lines per pole pitch for linear motor encoders are shown below.

(1) Linear motor with an absolute or incremental encoder: pole pitch = 32 mm, encoder resolution P01.30 = 1 um/p;

Pulses per pole pitch = (32*1000)/1 = 32000

Number of encoder lines = 32000/4 = 8000

(2) Linear motor with a sin/cos encoder: number of sin/cos encoder lines P01.24 = 8192, sin/cos encoder interpolation bits P01.25 = 16;

Pulses per pole pitch = 8192 * 2^{16} = 536870912

Number of sin/cos encoder lines after interpolation = 536870912/4 = 134217728

6.3.3 Related function codes

a. Electronic gear ratio parameter value setting:

Function code	P05.05	P05.08	P05.09	P05.10	P05.11	P05.12
Name	Command pulses per motor revolution or per pole pitch	Electronic gear numerator	Electronic gear denominator 1	Electronic gear denominator 2	Electronic gear denominator 3	Electronic gear denominator 4
Range	0 to 8388608 [P/r] / [P/N-N]	1 to 1073741824	1 to 1073741824	1 to 1073741824	1 to 1073741824	1 to 1073741824
Min. unit	1 [P/r]/[P/N-N]	1	1	1	1	1
Default	10000	8388608	10000	10000	10000	10000
Effective time	Immediate	Immediate	Immediate	Immediate	Immediate	Immediate
Property	At stop	At stop	At stop	At stop	At stop	At stop
Function	It is used to set the number of position commands per motor revolution or per pole pitch	It is used to set the numerator of the electronic gear ratio	It is used to set the denominator of the first electronic gear ratio	It is used to set the denominator of the second electronic gear ratio	It is used to set the denominator of the third electronic gear ratio	It is used to set the denominator of the fourth electronic gear ratio

Note:

The setting range for the electronic gear ratio is $0.001 < \frac{B}{A} < 30000$; otherwise, fault Er.061 (Electronic gear ratio setting error) will occur.

b. Electronic gear ratio switchover setting

When P05.05 is set to 0, the electronic gear ratio switchover function is enabled. The switchover among the four electronic gear ratios shall be determined by the mechanical operation conditions, and it is required to set the conditions for switching the electronic gear ratio. There shall be only one electronic gear ratio effective at any time.

Related function codes:

Function code	Name	Range	Min. unit	Default	Effective time	Property	Function
P05.13	Electronic gear ratio switchover	0: Switchover after 3 ms delay when the position command	1	0	Immediate	At stop	It is used to set the conditions for switching the

Function code	Name	Range	Min. unit	Default	Effective time	Property	Function
	conditions	is 0 1: Real-time switchover					electronic gear ratio.

At the same time, set the two DI terminals of the servo drive to functions 15 and 16 (FunIN.15 and FunIN.16), and determine the active logic of the DI terminals. Refer to the table below for electronic gear ratio selection. When no DI is set to FunIN.15 or FunIN.16, FunIN.15 and FunIN.16 are disabled by default.

P05.05	P05.13	DI level of FunIN15	DI level of FunIN16	Electronic gear ratio B/A
0	0 or 1	Inactive	Inactive	P05.08/P05.09
		Active	Inactive	P05.08/P05.10
		Inactive	Active	P05.08/P05.11
		Active	Active	P05.08/P05.12
1 to 8388608	---			Encoder resolution / P05.05

6.3.4 Calculation method of electronic gear ratio

When the mechanical reduction ratio of the motor shaft and the load side is m/n, the calculation formula for the set value of the electronic gear ratio is as follows:

$$\text{Electronic gear ratio } \frac{B}{A} = \frac{\text{Pulses per encoder revolution (or pole pitch)}}{\text{Movement amount (command unit) per load revolution (or pole pitch)}} \times \frac{m}{n}$$

Note:

For rotary motors, m/n indicates that the load shaft rotates for n circles when the motor shaft rotates for m circles; for linear motors, m/n indicates that the load moves for n pole pitches when the motor moves m pole pitches.

a. Confirm the mechanical parameters and the servo motor encoder resolution

Confirm the mechanical parameters, including the reduction ratio, ball screw lead, pulley transmission ratio, etc., and confirm the servo motor encoder resolution.

b. Confirm positioning precision (i.e. pulse equivalent)

Pulse equivalent refers to the minimum movement unit of the load corresponding to a single pulse command signal. Pulse equivalent can be represented by forms of 0.001 mm, 0.1°, or 0.01 inch, which means when a pulse is input, a load movement in distance or angle corresponding to the pulse equivalent will be implemented.

For example, when the pulse equivalent is set to 0.001 mm, if the input command pulse reaches 50000,

the load movement amount will be (50000 * 0.001 mm) = 50 mm.

c. Calculate the number of position commands required for one rotation (or movement of one pole pitch) of the load shaft

Calculate the position command count required for one rotation (or movement of one pole pitch) of the load shaft using the mechanical parameters and the pulse equivalent.

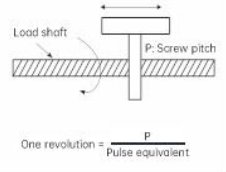
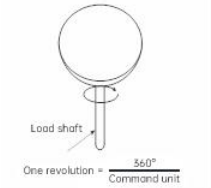
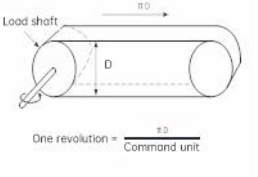
For example, if the ball screw pitch sits at 5 mm, and the pulse equivalent sits at 0.001 mm, the number of position commands for the load displacement (command bits) of one shaft rotation (or of one pole pitch) = 5 mm / 0.001 mm = 5000.

d. Calculate the electronic gear ratio

When the reduction ratio between the motor shaft and the load shaft is represented by m/n (i.e. the load shaft rotates for n circles when the motor shaft rotates for m circles), the formula is

$$\text{Electronic gear ratio} = \frac{P05.08}{P05.09} = \frac{\text{Pulses per encoder revolution (or pole pitch)}}{\text{Displacement (command unit) of one revolution (or one pole pitch) of the load shaft}} \times \frac{m}{n}$$

6.3.5 Example of electronic gear ratio setting

Step	Content	Mechanical unit		
		Ball screw	Disc	Belt pulley
				
1	Mechanical structure	Screw lead: 5 mm Reduction ratio: 1/1	Angle for one rotation: 360° Reduction ratio: 1/100	Pulley diameter: 100 mm (pulley circumference: 314 mm) Reduction ratio: 1/50
2	Pulses per encoder revolution (or pole pitch)	8388608 (23-bit)	8388608 (23-bit)	8388608 (23-bit)
3	Load displacement corresponding to one command	0.001 mm	0.01°	0.005 mm

	unit			
4	Number of position commands for one load rotation (or for movement of one pole pitch)	5 mm / 0.001 mm = 5000	360°/0.01° = 36000	314 mm / 0.005 mm = 62800 mm
5	Electronic gear ratio	$\frac{B}{A}=\frac{8388608}{5000}\times\frac{1}{1}=$	$\frac{B}{A}=\frac{8388608}{36000}\times\frac{100}{1}=$	$\frac{B}{A}=\frac{8388608}{62800}\times\frac{50}{1}=$
6	Function code	P05.08 = 8388608 P05.09 = 5000	P05.08 = 838860800 P05.09 = 36000	P05.08 = 419430400 P05.09 = 62800

6.4 Brake setting

6.4.1 Wiring diagram of servo motor brake

Wiring is required when the motor is configured with the brake unit. The brake signal connection does not involve polarity. User shall prepare a 24 V power supply. The standard wiring of the brake signal BK and the brake power supply is illustrated below.

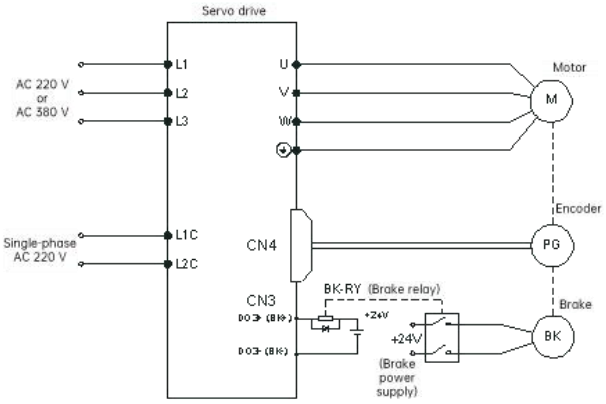


Figure 6-3 Brake wiring diagram

Note:

It is not recommended for the brake to share its power supply with other electrical units. Such measures are intended to prevent brake malfunctions caused by voltage/current drop resulted from the operation

of other electrical units.

6.4.2 Time sequence of brake

For servo motors with brake, it is required to set one DO terminal of the servo drive to function 18 (brake output signal), and determine the active logic of the DO terminal.

Based on the present state of the servo drive, the working time sequence of the brake unit offers two modes: "normal state" brake time sequence, and "fault state" brake time sequence of the servo drive.

There are two scenarios for the brake time sequence in normal state: static motor scenario, and rotating motor scenario.

a. Static motor: actual motor rotating speed less than P02.12;

b. Rotating motor: actual motor rotating speed higher than P02.12.

6.4.3 Brake time sequence for static motor

When the servo enable is switched from ON to OFF, if the present rotating speed of the motor is lower than P02.12, the drive will act in static motor time sequence.

Note:

- Do not input speed/position/torque command during the period defined by P02.10 when the brake output is switched from OFF to ON; otherwise, a command loss or operation error may occur.
- When the servo is working with perpendicular shafts, the gravity of the mechanical part in motion or any external force may cause slight movement of the mechanical unit. When the servo motor is in the static state, if the servo enable is switched to OFF, the brake output will be switched to OFF immediately. However, within the time defined by P02.11, the motor will remain powered to prevent the mechanical part movement caused by gravity or external forces.

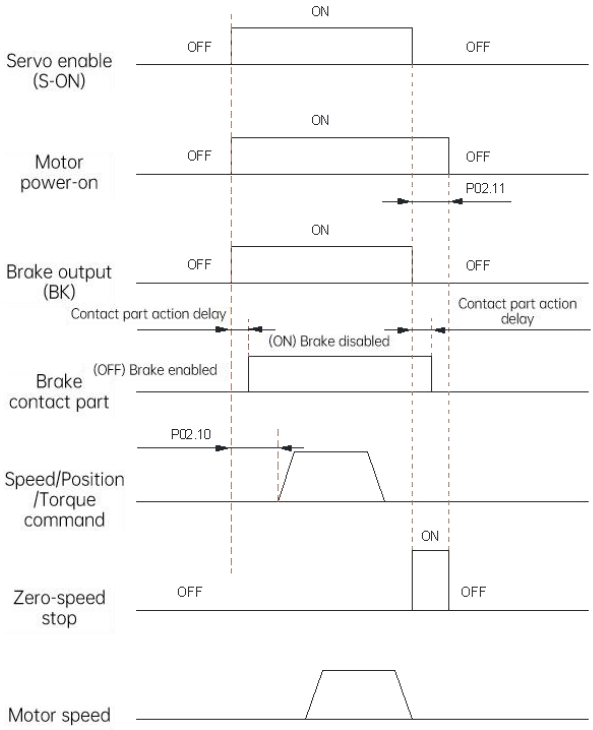


Figure 6-4 Brake time sequence for static motor

As shown in Figure 6-4, the brake function in static motor state is described below:

a. When the servo enable is ON, the brake output will be switched to ON, and the motor will enter the power-on state;

b. For the delay time of the brake contact part action, refer to the related motor specifications;

c. The time interval from the brake output being switched to ON to the command input shall be greater than the length defined by P02.10;

d. In the static servo motor state (the motor speed is less than the set value of P02.12), when the servo enable is switched to OFF, the brake output will be switched to OFF at the same time; P02.11 enables the setting of delay from the brake output being switched to OFF to the motor's entry into the non-powered state.

Function code	Name	Range	Default	Effective time	Property
P02.10	Delay from the brake output being switched to ON to the command input	20 to 500 ms	250	Immediate	During running
P02.11	Delay from the brake output being	1 to	150	Immediate	During

Function code	Name	Range	Default	Effective time	Property
	switched to OFF to the motor's entry into the non-powered state	1000 ms			running

6.4.4 Brake time sequence for rotating motor

When the servo motor is in the rotating state, pay special attention to the followings:

- Do not input speed/position/torque command during the period defined by P02.10 when the brake output is switched from OFF to ON; otherwise, a command loss or operation error may occur.
- When the servo motor is rotating, if the servo enable is switched to OFF, the motor will enter the zero-speed stop state; however, the brake output will be switched to OFF only when any of the following prerequisites is met:

  a. The time defined by P02.13 is not reached when the motor speed is decreased to P02.12;

  b. The time defined by P02.13 is reached, but the motor speed remains higher than P02.12.
- After the brake output is switched from ON to OFF, the motor will remain powered during the following 40 ms; such measures are intended to prevent the unnecessary movement of the mechanical part caused by gravity or external forces.

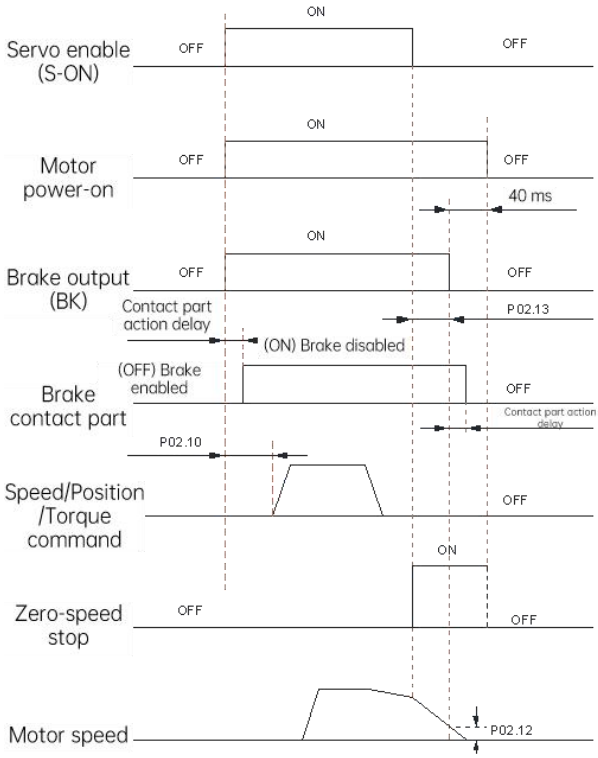


Figure 6-5 Brake time sequence for rotating motor

As shown in Figure 6-5, the brake function in rotating motor state is described below:

a. When the servo enable is ON, the brake output will be switched to ON, and the motor will enter the power-on state;

b. For the delay time of the brake contact part action, refer to the related motor specifications;

c. The time interval from the brake output being switched to ON to the command input shall be greater than the length defined by P02.10;

d. In the rotating servo motor state, when the servo enable is OFF, the brake output delay, which starts after the servo enable is switched to OFF, can be set via P02.12 and P02.13; the motor will enter the non-powered state only when the 50 ms delay is reached after the brake output is switched to OFF.

Function code	Name	Range	Default	Effective time	Property
P02.12	Brake command output speed limit value	0 to 3000 [rpm] / [mm/s]	10	Immediate	During running

Function code	Name	Range	Default	Effective time	Property
P02.13	Delay from the servo enable being switched to OFF to the brake output being switched to OFF	1 to 30000 ms	500	Immediate	During running

6.4.5 Brake time sequence in fault state

Once a drive fault occurs, the motor enters the non-powered state immediately, and at the same time, the brake output will be switched from ON to OFF to disable the brake function.

Chapter 7 EtherCAT Communication

7.1 EtherCAT bus overview

EtherCAT is an industrial Ethernet-based fieldbus system that features high performance, low cost, easy use, and flexible topology. It is favorable for applications requiring ultra-high speed I/O network. EtherCAT adopts standard Ethernet physical layer with twisted pair cabling or optical fibers (100Base-TX or 100Base-FX) used as the transmission media.

An EtherCAT system includes the master and the slave. The master requires a common network adapter, and the slave requires a special slave control chip, such as ET1100, ET1200, or FPGA.

EtherCAT offers comprehensive trans-layer data processing abilities throughout the system where I/O layer is included, and it features the following advantages:

- No sub-bus is required for the lower layer;
- No gateway delay;
- Single EtherCAT communication system covering all devices in the network, including:
  - I/O, sensors, actuators, drives, display, etc.
- Transmission rate: 2 x 100 Mbit/s (high-speed Ethernet, full duplex mode)
- Synchronization: synchronization jitter < 1 μs (number of nodes up to 300, and cable length within 120 m between two devices)
- Update time (in typical applications):
  - 256 DI/DOs: 11 μs
  - 1000 DI/DOs distributed within 100 nodes: 30 μs = 0.03 ms
  - 200 AI/AOs (16-bit): 50 μs, sampling rate at 20 kHz
  - 100 servo axes (8 bytes IN + 8 bytes OUT for each): 100 μs = 0.1 ms
  - 12000 DI/DOs: 350 μs

To support more types of devices and extend its application layer, EtherCAT establishes the following application protocols:

- CoE (CAN application protocol over EtherCAT interface)
- SoE (Servo Drive Profile over EtherCAT, compliant with IEC 61800-7-204)
- EoE (Ethernet over EtherCAT)
- FoE (File Access over EtherCAT)

The slave device does not need to offer compatibility with all the above communication protocols; instead, it only needs to support the protocol which is the most applicable.

7.2 M6-L series drive bus function introduction

M6-L series servo drive adopts EtherCAT communication (real-time Ethernet communication), and CANopen Drive Profile (CiA 402) on the application layer.

7.2.1 M6-L series communication specifications

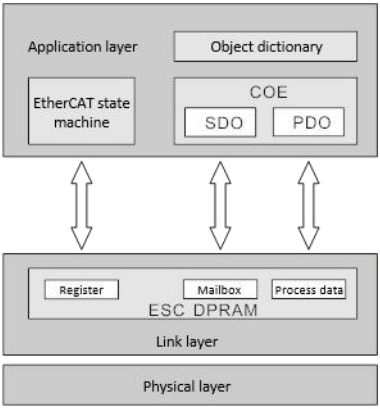
The communication specifications are shown in the table below:

Item		Specification
Communication standard		IEC 61158 Type12, IEC 61800-7 CiA 402 Drive Profile
Physical layer	Transfer protocol	100BASE-TX (IEEE 802.3)
	Maximum distance	100 m
	Interface	CN1 (RJ45): EtherCAT Signal IN CN2 (RJ45): EtherCAT Signal OUT
	Cable	Category 5 cable
Application layer	SDO	SDO requests, SDO responses
	PDO	Mutable PDO mapping
	CiA 402 Drive Profile	Profile position mode Profile velocity mode Profile torque mode Homing mode Cyclic synchronous position mode Cyclic synchronous velocity mode Cyclic synchronous torque mode
Distributed clock		DC mode, DC cycle ⩾ 250 μs

7.2.2 EtherCAT Network reference model

Multiple kinds of application layer protocols are available for EtherCAT communication. The IEC 61800-7 (CiA 402) - CANopen motion control profile is used for M6-L series servo drives.

The following figure shows the EtherCAT communication structure based on CANopen application layer.



The EtherCAT (CoE) network reference model consists of two parts: the data link layer and the application layer.

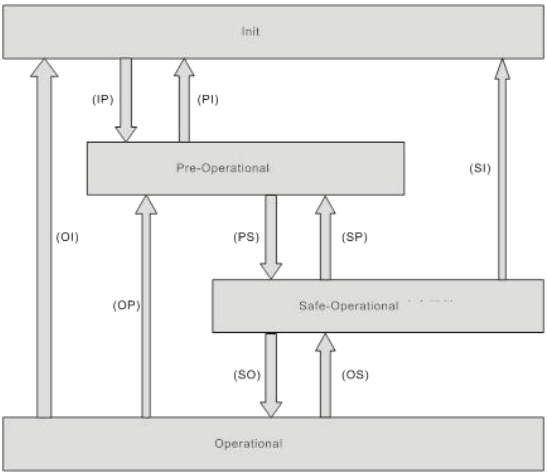
The data link layer is responsible for EtherCAT communication protocol, and the application layer is embedded with the CANopen drive Profile (CiA 402) communication protocol. The application layer object dictionary in the CoE contains communication parameters, application data, and PDO mapping information.

The process data object (PDO) consists of a mappable Object Dictionary. The contents of the PDO data are defined by PDO mapping. While PDO data is read and written periodically and does not need searches in an object dictionary, mailbox communication (SDO) is non-periodic and needs searches in the object dictionary during reading and writing.

7.2.3 EtherCAT network state machine

EtherCAT state machine is used to describe the state and state changes of the slave application.

State change requests are usually initiated by the master station and responded to by the slave station.



The EtherCAT state machine must support the following four states and coordinate the states of the master and slave application programs during initialization and operation.

These four states are:

Init (I), indicating initialization;

Pre-Operational (P);

Safe-Operational (S);

Operational (O).

Transition from "Init" to "Operational" must be processed in the sequence of "Init → Pre-Operational → Safe-Operational → Operational"; no evasion of state is allowed. Transition from "Operational" to "Init" can be processed with certain states bypassed.

The table below explains the state transition and initialization process.

State & transition	State description & transition process
Init (I)	No communication in the application layer, neither mailbox data or process data; The master can read/write EtherCAT Slave Controller (ESC) register only.
IP	The master configures the slave address; Configure the mailbox channel; Configure the Distributed clock (DC); Check whether the mailbox is successfully initialized; Request for Pre-Operational state.
Pre-Operational (P)	Mailbox data communication in the application layer (SDO) is activated.

State & transition	State description & transition process
PS	The master initializes the process data mapping via mailbox communication; The master configures the Sync Manager (SM) channel for the process data communication; The master configures FMMU (Fieldbus Memory Management Units); The master requests for Safe-Operational state.
Safe-Operational (S)	Process data communication is available, but only the reading of input data is allowed. No output signal is generated. The output is set to the Safe-Operational state. (SDO, TPDO)
SO	The master sends valid output data; The master requests for Operational state.
Operational (O)	Both input and output are valid; Mailbox communication is available. (SDO, TPDO, RPDO)

7.2.4 Process data object (PDO)

EtherCAT PDO consists of Reception PDO (RPDO) and Transmission PDO (TPDO). The slave receives the master command via RPDO, and responds with its state via TPDO.

7.2.4.1 Sync Manager PDO assignment

The process data contains multiple PDO mapping data objects during EtherCAT cyclic data communication. The CoE protocol defines the PDO mapping object list of the Sync Manager using the data objects 1C10h to 1C2Fh. Multiple PDOs can be mapped to different sub-indexes. The M6-L series servo drive supports assignment of four RPDOs and four TPDOs, as described in the table below.

Index	Sub-index	Description
1C12h	01	Assign 1600h as the RPDO mapping object
1C13h	01	Assign 1A00h as the TPDO mapping object

7.2.4.2 PDO mapping parameter

PDO mapping is used to establish the mapping relation between the object dictionary and the PDO (real-time process data).

In the object dictionary, indexes 1600h to 1603h store RPDO mapping, and indexes 1A00h to 1A03h store TPDO mapping.

The M6-L series servo drive provides one mutable RPDO1, three fixed RPDO2 to RPDO4, one mutable TPDO1, and three fixed TPDO2 to TPDO4 for use, as listed in the table below.

PDO	Index	Max. number of mapping objects	Max. number of bytes	Default Mapping Object
RPDO1	1600h	10	40	6040h (Control word) ……
RPDO2	1601h	2	6	6040 (Control word) 60FF (Target velocity)
RPDO3	1602h	2	6	6040 (Control word) 607A (Target position)
RPDO4	1603h	2	4	6040 (Control word) 6071 (Target torque)
TPDO1	1A00h	10	40	6041h (Status word) ……
TPDO2	1A01h	3	10	6041 (Status word) 6064 (Position actual value) 606C (Velocity actual value)
TPDO3	1A02h	2	6	6041 (Status word) 6064 (Position actual value)
TPDO4	1A03h	3	8	6041 (Status word) 6064 (Position actual value) 6077 (Torque actual value)

7.2.4.3 PDO configuration

PDO mapping parameters contain the objects which are mapped to the process data, including the index, sub-index, and mapping object length. The sub-index 0 indicates the number (n) of mapping

objects in the PDO, and the maximum length of each PDO is 4*n bytes, with each PDO capable of mapping one or multiple objects simultaneously. Sub-indexes 1 to n indicate the mapping content.

The contents of mapping parameters are defined as below:

Bit	31	…	16	15	…	8	7	…	0
Definition	Index			Sub-index			Object length		

The index and sub-index together define the position of an object in the object dictionary. The object length indicates the bit length of the object in hexadecimal, as shown below:

Object Length	Data Length (bit)
08h	8
10h	16
20h	32

Examples:

The mapping parameter of the 8-bit operating mode 6060-00h is 60600008h;

The mapping parameter of the 16-bit control word 6040-00h is 60400010h;

The mapping parameter of the 32-bit interpolated position 60C1-01h is 60C10120h

7.2.4.4 PDO mapping procedure

- Stop PDO assignment function (Write 0 into the sub-index 00h of both 1C12h and 1C13h; PDO assignment disabled);
- Stop PDO mapping function (Set sub-index 00h of both 1600h and 1A00h to 0 to clear the original mapping content);
- Set the content of the PDO mapping object (Based on actual application, the index, sub-index, and length of the mapping object are written respectively into the sub-indexes 1 to 10 of 1600h and 1A00h);
- Set the number of PDO mapping objects (Based on actual application, the sub-index 00h of 1600h and 1A00h is set to 1 to 10);
- Set PDO assignment object (Set the sub-index 1 of 1C12h and 1C13h);
- Enable the PDO assignment function again (Set the sub-index 00h of 1C12h and 1C13h to 1).

7.2.5 Service data object (SDO) for mailbox communication

The EtherCAT mailbox communication SDO is used for acyclic data transmission, such as communication parameter configuration and servo drive parameter configuration.

The CoE service of EtherCAT includes: Emergency message, SDO request, SDO response, Remote TxPDO transmission request, Remote RxPDO transmission request, and SDO message.

The M6-L series supports SDO request, SDO response, and SDO message.

7.2.6 Distributed Clock

In the Ethernet-based EtherCAT system, the master initializes, configures, starts, and compensate the clock drift of the distributed clock. The distributed clock at the slave end is implemented by the ESC control chip, which provides the interrupt signal and clock information for the slave. The distributed clock also records the input time of the latched input signal.

The distributed clock enables all devices in the EtherCAT system to use the same system time, which facilitates the synchronous task execution of devices. The slave device is able to generate synchronous signals based on the synchronized system time.

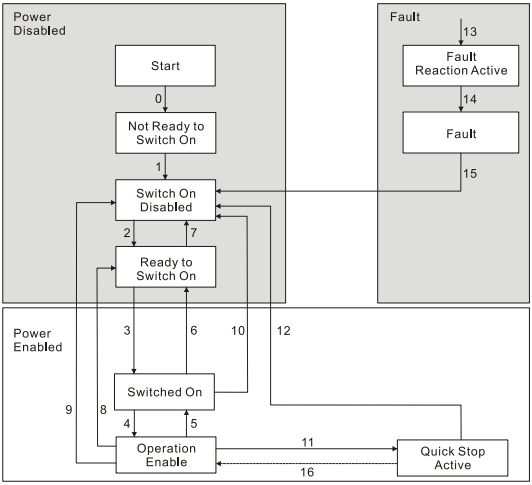
The M6-L series servo drive supports the distributed clock synchronization function. The synchronization cycle is determined by SYNC0. The synchronization cycle range varies for different operation modes. The typical synchronization cycle includes 250 μs, 500 μs, 1 ms, and 2 ms. The minimum synchronization cycle supported by M6-L series is 250 μs.

7.3 CiA 402 device control (device profile)

The device control function serves for the implementation of all the operational functions of the drive, including device state machine control and device running mode. The master station controls the drive via the control word and learns the present status of the drive via the status word of the drive.

7.3.1 CoE state machine

The CoE state machine is illustrated in the diagram below:



As shown in the diagram above, the state machine consists of three scenarios, namely Power Disabled, Power Enabled, and Fault.

After power-on, the drive completes initialization, and enters the SWITCH ON DISABLED state. Configuration of the drive operation mode is available at this moment while the power remains disabled.

After the state transition 2, 3, and 4, the system enters the OPERATION ENABLE state. The power is turned on at this moment, and the drive is in control of the motor based on the configured operation mode. Therefore, before the entry of this state, it is required to confirm that the drive parameters are correctly configured and the corresponding values are set to zero.

Switch off the circuit power after the completion of state transition 9.

If the drive reports an alarm, it will enter the Fault state. The drive will enter the Fault state whichever state it is in when an alarm is reported.

The drive states and their definitions are explained in the table below.

State	Definition
Not Ready to Switch On	The drive is in the process of initialization.
Switch On Disabled	The drive initialization is completed; The drive parameters are ready for configuration.
Ready to Switch On	The drive is ready to power on; The drive parameters are ready for configuration.

State	Definition
Switch On	The drive is powered on; The drive parameters are ready for configuration.
Operation Enable	The drive is fault-free; The drive is enabled; The parameter setting of the drive is valid.
Quick Stop Active	The drive stops quickly.
Fault Reaction Active	A fault is detected, and the drive performs the fault stop procedure.
Fault	The fault occurs, and the fault stop procedure finishes; The drive functions are disabled.

The switchover of the drive state is explained in the table below.

State switchover ID	Description
0	Automatic switchover of state upon drive reset
1	Automatic switchover of state upon drive reset
2	Shut Down command received
3	Switch On command received
4	Enable Operation command received
5	Disable Operation command received
6	Shut Down command received
7	Quick Stop and Disable Voltage command received
8	Shut Down command received
9	Disable Voltage command received
10	Quick Stop or Disable Voltage command received
11	Quick Stop command received
12	Quick Stop or Disable Voltage command received
13	Automatic switchover of state upon drive error
14	Automatic switchover of state upon drive error response completion
15	Fault Reset command received

State switchover ID	Description
16	Enable Operation command received

7.3.2 Object dictionary

The object dictionary is the most important part of the device specification. It is an ordered set of parameters and variables, containing all parameters of device description and device network state.

It contains sets of objects that can be accessed through a network in an ordered, predefined manner.

The CANopen protocol uses an object dictionary with 16-bit indexes and 8-bit sub-indexes. The structure of the object dictionary is shown in the table below.

Index range	Description
0000h–0FFFh	Data type description object area
1000h–1FFFh	Communication object area: storage of common communication parameters
2000h–5FFFh	Manufacturer-defined object area: storage of manufacturer device parameters, such as drive parameters
6000h–9FFFh	Subprotocol object area: CiA 402 protocol parameters
A000h–FFFFh	Reserved area

7.3.3 Device control word and status word

Index	Data structure	Name	Data type	Accessibility
6040h	VAR	Control word	UINT16	RW
6041h	VAR	Status word	UINT16	RO

7.3.3.1 Control word

The bit definitions of the control word are shown in the table below.

Bit15 to Bit11	Bit10 to Bit9	Bit8	Bit7	Bit6 to Bit4	Bit3	Bit2	Bit1	Bit0
Manufacture specific	Reserved	Halt	Fault reset	Operation mode specific	Enable operation	Quick stop	Enable voltage	Switch on
O	O	O	M	O	M	M	M	M

(In the table above, O is for Optional, and M is for Mandatory.)

The control commands consisting of Bit0, Bit1, Bit2, Bit3, and Bit7 of the control word are used to switch the state machine. The following table describes the defined control commands.

Command	Bit of control word					Transitions
	Fault reset	Enable operation	Quick stop	Enable voltage	Switch on	
Shutdown	0	X	1	1	0	2, 6, 8
Switch on	0	0	1	1	1	3*
Switch on	0	1	1	1	1	3**
Disable voltage	0	X	X	0	X	7, 9, 10, 12
Quick stop	0	X	0	1	X	7, 10, 11
Disable operation	0	0	1	1	1	5
Enable operation	0	1	1	1	1	4, 16
Fault reset		X	X	X	X	15

(In the table above, the bit marked with X can be bypassed.)

Bit4, Bit5, Bit6, and Bit8 of the control word have different definitions in different control modes.

Bit	Operation mode					
	Profile position mode	Profile velocity mode	Homing mode	Interpolated position mode	Cyclic synchronous position mode	Cyclic synchronous velocity mode
4	New set-point	Reserved	Homing operation start	Enable ip Mode	Reserved	Reserved
5	Change set	Reserved	Reserved	Reserved	Reserved	Reserved

Bit	Operation mode					
	Profile position mode	Profile velocity mode	Homing mode	Interpolated position mode	Cyclic synchronous position mode	Cyclic synchronous velocity mode
	immediately					
6	Abs/Rel	Reserved	Reserved	Reserved	Reserved	Reserved
8	Halt	Halt	Halt	Halt	Halt	Halt

(For definitions of each bit in the above table, please refer to the running mode description.)

7.3.3.2 Status word

The bit definitions of the status word are shown in the table below.

Bit	Description
0	Ready to switch on
1	Switched on
2	Operation enabled
3	Fault
4	Voltage enabled
5	Quick stop
6	Switch on disabled
7	Warning
8	Manufacturer specific
9	Remote
10	Target reached
11	Internal limit active
12 to 13	Operation mode specific
14 to 15	Manufacturer specific

Bit0, Bit1, Bit2, Bit3, Bit5, and Bit6 in the status word are used to indicate the state of the drive, as shown in the table below.

Bit value (binary)	State
xxxx xxxx x0xx 0000	Not ready to switch on
xxxx xxxx x1xx 0000	Switch on disabled
xxxx xxxx x01x 0001	Ready to switch on
xxxx xxxx x01x 0011	Switched on
xxxx xxxx x01x 0111	Operation enabled
xxxx xxxx x00x 0111	Quick stop active
xxxx xxxx x0xx 1111	Fault reaction active
xxxx xxxx x0xx 1000	Fault

The status word is described as below:

- The definitions for bits (Bit0 to Bit9) stay the same in different control modes; when the master sends the control word 6040h, the drive will respond with a certain state;
- Bit10, Bit11, Bit12, and Bit13 are related to control modes;
- Bit14 and Bit15 are defined by the manufacturer.

7.3.4 Common conversion factor

User-defined units are usually different from the units applied for the drive-controlled motor. To implement a unified unit system, a set of conversion factors are provided by the CiA 402 device profile to facilitate the conversion between the user-defined units and the motor units.

The default motor units of M6-L series are as follows:

- Motor displacement unit: p (pulse)
- Motor speed unit: rpm, or mm/s

The units commonly used by users are as follows:

- Load displacement unit: mm
- Load speed unit: mm/s

7.3.4.1 Gear ratio factor (6091h)

The substantial meaning of the conversion factor: the motor displacement (unit: p) corresponding to the load displacement of one user-defined unit.

The gear ratio consists of the numerator 6091-1h and the denominator 6091-2h. The proportional relationship between the load displacement (user-defined unit) and the motor displacement (motor unit) can be established via the gear ratio:

$$\text{Gear ratio factor (6091h)} = \frac{\text{Motor encoder resolution (6091 - 1h)}}{\text{Load shaft resolution (6091 - 2h)}}$$

$$\text{Motor displacement} = \text{Load displacement (user defined)} \times \text{gear ratio factor}$$

$$\text{Load feedback displacement (user defined)} = \frac{\text{Motor feedback displacement}}{\text{Gear ratio factor}}$$

Examples

For ball screw applications:

- Each load feed: 40 mm
- Screw lead: PB = 10 mm/r
- 23-bit motor encoder; resolution: P = 8388608 (p/r)

Based upon the above descriptions, the position factor is calculated as below.

Each load shaft feed:

$$\text{Position factor: Each load shaft feed} = \frac{\text{Load feed}}{\text{Lead}} = \frac{40\ \text{mm}}{10\ \text{mm/r}} = 4\ (\text{r})$$

$$\text{Position factor} = \frac{\text{Each load shaft feed} \times \text{Motor resolution}}{\text{Each load feed}} = \frac{4\ \text{r} \times 8388608\ \text{p/r}}{40} = \frac{8388608}{10}$$

It indicates that the motor displacement reaches to 8388608 pulses when the load displacement is 10 mm.

Therefore, the numerator 6091-1h can be set to 8388608, and the denominator 6091-2h can be set to 10.

7.4 Bus operation mode

M6-L series supports the following bus operation modes in CoE:

- Profile position mode
- Profile velocity mode
- Profile torque mode
- Homing mode
- Cyclic synchronous position mode
- Cyclic synchronous velocity mode
- Cyclic synchronous torque mode

The objects related to the operation modes are listed in the table below. 6060h is used to set the drive operation mode, and 6061h is used to display the present operation mode of the drive.

Index	Data structure	Name	Data type	Accessibility
6060h	VAR	Modes of operation	INT8	RW
6061h	VAR	Modes of operation display	INT8	RO

The values and meanings of the above two objects are explained in the table below.

Value	Description
1	Profile position mode
3	Profile velocity mode
4	Profile torque mode
6	Homing mode
8	Cyclic synchronous position mode
9	Cyclic synchronous velocity mode
10	Cyclic synchronous torque mode

7.4.1 Profile position mode

This mode is used mainly in applications of point-to-point positioning. In this mode, the master sets the target position (absolute or relative), and the speed/acceleration/deceleration of the position curve. Based on the above settings, the drive generates the target position curve command and performs the complete process of positioning control.

7.4.1.1 Common object

The objects related to this operation mode are listed in the table below.

Index	Data structure	Name	Data type	Accessibility	Mapping type	Unit
603Fh	VAR	Error Code	UINT16	RW	TPDO	-
6040h	VAR	Control word	UINT16	RW	RPDO	-
6041h	VAR	Status word	UINT16	RO	TPDO	-
6060h	VAR	Modes of operation	INT8	RW	RPDO	-

Index	Data structure	Name	Data type	Accessibility	Mapping type	Unit
6061h	VAR	Modes of operation display	INT8	RO	TPDO	-
6063h	VAR	Position actual value* (motor unit)	INT32	RO	TPDO	p
6064h	VAR	Position actual value (user-defined unit)	INT32	RO	TPDO	Command unit
6065h	VAR	Following error window	UINT32	RW	RPDO	Command unit
6066h	VAR	Following error window time	UINT16	RW	RPDO	ms
6067h	VAR	Position window	UINT32	RW	RPDO	Command unit
6068h	VAR	Position window time	UINT16	RW	RPDO	ms
607Ah	VAR	Target position	INT32	RW	RPDO	Command unit
607Dh	ARRAY	Software position limit	INT32	RW	RPDO	Command unit
607Eh	VAR	Polarity	UINT8	RW	RPDO	-
607Fh	VAR	Max. profile velocity	UINT32	RW	RPDO	Command unit / s
6080h	VAR	Max. motor speed	UINT32	RW	RPDO	[rpm]/[mm/s]
6081h	VAR	Profile velocity	UINT32	RW	RPDO	Command unit / s
6083h	VAR	Profile acceleration	UINT32	RW	RPDO	Command unit / s^2
6084h	VAR	Profile deceleration	UINT32	RW	RPDO	Command unit / s^2
6091h	ARRAY	Gear ratio factor	UINT32	RW	RPDO	-
60F4h	VAR	Following error actual value	INT32	RO	TPDO	Command unit

Note:

There are default settings in the drive, including the profile speed, acceleration, deceleration, maximum profile speed, and gear ratio factor of the position curve, which are set via the function parameters. If the master does not offer new settings of these parameters, the default settings will turn valid. To change the default settings, the drive needs to be powered off and restarted.

7.4.1.2 Control word and status word

The control word in the profile position mode (PP) is explained in the table below:

Bit15 to Bit7	Bit6	Bit5	Bit4	Bit3 to Bit0
*	Abs/Rel	Change set immediately	New set-point	*

Note:

The mark * here and hereinafter indicates that the definition of the corresponding bit are the same with the standard definition.

The bits of the control word in the profile position mode are described in the table below.

Bit	Set value	Function
New set-point	0	No set position
	1	New set position; start positioning
Change set immediately	0	The position is not updated immediately.
	1	The position is updated immediately.
Abs/Rel	0	Absolute position setting
	1	Relative position setting

The status word in the profile position mode (PP) is listed in the table below:

Bit15 to Bit14	Bit13	Bit12	Bit11	Bit10	Bit9 to Bit0
*	Following error	Set-point acknowledge	*	Target reached	*

The bits of the status word in the profile position mode are described in the table below:

Bit	Set value	Function
Target reached	0	Target position not reached
	1	Target position reached
Set-point acknowledge	0	The target position can be updated.

Bit	Set value	Function
	1	The target position cannot be updated.
Following error	0	No position deviation
	1	There is position deviation.

7.4.1.3 Function description

- Running mode setting: Set 6060h to 1;
- Target position setting: Set the target position in the user-defined unit via 607Ah; if necessary, set the gear ratio factor 6091h;
- Positioning mode setting: Set the positioning mode (including the absolute/relative position setting, the immediate upgrade / non-immediate upgrade setting, etc.) via control word 6040h;
- Positioning speed setting: Set the positioning speed in the user-defined unit via 6081h; if necessary, set the gear ratio factor 6091h, profile acceleration time 6083h, and the profile deceleration time 6084h;
- Positioning enable: Enable the operation of the drive via the object 6040h, and enable the positioning via Bit4;
- Speed limit setting: Select the speed limit channel via 2007.0Ah (P07.09 FWD speed limit channel) and 2007.0Ch (P07.11 REV speed limit channel) in the object dictionary of the function code, where the bus channel is selected by default. The range for the bus speed limit channel is determined by 607Fh maximum profile velocity and 6080h maximum motor speed. Otherwise, set an internal speed limit channel, and the range is determined by 2007.0Bh (P07.10 FWD speed limit) and 2007.0Dh (P07.12 REV speed limit) in the object dictionary of the function code. The speed limit can be decreased to zero based on the decrease time set by P20.19 (2014.14h);

Function code	Name	Range	Max. unit	Default	Effective time	Property	Function
P20.19	Bus speed limit decrease time	0 to 65535	1	0	Immediate	At stop	Set the time of the speed limit decreasing from the max. value to zero (unit: ms)

- Torque limit setting: Select the torque limit channel via 2006.0Dh (P06.12 positive torque limit channel) and 2006.0Eh (P06.13 negative torque limit channel) in the object dictionary of the function code, where the bus channel is selected by default. The range for the bus torque limit channel is determined by the minimum value among 6072h maximum torque, 60E0h positive torque limit, and 60E1h negative torque limit. Otherwise, set an internal torque limit channel, and the range is determined by 2006.0Fh (P06.14 positive torque limit) and 2006.10h (P06.15 negative torque limit) in the object dictionary of the function code;

- Positioning arrival judgement: If the position deviation in the user-defined unit is less than 6067h and the time reaches 6068h, it indicates that the position is arrived; at this point, set bit10 of the status word 6041h to 1;
- Excessive position deviation judgement: If the position deviation in the user-defined unit 60F4h is greater than 6065h, a fault is reported; at this point, bit13 of the status word 6041h is set to 1;
- Polarity 0x607E of command: The command logic of torque, speed, and position shall be set according to the corresponding bit of 0x607E in the object dictionary.

Bit	Name	Set value	Function
BIT5	Torque command polarity	0	Torque command positive logic
		1	Torque command negative logic
BIT6	Speed command polarity	0	Speed command positive logic
		1	Speed command negative logic
BIT7	Position command polarity	0	Position command positive logic
		1	Position command negative logic

7.4.1.4 Basic configuration

The basic configuration of the objects in the profile position mode is described in the table below.

RPDO object	TPDO object	Remark
Control word 6040h	Status word 6041h	Required
Target position 607Ah	Position actual value 6064h	Required
Profile velocity 6081h		Required
Other object		Optional; it can be configured as an SDO parameter; otherwise, use the default parameter of the drive.

7.4.2 Profile velocity mode

In this mode, the master sets the target speed, acceleration, and deceleration, and the drive generates the target speed curve command based on the above settings, and performs the complete process of acceleration/deceleration control.

7.4.2.1 Common object

The objects related to this operation mode are listed in the table below.

Index	Data structure	Name	Data type	Accessibility	Mapping type	Unit
603Fh	VAR	Error Code	UINT16	RW	TPDO	-
6040h	VAR	Control word	UINT16	RW	RPDO	-
6041h	VAR	Status word	UINT16	RO	TPDO	-
6060h	VAR	Modes of operation	INT8	RW	RPDO	-
6061h	VAR	Modes of operation display	INT8	RO	TPDO	-
6063h	VAR	Position actual value* (motor unit)	INT32	RO	TPDO	p
6064h	VAR	Position actual value (user-defined unit)	INT32	RO	TPDO	Command unit
6069h	VAR	Velocity sensor actual value	INT32	RO	TPDO	rpm
606Bh	VAR	Velocity demand value	INT32	RO	TPDO	[rpm]/[mm /s]
606Ch	VAR	Velocity actual value	INT32	RO	TPDO	Command unit / s
606Dh	VAR	Velocity window	UINT16	RW	RPDO	[rpm]/[mm /s]
606Eh	VAR	Velocity window time	UINT16	RW	RPDO	ms
606Fh	VAR	Velocity threshold	UINT16	RW	RPDO	[rpm]/[mm /s]
6070h	VAR	Velocity threshold time	UINT16	RW	RPDO	ms
607Eh	VAR	Polarity	UINT8	RW	RPDO	-
607Fh	VAR	Max. profile velocity	UINT32	RW	RPDO	Command unit / s
6080h	VAR	Max. motor speed	UINT32	RW	RPDO	[rpm]/[mm /s]

Index	Data structure	Name	Data type	Accessibility	Mapping type	Unit
6083h	VAR	Profile acceleration	UINT32	RW	RPDO	Command unit / s^2
6084h	VAR	Profile deceleration	UINT32	RW	RPDO	Command unit / s^2
6091h	ARRAY	Gear ratio factor	UINT32	RW	RPDO	-
60FFh	VAR	Target velocity	INT32	RW	RPDO	Command unit / s

Note:

There are default settings in the drive, including the acceleration, deceleration, maximum speed, and gear ratio factor of the speed curve, which are set via the function parameters. If the master does not offer new settings of these parameters, the default settings will turn valid. To change the default settings, the drive needs to be powered off and restarted.

7.4.2.2 Control word and status word

The definition of the control word in the profile velocity mode is the same with the standard definition.

The status word in the profile velocity mode is explained in the table below.

Bit15 to Bit13	Bit12	Bit11	Bit10	Bit9 to Bit0
*	Speed	*	Target reached	*

The bits of the status word in the profile velocity mode are described in the table below.

Bit	Set value	Function
Target reached	0	Target speed not reached
	1	Target speed reached
Speed	0	Speed is not equal to 0.
	1	Speed is equal to 0.

7.4.2.3 Function description

- Control mode setting: Set P02.00 to 8;
- Running mode setting: Set 6060h to 3;

- Target velocity setting: Set the target velocity in the user-defined unit via 60FFh; if necessary, set the gear ratio factor 6091h;
- Acceleration curve setting: If necessary, set the profile acceleration time 6083h, and profile deceleration time 6084h;
- Operation enable: Enable the operation of the drive via the control word 6040h;
- Speed limit setting: Select the speed limit channel via 2007.0Ah (P07.09 FWD speed limit channel) and 2007.0Ch (P07.11 REV speed limit channel) in the object dictionary of the function code, where the bus channel is selected by default. The range for the bus speed limit channel is determined by 607Fh maximum profile velocity and 6080h maximum motor speed. Otherwise, set an internal speed limit channel, and the range is determined by 2007.0Bh (P07.10 FWD speed limit) and 2007.0Dh (P07.12 REV speed limit) in the object dictionary of the function code. The speed limit can be decreased to zero based on the decrease time set by P20.19 (2014.14h);

Function code	Name	Range	Max. unit	Default	Effective time	Property	Function
P20.19	Bus speed limit decrease time	0 to 65535	1	0	Immediate	At stop	Set the time of the speed limit decreasing from the max. value to zero (unit: ms)

- Torque limit setting: Select the torque limit channel via 2006.0Dh (P06.12 positive torque limit channel) and 2006.0Eh (P06.13 negative torque limit channel) in the object dictionary of the function code, where the bus channel is selected by default. The range for the bus torque limit channel is determined by the minimum value among 6072h maximum torque, 60E0h positive torque limit, and 60E1h negative torque limit. Otherwise, set an internal torque limit channel, and the range is determined by 2006.0Fh (P06.14 positive torque limit) and 2006.10h (P06.15 negative torque limit) in the object dictionary of the function code;
- Velocity arrival judgement: If the deviation between 606Ch feedback velocity and 60FFh target velocity is less than 606Dh and the time reaches 606Eh, it indicates that the velocity is arrived; at this point, set bit10 of the status word 6041h to 1;
- Zero-speed operation judgement: if the feedback velocity 606Ch in the user-defined unit is less than 606Fh and the time reaches 6070h, it indicates that zero speed is reached; at this point, set bit12 of the status word 6041h to 1;
- Polarity 0x607E of command: The command logic of torque, speed, and position shall be set according to the corresponding bit of 0x607E in the object dictionary.

Bit	Name	Set value	Function
BIT5	Torque command polarity	0	Torque command positive logic
		1	Torque command negative logic

Bit	Name	Set value	Function
BIT6	Speed command polarity	0	Speed command positive logic
		1	Speed command negative logic
BIT7	Position command polarity	0	Position command positive logic
		1	Position command negative logic

7.4.2.4 Basic configuration

The basic configuration of the objects in the profile velocity mode is described in the table below.

RPDO object	TPDO object	Remark
Control word 6040h	Status word 6041h	Required
Target velocity 60FFh		Required
	Velocity actual value 606Ch	Optional
Other object		Optional; it can be configured as an SDO parameter; otherwise, use the default parameter of the drive.

7.4.3 Profile torque mode

The servo drive (slave) controls the torque via the torque command received from the host (master).

7.4.3.1 Common object

The objects related to this operation mode are listed in the table below.

Index	Data structure	Name	Data type	Accessibility	Mapping type	Unit
603Fh	VAR	Error Code	UINT16	RW	TPDO	-
6040h	VAR	Control word	UINT16	RW	RPDO	-
6041h	VAR	Status word	UINT16	RO	TPDO	-
6060h	VAR	Modes of operation	INT8	RW	RPDO	-

Index	Data structure	Name	Data type	Accessibility	Mapping type	Unit
6061h	VAR	Modes of operation display	INT8	RO	TPDO	-
6063h	VAR	Position actual value* (motor unit)	INT32	RO	TPDO	Encoder unit
6064h	VAR	Position actual value (user-defined unit)	INT32	RO	TPDO	Command unit
6069h	VAR	Velocity sensor actual value	INT32	RO	TPDO	[rpm]/[mm /s]
606Bh	VAR	Velocity demand value	INT32	RO	TPDO	[rpm]/[mm /s]
606Ch	VAR	Velocity actual value	INT32	RO	TPDO	Command unit / s
606Dh	VAR	Velocity window	UINT16	RW	RPDO	[rpm]/[mm /s]
606Eh	VAR	Velocity window time	UINT16	RW	RPDO	ms
606Fh	VAR	Velocity threshold	UINT16	RW	RPDO	[rpm]/[mm /s]
6070h	VAR	Velocity threshold time	UINT16	RW	RPDO	ms
6071h	VAR	Target torque	INT16	RW	RPDO	0.1%
6072h	VAR	Max. torque	UINT16	RW	RPDO	0.1%
6074h	VAR	Torque demand	INT16	RO	TPDO	0.1%
6077h	VAR	Torque actual value	INT16	RO	TPDO	0.1%
607Eh	VAR	Polarity	UINT8	RW	RPDO	-
607Fh	VAR	Max. profile velocity	UINT32	RW	RPDO	Command unit / s
6080h	VAR	Max. motor speed	UINT32	RW	RPDO	[rpm]/[mm /s]
6087h	VAR	Torque slope	UINT16	RW	RPDO	0.1%/s
60E0h	VAR	FWD torque limit	UINT16	RW	RPDO	0.1%

Index	Data structure	Name	Data type	Accessibility	Mapping type	Unit
60E1h	VAR	REV torque limit	UINT16	RW	RPDO	0.1%

7.4.3.2 Control word and status word

The definition of the control word in the profile torque mode is the same with the standard definition.

The status word in the profile torque mode is explained in the table below:

Bit15 to Bit13	Bit12	Bit11	Bit10	Bit9 to Bit0
*	*	*	Target reached	*

The bits of the status word in the profile torque mode are described in the table below:

Bit	Set value	Function
Target reached	0	Target torque not reached
	1	Target torque reached

7.4.3.3 Function description

- Control mode setting: Set P02.00 to 8;
- Running mode setting: Set 6060h to 4;
- Target torque setting: Set the target torque in the user-defined unit via 6071h (unit: 0.1%);
- Speed limit setting: Select the speed limit channel via 2007.0Ah (P07.09 FWD speed limit channel) and 2007.0Ch (P07.11 REV speed limit channel) in the object dictionary of the function code, where the bus channel is selected by default. The range for the bus speed limit channel is determined by 607Fh maximum profile velocity and 6080h maximum motor speed. Otherwise, set an internal speed limit channel, and the range is determined by 2007.0Bh (P07.10 FWD speed limit) and 2007.0Dh (P07.12 REV speed limit) in the object dictionary of the function code. The speed limit can be decreased to zero based on the decrease time set by P20.19 (2014.14h);

Function code	Name	Range	Max. unit	Default	Effective time	Property	Function
P20.19	Bus speed limit decrease time	0 to 65535	1	0	Immediate	At stop	Set the time of the speed limit decreasing from the max. value to zero (unit: ms)

- Torque limit setting: Select the torque limit channel via 2006.0Dh (P06.12 positive torque limit channel) and 2006.0Eh (P06.13 negative torque limit channel) in the object dictionary of the function code, where the bus channel is selected by default. The range for the bus torque limit channel is determined by the minimum value among 6072h maximum torque, 60E0h positive torque limit, and 60E1h negative torque limit. Otherwise, set an internal torque limit channel, and the range is determined by 2006.0Fh (P06.14 positive torque limit) and 2006.10h (P06.15 negative torque limit) in the object dictionary of the function code;
- Operation enable: Enable the operation of the drive via the control word 6040h;
- Polarity 0x607E of command: The command logic of torque, speed, and position shall be set according to the corresponding bit of 0x607E in the object dictionary;

Bit	Name	Set value	Function
BIT5	Torque command polarity	0	Torque command positive logic
		1	Torque command negative logic
BIT6	Speed command polarity	0	Speed command positive logic
		1	Speed command negative logic
BIT7	Position command polarity	0	Position command positive logic
		1	Position command negative logic

- Torque arrival: This function determines whether the torque actual value has reached the torque window. If the discrepancy between the torque actual value (6077h) and the torque reference value (2007.0Eh) is greater than the torque arrival effective value (2007.0Fh), bit10 (target reached) of the status word will be set to 1. If the discrepancy between the torque actual value (6077h) and the torque reference value (2007.0Eh) is lower than the torque arrival non-effective value (2007.10h), bit10 (target reached) of the status word will be cleared immediately.

7.4.3.4 Basic configuration

The basic configuration of the objects in the profile torque mode is described in the table below.

RPDO object	TPDO object	Remark
Control word 6040h	Status word 6041h	Required
Target torque 6071h		Required
	Torque actual value 6077h	Optional
Other object		Optional; it can be configured as an SDO parameter; otherwise, use the

RPDO object	TPDO object	Remark
		default parameter of the drive.

7.4.4 Homing mode

M6-L series supports the homing mode. In this mode, the drive returns to the designated position based on the settings of homing mode, homing speed, and home offset.

7.4.4.1 Common object

The objects related to this operation mode are listed in the table below.

Index	Data structure	Name	Data type	Accessibility	Mapping type	Unit
6040h	VAR	Control word	UINT16	RW	RPDO	-
6041h	VAR	Status word	UINT16	RO	TPDO	-
6060h	VAR	Modes of operation	INT8	RW	RPDO	-
6061h	VAR	Modes of operation display	INT8	RO	TPDO	-
6098h	VAR	Homing method	INT8	RW	RPDO	-
607Ch	VAR	Home offset	INT32	RW	RPDO	Command unit
6099h	ARRAY	Homing speeds	UINT32	RW	RPDO	Command unit / s
609Ah	VAR	Homing acceleration	UINT32	RW	RPDO	Command unit / s^2

Object description:

- Homing method (6098h)

  M6-L series drive supports homing methods of 1 to 35 in CiA 402.

- Home offset (607Ch)

  It indicates the pulses of offset when the home position is found.

- Homing speeds (6099h)

Sub-index	Name	Unit
0	Number of sub-indexes (2)	-
1	High speed homing	[rpm]/[mm/s]

Sub-index	Name	Unit
2	Low speed homing	[rpm]/[mm/s]

7.4.4.2 Control word and status word

The control word in the homing mode is explained in the table below:

Bit15 to Bit5	Bit4	Bit3 to Bit0
*	Homing start	*

The bits of the control word in the homing mode are described in the table below:

Bit	Set value	Function
Homing start	0->1	Homing start
	1	Homing in progress
	1->0	End of homing

The status word in the homing mode is explained in the table below:

Bit15 to Bit14	Bit13	Bit12	Bit11	Bit10	Bit9 to Bit0
*	Homing error	Homing attained	*	Target reached	*

The bits of the status word in the homing mode are described in the table below:

Bit	Set value	Function
Target reached	0	Target speed not reached
	1	Target speed reached
Homing attained	0	Unsuccessful homing
	1	Successful homing
Homing error	0	No homing error
	1	Homing error occurred

7.4.4.3 Function description

- Running mode setting:Set 6060h to 6;
- Homing method setting: Set the homing method via object 6098h;

- Home offset setting: Set the value of home offset via object 607Ch;

  When P12.11 = 0, once the home position is found, position actual value 6064h = 607Ch

  When P12.11 = 1, once the home position is found, position actual value 6064h = present position+ home offset 607Ch

  When P12.11 = 2, once the home position is found, continue to perform the home offset position segment; when completed, position actual value 6064h = 0

  When P12.11 = 3, once the home position is found, continue to perform the home offset position segment; when completed, position actual value 6064h = 607Ch

Note:

When P12.11 = 0/1, the drive does not perform the position offset displacement in actual operation.

- Homing speeds setting: Set the running speed of the drive during the homing process via the sub-indexes 01h and 02h of object 6099h;
- Homing enable: Enable the homing function of the drive via control word 6040h.

7.4.4.4 Basic configuration

The basic configuration of the objects in the homing mode is described in the table below.

RPDO object	TPDO object	Remark
Control word 6040h	Status word 6041h	Required
Homing method 6098h		Optional; it can be configured as an SDO parameter.
Home offset 607Ch		Optional; it can be configured as an SDO parameter.
Homing speeds 6099-01h		Optional; it can be configured as an SDO parameter.
Homing speeds 6099-02h		Optional; it can be configured as an SDO parameter.
Other object		Optional; it can be configured as an SDO parameter.

7.4.4.5 Homing mode

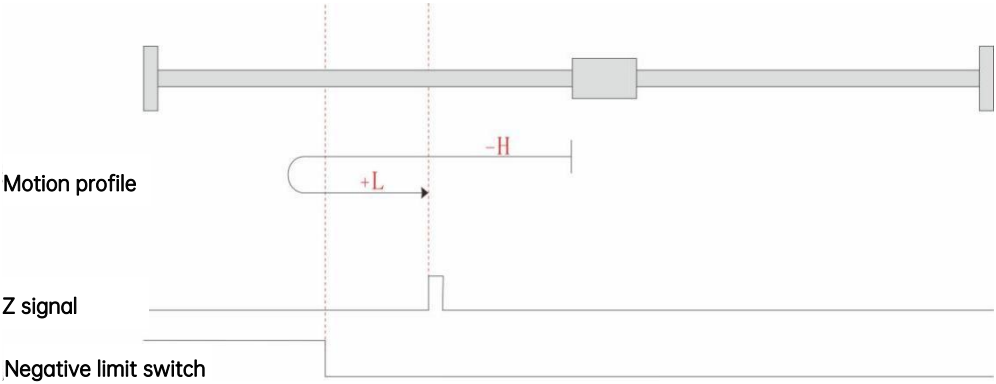
To diversify its applicability, M6-L series servo system supports the homing methods of -4 to 35 in CANopen CiA 402.

- 0x6098 = 1

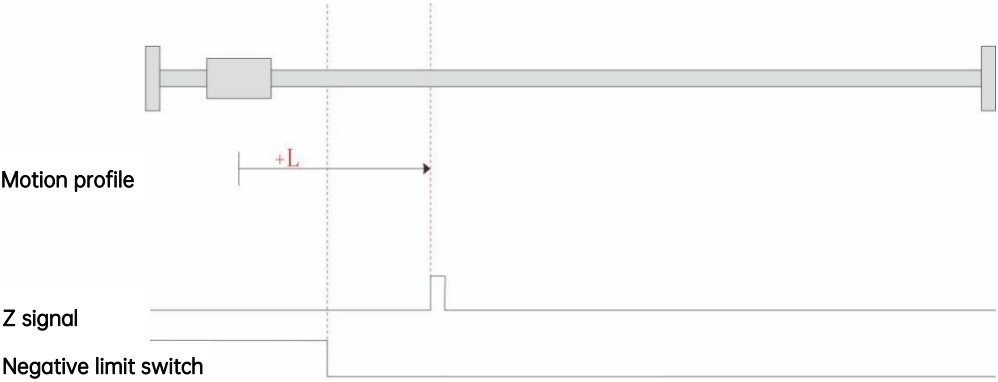
Homing in backward direction, negative limit switch as the deceleration point, and motor Z signal as the home position

The present motor position is in the non-effective zone of the negative limit switch. When homing starts,

the negative limit switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the negative limit switch. Then, homing is processed in the forward direction at a low speed till it reaches the falling edge of the negative limit switch. Afterwards, homing continues in the forward direction at a low speed, and stops when the rising edge of the Z signal is reached.



The present motor position is in the effective zone of the negative limit switch. When homing starts, the negative limit switch is at a high level, and homing is process in the forward direction at a low speed till it reaches the falling edge of the negative limit switch. Then, homing continues in the forward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.

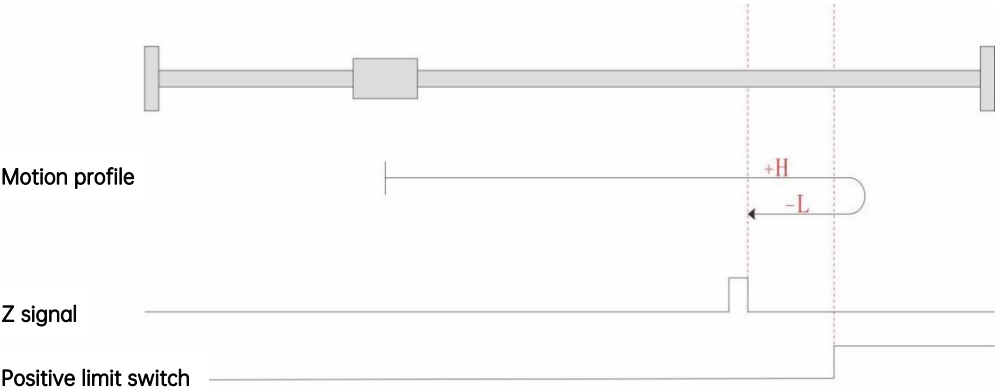


- 0x6098 = 2

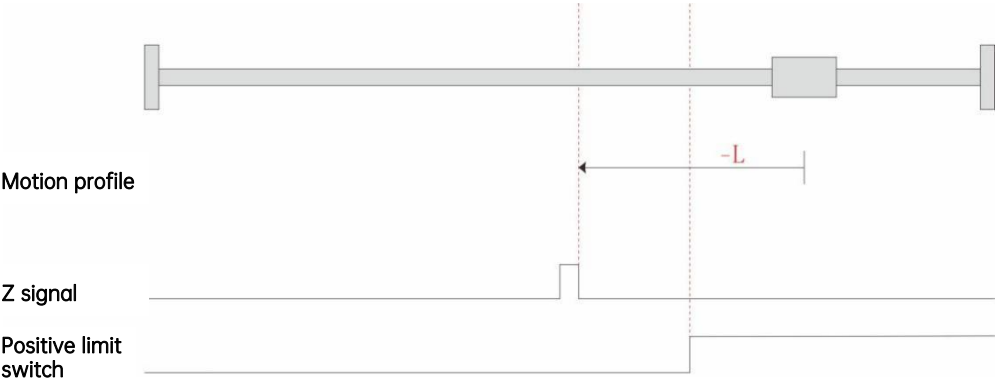
Homing in forward direction, positive limit switch as the deceleration point, and motor Z signal as the home position

The present motor position is in the non-effective zone of the positive limit switch. When homing starts, the positive limit switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the positive limit switch. Then, homing is processed in the backward direction at a low speed till it reaches the falling edge of the positive limit switch. Afterwards,

homing continues in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



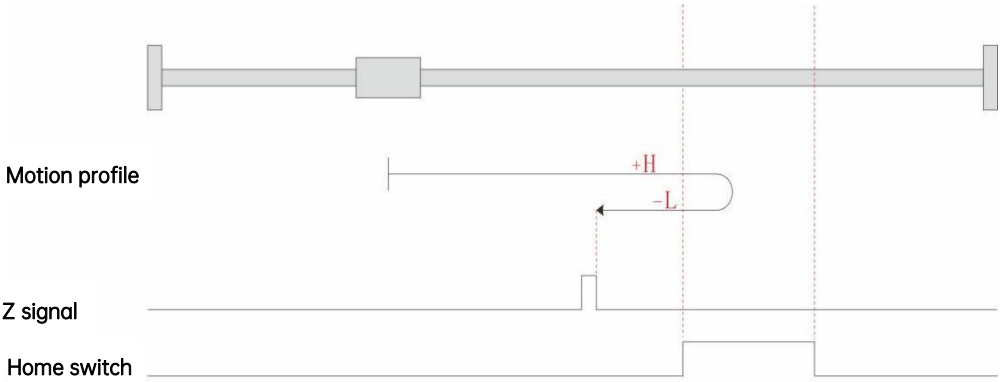
The present motor position is in the effective zone of the positive limit switch. When homing starts, the positive limit switch is at a high level, and homing is processed in the backward direction at a low speed till it reaches the falling edge of the positive limit switch. Then, homing continues in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



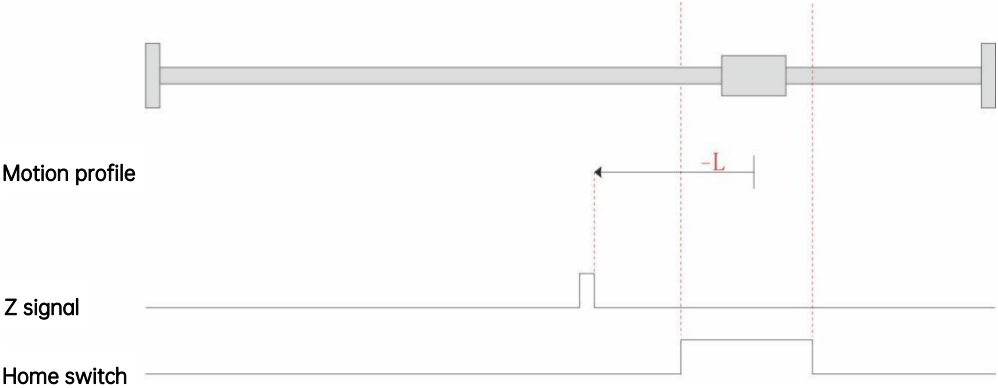
- 0x6098 = 3

Homing in forward direction, home switch as the deceleration point, and motor Z signal as the home position

The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Then , homing is processed in the backward direction at a low speed till it reaches the falling edge of the home switch. Afterwards, homing continues in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the backward direction at a low speed till it reaches the falling edge of the home switch. Then, homing continues in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.

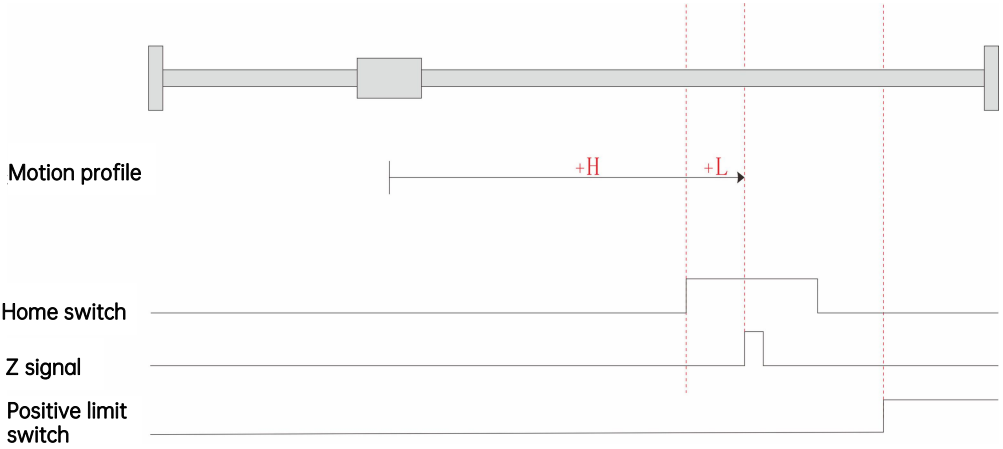


- 0x6098 = 4

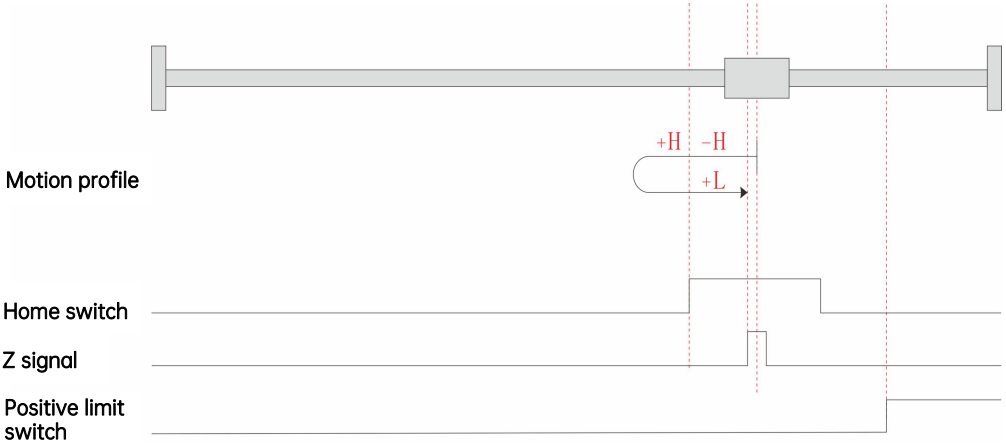
Homing in forward direction, home switch as the deceleration point, and the motor Z signal as the home position

The present motor position is between the negative limit switch and the home switch. When homing

starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Then, homing continues in the forward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.

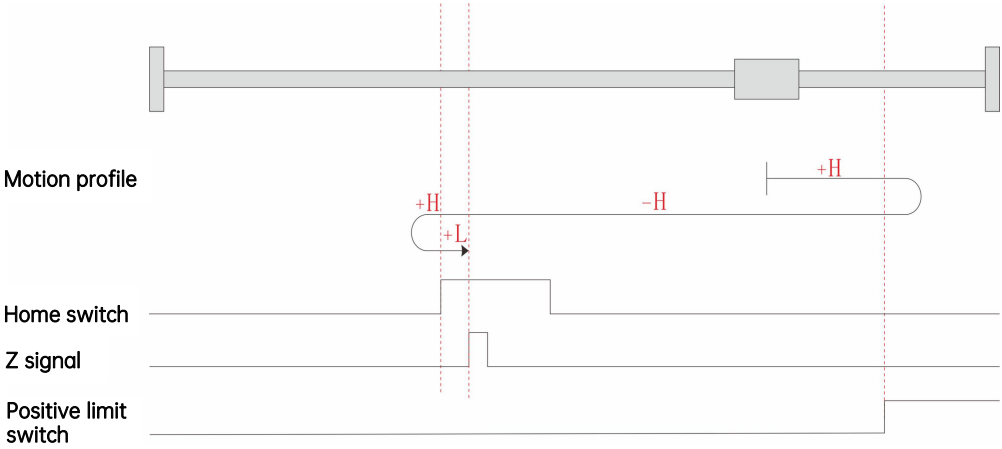


The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the backward direction at a high speed till it reaches the falling edge of the home switch. Then, homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing continues in the forward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



The present motor position is between the home switch and the positive limit switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the positive limit switch. Then, homing is processed in the backward direction at a high speed till it reaches the falling edge of the home switch. Next, homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch.

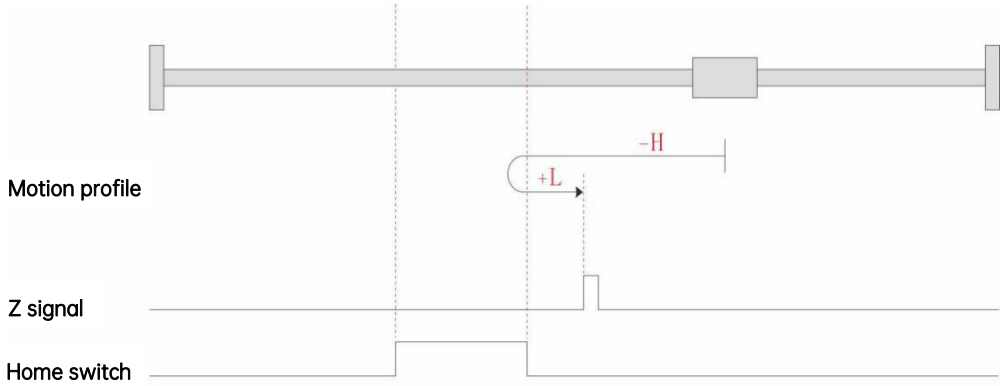
Afterwards, homing continues in the forward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



- 0x6098 = 5

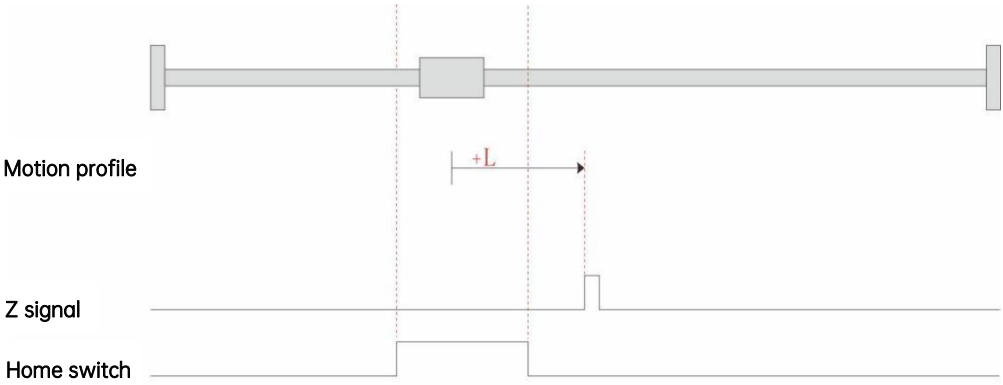
Homing in backward direction, home switch as the deceleration point, and the motor Z signal as the home position

The present motor position is between the positive limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Then, homing is processed in the forward direction at a low speed till it reaches the falling edge of the home switch. Afterwards, homing continues in the forward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the forward direction at a low speed till it reaches the falling edge of the home switch. Afterwards, homing continues in the forward direction at a low

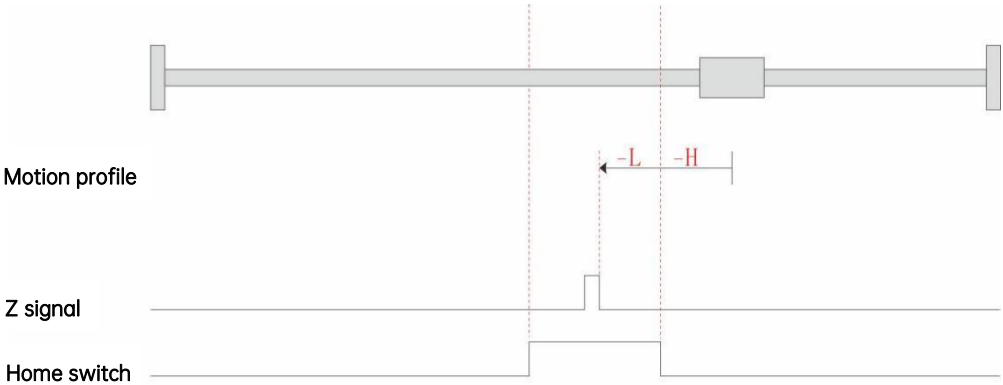
speed, and stops when the motor reaches the rising edge of the Z signal.



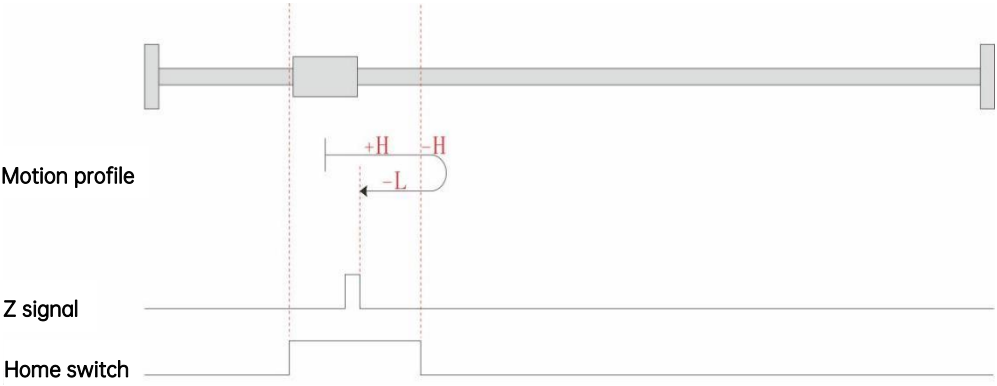
- 0x6098 = 6

Homing in backward direction, home switch as the deceleration point, and the motor Z signal as the home position

The present motor position is between the positive limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Then, homing continues in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



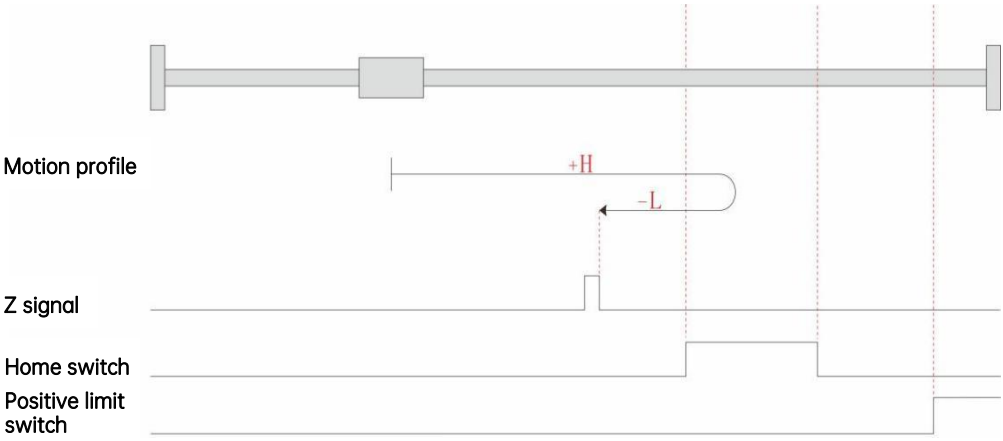
The present motor position is in the effective zone of the home switch. When homing starts, the home switch is a high level, and homing is processed in the forward direction at a high speed till it reaches the falling edge of the home switch. Then, homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing continues in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



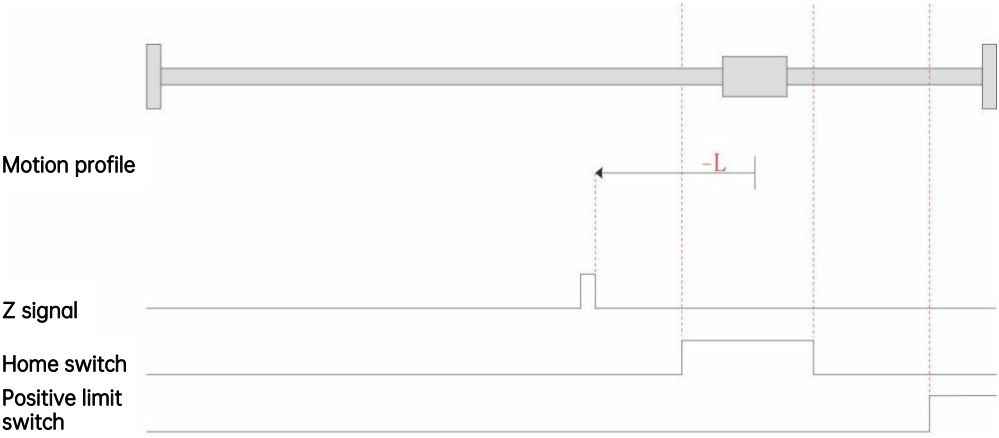
- 0x6098 = 7

Homing in forward direction, home switch as the deceleration point, and the motor Z signal as the home position

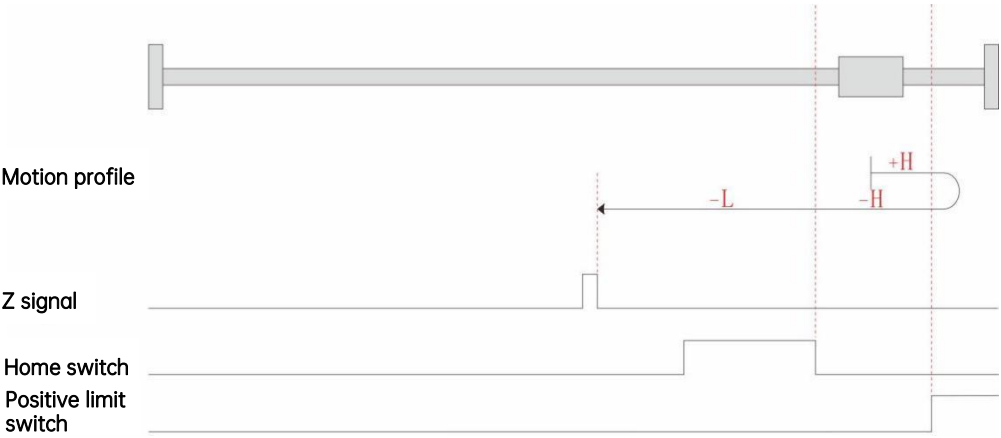
The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Then, homing is processed in the backward direction at a low speed till it reaches the falling edge of the home switch. Afterwards, homing continues in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the backward direction at a low speed till it reaches the falling edge of the home switch. Then, homing continues in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



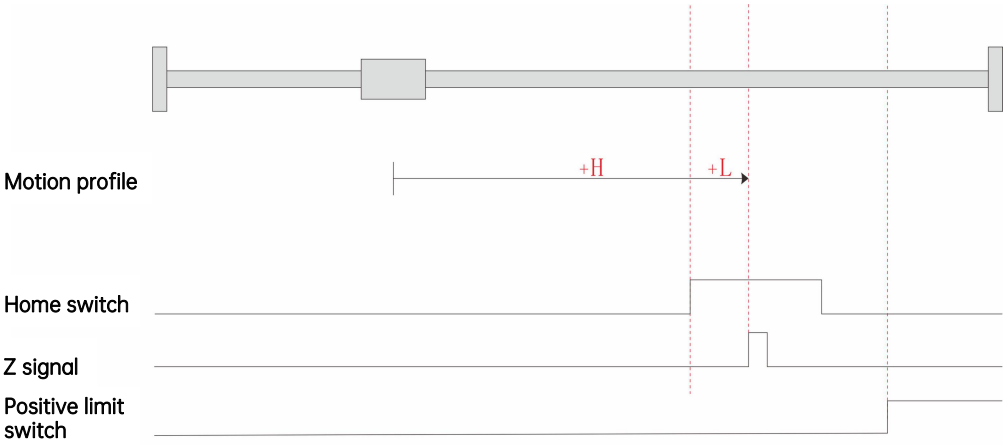
The present motor position is between the positive limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the positive limit switch. Then, homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing continues in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



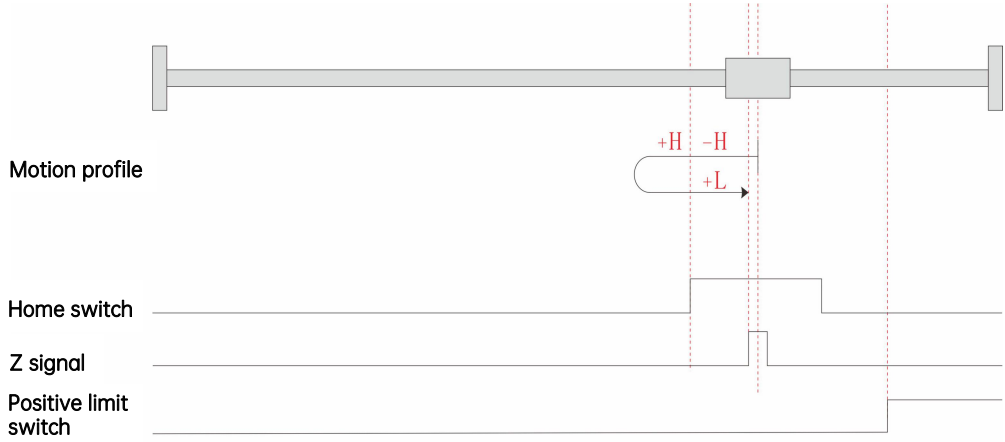
- 0x6098 = 8

Homing in forward direction, home switch as the deceleration point, and the motor Z signal as the home position

The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Then, homing continues in the forward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.

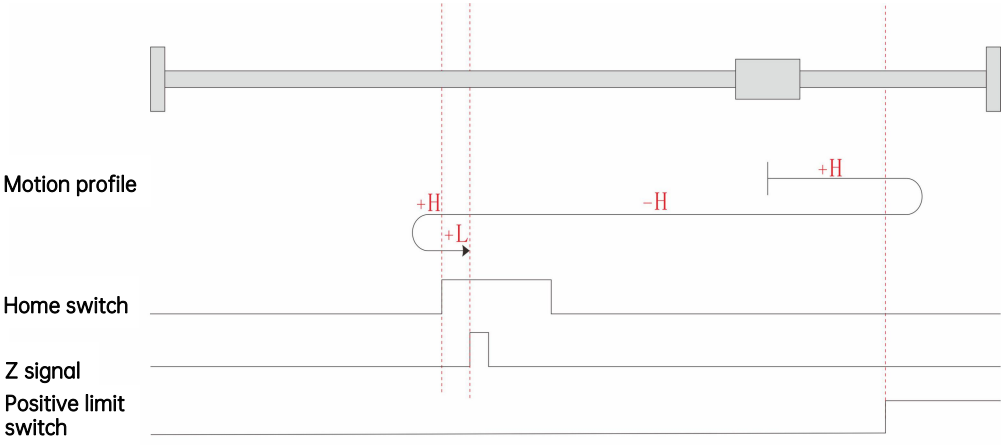


The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the backward direction at a high speed till it reaches the falling edge of the home switch. Then, homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing continues in the forward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



The present motor position is between the home switch and the positive limit switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the positive limit switch. Then, homing is processed in the backward direction at a high speed till it reaches the falling edge of the home switch. Next, homing is

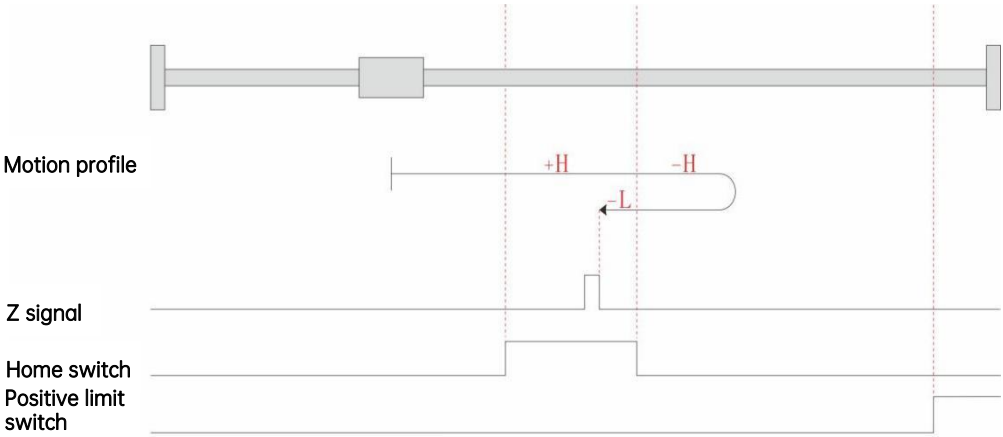
processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing continues in the forward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



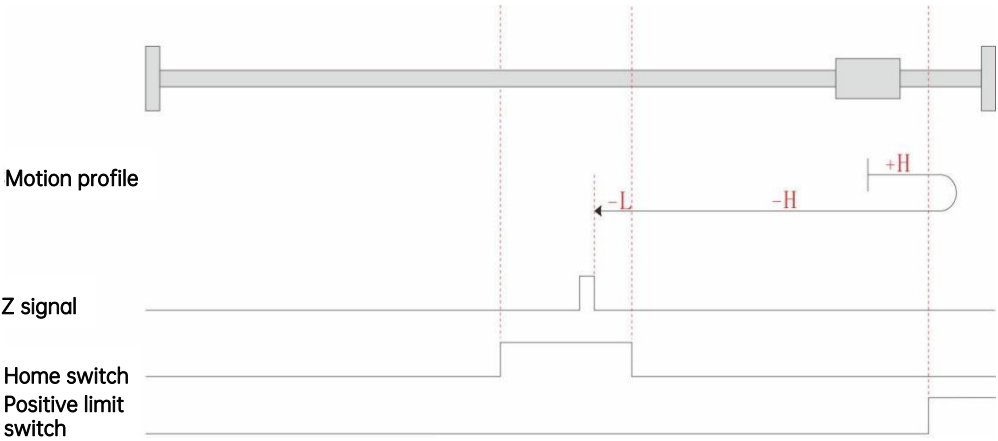
- 0x6098 = 9

Homing in forward direction, home switch as the deceleration point, and the motor Z signal as the home position

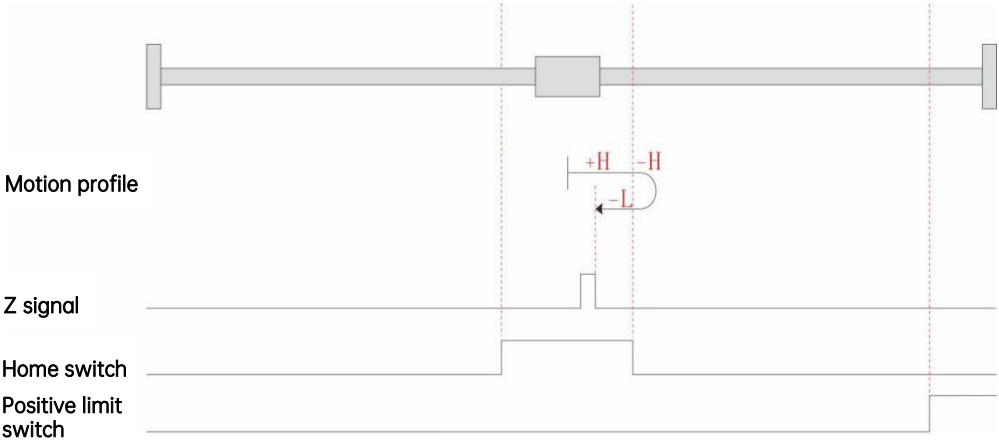
The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the falling edge of the home switch. Then, homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing continues in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



The present motor position is between the positive limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the positive limit switch. Then, homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing continues in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the forward direction at a a high speed till it reaches the falling edge of the home switch. Then, homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing continues in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.

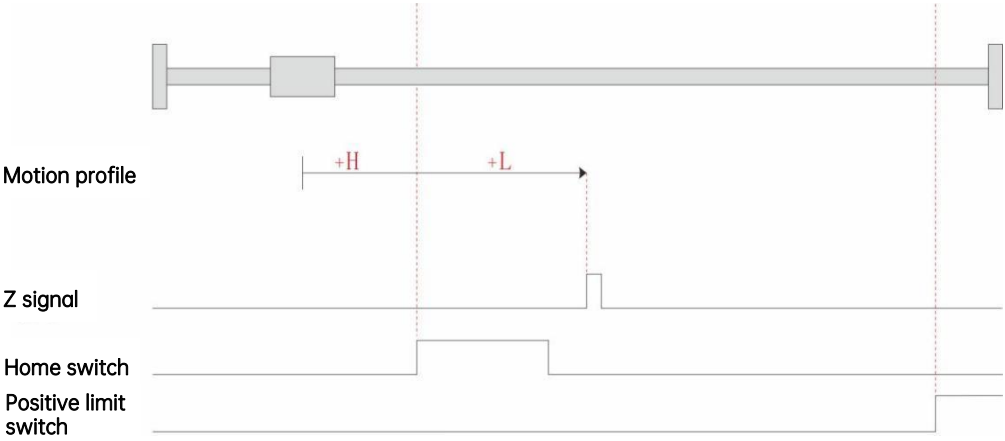


- 0x6098 = 10

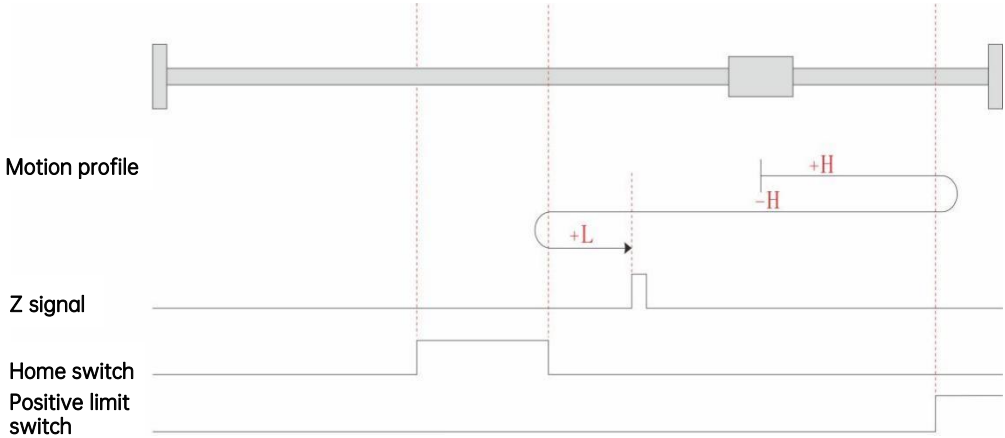
Homing in forward direction, home switch as the deceleration point, and the motor Z signal as the home

position

The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Then, homing continues in the forward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.

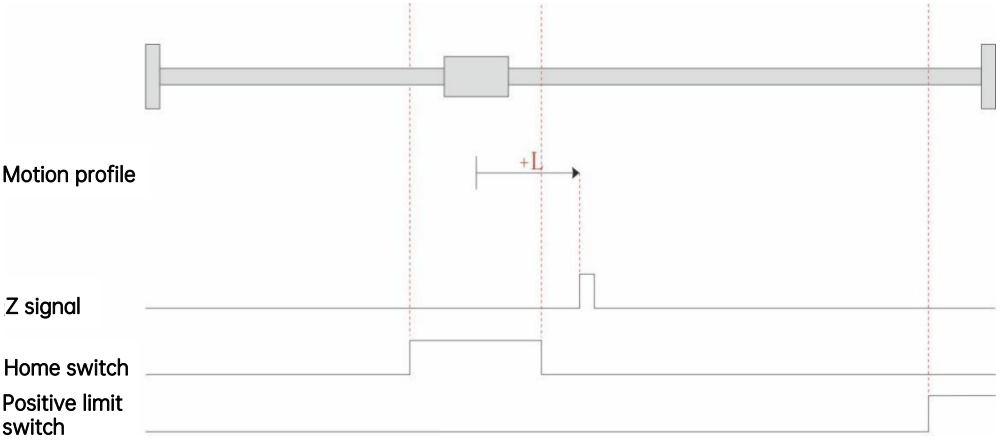


The present motor position is between the positive limit switch and the home switch. When homing starts, the home switch is at low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the positive limit switch. Then, homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing is processed in the forward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the forward direction at a low speed. Homing stops

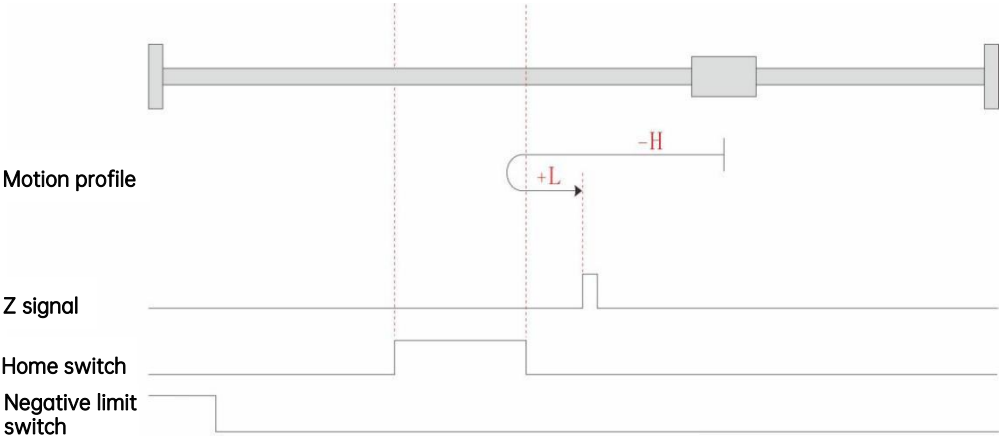
when the motor reaches the rising edge of the Z signal.



- 0x6098 = 11

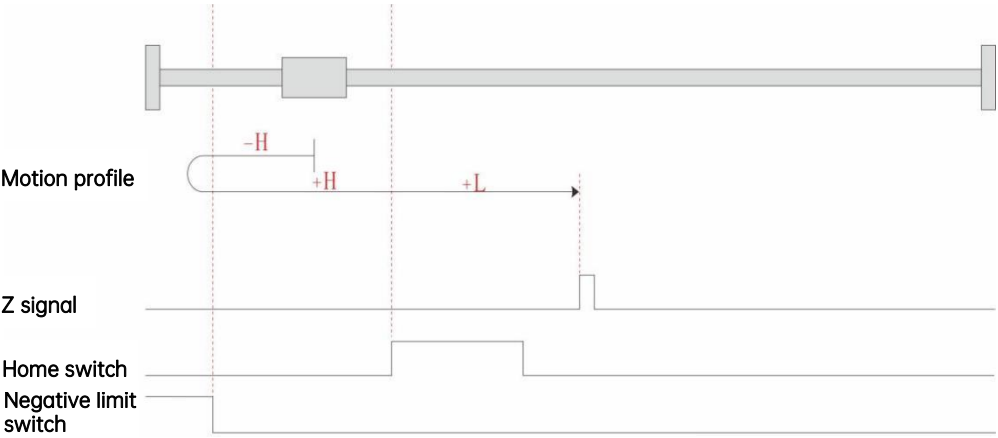
Homing in the backward direction, home switch as the deceleration point, and the motor Z signal as the home position

The present motor position is between the positive limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Then, homing is processed in the forward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.

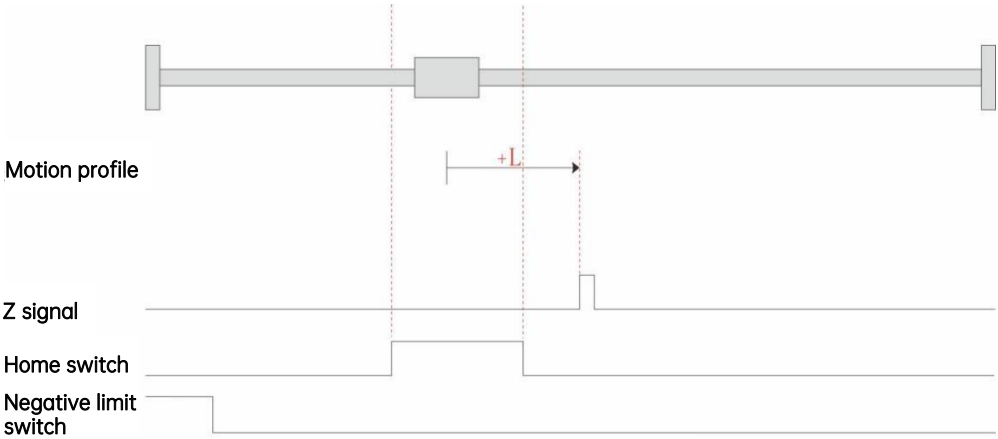


The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the negative limit switch. Then, homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing continues

in the forward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



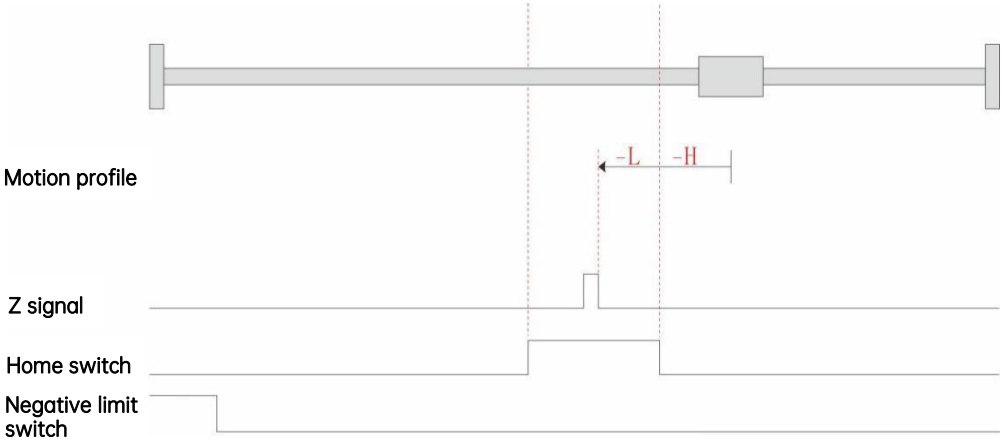
The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the forward direction at a low speed. Homing stops when the motor reaches the rising edge of the Z signal.



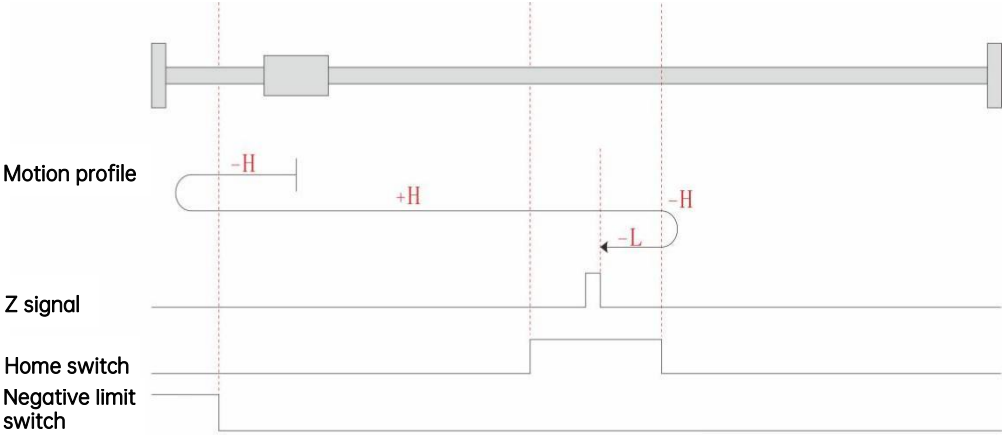
- 0x6098 = 12

Homing in backward direction, home switch as the deceleration point, and the motor Z signal as the home position

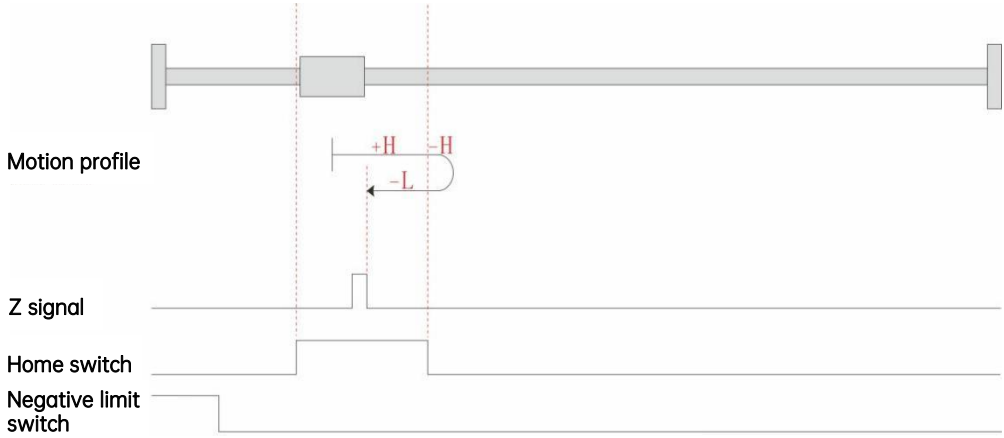
The present motor position is between the positive limit switch and the home switch. When homing starts, the home switch is as a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Then, homing continues in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the negative limit switch. Then, homing is processed in the forward direction at a high speed till it reaches the falling edge of the home switch. Next, homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing continues in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



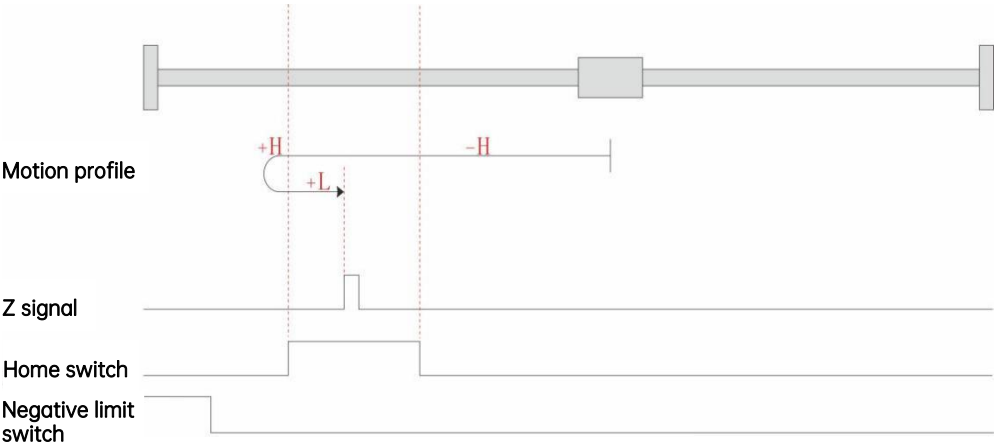
The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the forward direction at a high speed till it reaches the falling edge of the home switch. Then, homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing continues in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



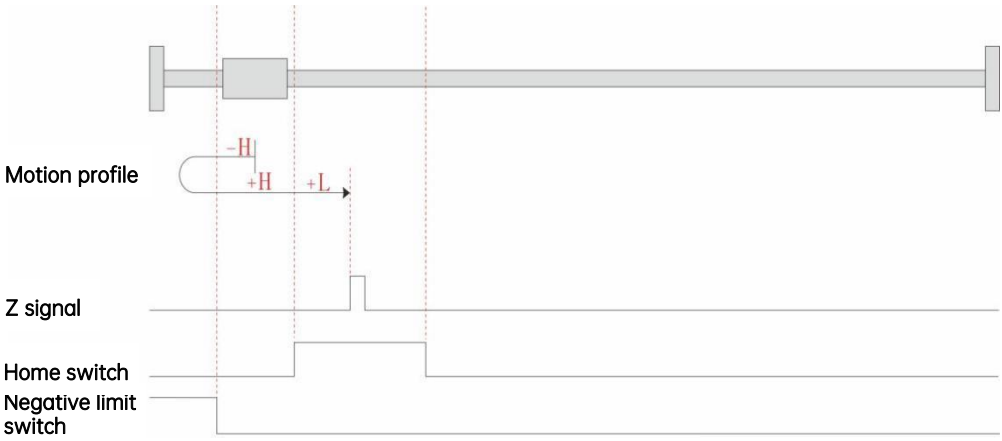
- 0x6098 = 13

Homing in backward direction, home switch as the deceleration point, and the motor Z signal as the home position

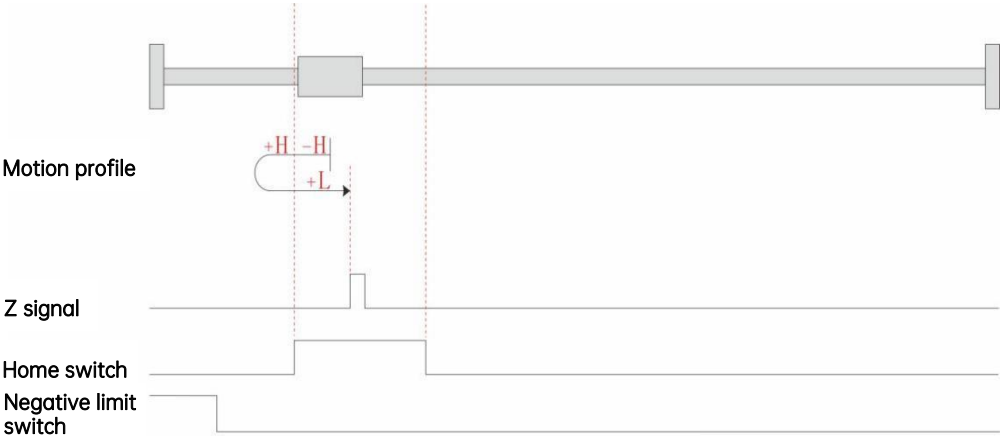
The present motor position is between the positive limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the falling edge of the home switch. Then, homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing continues in the forward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the negative limit switch. Then, homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing continues in the forward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the backward direction at a high speed till it reaches the falling edge of the home switch. Then, homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing continues in the forward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.

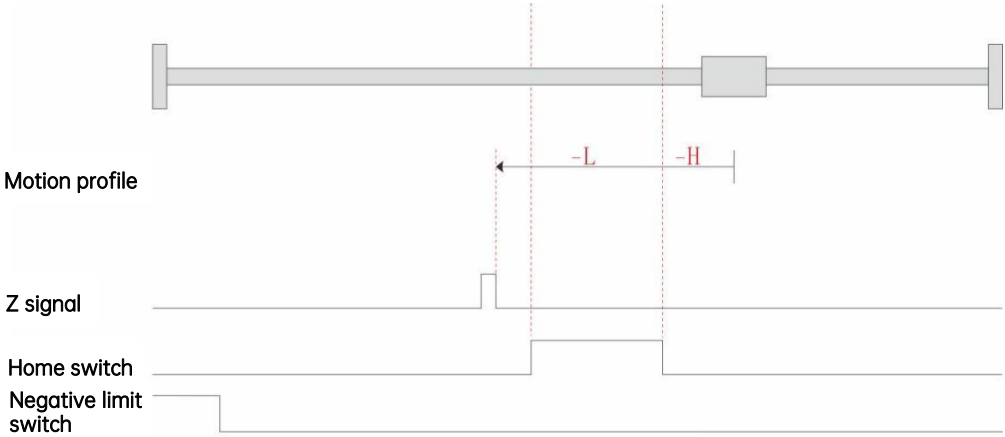


- 0x6098 = 14

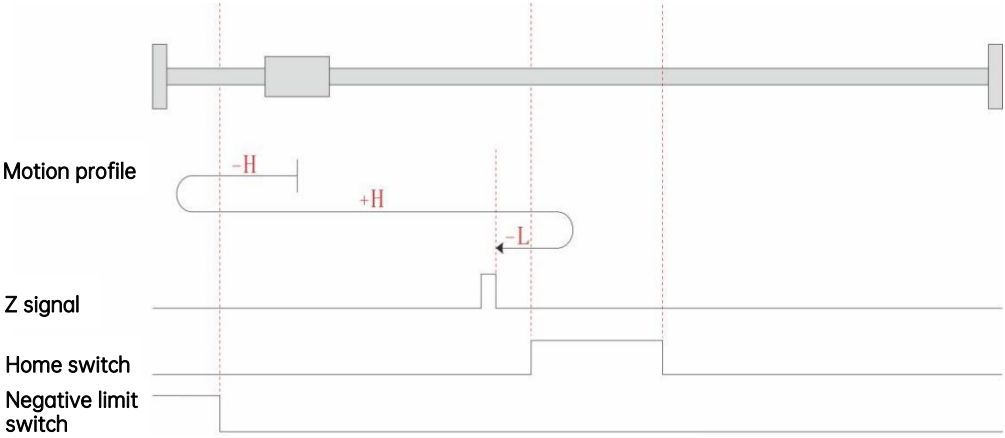
Homing in backward direction, home switch as the deceleration point, and the motor Z signal as the

home position

The present motor position is between the positive limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Then, homing continues in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.

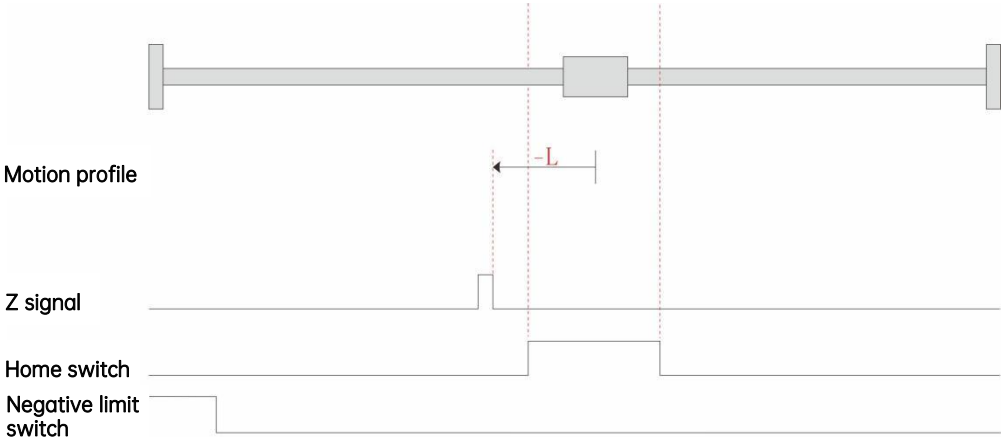


The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the negative limit switch. Then, homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing is processed in the backward direction at a low speed, and stops when the motor reaches the rising edge of the Z signal.



The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the backward direction at a low speed. Homing

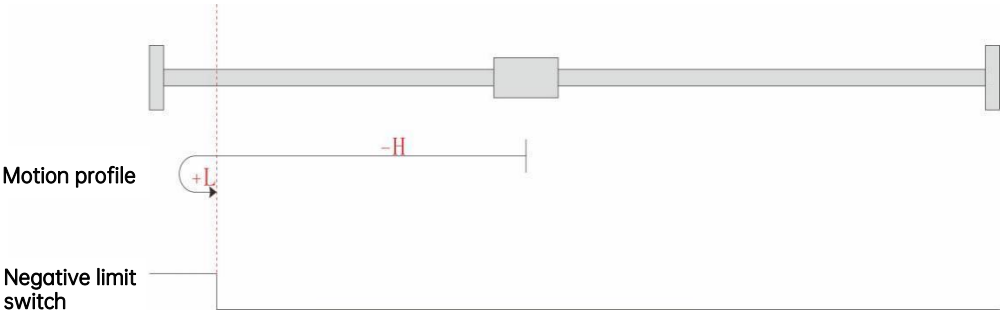
stops when the motor reaches the rising edge of the Z signal.



- 0x6098 = 17

Homing in backward direction, and the negative limit switch as both the deceleration point and the home position

The present motor position is in the non-effective zone of the negative limit switch. When homing starts, the negative limit switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the negative limit switch. Then, homing is processed in the forward direction at a low speed, and stops when the motor reaches the falling edge of the negative limit switch.

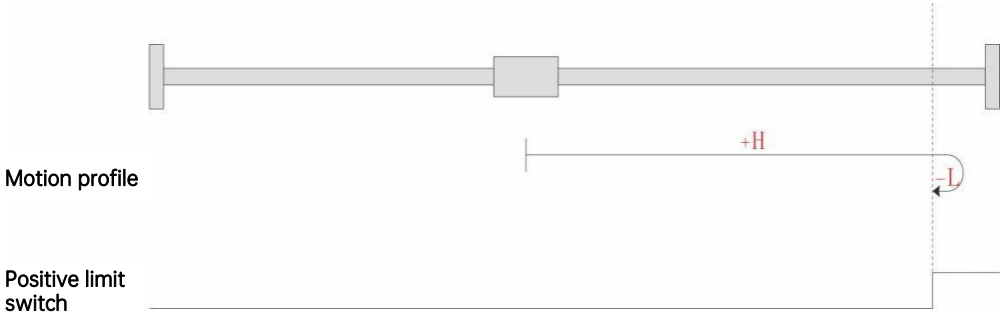


The present motor position is in the effective zone of the negative limit switch. When homing starts, the negative limit switch is at a high level, and homing is processed in the forward direction at a low speed. Homing stops when the motor reaches the falling edge of the negative limit switch.

- 0x6098 = 18

Homing in forward direction, and the positive limit switch as both the deceleration point and the home position

The present motor position is in the non-effective zone of the positive limit switch. When homing starts, the positive limit switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the positive limit switch. Then, homing is processed in the backward direction at a low speed, and stops when the motor reaches the falling edge of the positive limit switch.

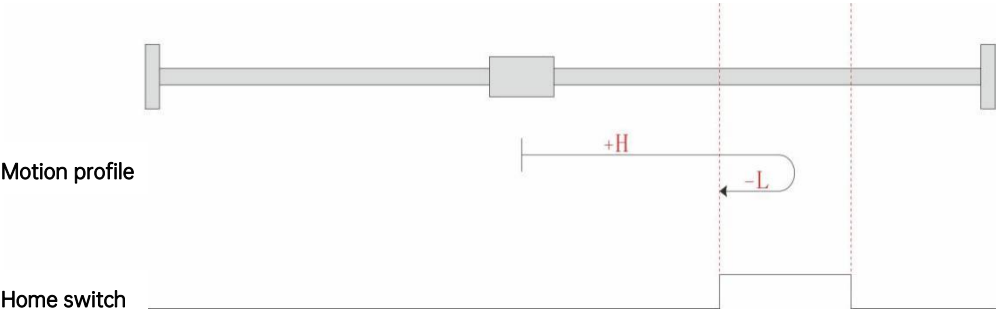


The present motor position is in the effective zone of the positive limit switch. When homing starts, the positive limit switch is at a high level, and homing is processed in the backward direction at a low speed. Homing stops when the motor reaches the falling edge of the positive limit switch.

- 0x6098 = 19

Homing in forward direction, and the home switch as both the deceleration point and the home position

The present motor position is in the non-effective zone of the home switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Then, homing is processed in the backward direction at a low speed, and stops when the motor reaches the falling edge of the home switch.

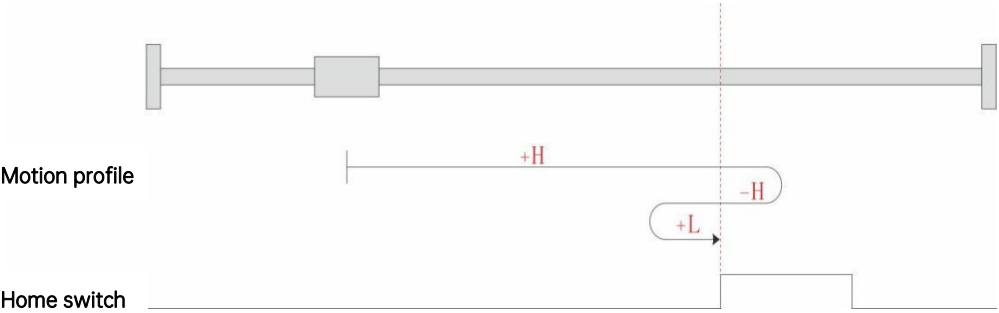


The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the backward direction at a low speed. Homing stops when the motor reaches the falling edge of the home switch.

- 0x6098 = 20

Homing in forward direction, and the home switch as both the deceleration point and the home position

The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Then, homing is processed in the backward direction at a high speed till it reaches the falling edge of the home switch. Afterwards, homing is processed in the forward direction at a low speed, and stops when the motor reaches the rising edge of the home switch.

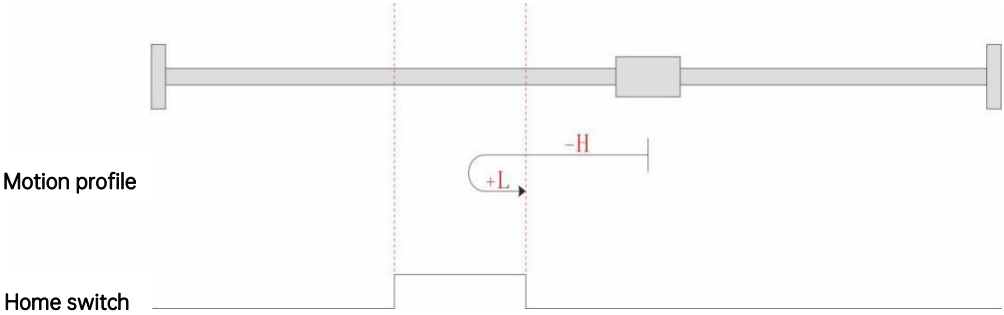


The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the backward direction at a high speed till it reaches the falling edge of the home switch. Then, homing is processed in the forward direction at a low speed, and stops when the motor reaches the rising edge of the home switch.

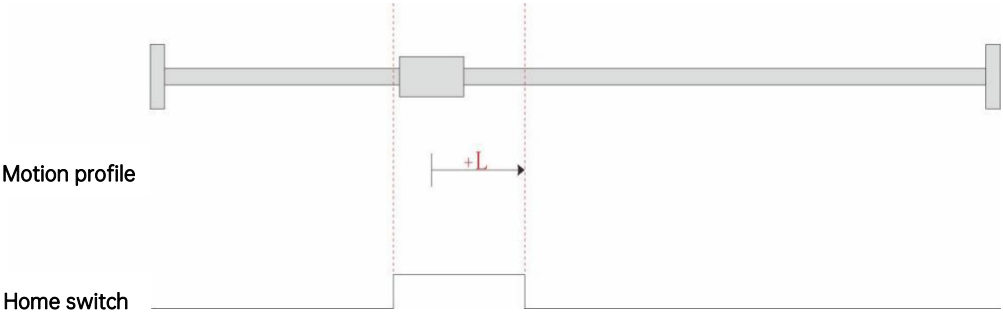
- 0x6098 = 21

Homing in backward direction, and home switch as both the deceleration point and the home position

The present motor position is in the non-effective zone of the home switch. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Then, homing is processed in the forward direction at a low speed, and stops when the motor reaches the falling edge of the home switch.



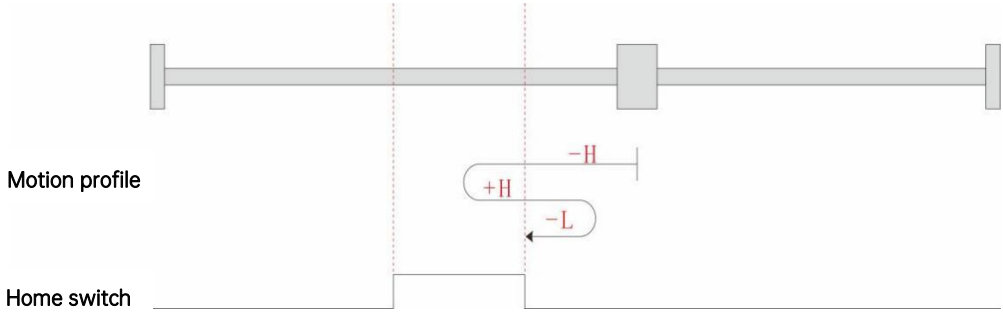
The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the forward direction at a low speed. Homing stops when the motor reaches the falling edge of the home switch.



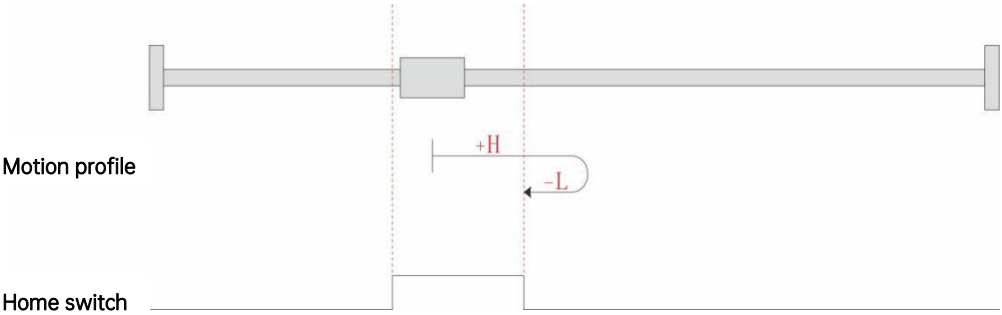
- 0x6098 = 22

Homing in backward direction, and home switch as both the deceleration point and the home position

The present motor position is between the home switch and the positive limit switch. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Then, homing is processed in the forward direction at a high speed till it reaches the falling edge of the home switch. Afterwards, homing is processed in the backward direction at a low speed, and stops when the motor reaches the rising edge of the home switch.



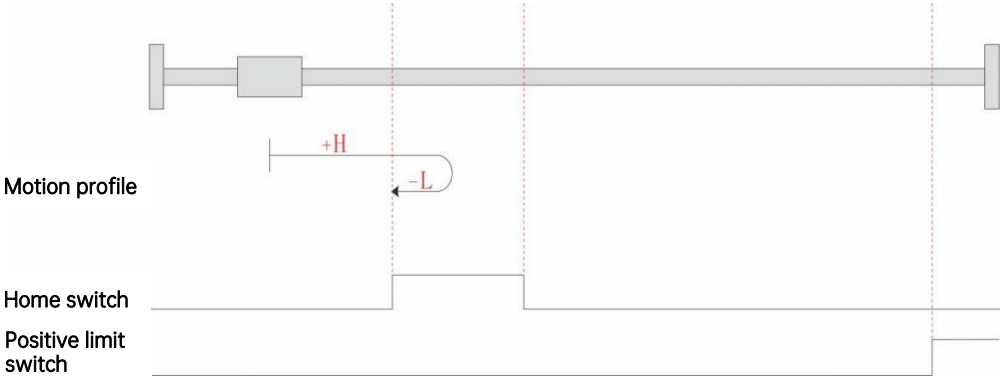
The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the forward direction at a high speed till it reaches the falling edge of the home switch. Then, homing is processed in the backward direction at a low speed, and stops when the motor reaches the rising edge of the home switch.



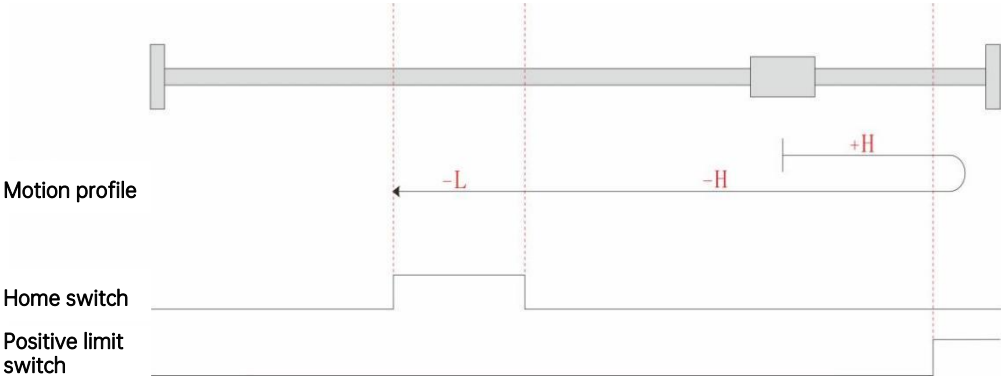
- 0x6098 = 23

Homing in forward direction, and home switch as both the deceleration point and the home position

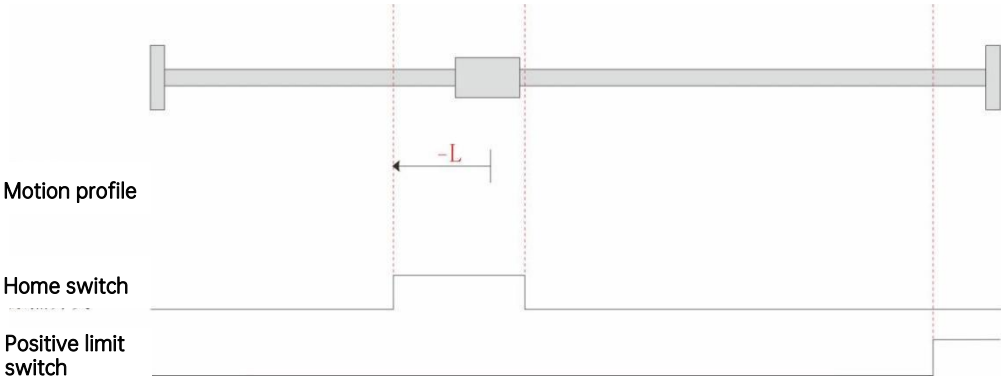
The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Then, homing is processed in the backward direction at a low speed, and stops when the motor reaches the falling edge of the home switch.



The present motor position is between the positive limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the positive limit switch. Then, homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing continues in the backward direction at a low speed, and stops when the motor reaches the falling edge of the home switch.



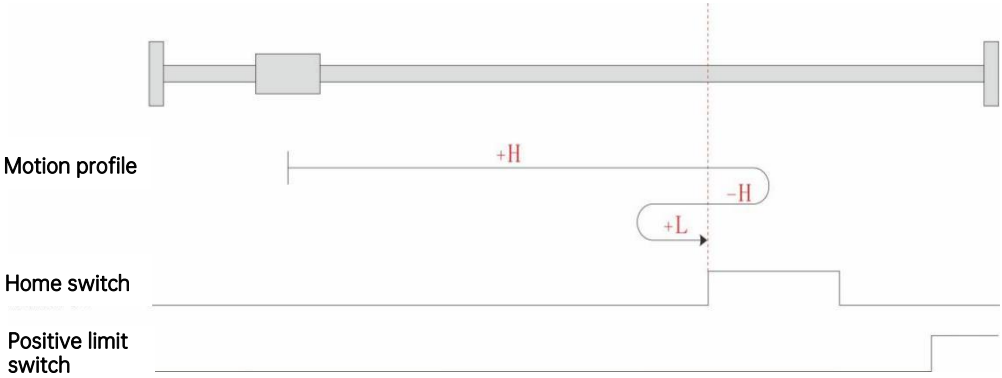
The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the backward direction at a low speed. Homing stops when the motor reaches the falling edge of the home switch.



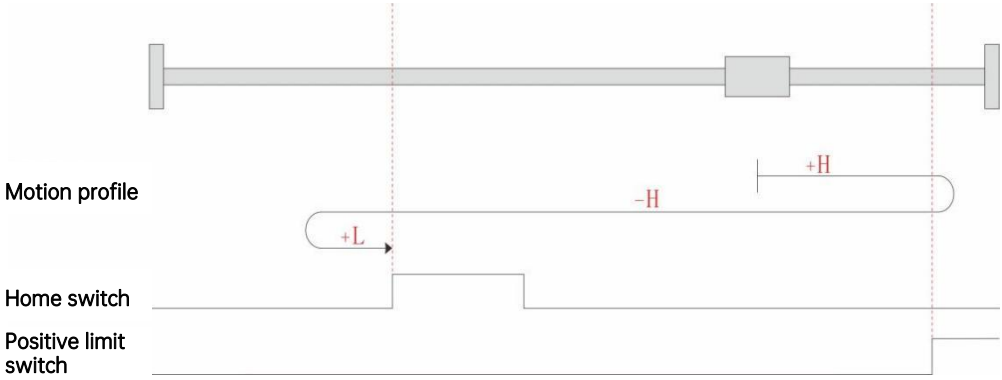
- 0x6098 = 24

Homing in forward direction, and home switch as both the deceleration point and the home switch

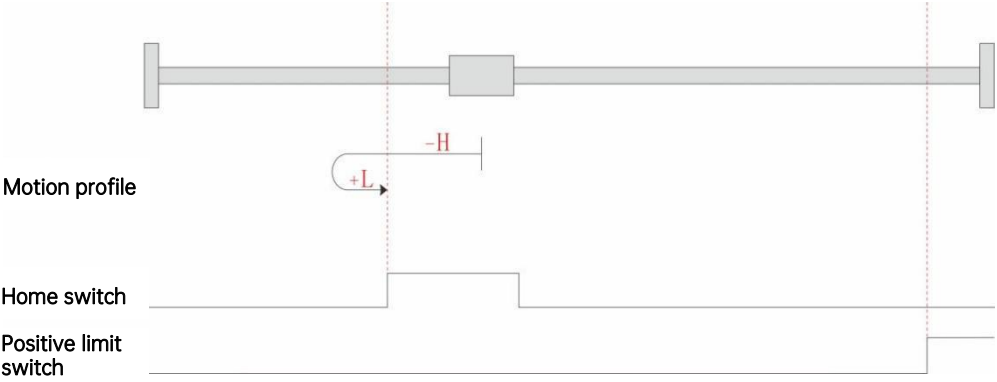
The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Then, homing is processed in the backward direction at a high speed till it reaches the falling edge of the home switch. Afterwards, homing is processed in the forward direction at a low speed, and stops when the motor reaches the rising edge of the home switch.



The present motor position is between the home switch and the positive limit switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the positive limit switch. Then, homing is processed in the backward direction at a high speed till it reaches the falling edge of the home switch. Afterwards, homing is processed in the forward direction at a low speed, and stops when the motor reaches the rising edge of the home switch.



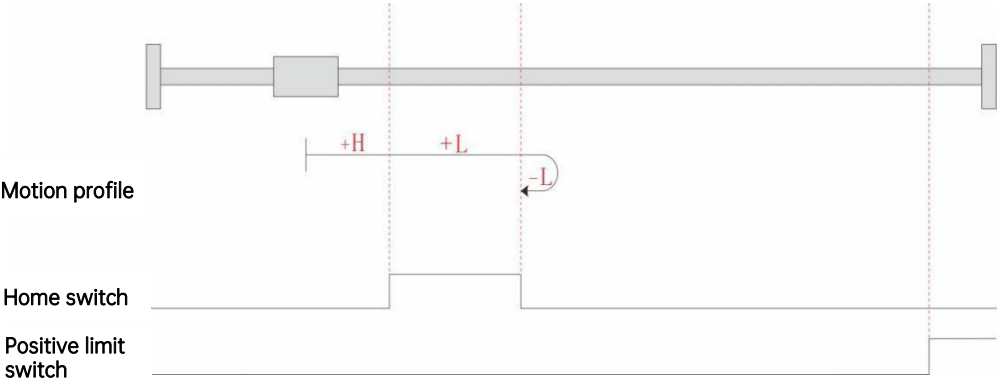
The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the backward direction at a high speed till it reaches the falling edge of the home switch. Then, homing is processed in the forward direction at a low speed, and stops when the motor reaches the rising edge of the home switch.



- 0x6098 = 25

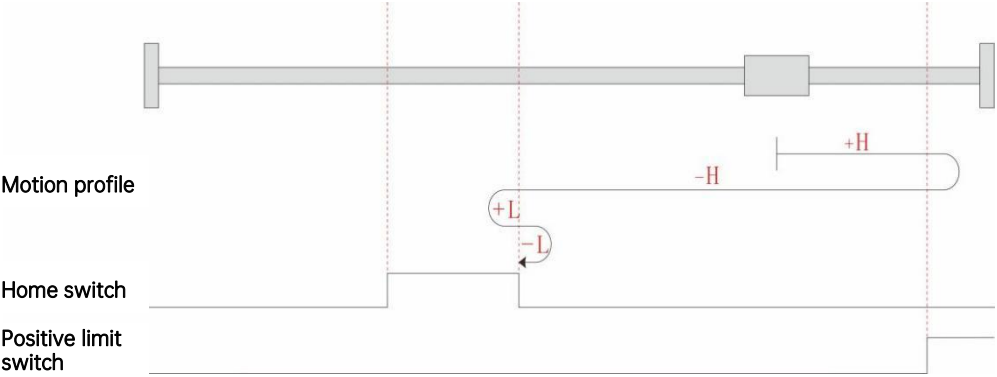
Homing in forward direction, and home switch as both the deceleration point and the home position

The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Then, homing continues in the forward direction at a low speed till it reaches the falling edge of the home switch. Afterwards, homing is processed in the backward direction at a low speed, and stops when the motor reaches the rising edge of the home switch.

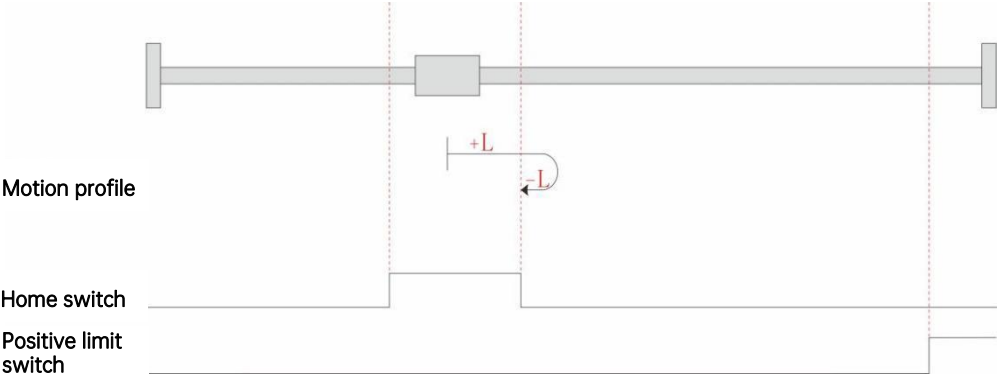


The present motor position is between the positive limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the positive limit switch. Then, homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Next, homing is processed in the forward direction at a low speed till it reaches the falling edge of the home switch.

Afterwards, homing is processed in the backward direction at a low speed, and stops when the motor reaches the rising edge of the home switch.



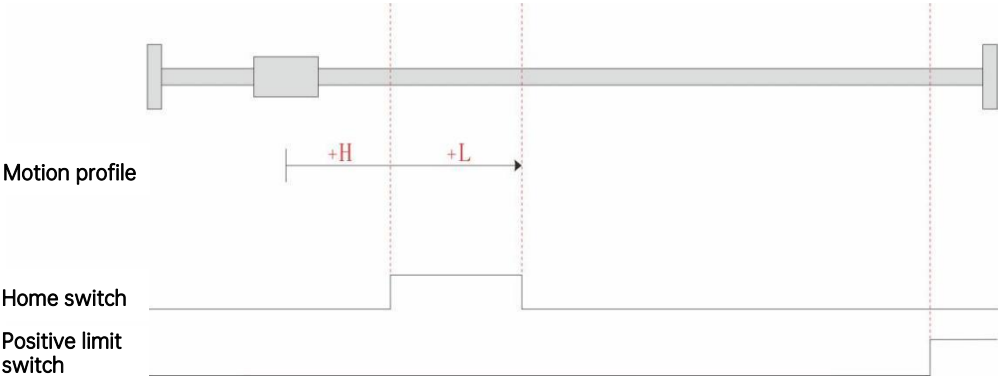
The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the forward direction at a low speed till it reaches the falling edge of the home switch. Then, homing is processed in the backward direction at a low speed, and stops when the motor reaches the rising edge of the home switch.



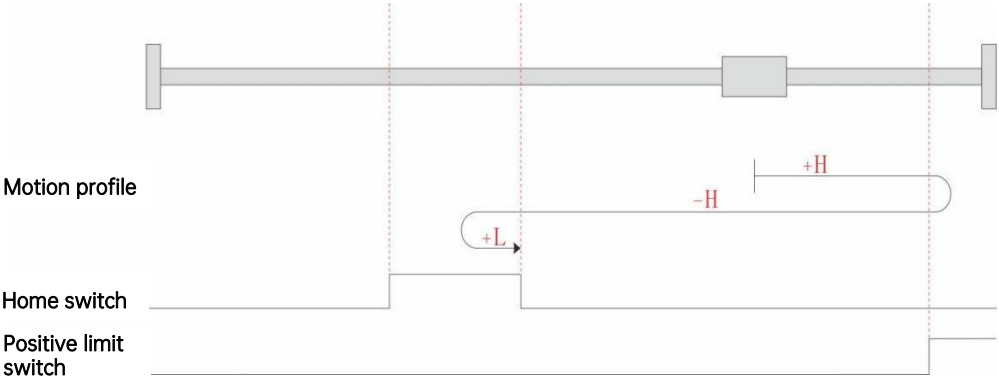
- 0x6098 = 26

Homing in forward direction, and home switch as both the deceleration point and the home position

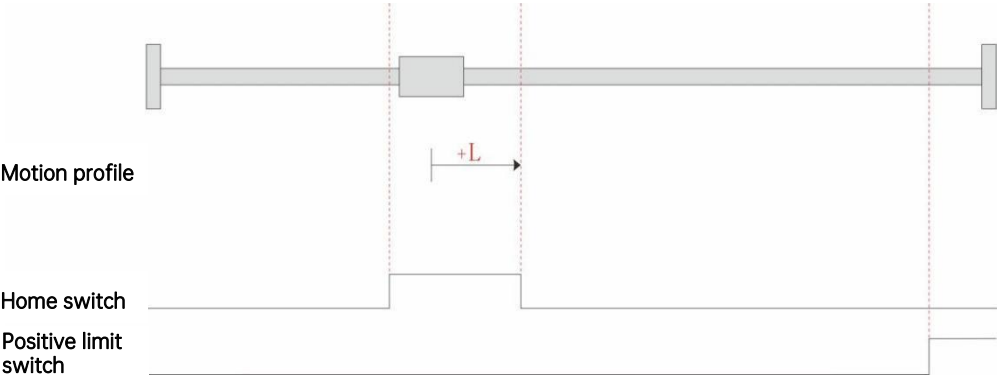
The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Then, homing continues in the forward direction at a low speed, and stops when the motor reaches the falling edge of the home switch.



The present motor position is between the positive limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the forward direction at a high speed till it reaches the rising edge of the positive limit switch. Then, homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing is processed in the forward direction at a low speed, and stops when the motor reaches the falling edge of the home switch.



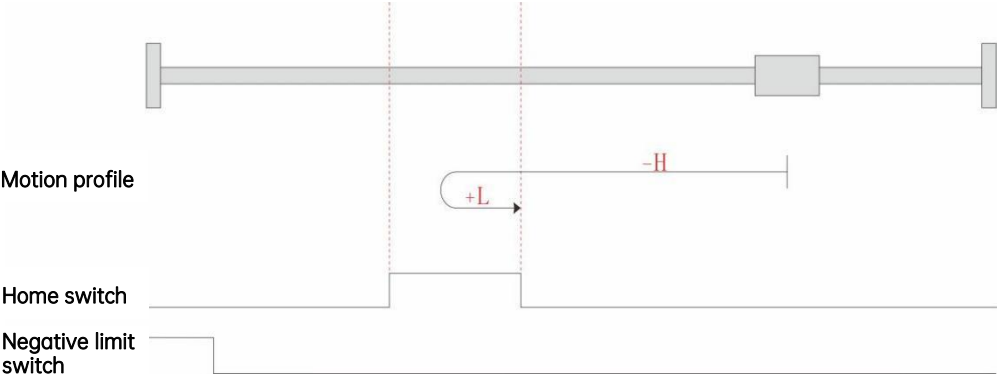
The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the forward direction at a low speed. Homing stops when the motor reaches the falling edge of the home switch.



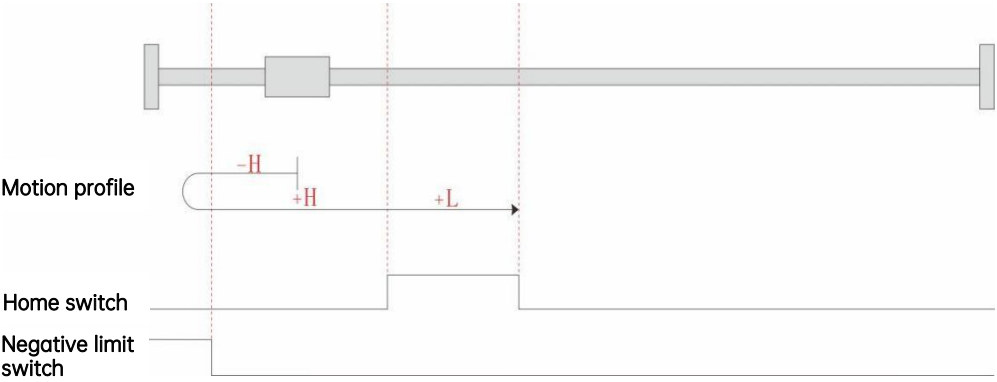
- 0x6098 = 27

Homing in backward direction, and home switch as both the deceleration point and the home position

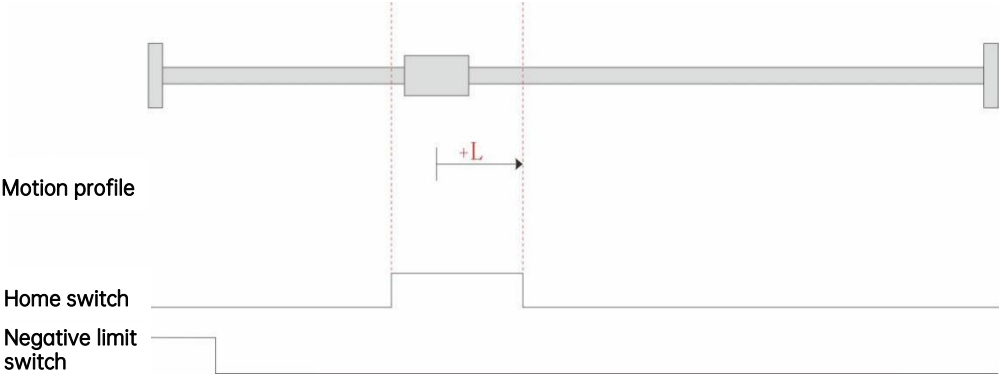
The present motor position is between the positive limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Then, homing is processed in the forward direction at a low speed, and stops when the motor reaches the falling edge of the home switch.



The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed int the backward direction at a high speed till it reaches the rising edge of the negative limit switch. Then, homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing continues in the forward direction at a low speed, and stops when the motor reaches the falling edge of the home switch.



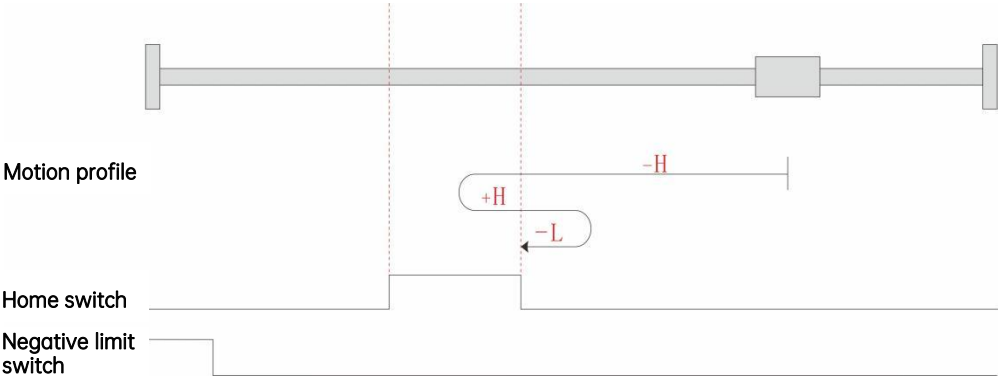
The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the forward direction at a low speed. Homing stops when the motor reaches the falling edge of the home switch.



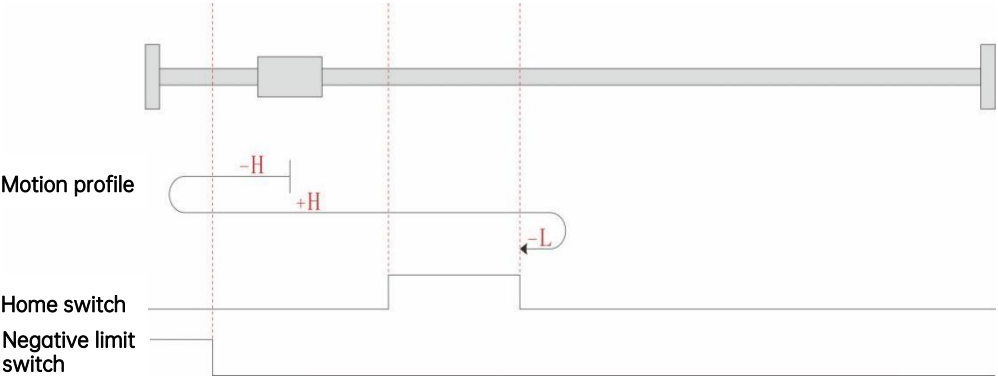
- 0x6098 = 28

Homing in backward direction, and home switch as both the deceleration point and the home position

The present motor position is between the home switch and the positive limit switch. When homing starts, the home switch is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Then, homing is processed in the forward direction at a high speed till it reaches the falling edge of the home switch. Afterwards, homing is processed in the backward direction at a low speed, and stops when the motor reaches the rising edge of the home switch.

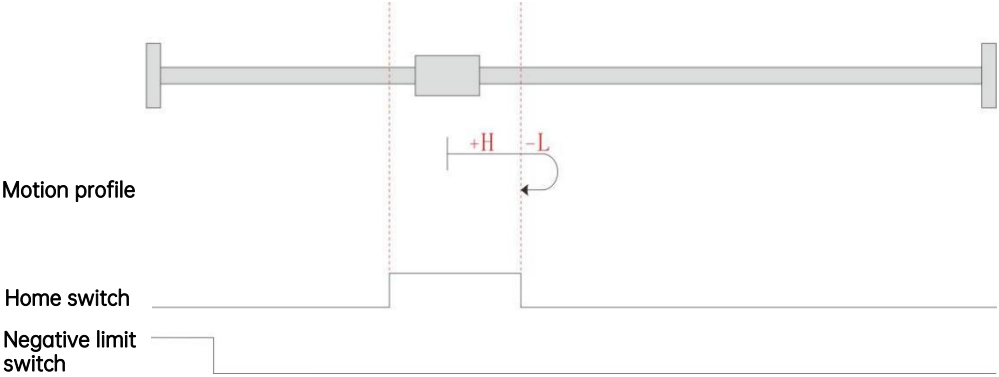


The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the negative limit switch. Then, homing is processed in the forward direction at a high speed till it reaches the falling edge of the home switch. Afterwards, homing is processed in the backward direction at a low speed, and stops when the motor reaches the rising edge of the home switch.



The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the forward direction at a high speed till it reaches

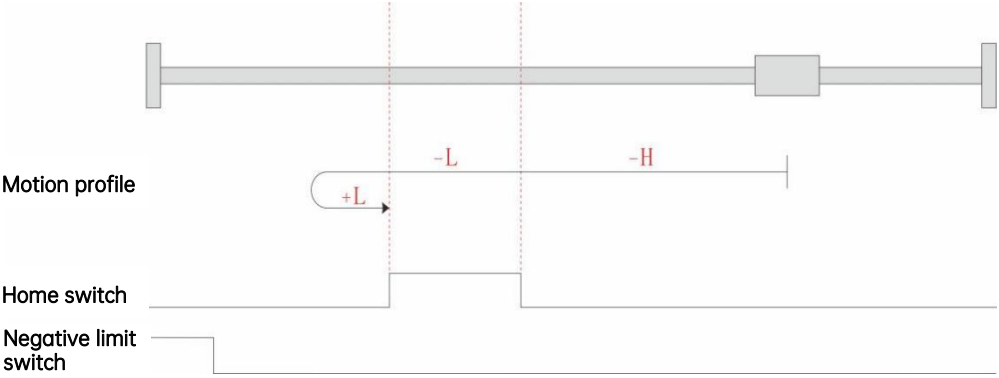
the falling edge of the home switch. Then, homing is processed in the backward direction at a low speed, and stops when the motor reaches the rising edge of the home switch.



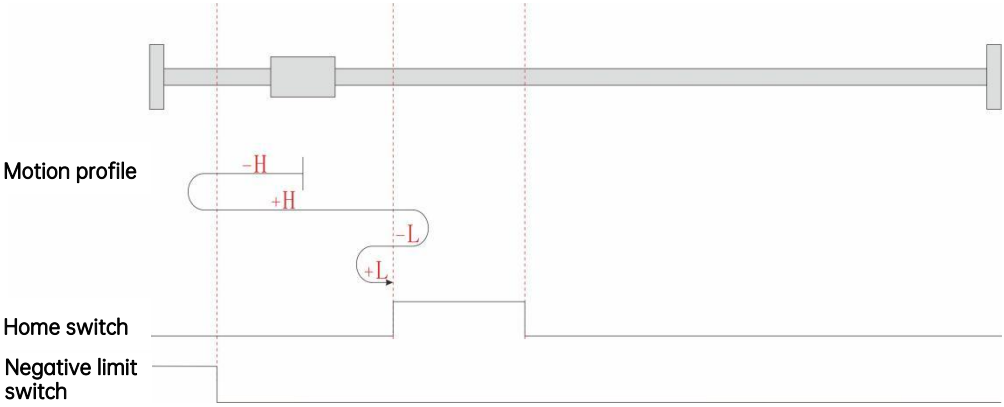
- 0x6098 = 29

Homing in backward direction, and home switch as both the deceleration point and the home position

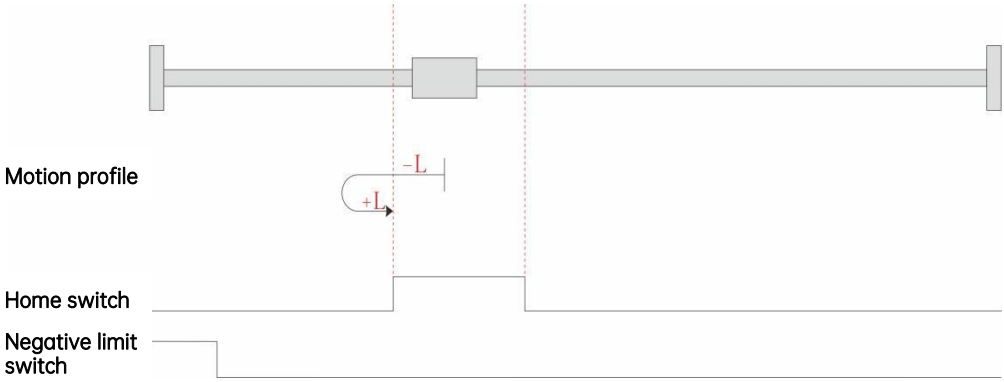
The present motor position is between the positive limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the home switch. Then, homing continues in the backward direction at a low speed till it reaches the falling edge of the home switch. Afterwards, homing is processed in the forward direction at a low speed, and stops when the motor reaches the rising edge of the home switch.



The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the negative limit switch. Then, homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Next, homing is processed in the backward direction at a low speed till it reaches the falling edge of the home switch. Afterwards, homing is processed in the forward direction at a low speed, and stops when the motor reaches the rising edge of the home switch.



The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the backward direction at a low speed till it reaches the falling edge of the home switch. Then, homing is processed in the forward direction at a low speed, and stops when the motor reaches the rising edge of the home switch.

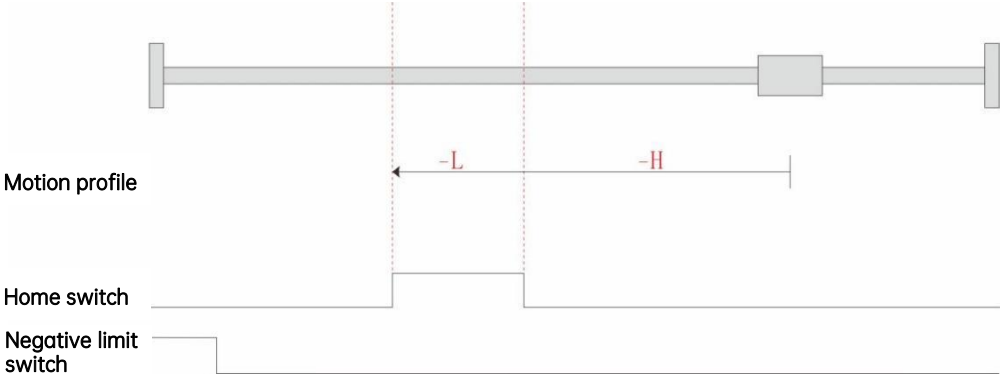


- 0x6098 = 30

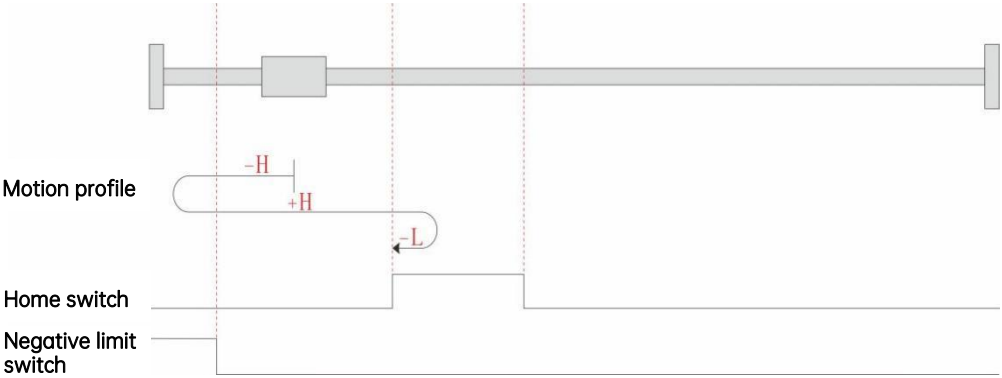
Homing in backward direction, and home switch as both the deceleration point and the home position

The present motor position is between the positive limit switch and the home position. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high

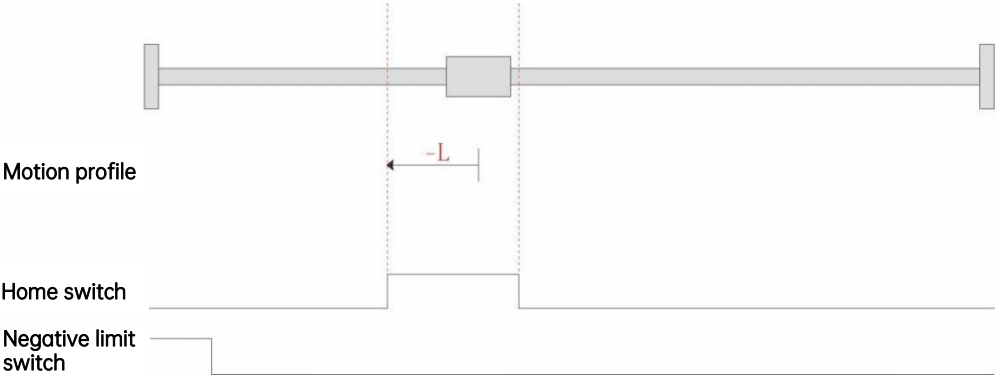
speed till it reaches the rising edge of the home switch. Then, homing continues in the backward direction at a low speed, and stops when the motor reaches the falling edge of the home switch.



The present motor position is between the negative limit switch and the home switch. When homing starts, the home switch is at a low level, and homing is processed in the backward direction at a high speed till it reaches the rising edge of the negative limit switch. Then, homing is processed in the forward direction at a high speed till it reaches the rising edge of the home switch. Afterwards, homing is processed in the backward direction at a low speed, and stops when the motor reaches the falling edge of the home switch.



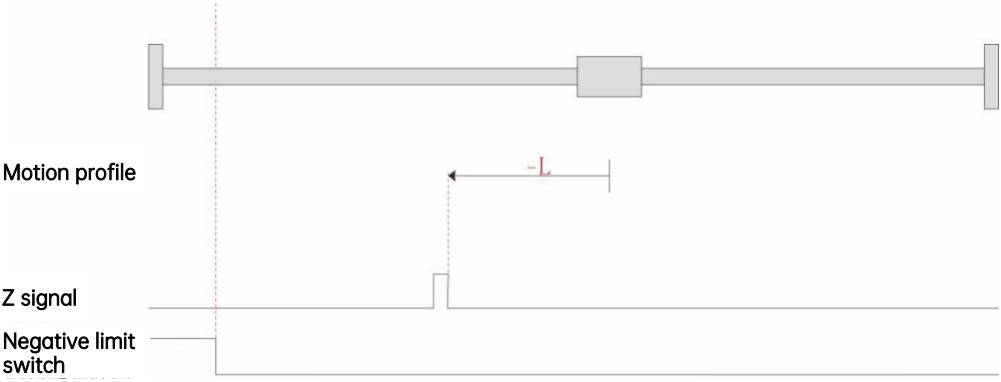
The present motor position is in the effective zone of the home switch. When homing starts, the home switch is at a high level, and homing is processed in the backward direction at a low speed. Homing stops when the motor reaches the falling edge of the home switch.



- 0x6098 = 33

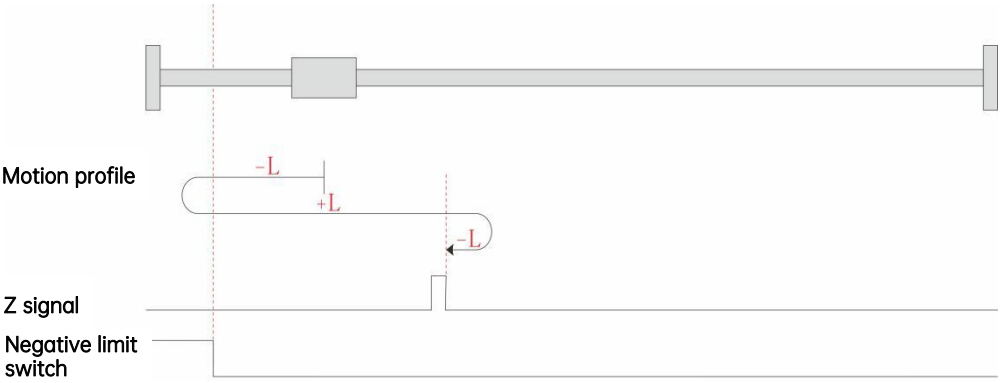
Homing in backward direction, and the motor Z signal as both the deceleration point and the home position

When there is at least one Z signal between the present motor position and the negative limit switch, homing will be processed in the backward direction at a low speed, and stop when the motor reaches the rising edge of the Z signal.



When the present motor position is at the Z signal, homing enable will be activated, the present position will be recorded as the home position, and homing will stop immediately.

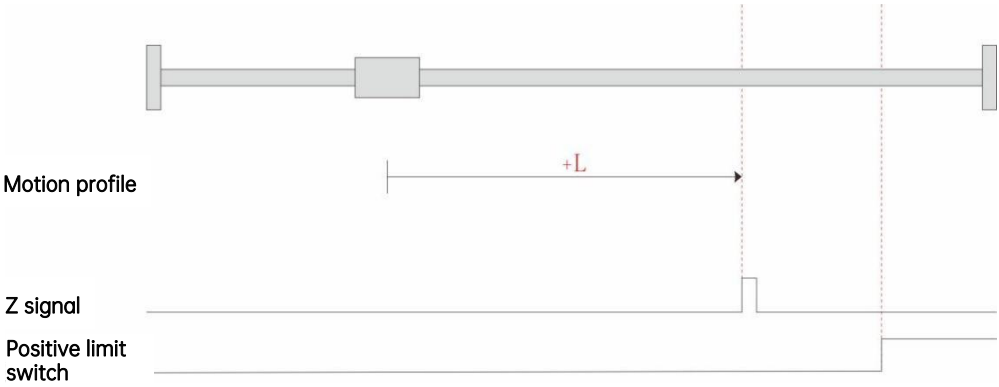
When there is no Z signal between the present motor position and the negative limit switch, homing will be processed in the backward direction at a low speed before it reaches the rising edge of the negative limit switch. Then, homing will be processed in the forward direction at a low speed before it reaches the falling edge of the Z signal. Afterwards, homing will be processed in the backward direction at a low speed, and stop when the motor reaches the Z signal.



- 0x6098 = 34

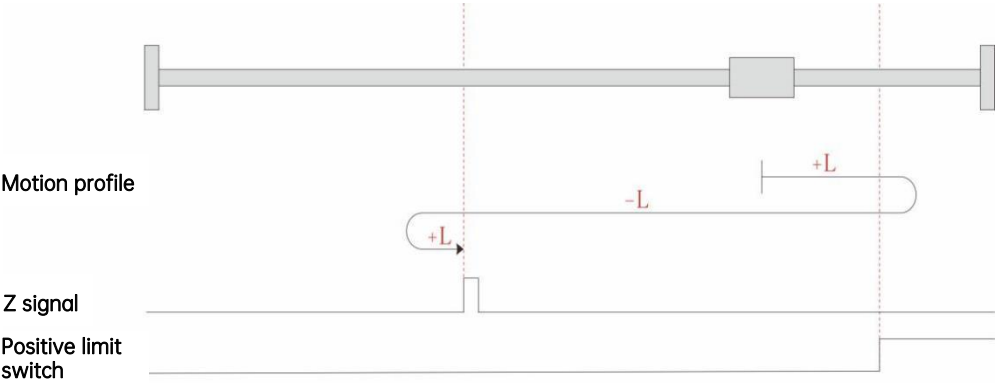
Homing in forward signal, and the motor Z signal as both the deceleration point and the home position

When there is at least one Z signal between the present motor position and the positive limit switch, homing will be processed in the forward direction at a low speed, and stop when the motor reaches the rising edge of the Z signal.



When the present motor position is at the Z signal, homing enable will be activated, the present position will be recorded as the home position, and homing will stop immediately.

When there is no Z signal between the present motor position and the positive limit switch, homing will be processed in the forward direction at a low speed before it reaches the rising edge of the positive limit switch. Then, homing will be processed in the backward direction at a low speed before it reaches the falling edge of the Z signal. Afterwards, homing will be processed in the forward direction at a low speed, and stop when the motor reaches the Z signal.



- 0x6098 = 35

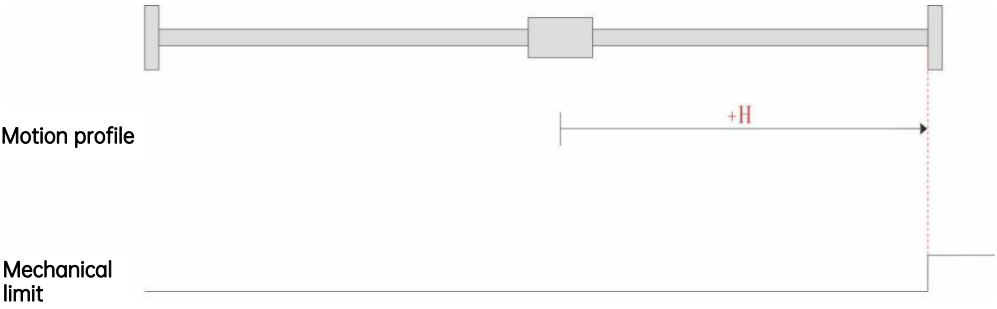
The present position will be determined as the home position.

- 0x6098 = -1

Homing in forward direction, and the mechanical limit position as both the deceleration point and the home position

Homing is processed in the forward direction at a high speed. When it reaches the mechanical limit position, if the output torque reaches 2017.15h (P23.20 homing torque limit) and the hold time reaches 2017.16h (P23.21 homing torque arrival time), homing stops.

Function code	Name	Range	Max. unit	Default	Effective time	Property	Function
P23.20	Homing torque limit	0 to 400.0%	0.1%	30.0%	Immediate	At stop	Judgement of mechanical limit arrival: the output torque reaches the homing torque limit value (P23.20) and the hold time of such state reaches a certain amount (P23.21), then the mechanical limit is determined as reached.
P23.21	Homing torque arrival time	0 to 65535 ms	1 ms	1	Immediate	At stop	

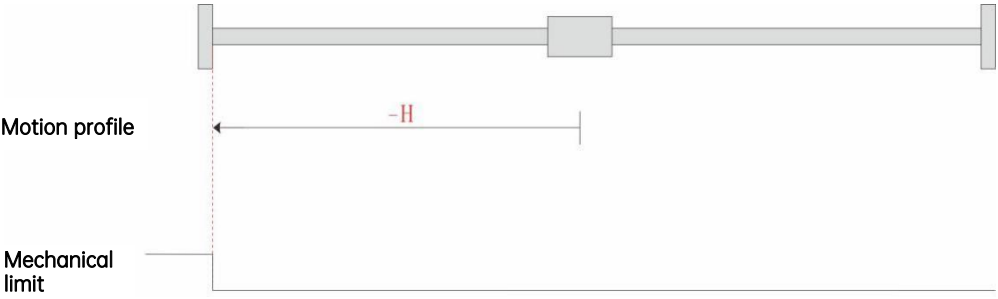


- 0x6098 = -2

Homing in backward direction, and the mechanical limit position as both the deceleration point and the home position

Homing is processed in the backward direction at a high speed. When it reaches the mechanical limit position, if the torque reaches 2017.15h (P23.20 homing torque limit) and the hold time reaches 2017.16h (P23.21 homing torque arrival time), homing stops.

Function code	Name	Range	Max. unit	Default	Effective time	Property	Function
P23.20	Homing torque limit	0 to 400.0%	0.1%	30.0%	Immediate	At stop	Judgement of mechanical limit arrival: the output torque reaches the homing torque limit value (P23.20) and the hold time of such state reaches a certain amount (P23.21), then the mechanical limit is determined as reached.
P23.21	Homing torque arrival time	0 to 65535 ms	1 ms	1	Immediate	At stop	

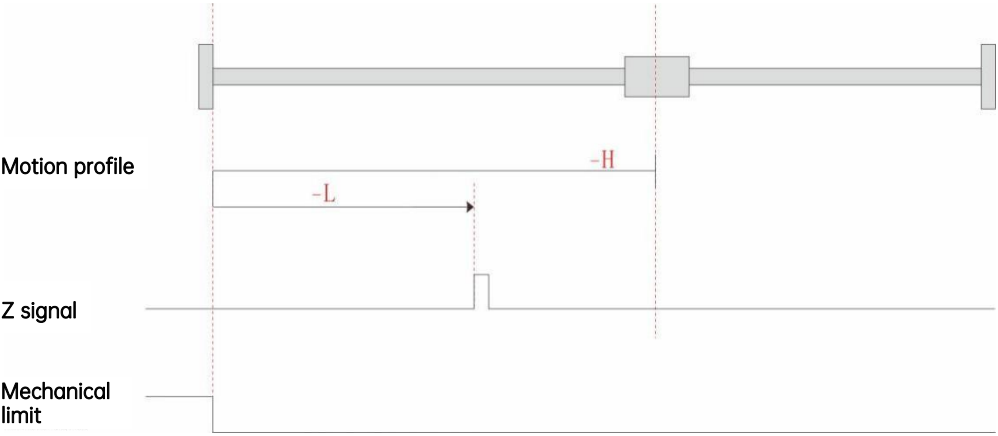


- 0x6098 = -3

Homing in backward direction, mechanical limit position as the deceleration point, and the motor Z signal as the home position

Homing is processed in the backward direction at a high speed. When it reaches the mechanical limit position, if the torque reaches 2017.15h (P23.20 homing torque limit) and the hold time reaches 2017.16h (P23.21 homing torque arrival time), homing is reversed to the forward direction at a low speed and stops when the motor reaches the Z signal.

Function code	Name	Range	Max. unit	Default	Effective time	Property	Function
P23.20	Homing torque limit	0 to 400.0%	0.1%	30.0%	Immediate	At stop	Judgement of mechanical limit arrival: the output torque reaches the homing torque limit value (P23.20) and the hold time of such state reaches a certain amount (P23.21), then the mechanical limit is determined as reached.
P23.21	Homing torque arrival time	0 to 65535 ms	1 ms	1	Immediate	At stop	



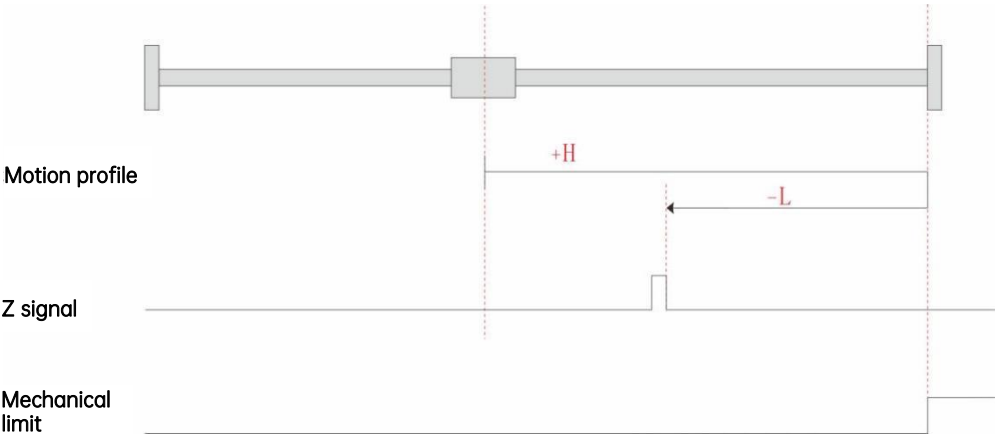
- 0x6098 = -4

Homing in forward direction, mechanical limit position as the deceleration point, and the motor Z signal as the home position

Homing is processed in the forward direction at a high speed. When it reaches the mechanical limit position, if the torque reaches 2017.15h (P23.20 homing torque limit) and the hold time reaches 2017.16h (P23.21 homing torque arrival time), homing is reversed to the backward direction at a low speed, and stops when the motor reaches the Z signal.

Function code	Name	Range	Max. unit	Default	Effective time	Property	Function
P23.20	Homing	0 to	0.1%	30.0%	Immediate	At stop	Judgement of mechanical

Function code	Name	Range	Max. unit	Default	Effective time	Property	Function
	torque limit	400.0%					limit arrival: the output torque reaches the homing torque limit value (P23.20) and the hold time of such state reaches a certain amount (P23.21), then the mechanical limit is determined as reached.
P23.21	Homing torque arrival time	0 to 65535 ms	1 ms	1	Immediate	At stop	



7.4.5 Cyclic synchronous position mode

The principle of the cyclic synchronous position mode is similar to that of the interpolated position mode. In this mode, the master station performs the planning of the position command, and sends the planned target position to the slave station drive in a periodic synchronous manner. In this mode, the target position object is 607Ah.

The cyclic synchronous position mode supports the absolute position command only, and M6-L series supports linear interpolation only.

7.4.5.1 Common object

The objects related to this operation mode are listed in the table below.

Index	Data structure	Name	Data type	Accessibility	Mapping type	Unit
6040h	VAR	Control word	UINT16	RW	RPDO	-
6041h	VAR	Status word	UINT16	RO	TPDO	-
6060h	VAR	Modes of operation	INT8	RW	RPDO	-
6061h	VAR	Modes of operation display	INT8	RO	TPDO	-
6063h	VAR	Position actual value* (motor unit)	INT32	RO	TPDO	p
6064h	VAR	Position actual value (user-defined unit)	INT32	RO	TPDO	Command unit
6065h	VAR	Following error window	UINT32	RW	RPDO	Command unit
6066h	VAR	Following error window time	UINT16	RW	RPDO	ms
6067h	VAR	Position window	UINT32	RW	RPDO	Command unit
6068h	VAR	Position window time	UINT16	RW	RPDO	ms
607Ah	VAR	Target position	INT32	RW	RPDO	Command unit
607Dh	ARRAY	Software position limit	INT32	RW	RPDO	Command unit
607Eh	VAR	Polarity	UINT8	RW	RPDO	-
6091h	ARRAY	Gear ratio factor	UINT32	RW	RPDO	-
60F4h	VAR	Following error actual value	INT32	RO	TPDO	Command unit
2014.0bh	VAR	Data interpolation cycle	UINT16	RW	RPDO	μs

Note:

Data interpolation cycle P20.10 (2014.0bh) is implemented only in the situation where the synchronization cycle is not consistent with the data cycle. Under the circumstances, the data interpolation cycle is used as the data cycle, and the unit is μs.

7.4.5.2 Control word and status word

The definition of the control word in the cyclic synchronous position mode is the same with the standard definition.

The status word in the cyclic synchronous position mode is explained in the table below:

Bit15 to Bit14	Bit13	Bit12	Bit11	Bit10	Bit9 to Bit0
*	Following error	Target position ignored	*	Target reached	*

The bits of the status word in the cyclic synchronous position mode are described in the table below:

Bit	Set value	Function
Target reached	0	Target position not reached
	1	Target position reached
Target position ignored	0	Position command not followed
	1	Position command followed
Following error	0	No position deviation
	1	There is position deviation.

7.4.5.3 Function description

- Running mode setting: Set 6060h to 8;
- Target position setting: Set the target position in the user-defined unit via 607Ah; if necessary, set the gear ratio factor 6091h;
- Operation enable: Enable the operation of the drive via the control word 6040h;
- Speed limit setting: Select the speed limit channel via 2007.0Ah (P07.09 FWD speed limit channel) and 2007.0Ch (P07.11 REV speed limit channel) in the object dictionary of the function code, where the bus channel is selected by default. The range for the bus speed limit channel is determined by 607Fh maximum profile velocity and 6080h maximum motor speed. Otherwise, set an internal speed limit channel, and the range is determined by 2007.0Bh (P07.10 FWD speed limit) and 2007.0Dh (P07.12 REV speed limit) in the object dictionary of the function code. The speed limit can be decreased to zero based on the decrease time set by P20.19 (2014.14h);

Function code	Name	Range	Max. unit	Default	Effective time	Property	Function
P20.19	Bus speed limit decrease time	0 to 65535	1	0	Immediate	At stop	Set the time of the speed limit decreasing from the max. value to zero (unit: ms)

- Torque limit setting: Select the torque limit channel via 2006.0Dh (P06.12 positive torque limit channel) and 2006.0Eh (P06.13 negative torque limit channel) in the object dictionary of the function code, where the bus channel is selected by default. The range for the bus torque limit channel is determined by the minimum value among 6072h maximum torque, 60E0h positive torque limit, and 60E1h negative torque limit. Otherwise, set an internal torque limit channel, and the range is determined by 2006.0Fh (P06.14 positive torque limit) and 2006.10h (P06.15 negative torque limit) in the object dictionary of the function code;
- Excessive position deviation judgement: If the position deviation in the user-defined unit 60F4h is greater than 6065h, a fault is reported; at this point, bit13 of the status word 6041h is set to 1;
- When the synchronization cycle is not consistent with the data cycle, it is required to set the data interpolation cycle 2014.0bh;
- Polarity 0x607E of command: The command logic of torque, speed, and position shall be set according to the corresponding bit of 0x607E in the object dictionary.

Bit	Name	Set value	Function
BIT5	Torque command polarity	0	Torque command positive logic
		1	Torque command negative logic
BIT6	Speed command polarity	0	Speed command positive logic
		1	Speed command negative logic
BIT7	Position command polarity	0	Position command positive logic
		1	Position command negative logic

7.4.5.4 Basic configuration

The basic configuration of the objects in the cyclic synchronous position mode is described in the table below.

RPDO object	TPDO object	Remark
Control word 6040h	Status word 6041h	Required
Target position 607Ah	Position actual value 6064h	Required
Other object		Optional; it can be configured as an SDO parameter.

7.4.6 Cyclic synchronous velocity mode

In this mode, the master sends the calculated target velocity to the slave drive in a cyclic synchronous manner. The slave drive implements the target velocity sent by the master. The interpolation cycle is the same with the synchronous signal cycle.

7.4.6.1 Common object

The objects related to this operation mode are listed in the table below.

Index	Data structure	Name	Data type	Accessibility	Mapping type	Unit
603Fh	VAR	Error Code	UINT16	RW	TPDO	-
6040h	VAR	Control word	UINT16	RW	RPDO	-
6041h	VAR	Status word	UINT16	RO	TPDO	-
6060h	VAR	Modes of operation	INT8	RW	RPDO	-
6061h	VAR	Modes of operation display	INT8	RO	TPDO	-
606Ch	VAR	Velocity actual value	INT32	RO	TPDO	Command unit / s
606Dh	VAR	Velocity window	UINT16	RW	RPDO	[rpm] / [mm/s]
606Eh	VAR	Velocity window time	UINT16	RW	RPDO	ms
607Eh	VAR	Polarity	UINT8	RW	RPDO	-
6091h	ARRAY	Gear ratio factor	UINT32	RW	RPDO	-
60FFh	VAR	Target velocity	INT32	RW	RPDO	Command unit / s

7.4.6.2 Control word and status word

The definition of the control word in the cyclic synchronous velocity mode is the same with the standard definition.

The status word in the cyclic synchronous velocity mode is explained in the table below:

Bit15 to Bit13	Bit12	Bit11	Bit10	Bit9 to Bit0
*	Target velocity ignored	*	Target reached	*

The bits of the status word in the cyclic synchronous velocity mode are described in the table below:

Bit	Set value	Function
Target reached	0	Target speed not reached
	1	Target speed reached
Target velocity ignored	0	Velocity command not followed
	1	Velocity command followed

7.4.6.3 Function description

- Running mode setting: Set 6060h to 9;
- Target velocity setting: Set the target velocity in the user-defined unit via 60FFh; if necessary, set the gear ratio factor 6091h;
- Operation enable: Enable the operation of the drive via the control word 6040h;
- Speed limit setting: Select the speed limit channel via 2007.0Ah (P07.09 FWD speed limit channel) and 2007.0Ch (P07.11 REV speed limit channel) in the object dictionary of the function code, where the bus channel is selected by default. The range for the bus speed limit channel is determined by 607Fh maximum profile velocity and 6080h maximum motor speed. Otherwise, set an internal speed limit channel, and the range is determined by 2007.0Bh (P07.10 FWD speed limit) and 2007.0Dh (P07.12 REV speed limit) in the object dictionary of the function code. The speed limit can be decreased to zero based on the decrease time set by P20.19 (2014.14h);

Function code	Name	Range	Max. unit	Default	Effective time	Property	Function
P20.19	Bus speed limit decrease time	0 to 65535	1	0	Immediate	At stop	Set the time of the speed limit decreasing from the max. value to zero (unit: ms)

- Torque limit setting: Select the torque limit channel via 2006.0Dh (P06.12 positive torque limit channel) and 2006.0Eh (P06.13 negative torque limit channel) in the object dictionary of the function code, where the bus channel is selected by default. The range for the bus torque limit channel is determined by the minimum value among 6072h maximum torque, 60E0h positive torque limit, and 60E1h negative torque limit. Otherwise, set an internal torque limit channel, and the range is determined by 2006.0Fh (P06.14 positive torque limit) and 2006.10h (P06.15 negative torque limit) in the object dictionary of the function code;

- Polarity 0x607E of command: The command logic of torque, speed, and position shall be set according to the corresponding bit of 0x607E in the object dictionary.

Bit	Name	Set value	Function
BIT5	Torque command polarity	0	Torque command positive logic
		1	Torque command negative logic
BIT6	Speed command polarity	0	Speed command positive logic
		1	Speed command negative logic
BIT7	Position command polarity	0	Position command positive logic
		1	Position command negative logic

7.4.6.4 Basic configuration

The basic configuration of the objects in the cyclic synchronous velocity mode is described in the table below.

RPDO object	TPDO object	Remark
Control word 6040h	Status word 6041h	Required
Target position 60FFh		Required
	Velocity actual value 606Ch	Optional
Other object		Optional; it can be configured as an SDO parameter.

7.4.7 Cyclic synchronous torque mode

In this mode, the master sends the calculated target torque to the slave drive in a cyclic synchronous manner. The slave drive implements the target torque sent by the master. The interpolation cycle is consistent with the synchronous signal cycle.

7.4.7.1 Common object

The objects related to this operation mode are listed in the table below.

Index	Data structure	Name	Data type	Accessibility	Mapping type	Unit
603Fh	VAR	Error Code	UINT16	RW	TPDO	-
6040h	VAR	Control word	UINT16	RW	RPDO	-
6041h	VAR	Status word	UINT16	RO	TPDO	-
6060h	VAR	Modes of operation	INT8	RW	RPDO	-
6061h	VAR	Modes of operation display	INT8	RO	TPDO	-
6063h	VAR	Position actual value* (motor unit)	INT32	RO	TPDO	Encoder unit
6064h	VAR	Position actual value (user-defined unit)	INT32	RO	TPDO	Command unit
606Ch	VAR	Velocity actual value	INT32	RO	TPDO	Command unit / s
606Dh	VAR	Velocity window	UINT16	RW	RPDO	[rpm] / [mm/s]
6071h	VAR	Target torque	INT16	RW	RPDO	0.1%
6072h	VAR	Max. Torque	UINT16	RW	RPDO	0.1%
6074h	VAR	Torque demand	INT16	RO	TPDO	0.1%
6077h	VAR	Torque actual value	INT16	RO	TPDO	0.1%
607Eh	VAR	Polarity	UINT8	RW	RPDO	-
607Fh	VAR	Max. profile velocity	UINT32	RW	RPDO	Command unit / s
6080h	VAR	Max. motor speed	UINT32	RW	RPDO	[rpm] / [mm/s]
60E0h	VAR	FWD Torque Limit	UINT16	RW	RPDO	0.1%
60E1h	VAR	REV Torque Limit	UINT16	RW	RPDO	0.1%

7.4.7.2 Control word and status word

The definition of the control word in the cyclic synchronous torque mode is the same with the standard

definition.

The status word in the cyclic synchronous torque mode is explained in the table below:

Bit15 to Bit13	Bit12	Bit11	Bit10	Bit9 to Bit0
*	Target torque ignored	*	Target reached	*

The bits of the status word in the cyclic synchronous torque mode are described in the table below:

Bit	Set value	Function
Target reached	0	Target torque not reached
	1	Target torque reached
Target torque ignored	0	Torque command not followed
	1	Torque command followed

7.4.7.3 Function description

- Control mode setting: Set P02.00 to 8;
- Running mode setting: Set 6060h to 10;
- Target torque setting: Set the target torque in the user-defined unit via 6071h (unit: 0.1%);
- Speed limit setting: Select the speed limit channel via 2007.0Ah (P07.09 FWD speed limit channel) and 2007.0Ch (P07.11 REV speed limit channel) in the object dictionary of the function code, where the bus channel is selected by default. The range for the bus speed limit channel is determined by 607Fh maximum profile velocity and 6080h maximum motor speed. Otherwise, set an internal speed limit channel, and the range is determined by 2007.0Bh (P07.10 FWD speed limit) and 2007.0Dh (P07.12 REV speed limit) in the object dictionary of the function code. The speed limit can be decreased to zero based on the decrease time set by P20.19 (2014.14h);

Function code	Name	Range	Max. unit	Default	Effective time	Property	Function
P20.19	Bus speed limit decrease time	0 to 65535	1	0	Immediate	At stop	Set the time of the speed limit decreasing from the max. value to zero (unit: ms)

- Torque limit setting: Select the torque limit channel via 2006.0Dh (P06.12 positive torque limit channel) and 2006.0Eh (P06.13 negative torque limit channel) in the object dictionary of the function code, where the bus channel is selected by default. The range for the bus torque limit channel is determined by the minimum value among 6072h maximum torque, 60E0h positive torque limit, and 60E1h negative torque limit. Otherwise, set an internal torque limit channel, and the range is determined by 2006.0Fh (P06.14 positive torque limit) and 2006.10h (P06.15 negative torque limit) in the object dictionary of the function code;

- Operation enable: Enable the operation of the drive via the control word 6040h;
- Polarity 0x607E of command: The command logic of torque, speed, and position shall be set according to the corresponding bit of 0x607E in the object dictionary;

Bit	Name	Set value	Function
BIT5	Torque command polarity	0	Torque command positive logic
		1	Torque command negative logic
BIT6	Speed command polarity	0	Speed command positive logic
		1	Speed command negative logic
BIT7	Position command polarity	0	Position command positive logic
		1	Position command negative logic

- Torque arrival: This function determines whether the torque actual value has reached the torque window. If the discrepancy between the torque actual value (6077h) and the torque reference value (2007.0Eh) is greater than the torque arrival effective value (2007.0Fh), bit10 (target reached) of the status word will be set to 1. If the discrepancy between the torque actual value (6077h) and the torque reference value (2007.0Eh) is lower than the torque arrival non-effective value (2007.10h), bit10 (target reached) of the status word will be cleared immediately.
- Target torque ramp: This function defines the acceleration/deceleration time of the target torque. When the controller cannot plan the ramp for the target torque (6071h), the system can plan the acceleration/deceleration for the servo internal torque via the setting of P20.20 (2014.15h), and the unit is 0.01% / 1 ms. If only the deceleration ramp from the target torque to zero is required, set P20.18 (2014.13h) to plan the servo internal torque deceleration. If P20.18 and P20.20 are both set, P20.18 will be valid when the target torque is decreased to zero, and P20.20 will be valid under other circumstances. If the controller offers planning of the torque ramp, neither P20.18 nor P20.20 can be set.

Function code	Name	Range	Max. unit	Default	Effective time	Property	Function
P20.18	Bus torque command full deceleration ramp	0 to 65535	1	0	Immediate	At stop	Set the ramp of the torque decreasing to zero (unit: 0.01% / 1 ms)
P20.20	Bus torque command acceleration/ deceleration ramp	0 to 65535	1	0	Immediate	At stop	Set the ramp of the torque acceleration/ deceleration (unit: 0.01% / 1 ms); it can be valid with P20.18 at the same time.

7.4.7.4 Basic configuration

The basic configuration of the objects in the cyclic synchronous torque mode is described in the table below.

RPDO object	TPDO object	Remark
Control word 6040h	Status word 6041h	Required
Target torque 6071h		Required
	Torque actual value 6077h	Optional
Other object		Optional; it can be configured as an SDO parameter; otherwise, use the default parameter of the drive.

7.5 Servo drive stop

Stop mode: coast to stop; decelerate to stop.

When the drive is in the running state, if the control word receives a Shutdown command, the drive will stop in the mode defined by 605Bh.

When the drive is in the running state, if the control word receives a Disable operation command, the drive will stop in the mode defined by 605Ch.

When the drive is in the running state, if the control word receives a Quick stop command, the drive will stop in the mode defined by 605Ah.

When the emergency stop DI (FunIN.34) is applied, the drive will stop in the mode defined by 605Ah.

Object dictionary	Name	Data type	Accessibility	Mapping type	Unit	Function
605Ah	Quick stop option code	INT16	RW	RPDO	-	0 - Coast to stop 1 - 6084h / 609Ah (HM) / 6087h (PT/CST) 2 - 6085h / 6087h (PT/CST) 5 - 6084h / 609Ah (HM) / 6087h (PT/CST), drive position lock 6 - 6085h / 6087h

Object dictionary	Name	Data type	Accessibility	Mapping type	Unit	Function
						(PT/CST), drive position lock **Remark:** The torque mode does not support position lock.
605Dh	Halt option code	INT16	RW	RPDO	-	1 - 6084h / 609Ah (HM) / 6087h (PT/CST) 2 - 6085h / 6087h (PT/CST)
605Bh	Shutdown option code	INT16	RW	RPDO	-	0 - Coast to stop 1 - 6084h / 609Ah (HM) / 6087h (PT/CST)
605Ch	Disable operation option code	INT16	RW	RPDO	-	0 - Coast to stop 1 - 6084h / 609Ah (HM) / 6087h (PT/CST)
6084h	Profile deceleration	UINT32	RW	RPDO	Command unit / s^2	
6085h	Quick stop deceleration	UINT32	RW	RPDO	Command unit / s^2	
6087h	Torque slope	UINT16	RW	RPDO	0.1% / s	
609Ah	Homing acceleration	UINT32	RW	RPDO	Command unit / s^2	

7.6 Servo drive application

7.6.1 Touch Probe function

M6 series adopts two channels of touch probes, capable of simultaneously recording the position

information of the positive and negative values of the touch probe signals.

If the DI terminal is used as the touch probe trigger signal terminal, DI3 and DI4 will be the high-speed input terminal; select terminal function 49 (Touch probe 1) for P03.02 (DI3), and terminal function 50 (Touch probe 2) for P03.03 (DI4).

Z signal can be used as the touch probe trigger signal.

Object dictionary	Name	Data type	Accessibility	Mapping type	Unit
60B8h	Touch Probe function	INT16	RW	RPDO	-
60B9h	Touch probe status	UINT16	RO	TPDO	-
60BAh	Touch probe Pos1 pos value	INT32	RO	TPDO	Command unit
60BBh	Touch probe Pos1 neg value	INT32	RO	TPDO	Command unit
60BCh	Touch probe Pos2 pos value	INT32	RO	TPDO	Command unit
60BDh	Touch probe Pos2 neg value	INT32	RO	TPDO	Command unit

	Bit	Function
60B8h Touch probe function	0	0 - Disable touch probe 1 1 - Enable touch probe 1
	1	0 - Touch probe 1 single latch 1 - Touch probe 1 consecutive latch
	2	0 - Trigger touch probe 1 by DI terminal 1 - Trigger touch probe 1 by Z signal
	3	Reserved
	4	0 - Touch probe Pos1 pos value not latch 1 - Touch probe Pos1 pos value latch
	5	0 - Touch probe Pos1 neg value not latch 1 - Touch probe Pos1 neg value latch
	6 to 7	Reserved
	8	0 - Disable touch probe 2 1 - Enable touch probe 2

	9	0 - Touch probe 2 single latch 1 - Touch probe 2 consecutive latch
	10	0 - Trigger touch probe 2 by DI terminal 1 - Trigger touch probe 2 by Z signal
	11	Reserved
	12	0 - Touch probe Pos2 pos value not latch 1 - Touch probe Pos2 pos value latch
	13	0 - Touch probe Pos2 neg value not latch 1 - Touch probe Pos2 neg value latch
	14 to 15	Reserved

	Bit	Function
60B9h Touch probe status	0	0 - Touch probe 1 not enabled 1 - Touch probe 1 enabled
	1	0 - Touch probe Pos1 pos value latch not implemented 1 - Touch probe Pos1 pos value latch implemented
	2	0 - Touch probe Pos1 neg value latch not implemented 1 - Touch probe Pos1 neg value latch implemented
	3 to 7	Reserved
	8	0 - Touch probe 2 not enabled 1 - Touch probe 2 enabled
	9	0 - Touch probe Pos2 pos value latch not implemented 1 - Touch probe Pos2 pos value latch implemented
	10	0 - Touch probe Pos2 neg value latch not implemented 1 - Touch probe Pos2 neg value latch implemented
	11 to 15	Reserved

7.6.2 I/O terminal 60FDh/60FEh

M6 series servo drive supports 60FDh, which is used to set the input state of each drive terminal.

	Bit	Function
60FDh Digital inputs	0	1 - Negative limit valid 0 - Negative limit invalid
	1	1 - Positive limit valid 0 - Positive limit invalid
	2	1 - Home signal valid 0 - Home signal invalid
	3 to 15	Reserved
	16	1 - DI1 input valid 0 - DI1 input invalid
	17	1 - DI2 input valid 0 - DI2 input invalid
	18	1 - DI3 input valid 0 - DI3 input invalid
	19	1 - DI4 input valid 0 - DI4 input invalid
	20	1 - DI5 input valid 0 - DI5 input invalid
	21	1 - DI6 input valid 0 - DI6 input invalid
	22	1 - DI7 input valid 0 - DI7 input invalid
	23	1 - DI8 input valid 0 - DI8 input invalid
	24	1 - DI9 input valid 0 - DI9 input invalid
	25	1 - Z signal valid 0 - Z signal invalid
	26	1 - Touch probe 1 valid 0 - Touch probe 1 invalid

	27	1 - Touch probe 2 valid 0 - Touch probe 2 invalid
	28 to 31	Reserved

M6 series servo drive supports 60FEh, which is used for the EtherCAT bus to control the forced output of the DO signal.

Before the drive enters the OP state, DO terminal does not output.

When the drive is in the OP state, DO terminal controls the digital output via the corresponding bits of 60FESUB1 after enabled via 60FESUB2.

When the drive exits the OP state (i.e. cutoff), the drive will perform digital output as set by P20.27.

	Bit	Function
60FEh sub1 DO forced output control	0 to 15	Reserved
	16	1 - DO1 Switch on 0 - DO1 Switch off
	17	1 - DO2 Switch on 0 - DO2 Switch off
	18	1 - DO3 Switch on 0 - DO3 Switch off
	19	1 - DO4 Switch on 0 - DO4 Switch off
	20	1 - DO5 Switch on 0 - DO5 Switch off
	21 to 31	Reserved
60FEh sub2 DO forced output enable	0 to 15	Reserved
	16	1 - Enable DO1 output 0 - Disable DO1 output
	17	1 - Enable DO2 output 0 - Disable DO2 output
	18	1 - Enable DO3 output 0 - Disable DO3 output
	19	1 - Enable DO4 output 0 - Disable DO4 output

	20	1 - Enable DO5 output 0 - Disable DO5 output
	21 to 31	Reserved
P20.27 DO forced output selection	0	0 - DO1 state hold (hold the state as before cutoff) 1 - Disable DO1 output
	1	0- DO2 state hold (hold the state as before cutoff) 1 - Disable DO2 output
	2	0 - DO3 state hold (hold the state as before cutoff) 1 - Disable DO3 output
	3	0- DO4 state hold (hold the state as before cutoff) 1 - Disable DO4 output
	4	0 - DO5 state hold (hold the state as before cutoff) 1 - Disable DO5 output
	5 to 15	Reserved

7.6.3 Slave address distribution function

When the slave address is distributed automatically by the master, P20.09 (2014.0Ah) displays the addresses distributed by the master. When it is required to set the address by the slave, P20.08 (2014.09h) sets the slave address number.

7.6.4 User-defined unit selection

7.6.4.1 User-defined unit for position

The user can set P05.05 (2005.06h) number of command pulses per motor revolution or number of command pulses per pole pitch, and match the setting with controller target position. The default value is 8388608 P/r. The electronic gear ratio 6091h can be set at the same time.

7.6.4.2 User-defined unit for velocity

The user can select the user-defined unit of velocity via the setting of P20.15 (2014.10h). The default user-defined unit for bus velocity is command unit / s.

7.6.4.3 User-defined unit for torque

The user can select the user-defined unit of torque via the setting of P20.14 (2014.0Fh). The default user-defined unit for bus torque is 0.1% of the rated torque P01.04 (2001.05h).

Chapter 8 Drive Parameter Object

8.1 M6-L series drive parameter

Function parameter index description

Parameter group	Index	Sub-index	Remark
P00	2000h	01h to the number of parameters in the group	Index of the drive parameter = (2000h + Group number); Sub-index of the drive parameter = (The offset of the parameter within this group + 1) Examples: The 1st parameter P00.00 of group P00: Index = 2000h, sub-index = 01h; The 11th parameter P12.10 of group P12: Index = 200Ch, sub-index = 0Bh.
P01	2001h	01h to the number of parameters in the group	
…			

List of function parameters

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
Index 2000h (P00): Drive parameters							
P00.00	01h	Series number	0 to FFFF	1	Manufacturer setting	-	At display
P00.01	02h	DSP software version number	0.00 to 99.99	0.01	Manufacturer setting	-	At display
P00.02	03h	Customized version number	0 to 9999	1	Manufacturer setting	-	At display
P00.03	04h	FPGA software version number	0.00 to 99.99	0.01	Manufacturer setting	-	At display
P00.04	05h	Servo drive voltage class	0: 220 V 1: 380 V	1	Manufacturer setting	-	At display
P00.05	06h	Servo drive rated current	0 to 999.9 A	0.1 A	Manufacturer setting	-	At display
P00.06	07h	Servo drive maximum current	0 to 999.9 A	0.1 A	Manufacturer setting	-	At display
Index 2001h (P01): Motor parameters							
P01.00	01h	Motor number	0: Motor parameter can be set	1	0	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			0x0001 to 0xFFFF: Motor parameter is set automatically based on motor number				
P01.01	02h	Rated power	0.04 to 99.99 kW	0.01 kW	Depend on model	Power-on again	At stop
P01.02	03h	Rated voltage	0 to "Servo drive rated voltage"	1 V	0	Power-on again	At stop
P01.03	04h	Rated current	0.1 to 999.9 A	0.1 A	Depend on model	Power-on again	At stop
P01.04	05h	Rated torque	0.1 to 655.35 Nm	0.01 Nm	Depend on model	Power-on again	At stop
P01.05	06h	Maximum torque	0.1 to 655.35 Nm	0.01 Nm	Depend on model	Power-on again	At stop
P01.06	07h	Rated rotating speed	0.1 to 6000.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]	Depend on model	Power-on again	At stop
P01.07	08h	Maximum rotating speed	0.1 to 6000.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]	Depend on model	Power-on again	At stop
P01.08	09h	Rotor inertia Jm	0.001 to 65.535 kg*cm^2	0.01 kg*cm^2	Depend on model	Power-on again	At stop
P01.09	0Ah	Number of pole pairs	1 to 72 pole pairs	1 pole pair	Depend on model	Power-on again	At stop
P01.10	0Bh	Stator Resistance R1	0.000 to 65.000 Ω	0.001 Ω	Depend on model	Power-on again	At stop
P01.11	0Ch	Direct axis inductance Ld	0.00 to 200.00 mH	0.01 mH	Depend on model	Power-on again	At stop
P01.12	0Dh	Q-axis Inductance Lq	0.00 to 200.00 mH	0.01 mH	Depend on model	Power-on again	At stop
P01.13	0Eh	Line back-EMF constant	1.0 to 6553.5 [Vrms/krpm] / [Vrms/(m/s)]	0.1 [Vrms/krpm] / [Vrms/(m/s)]	Depend on model	Power-on again	At stop
P01.14	0Fh	Torque coefficient Kt	0.01 to 650.00 N·M/A	0.01 N·M/A	Depend on model	Power-on again	At stop
P01.15	10h	Electrical constant Te	0.01 to 650.00 ms	0.01 ms	Depend on model	Power-on again	At stop
P01.16	11h	Mechanical constant Tm	0.01 to 650.00 ms	0.01 ms	Depend on model	Power-on again	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
P01.17	12h	Brake function	0: Without brake 1: With brake	1	Depend on model	Immediate	At stop
P01.18	13h	Encoder selection	0: Line-saving incremental encoder (without UVW) 1: Tamagawa protocol 23-bit absolute encoder 2: Reserved 3: Sin/Cos encoder 4: Full line incremental encoder 5: Tamagawa protocol 17-bit absolute encoder 6: (Reserved) 7: BiSS-C absolute encoder	1	1	Immediate	At stop
P01.19	14h	Number of encoder lines	1 to 4194304	1	2097152	Immediate	At stop
P01.20	15h	Initial angle tuning during encoder installation	0: No action 1: Action (static motor) 2: Action (rotating motor)	1	0	Immediate	At stop
P01.21	16h	Rotation direction	0: A ahead of B 1: B ahead of A	1	0	Immediate	At stop
P01.22	17h	Initial angle of encoder installation	0.0 to 359.9°	0.1°	180.0	Immediate	At stop
P01.23	18h	Absolute encoder mode	0: Absolute position multi-turn mode 1: Absolute position single-turn mode 2: Incremental position mode Others: Reserved	1	0	Immediate	At stop
P01.24	19h	Number of sin/cos encoder lines	1 to 65535	1	8192	Immediate	At stop
P01.25	1Ah	Sin/Cos encoder interpolation bits	2 to 16	1	16	Immediate	At stop
P01.26	1Bh	Reserved					
P01.27	1Ch	BiSS-C encoder	0 to 32	1	23	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		data bits					
P01.28	1Dh	Motor type selection	0: General rotary motor (ROT) 1: Direct drive rotary motor (DDR) 2: Direct drive linear (DDL) Others: Reserved	1	2	Immediate	At stop
P01.29	1Eh	Linear motor pole pitch N-N	0.01 to 655.35 mm	0.01	32.00	Immediate	At stop
P01.30	1Fh	Linear motor encoder resolution	0.001 to 65.535 um/p	0.001	1.000	Immediate	At stop
P01.31	20h	Command unit selection	0: pulse 1: mm 2: um	1	0	Immediate	At stop
P01.32	21h	Motor installation enable	0: Disable 1: Enable (Models with Hall-effect sensors offer phase sequence tuning and static Hall-effect magnetic pole identification; models without Hall-effect sensors offer phase sequence tuning only)	1	0	Immediate	At stop
P01.33	22h	Hall-effect sensor type	0: Without Hall-effect sensor 1: Single-end Hall-effect sensor 2: Differential Hall-effect sensor	1	0	Immediate	At stop
P01.34	23h	Motor temperature sensor type	0: Without motor temperature sensor 1: KTY Others: Reserved	1	0	Immediate	At stop
P01.35	24h	Reserved					
Index 2002h (P02): Basic control parameters							
P02.00	01h	Control mode	0: Speed mode	1	8	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		selection	1: Position mode 2: Torque mode 3: Speed mode ←→ position mode (switchover via function 9) 4: Torque mode ←→ position mode (switchover via function 9) 5: Speed mode ←→ torque mode (switchover via function 9) 6: Speed mode ←→ torque mode ←→ position mode(torque switchover via function 9; position switchover via function 10; no switchover when function 9 and 10 are both valid or invalid, and the system stays in speed mode under the circumstances) 8: EtherCAT mode				
P02.01	02h	Internal servo enable	0: Disable 1: Enable	1	0	Immediate	During running
P02.02	03h	Absolute system mode selection	0: Absolute position linear mode 1: Absolute position rotation mode	1	0	Immediate	At stop
P02.03	04h	Rotation direction selection	0: CCW direction as the forward direction (A ahead of B) 1: CW direction as the forward direction (reverse mode; A after B)	1	0	Immediate	During running

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
P02.04	05h	Encoder frequency-division output pulses	1 to 32768 P/r	1	2500 P/r	Immediate	During running
P02.05	06h	Pulse output source selection	0: Motor encoder frequency-division output 1: Pulse command synchronous output 2: Frequency-division or synchronous output prohibit	1	2	Immediate	During running
P02.06	07h	Output pulse direction selection	0: A ahead of B 1: A after B	1	0	Immediate	During running
P02.07	08h	Z pulse output polarity selection	0: Positive output (Z pulse at a high level) 1: Negative output (Z pulse at a low level)	1	0	Immediate	During running
P02.08	09h	Stop mode	0: Decelerate to stop 1: Coast to stop	1	0	Immediate	During running
P02.09	0Ah	Emergency stop enable	0: No operation; remain in the present running state 1: Enable the emergency stop; stop based on the set stop mode (P02.08); report an alarm AI.038	1	0	Immediate	During running
P02.10	0Bh	Delay from the brake output being switched to ON to the command input	20 to 500 ms	1 ms	250	Immediate	During running
P02.11	0Ch	Delay from the brake output being switched to OFF to the motor's entry into the non-powered state	1 to 1000 ms	1 ms	150	Immediate	During running
P02.12	0Dh	Brake command	0 to 3000.0 [rpm] /	1[rpm] /	10.0	Immediate	During

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		output speed limit value	[mm/s]	[mm/s]			running
P02.13	0Eh	Delay from the servo enable being switched to OFF to the brake output being switched to OFF	1 to 30000 ms	1 ms	500	Immediate	During running
P02.14	0Fh	Minimum energy consumption resistor allowed by the drive	-	1	Depend on model	-	At display
P02.15	10h	Built-in energy consumption resistor power	-	1	Depend on model	-	At display
P02.16	11h	Built-in energy consumption resistor resistance	-	1	Depend on model	-	At display
P02.17	12h	Resistor heat dissipation coefficient	0: 0% 1: 25% 2: 50% 3: 75% 4: 100%	1	2	Immediate	During running
P02.18	13h	Energy consumption resistor selection	0: Use built-in energy consumption resistor 1: Use external energy consumption resistor 2: Energy consumption resistor not used	1	0	Immediate	At stop
P02.19	14h	External energy consumption resistor power	1 to 65535 W	1 W	Depend on model	Immediate	At stop
P02.20	15h	External energy consumption resistor resistance	1 to 65535 Ω	1 Ω	Depend on model	Immediate	At stop
P02.21	16h	Parameter protection setting	0: Modification available for all data; 1: Modification prohibited except for this function code and P06.01;	1	0	Immediate	During running

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			2: Modification prohibited except for this function code;				
P02.22	17h	Parameter initialization	0: State of parameter modification 1: Clear fault memory information 2: Restore to default value	1	0	Immediate	At stop
P02.23	18h	LED display parameter selection	0: Switch to display P11.00 1: Switch to display P11.01 2: Switch to display P11.02 3: Switch to display P11.03 4: Switch to display P11.04 5: Switch to display P11.05 …	1	0	Immediate	During running
Index 2003h (P03): Digital input/output terminal parameters							
P03.00	01h	DI1 terminal function selection	0: No function 1: Servo enable 2: External reset (RESET) input 3: Gain switchover 4: Multi-speed DI switchover of running direction 5: Multi-segment running reference switchover 1 6: Multi-segment running reference switchover 2 7: Multi-segment running reference switchover 3 8: Multi-segment running reference switchover 4 9: Control mode switchover 1	1	1	Immediate	At stop
P03.01	02h	DI2 terminal function selection		1	2	Immediate	At stop
P03.02	03h	DI3 terminal function selection		1	5	Immediate	At stop
P03.03	04h	DI4 terminal function selection		1	6	Immediate	At stop
P03.04	05h	DI5 terminal function selection		1	3	Immediate	At stop
P03.05	06h	DI6 terminal function selection		1	9	Immediate	At stop
P03.06	07h	DI7 terminal function selection		1	10	Immediate	At stop
P03.07	08h	DI8 terminal function selection		1	35	Immediate	At stop
P03.08	09h	DI9 terminal function selection		1	36	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
P03.09	0Ah	Reserved	10: Control mode switchover 2 11: Zero servo enable terminal 12: Pulse input prohibit 13: FWD rotation prohibit 14: REV rotation prohibit 15: Electronic gear ratio switchover 1 16: Electronic gear ratio switchover 2 17: FWD jog 18: REV jog 19: External torque limit during FWD rotation 20: External torque limit during REV rotation 21: Multi-segment position reference 1 23: Multi-segment position reference 2 23: Multi-segment position reference 3 24: Multi-segment position reference 4 25: Multi-segment position reference 5 26: Speed command direction switchover 27: Torque command direction switchover 28: Multi-segment / Signal-point position command enable 29: Position deviation counter clear 30: Interrupt positioning state release 31: Interrupt positioning prohibit				

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			32: Home switch 33: Homing enable 34: Emergency stop 35: Positive limit switch 36: Negative limit switch 37: Main/Auxiliary speed reference switchover 38: External fault input 39 to 48: Reserved 49: Touch probe 1 50: Touch probe 2				
P03.10	0Bh	Low-speed terminal (DI1 to DI9) filter time	1 to 500 ms	1 ms	10	Immediate	During running
P03.11	0Ch	High-speed terminal filter time (valid when terminals DI3 to DI4 are used as high-speed terminal)	0 to 127 (filter time = set value x 100 ns)	100 ns	50	Immediate	During running
P03.12	0Dh	Reserved					
P03.13	0Eh	Status of enabled input terminal	Binary setting 0: Normal logic, positive logic active 1: logical negation, negative logic active LED ones place BIT0 to BIT3: DI1 to DI4 LED tens place BIT0 to BIT3: DI5 to DI8 LED hundreds place BIT0: DI9	1	000	Immediate	During running
P03.14	0Fh	Virtual input terminal setting	Binary setting 0: Disabled 1: Enabled LED ones place BIT0 to BIT3: DI1 to DI4 LED tens place BIT0 to BIT3: DI5 to DI8	1	000	Immediate	During running

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			LED hundreds place BIT0: DI9				
P03.15	10h	DO1 function selection	0: Servo drive ready (RDY) 1: Servo drive running signal (RUN) 2: Consistent speed 3: Speed arrival signal 4: Zero-speed operation 5: Drive fault 6: Drive alarm 7: Host device switch signal 8: Torque limiting 9: Speed limiting 10: Zero servo completed 11: Positioning completed 12: Position proximity 13: Alarm of position exceeding tolerance 14: Homing 15: Homing completed 16: Electrical homing 17: Electrical homing completed 18: Brake output (brake output signal) 19: Torque arrival signal 20: FWD/REV indication terminal 21: Reserved 22: Position arrival 1 23: Position arrival 2 24: Position arrival 3 25: Position arrival 4 26: Position arrival 5 27: Reserved 28: ECAT DO forced output 29: Reserved	1	0	Immediate	At stop
P03.16	11h	DO2 function selection		1	1	Immediate	At stop
P03.17	12h	DO3 function selection		1	3	Immediate	At stop
P03.18	13h	DO4 function selection		1	11	Immediate	At stop
P03.19	14h	DO5 function selection		1	5	Immediate	At stop
P03.20	15h	Reserved					

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			30: Reserved				
P03.21	16h	Status setting of enabled output terminal	Binary setting 0: Positive logic active 1: Negative logic active LED ones place BIT0 to BIT3: DO1 to DO4 LED tens place BIT0: DO5	1	00	Immediate	During running
Index 2005h (P05): Position control parameters							
P05.00	01h	Position reference mode	0: Pulse reference 1: Single-point position reference 2: Multi-segment position reference	1	0	Immediate	At stop
P05.01	Reserved						
P05.02	03h	Pulse command mode	0: A/B phase pulse 1: Pulse + Sign 2: CW/CCW pulse	1	0	Immediate	At stop
P05.03	04h	Pulse command logic	0: Positive logic 1: Negative logic	1	0	Immediate	At stop
P05.04	Reserved						
P05.05	06h	Command pulses per motor revolution or per pole pitch	0 to 8388608 [P/r] / [P/N-N]	1 P/r	10000	Immediate	At stop
P05.06	07h	Position command first-order low-pass filter time	0.0 to 2000.0 ms	0.1 ms	0	Immediate	During running
P05.07	08h	Position command movement average filter time	0.0 to 12.8 ms	0.1 ms	0	Immediate	During running
P05.08	09h	Electronic gear ratio numerator	1 to 1073741824	1	8388608	Immediate	At stop
P05.09	0Ah	Electronic gear ratio denominator 1	1 to 1073741824	1	10000	Immediate	At stop
P05.10	0Bh	Electronic gear ratio denominator	1 to 1073741824	1	10000	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		2					
P05.11	0Ch	Electronic gear ratio denominator 3	1 to 1073741824	1	10000	Immediate	At stop
P05.12	0Dh	Electronic gear ratio denominator 4	1 to 1073741824	1	10000	Immediate	At stop
P05.13	0Eh	Electronic gear ratio switchover conditions	0: Switch when the position command is 0 and holds for 3 ms; 1: Real-time switchover.	1	0	Immediate	At stop
P05.14	0Fh	Position deviation clear method selection	0: Clear position deviation when servo enable is OFF or when servo is stopped; 1: Clear position deviation when servo enable is OFF or a fault/alarm occurs; 2: Clear position deviation when servo enable is OFF or the external position deviation clear DI is valid.	1	00	Immediate	At stop
P05.15	10h	Position deviation clear DI signal type	0: Pulse mode 1: Level mode	0	0	Immediate	At stop
P05.16	11h	Speed feedforward control selection	0: No speed feedforward; 1: Internal speed feedforward (take the speed information corresponding to the position command in the encoder unit as the source of the speed feedforward signal); 2 to 3: Reserved.	1	1	Immediate	At stop
P05.17	12h	Position controller output limit	0 to Maximum speed	0.1 rpm	6000.0	Immediate	During running

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
P05.18	13h	Output conditions for positioning completion	0: The absolute value of position deviation is smaller than the amplitude of positioning completion; 1: The absolute value of position deviation is smaller than the amplitude of positioning completion, and the command after the position command filtering is zero; 2: The absolute value of position deviation is smaller than the amplitude of positioning completion, and the position command is zero.	1	0	Immediate	At stop
P05.19	14h	Positioning completion range	0 to 10000	1 command unit	100	Immediate	During running
P05.20	15h	Position proximity signal width	1 to 32767	1 command unit	100	Immediate	During running
P05.21	16h	Position error detection range	0 to 32767	1 encoder unit	20000	Immediate	During running
P05.22	17h	Position error alarm invalid	0: Enable 1: Disable	1	0	Immediate	During running
P05.23	18h	Servo shutdown mode	0: Switch to speed control and stop according to servo shutdown time; 1: Switch to speed control and decelerate to stop	1	1	Immediate	During running
P05.24	19h	Servo shutdown time	0 to 3000 ms When PL (CCWL) or NL (CWL) occurs,	1	0	Immediate	During running

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			decelerate to stop according to the shutdown time				
P05.25	1Ah	Mechanical gear ratio numerator in the absolute position rotation mode	1 to 65535	1	1	Immediate	At stop
P05.26	1Bh	Mechanical gear ratio denominator in the absolute position rotation mode	1 to 65535	1	1	Immediate	At stop
P05.27	1Ch	Position offset in the absolute position linear mode (lower 32 bits)	0 to 4294967295	1 encoder unit	0	Immediate	At stop
P05.28	1Dh	Position offset in the absolute position linear mode (higher 32 bits)	0 to 4294967295	1 encoder unit	0	Immediate	At stop
P05.29	1Eh	Number of pulses per load revolution in the absolute position rotation mode (lower 32 bits)	0 to 4294967295	1 encoder unit	0	Immediate	At stop
P05.30	1Fh	Number of pulses per load revolution in the absolute position rotation mode (higher 32 bits)	0 to 127	1 encoder unit	0	Immediate	At stop
P05.31	20h	Soft limit function setting	0: Disable soft limit 1: Enable software limit immediately upon power-on 2: Enable soft limit after	1	0	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			homing				
P05.32	21h	Software limit maximum point	-2147483647 to 2147483647	1 command unit	2147483647	Immediate	At stop
P05.33	22h	Software limit minimum point	-2147483647 to 2147483647	1 command unit	-2147483648	Immediate	At stop
Index 2006h (P06): Speed control parameters							
P06.00	01h	Main reference source selection	0: Digital reference (P06.01) 1 to 4: Reserved	1	0	Immediate	During running
P06.01	02h	Main reference speed setting	-6000.0 to 6000.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]	0.0	Immediate	During running
P06.02	03h	Auxiliary speed source selection	0: No auxiliary reference 1: Digital reference 2 to 4: Reserved	1	0	Immediate	During running
P06.03	04h	Auxiliary reference speed setting	-6000.0 to 6000.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]	0	Immediate	During running
P06.04	05h	Main/Auxiliary reference calculation	0: Main + Auxiliary 1: Main - Auxiliary 2: Main/Auxiliary reference switchover via terminal 3: MAX (main/auxiliary reference) 4: MIN (main/auxiliary reference)	1	0	Immediate	During running
P06.05	06h	Jog speed	0.0 to 6000.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]	100.0	Immediate	At stop
P06.06	07h	Jog operation					
P06.07	08h	Speed command acceleration time 1	0 to 65535 ms	1 ms	1000	Immediate	During running
P06.08	09h	Speed command deceleration time 1	0 to 65535 ms	1 ms	1000	Immediate	During running
P06.09	0Ah	Maximum speed threshold	0.0 to 6000.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]	6000.0	Immediate	During running
P06.10	0Bh	Forward speed threshold	0.0 to 6000.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]	6000.0	Immediate	During running
P06.11	0Ch	Reverse speed	0.0 to 6000.0 [rpm] /	0.1 [rpm] /	6000.0	Immediate	During

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		threshold	[mm/s]	[mm/s]			running
P06.12	0Dh	Positive torque limit channel	0: Internal positive torque limit value 1: Bus positive torque limit value 2: MIN limit (internal positive torque, bus positive torque) 3: External positive torque limit	1	0	Immediate	At stop
P06.13	0Eh	Negative torque limit channel	0: Internal negative torque limit 1: Bus negative torque limit 2: MIN limit (internal negative torque, bus negative torque) 3: External negative torque limit	1	0	Immediate	At stop
P06.14	0Fh	Internal positive torque limit value	0.0% to +400.0%	0.1%	Depend on model	Immediate	During running
P06.15	10h	Internal negative torque limit value	0.0% to +400.0%	0.1%	Depend on model	Immediate	During running
P06.16	11h	External positive torque limit value	0.0% to +400.0%	0.1%	100.0	Immediate	During running
P06.17	12h	External negative torque limit value	0.0% to +400.0%	0.1%	100.0	Immediate	During running
P06.18	13h	Torque feedforward control selection	0: No torque feedforward 1: Internal torque feedforward (take the speed command as the torque feedforward signal source. In the position control mode, the speed command comes from the output of the position controller)	1	1	Immediate	During running
P06.19	14h	Zero clamp function	0: Disabled 1: Always enabled	1	0	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			2: Enabled under conditions (enabled via terminal)				
P06.20	15h	Zero clamp gain	0 to 6.000	0.001	1.000	Immediate	During running
P06.21	16h	Zero clamp starting speed	0.0 to 1000.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]	2.0	Immediate	During running
P06.22	17h	Speed arrival detection width	0.0 to 5000.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]	20.0	Immediate	During running
P06.23	18h	Zero speed threshold	0.0% to 100.0% of maximum speed	0.1%	1.0	Immediate	During running
P06.24	19h	Speed consistency threshold	0.0 to 100.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]	10.0	Immediate	During running
Index 2007h (P07): Torque control parameters							
P07.00	01h	Torque reference selection	0: Digital reference 1 to 3: Reserved	1	0	Immediate	At stop
P07.01	02h	Positive direction selection of torque	0: FWD drive as positive 1: REV drive as positive	1	0	Immediate	At stop
P07.02	03h	Speed/Torque switchover mode selection	0: Direct switchover 1: Switch over the torque switchover point	1	0	Immediate	At stop
P07.03	04h	Torque digital reference	-400.0% to +400.0%	0.1%	0.0	Immediate	During running
P07.04	05h	Torque reference acceleration / deceleration time	0 to 6553.5 ms	0.1 ms	0	Immediate	At stop
P07.05	06h	Torque command filter time constant	0 to 30.0 ms	0.1 ms	1.0	Immediate	At stop
P07.06	07h	Second torque command filter time constant	0 to 30.0 ms	0.1 ms	1.0	Immediate	At stop
P07.07	08h	Speed/Torque switchover point	0.0% to 400.0% of initial torque	0.1%	100.0	Immediate	At stop
P07.08	09h	Speed/Torque switchover delay	0 to 1000.0 ms	0.1 ms	0.0	Immediate	At stop
P07.09	0Ah	FWD speed limit channel	0: FWD speed limit value 1: Bus speed limit value 2: MIN limit (FWD speed, bus speed)	1	1	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
P07.10	0Bh	FWD speed limit value	0.0% to 100.0%	0.1%	100.0	Immediate	During running
P07.11	0Ch	REV speed limit channel	0: REV speed limit value 1: Bus speed limit value 2: MIN limit (REV speed, bus speed)	1	1	Immediate	At stop
P07.12	0Dh	REV speed limit value	0.0% to 100.0%	0.1%	100.0	Immediate	During running
P07.13	0Eh	Torque arrival reference value	0.0 to 400.0%	0.1%	0.0	Immediate	During running
P07.14	0Fh	Torque arrival effective value	0.0 to 400.0%	0.1%	20.0	Immediate	During running
P07.15	10h	Torque arrival non-effective value	0.0 to 400.0%	0.1%	10.0	Immediate	During running
Index 2008h (P08): Gain parameters							
P08.00	01h	Speed loop proportional gain 1	0.1 to 5000.0 Hz	0.1 Hz	20.0	Immediate	During running
P08.01	02h	Speed loop integral time 1	0.00 to 1000.0 ms	0.1 ms	50.0	Immediate	During running
P08.02	03h	Position loop gain 1	1 to 8000 rad/s	1 rad/s	100	Immediate	During running
P08.03	04h	Speed regulator output filter time 1	0 to 32.0 ms	0.1 ms	0.8	Immediate	During running
P08.04	05h	Speed loop proportional gain 2	0.1 to 5000.0 Hz	0.1 Hz	20.0	Immediate	During running
P08.05	06h	Speed loop integral time 2	0.0 to 1000.0 ms	0.1 ms	10.0	Immediate	During running
P08.06	07h	Position loop gain 2	1 to 8000 rad/s	1 rad/s	100	Immediate	During running
P08.07	08h	Speed regulator output filter time 2	0 to 32.0 ms	0.1 ms	0.8	Immediate	During running
P08.08	09h	Gain selection mode	0: Gain 1 is fixed; P/PI switchover via external DI 1:Gain switchover based on condition selection of P08.09	1	0	Immediate	During running
P08.09	0Ah	Gain switchover condition selection	0: No switchover of gain 1 1: Switchover via external	1	0	Immediate	During running

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			DI terminal 2: Torque command 3: Speed command 4: Feedback speed 5: Speed command change rate 6: Position deviation 7: Speed command high/low speed threshold 8: Position command received 9: Positioning not completed 10: Position command received + actual speed				
P08.10	0Bh	Gain switchover delay	0 to 1000 ms	1 ms	5	Immediate	During running
P08.11	0Ch	Gain switchover level	0 to 20000	Switch on condition	50	Immediate	During running
P08.12	0Dh	Gain switchover hysteresis	0 to 20000	Switch on condition	30	Immediate	During running
P08.13	0Eh	Position gain switchover time	0 to 1000 ms	1 ms	5	Immediate	During running
P08.14	0Fh	Speed feedforward filter time	0.00 to 64.00 ms	0.01 ms	0.5	Immediate	During running
P08.15	10h	Speed feedforward gain	0.0 to 100.0%	0.01%	0.0	Immediate	During running
P08.16	11h	Torque feedforward filter time	0.00 to 64.00 ms	0.01	0.5	Immediate	During running
P08.17	12h	Torque feedforward gain	0.0 to 200.0%	0.1%	0.0	Immediate	During running
P08.18	13h	Encoder filter time	0.0 to 40.0 ms	0.0	40.0	Immediate	During running
P08.19	14h	PDFF (pseudo-differential feedforward)	0.0 to 100.0%	0.1%	100.0	Immediate	During running

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		control coefficient (reserved in non-torque control mode)					
Index 2009h (P09): Adjustment parameters							
P09.00	01h	Offline inertia identification function		0.01	0.00	Immediate	At stop
P09.01	02h	Inertia identification maximum speed	200 to 2000 [rpm] / [mm/s]	1 [rpm] / [mm/s]	800	Immediate	At stop
P09.02	03h	Inertia identification acceleration time	10 to 1000 ms	1 ms	60	Immediate	At stop
P09.03	04h	Motor revolutions for inertia identification	0.00 to 655.35 r	0.01 r	0.00	Immediate	At stop
P09.04	05h	Waiting time after single inertia identification	50 to 10000	1 ms	800	Immediate	At stop
P09.05	06h	Online inertia identification mode	0: Disabled 1: Enabled; change slowly 2: Enabled; change at normal speed 3: Enabled; change quickly	1	0	Immediate	At stop
P09.06	07h	Gain adjustment mode	0: Parameter auto-tuning is invalid; manual tuning is applied; 1: Parameter auto-tuning mode; automatically adjust the gain parameters using the rigidity table; 2: Positioning mode; automatically adjust the gain parameters using the rigidity table.	1	0	Immediate	At stop
P09.07	08h	Rigidity level	0 to 31	1	0	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
P09.08	09h	Adaptive notch filter mode	0: The parameters of the 3rd and 4th notch filters are not updated; 1: The adaptive results of the 3rd notch filter parameters are updated; 2: The parameter adaptive results of the 3rd and 4th notch filters are updated; 3: Automatically detect the mechanical resonance frequency, but do not set the relevant parameters of the notch filter; 4: Restore the parameters of the 4 notch filters to default values.	1	0	Immediate	At stop
P09.09	0Ah	Setting of sensitivity for automatic vibration suppression	1 to 100	1	1	Immediate	At stop
P09.10	0Bh	Notch filter 1 frequency	0 to 4000 Hz	1 Hz	0	Immediate	At stop
P09.11	0Ch	Notch filter 1 width	10 to 1000 Hz	1 Hz	100	Immediate	At stop
P09.12	0Dh	Notch filter 2 frequency	0 to 4000 Hz	1 Hz	0	Immediate	At stop
P09.13	0Eh	Notch filter 2 width	10 to 1000 Hz	1 Hz	100	Immediate	At stop
P09.14	0Fh	Notch filter 3 frequency	0 to 4000 Hz	1 Hz	0	Immediate	At stop
P09.15	10h	Notch filter 3 width	10 to 1000 Hz	1 Hz	100	Immediate	At stop
P09.16	11h	Notch filter 4 frequency	0 to 4000 Hz	1 Hz	0	Immediate	At stop
P09.17	12h	Notch filter 4	10 to 1000 Hz	1 Hz	100	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		width					
P09.18	13h	Speed loop low-pass filter time-constant	0 to 65536 μs	1 μs	0	Immediate	At stop
P09.19	14h	Speed reference notch filter frequency	0 to 1000 Hz	1 Hz	0	Immediate	At stop
P09.20	15h	Speed reference notch filter width	10 to 500 Hz	1 Hz	100	Immediate	At stop
P09.21	16h	Reserved					
P09.22	17h	Resonance frequency identification result	0 to 2000 Hz	1 Hz	-	Immediate	At stop
P09.23	18h	Disturbance torque compensation gain	0.0% to 100.0%	0.1%	0	Immediate	At stop
P09.24	19h	Disturbance observer filter time	0.0 to 25.0 ms	0.1 ms	0	Immediate	At stop
P09.25	1Ah	Low-frequency resonance suppression mode selection	0: Manually set vibration suppression parameters 1: Automatically set vibration suppression parameters	1	0	Immediate	During running
P09.26	1Bh	Low-frequency resonance frequency	0.0 to 100.0 Hz	0.1 Hz	0	Immediate	During running
P09.27	1Ch	Low-frequency resonance frequency filter setting	0 to 20	1	0	Immediate	During running
P09.28	1Dh	Low-frequency resonance position deviation judgment threshold	1 to 1000 P	1 P	10	Immediate	At stop
P09.29	1Eh	Torque command offset (vertical	-300.00% to 300.00%	0.01%	0.00	Immediate	During running

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		axis mode)					
P09.30	1Fh	Viscous friction compensation gain	0 to 1000.0	0.1%/ 10000 rpm	0	Immediate	At stop
P09.31	20h	Positive friction compensation	0 to 50.0%	0.1	0	Immediate	At stop
P09.32	21h	Negative friction compensation	0 to 50.0%	0.1%	0	Immediate	At stop
P09.33	22h	Quadrant protrusion positive direction compensation value	-100.00% to 100.00%	0.01%	0.00	Immediate	At stop
P09.34	23h	Quadrant protrusion opposite direction compensation value	-100.00% to 100.00%	0.01%	0.00	Immediate	At stop
P09.35	24h	Quadrant protrusion compensation delay	0 to 1000.0	0. 1 ms	0.0	Immediate	At stop
P09.36	25h	Quadrant protrusion compensation filter	0 to 1000.0	0. 1 ms	0.0	Immediate	At stop
P09.37	26h	Quadrant protrusion compensation effective position	0 to 65535	1	1	Immediate	At stop
P09.38	27h	Load's moment of inertia ratio	0.00 to 120.00	0.01	1.00	Immediate	At stop
Index 200Ah (P10): Fault and protection parameters							
P10.00	01h	Action selection upon phase loss	0: Activate protection upon input and output phase loss 1: No protection upon input phase loss 2: No protection upon output phase loss	1	0	Immediate	During running

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			3: No protection upon input/output phase loss				
P10.01	02h	Action selection upon communication timeout	0: Activate protection and coast to stop 1: Report an alarm and keep running 2: Report an alarm and stop according to the set stop mode	1	0	Immediate	During running
P10.02	03h	Action selection upon temperature sampling disconnection	0: Activate protection and coast to stop 1: Report an alarm and keep running 2: Report an alarm and stop according to the set stop mode	1	0	Immediate	During running
P10.03	04h	Action selection upon analog input fault	0: Activate protection and coast to stop 1: Report an alarm and keep running 2: Report an alarm and stop according to the set stop mode	1	0	Immediate	During running
P10.04	05h	Over-travel stop mode selection	0: Activate protection and coast to stop 1: Report an alarm, decelerate to zero, and hold the state of position lock	1	2	Immediate	During running
P10.05	06h	Output disconnection action selection	0: Decelerate to stop 1: Coast to stop 2: Decelerate to zero, and hold the state of position lock	1	0	Immediate	During running
P10.06	07h	Motor overload protection action selection	0: Activate protection and coast to stop 1: Report an alarm and keep running 2: Report an alarm and	1	1	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			stop according to the set stop mode				
P10.07	08h	Motor overload protection gain	20.0% to 300.0%	0.1%	100.0	Immediate	During running
P10.08	09h	Drive fan action selection	0: Control via temperature (activate the fan when module temperature > 35°; stop the fan when module temperature < 30°) 1: Keep the fan working 2: Control based on the drive state (activate the fan when the drive is enabled; when the drive is stopped, activate the fan when module temperature > 35°, and stop the fan when module temperature < 30°) 3: No action	1	0	Immediate	At stop
P10.09	0Ah	Locked rotor over-temperature protection enable (reserved)	0: Shield the detection for locked rotor over-temperature protection 1: Enable the detection for locked rotor over-temperature protection	1	0	Immediate	At stop
P10.10	0Bh	Locked rotor over-temperature protection time window (reserved)	10 to 800 ms	1 ms	200	Immediate	At stop
P10.11	0Ch	Action selection for encoder multi-turn overflow fault	0: Not shield 1: Shield	1	0	Immediate	At stop
P10.12	0Dh	Overspeed fault	0 to 10000 [rpm] / [mm/s]	1 [rpm] /	6000	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		threshold		[mm/s]			
P10.13	0Eh	Maximum position pulse frequency	100 to 4000 kHz	1 kHz	4000	Immediate	At stop
P10.14	0Fh	Action selection for absolute encoder battery undervoltage fault	0: Set the battery undervoltage as a fault; each time the drive is powered on or reset, detect the battery voltage and report an alarm if an undervoltage occurs; detection is disabled during other periods of operation; 1: Set the battery undervoltage as an alarm; report an alarm when the battery voltage is lower than 3 V; battery voltage detection is always enabled.	1	0	Immediate	At stop
P10.15	10h	Function selection when main circuit undervoltage occurs	0: Do not report an alarm when main circuit undervoltage is detected; 1: Report an alarm when main circuit undervoltage is detected; 2: Report an alarm when main circuit undervoltage is detected, and implement torque limit.	1	0	Immediate	At stop
P10.16	11h	Torque limit value during main circuit undervoltage	0 to 100%	1%	100	Immediate	At stop
P10.17	12h	Torque limit release time	0 to 1000 ms	1 ms	10	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		during main circuit undervoltage					
P10.18	13h	Type of the last fault	0: No record of abnormalities 1: Overcurrent 2: Main circuit overvoltage 3: Control circuit overvoltage 4: Motor locked rotor 5: Parameter modification without power off 6: Phase loss on the input side 7: Phase loss on the output side 8: Heatsink overheat 9: Braking resistor overload 10: Power module protection 11: Servo drive overload 12: Motor overload 13: EEPROM read/write error 14: Serial port communication error 15: Excessively small external brake resistance (reserved) 16: Abnormal current detection circuit 17: Reserved 18: Poor auto-tuning 19: Encoder fault 20: Undervoltage during main circuit operation 21: Reserved 22: Parameter setting	1	0	-	At display

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			error 23: Reserved 24: Reserved 25: Inverter module sampling disconnection protection 26: Reserved 27: Overspeed (the actual speed of the servo motor exceeds the overspeed fault threshold) 28: Reserved 29: Main circuit undervoltage 30: Encoder multi-turn count error 31: Encoder multi-turn count overflow 32: Excessively large position deviation 33: Abnormal pulse input 34: Excessively large position deviation in fully closed loop 35: Function parameter setting error in fully closed loop 36: Connection interruption in bus communication 37: Homing timeout 38: DI emergency brake (alarm only) 39: Forward over-travel alarm 40: Reverse over-travel alarm 41: Encoder battery				

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			failure 42: Reserved 43: External fault 44: Reserved 45: Reserved 46: Short circuit to ground at power-on 47: Parameter per-unit error 48: Internal logic error 1 49: Internal logic error 2 50: ASIC initialization error 51: Internal fault 51 52: Interpolation cycle error 53: Reserved 54: Internal fault 54 55: Internal fault 55 56: Internal fault 56 57: Phase sequence tuning error 58: Magnetic pole identification error 59: No magnetic pole identification performed after power-on 60: Motor overheat 61: Abnormal electronic gear ratio 62: Interrupt positioning alarm 63: Internal fault 63 64: Internal fault 64 65: ECAT initialization error 66: Homing logic error 70: Setting error of matching motor				

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			number 71: Incremental encoder UVW error 72: Program burning error 73: BOOT fault 74: STO fault 75: Encoder battery undervoltage fault 76: Encoder battery fault 77: PG type fault 78: PG not saving parameters 79: PG write error 80: Control circuit undervoltage 81: Encoder homing error 82: Internal fault 82 83: Internal fault 83 84: Absolute encoder EEPROM parameter read fault 85: Drive output disconnection				
P10.19	14h	Type of the second fault	Same as P10.18	1	0	-	At display
P10.20	15h	Type of the first fault	Same as P10.18	1	0	-	At display
P10.21	16h	Bus voltage at the last fault	0 to 999 V	1 V	0	-	At display
P10.22	17h	V-phase current at the last fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display
P10.23	18h	W-phase current at the last fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display
P10.24	19h	D-axis current reference value at the last fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display
P10.25	1Ah	Q-axis current reference value at the last fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
P10.26	1Bh	D-axis current feedback value at the last fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display
P10.27	1Ch	Q-axis current feedback value at the last fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display
P10.28	1Dh	Speed at the last fault	-6000.0 to 6000.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]	0.0	-	At display
P10.29	1Eh	Encoder position feedback at the last fault (PUU unit)	-2147483648 to 2147483647	1	0	-	At display
P10.30	1Fh	DI state at the last fault	LED ones place BIT0 to BIT3: DI1 to DI4 LED tens place BIT0 to BIT3: DI5 to DI8 LED hundreds place BIT0: DI9	1	0	-	At display
P10.31	20h	DO state at the last fault	LED ones place BIT0 to BIT3: DO1 to DO4 LED tens place BIT0: DO5	1	0	-	At display
P10.32	21h	Drive state at the last fault	0 to FFFFH (same as P11.11)	1	0	-	At display
P10.33	22h	Temperature at the last fault	-40.0℃ to 150.0℃	0.1℃	0.0	-	At display
P10.34	23h	Bus voltage at the second fault	0 to 999 V	1 V	0	-	At display
P10.35	24h	V-phase current at the second fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display
P10.36	25h	W-phase current at the second fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display
P10.37	26h	D-axis current reference value at the second fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display
P10.38	27h	Q-axis current reference value at the second fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display
P10.39	28h	D-axis current feedback value at	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		the second fault					
P10.40	29h	Q-axis current feedback value at the second fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display
P10.41	2Ah	Speed at the second fault	-6000.0 to 6000.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]	0.0	-	At display
P10.42	2Bh	Encoder position feedback at the second fault (PUU unit)	-2147483648 to 2147483647	1	0	-	At display
P10.43	2Ch	DI state at the second fault	LED ones place BIT0 to BIT3: DI1 to DI4 LED tens place BIT0 to BIT3: DI5 to DI8 LED hundreds place BIT0: DI9	1	0	-	At display
P10.44	2Dh	DO state at the second fault	LED ones place BIT0 to BIT3: DO1 to DO4 LED tens place BIT0: DO5	1	0	-	At display
P10.45	2Eh	Drive state at the second fault	0 to FFFFH (same as P11.11)	1	0	-	At display
P10.46	2Fh	Temperature at the second fault	-40.0℃ to 150.0℃	0.1℃	0.0	-	At display
P10.47	30h	Bus voltage at the first fault	0 to 999 V	1 V	0	-	At display
P10.48	31h	V-phase current at the first fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display
P10.49	32h	W-phase current at the first fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display
P10.50	33h	D-axis current reference value at the first fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display
P10.51	34h	Q-axis current reference value at the first fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display
P10.52	35h	D-axis current feedback value at the first fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
P10.53	36h	Q-axis current feedback value at the first fault	-1000.0 to 1000.0 A	0.1 A	0.0	-	At display
P10.54	37h	Speed at the first fault	-6000.0 to 6000.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]	0.0	-	At display
P10.55	38h	Encoder position feedback at the first fault (PUU unit)	-2147483648 to 2147483647	1	0	-	At display
P10.56	39h	DI state at the first fault	LED ones place BIT0 to BIT3: DI1 to DI4 LED tens place BIT0 to BIT3: DI5 to DI8 LED hundreds place BIT0: DI9	1	0	-	At display
P10.57	3Ah	DO state at the first fault	LED ones place BIT0 to BIT3: DO1 to DO4 LED tens place BIT0: DO5	1	0	-	At display
P10.58	3Bh	Drive state at the first fault	0 to FFFFH (same as P11.11)	1	0	-	At display
P10.59	3Ch	Temperature at the first fault	-40.0℃ to 150.0℃	0.1℃	0.0	-	At display
Index 200Bh (P11): Display parameters							
P11.00	01h	Speed command	-6000.0 to 6000.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]		-	At display
P11.01	02h	Actual motor speed	-6000.0 to 6000.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]		-	At display
P11.02	03h	Output voltage	0 to 480 V	1 V		-	At display
P11.03	04h	Output current	0.0 to 4Ie A	0.1 A		-	At display
P11.04	05h	Q-axis current	-400.0 to +400.0% Ie	0.1%		-	At display
P11.05	06h	D-axis current	-100.0 to +100.0% Ie	0.1%		-	At display
P11.06	07h	Output torque	-300.00 to +300.00 Nm	0.01 Nm		-	At display
P11.07	08h	Reserved					
P11.08	09h	Average load rate	0.0 to 400.0% Te	0.1%		-	At display
P11.09	0Ah	Bus voltage	0 to 900 V	1 V		-	At display
P11.10	0Bh	Control voltage	0 to 450 V	1 V		-	At display
P11.11	0Ch	Servo drive	0 to FFFFH	1		-	At display

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		operation status	bit0: RUN/STOP bit1: REV/FWD bit2: Running at zero speed bit3: Accelerating bit4: Decelerating bit5: Running at a constant speed bit6: Reserved bit7: Reserved bit8: Overcurrent limiting bit9: DC overvoltage limiting bit10: Torque limiting bit11: Speed limiting bit12: Servo drive fault bit13: Speed control bit14: Torque control bit15: Position control				
P11.12	0Dh	DI terminal status	0 to 1FFH 0: Disconnect 1: Connect The high-speed pulse reference will not be refreshed synchronously.	1		-	At display
P11.13	0Eh	DO terminal status	0 to 1FH 0: Disconnect 1: Connect The high-speed pulse output will not be refreshed synchronously.	1		-	At display
P11.14 to P11.17	0Fh to 12h	Reserved					
P11.18	13h	Motor encoder counter value	0 to 4 times motor encoder lines -1	1		-	At display
P11.19	14h	Motor encoder Z pulse position	0 to 4 times motor encoder lines -1	1		-	At display
P11.20	15h	Number of input pulses	-2147483648 to 2147483647			-	At display
P11.21	16h	Location of the	-2147483648 to	1		-	At display

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		position reference point	2147483647				
P11.22	17h	Position reference	-2147483648 to 2147483647	1		-	At display
P11.23	18h	Position feedback	-2147483648 to 2147483647	1		-	At display
P11.24	19h	Position deviation pulse	-2147483648 to 2147483647	1		-	At display
P11.25	1Ah	Location of the position reference point (PUU unit)	-2147483648 to 2147483647	1		-	At display
P11.26	1Bh	Position reference (PUU unit)	-2147483648 to 2147483647	1		-	At display
P11.27	1Ch	Position reference (PUU unit)	-2147483648 to 2147483647	1		-	At display
P11.28	1Dh	Position deviation pulse (PUU unit)	-2147483648 to 2147483647	1		-	At display
P11.29	1Eh	Accumulated time of power-on	0 to maximum 65535 hours	1 hour		-	At display
P11.30	1Fh	Accumulated time of operation	0 to maximum 65535 hours	1 hour		-	At display
P11.31	20h	Module temperature	-40.0℃ to 150.0℃	0.1℃		-	At display
P11.32	21h	Absolute encoder single-turn position	0 to 8388608	1		-	At display
P11.33	22h	Absolute encoder revolutions	0 to 65535 r	1 r		-	At display
P11.34	23h	Load's moment of inertia ratio	0.00 to 120.00	0.01		-	At display
P11.35	24h	Absolute position PUU value	Present absolute position of the machine (command unit) = Absolute mechanical position / Mechanical gear ratio -2147483648 to 2147483647	Command unit		-	At display
P11.36	25h	Absolute mechanical	Absolute mechanical position refers to the	Encoder unit		-	At display

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		position (lower 32 bits)	position at the motor end which is converted from the load position in absolute position linear mode or absolute position rotation mode (encoder unit). Absolute mechanical position = Absolute encoder position - Home offset				
P11.37	26h	Absolute mechanical position (higher 32 bits)		Encoder unit		-	At display
P11.38	27h	Absolute position of the absolute encoder (lower 32 bits)	Absolute position of the absolute encoder refers to the feedback absolute position of the absolute encoder. Encoder unit	Encoder unit		-	At display
P11.39	28h	Absolute position of the absolute encoder (higher 32 bits)		Encoder unit		-	At display
P11.40	29h	Single-turn position of the rotating load (lower 32 bits)	Single-turn position of the rotating load refers to the position at the motor end which is converted from the single-turn position of the rotating load in the absolute position rotation mode. Encoder unit	Encoder unit		-	At display
P11.41	2Ah	Single-turn position of the rotating load (higher 32 bits)		Encoder unit		-	At display
P11.42	2Bh	Single-turn position of the rotating load	It refers to the single turn position of the rotating load in the absolute position rotation mode. Command unit	Command unit		-	At display
P11.43	2Ch	Mechanical angle (number of pulses from home position)		Encoder unit		-	At display
P11.44	2Dh	Electrical angle	0.00 to 360.00°	0.01°		-	At display
P11.45	2Eh	Encoder multi-turn overflow value	-2147483648 to 2147483647	1		-	At display
P11.46	2Fh	High 32 bits of the	-2147483648 to	1		-	At display

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		position reference point location (PUU unit)	2147483647				
P11.47	30h	Motor temperature display	-40.0 to 150.0℃	0.1℃	0.0	-	At display
P11.48	31h	High 32 bits of the position reference point location (encoder unit)	-2147483648 to 2147483647	1		-	At display
P11.49 to P11.54	32h to 37h	Reserved					
Index 200Ch (P12): Servo positioning parameters							
P12.00	01h	Homing enable control	0: Disable homing 1: Enable homing by the HomingStart signal input via DI 2: Enable electrical homing by the HomingStart signal input via DI 3: Immediately activate homing upon power-on 4: Immediately activate homing 5: Activate electrical homing 6: Take the present position as the home position	1	0	Immediate	During running
P12.01	02h	Homing method	0: Homing in forward direction, and home switch as both the deceleration point and the home position; 1: Homing in backward direction, and home switch as both the deceleration point and	1	9	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			the home position; 2: Homing in forward direction, and the motor Z pulse as both the deceleration point and the home position; 3: Homing in backward direction, and the motor Z pulse as both the deceleration point and the home position; 4: Homing in forward direction, home switch as the deceleration point, and the motor Z pulse as the home position; 5: Homing in backward direction, home switch as the deceleration point, and the motor Z pulse as the home position; 6: Homing in forward direction, and the positive limit switch as both the deceleration point and the home position; 7: Homing in backward direction, and the negative limit switch as both the deceleration point and the home position; 8: Homing in forward direction, the positive limit switch as the deceleration point, and the motor Z pulse as				

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			the home position; 9: Homing in backward direction, the negative limit switch as the deceleration point, and the motor Z pulse as the home position; 100+X: CiA 402 homing method X				
P12.02	03h	Mode of the homing terminal command	0: Level mode 1: Pulse mode	1	0	Immediate	At stop
P12.03	04h	Reserved					
P12.04	05h	Positioning acceleration/ deceleration curve selection	0: T-shaped curve 1: S-shaped curve	1	0	Immediate	At stop
P12.05	06h	Speed of high-speed home position search	0.0 to 1000.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]	100.0	Immediate	At stop
P12.06	07h	Speed of low-speed home position search	0.0 to 1000.0 [rpm] / [mm/s]	0.1 [rpm] / [mm/s]	10.0	Immediate	At stop
P12.07	08h	Home offset	-1073741824 to 1073741824	1	0	Immediate	At stop
P12.08	09h	Acceleration/ Deceleration time of home position search	0 to 65535 ms	1	200	Immediate	At stop
P12.09	0Ah	Time limit for home position search	0 to 65535 ms	1	60000	Immediate	At stop
P12.10	0Bh	Positioning mode selection	0: Relative position 1: Absolute position	1	0	Immediate	At stop
P12.11	0Ch	Home offset mode	0: When home is located, position feedback 6064h = 607Ch 1: When home is located, position feedback 6064h = present	1	0	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			position + incremental displacement 607Ch 2: When the home position is located, continue to perform the home offset position segment; once completed, position actual value 6064h = 0 3: When the home position is located, continue to perform the home offset position segment; once completed, position actual value 6064h = 607Ch				
P12.85	56h	Mechanical position offset	-2147483648 to 2147483647			-	At display
Index 2011h (P17): EtherCAT communication parameters							
P17.00	01h	EtherCAT software version number	000 to FFF	1		-	At display
P17.01	02h	EtherCAT bus subprotocol	101: COE 102: SOE (reserved) Others: Reserved	1	-	-	At display
P17.02	03h	EtherCAT bus state	1: INIT 2: PRE-OPERATIONAL 3: SAFE-OPERATIONAL 4: OPERATIONAL	1	-	-	At display
P17.03	04h	Bus working mode	Drive operating mode in COE bus control 1: Profile Position Mode 3: Profile Velocity Mode 4: Profile Torque Mode 6: Homing Mode 8: Cyclic Synchronous Position Mode 9: Cyclic Synchronous Velocity Mode	1	-	-	At display

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			10: Cyclic Synchronous Torque Mode				
P17.04	05h	0x6040 control word	0 to 65535	1	-	_	At display
P17.05	06h	0x6060 control mode	0 to 65535	1	-	_	At display
P17.06	07h	0x607A position reference	-2147483648 to 2147483647	1	-	_	At display
P17.07	08h	0x60FF speed reference	-2147483648 to 2147483647	1	-	_	At display
P17.08	09h	0x6071 torque reference	-32768 to 32767	1	-	_	At display
P17.09	0Ah	0x60E0 positive torque limit	0 to 65535	1	-	_	At display
P17.10	0Bh	0x60E1 negative torque limit	0 to 65535	1	-	_	At display
P17.11	0Ch	0x6072 maximum torque	0 to 65535	1	-	_	At display
P17.12	0Dh	0x607F speed limit	0 to 4294967295	1	-	_	At display
P17.13	0Eh	0x6080 speed limit	0 to 4294967295	1	-	_	At display
P17.14	0Fh	0x6098 homing mode	0 to 65535	1	-	_	At display
P17.15	10h	0x607E polarity	0 to 65535	1	-	_	At display
P17.16	11h	0x6081 profile velocity	0 to 4294967295	1	-	_	At display
P17.17	12h	0x6041 control word	0 to 65535	1	-	_	At display
P17.18	13h	0x6061 control mode	0 to 65535	1	-	_	At display
P17.19	14h	0x6064 position feedback	-2147483648 to 2147483647	1	-	_	At display
P17.20	15h	0x606C speed feedback	-2147483648 to 2147483647	1	-	_	At display
P17.21	16h	0x6077 torque feedback	-32768 to 32767	1	-	_	At display
P17.22	17h	Reserved		1	-	_	At display
P17.23	18h	Reserved		1	-	_	At display
P17.24	19h	Options for storing the function code	0: Not store function code parameters	1	1	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		parameters written via EtherCAT communication into EEPROM	1: Store the data written via EtherCAT bus into the drive EEPROM				
P17.25	1Ah	EtherCAT communication disconnection detection time	0.0 to 1000.0 s (No disconnection detection when the parameter is set to 0)	0.1 s	0.1	Power-on again	At stop
P17.26	1Bh	EtherCAT bus parameter initialization	0: No action 1: Restore to default value 2: Save parameter	1	0	Immediate	At stop
Index 2012h (P18): Advanced parameters							
P18.00	01h	User password					
P18.01	02h	Drive operation mode	1: VC 2: IF (P02.00 is invalid for this setting; rotating speed reference is P06.01) 3: VF (same as above)	1	1	Immediate	At stop
P18.02	03h	Current loop gain	0.01 to 500.00	0.01	10.00	Immediate	At stop
P18.03	04h	Current loop integral	0.5 to 100.0 ms	0.1 ms	10.0	Immediate	At stop
P18.04 to P18.15	05h to 10h	Advanced parameters					
P18.16 to P18.28	11h to 1Dh	Reserved					
Index 2014h (P20): Bus application parameters							
P20.00	01h	Synchronization coefficient	0 to 65535	1	0	Power-on again	At stop
P20.01	02h	Synchronization coefficient upper limit	0 to 65535	1	-	-	At display
P20.02 to P20.07	03h to 08h	Reserved			-		

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
P20.08	09h	Slave station axis address	0 to 65535	1	0	Power-on again	At stop
P20.09	0Ah	Master station configuration address	0 to 65535	1	-	-	At display
P20.10	0Bh	Data interpolation cycle	0 to 65535	1	0	Power-on again	At stop
P20.11	0Ch	Zero-speed torque limit	0 to 65535	1	0	Immediate	At stop
P20.12	0Dh	Reserved					
P20.13	0Eh	Er.076 fault reset selection	0: Fault 76 reset unavailable via bus 1: Fault 76 reset available via bus	1	0	Immediate	At stop
P20.14	0Fh	Torque unit	0: 0.1% 1: 0.01 NM	1	0	Immediate	At stop
P20.15	10h	Speed unit	0: rpm 1: Command unit / s	1	1	Immediate	At stop
P20.16	11h	Command interpolation selection	0: Speed/Position/Torque command linear interpolation 1: No interpolation 2: Non-linear interpolation of position command in the CSP mode (available only in the scenario where the synchronization cycle is less than 4 ms)	1	0	Immediate	At stop
P20.17	12h	Bus torque command filter	0 to 65535	1	0	Immediate	At stop
P20.18	13h	Bus torque command full deceleration ramp	0 to 65535	1	0	Immediate	At stop
P20.19	14h	Bus speed limit decrease time	0 to 65535	1	0	Immediate	At stop
P20.20	15h	Bus torque command acceleration/	0 to 65535	1	0	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		deceleration ramp					
P20.21 to P20.26	16h to 1Bh	Reserved					
P20.27	1Ch	DO forced output selection	0 to 31	1	0	Immediate	At stop
P20.28 to P20.29	1Dh to 1Eh	Reserved					
Index 2017h (P23): Special function parameters							
P23.00 to P23.05	01h to 06h	Reserved					
P23.06	07h	Output torque filter time coefficient	0 to 100.0 ms	0.1 ms	0.0	Immediate	At stop
P23.07	08h	Power-off storage selection of encoder multi-turn overflow value	0: Store the value at power-off 1: Not store the value at power-off	1	0	Immediate	At stop
P23.08 to P23.10	09h to 0Bh	Reserved					
P23.11	0Ch	Accumulated number of absolute encoder position errors	0 to 65535	1	0	-	At display
P23.12	0Dh	Range of the number of pulses for homing completion	0: 100 pulses Others: Number set via parameters	1	0	Immediate	At stop
P23.13 to P23.39	0Eh to 28h	Reserved					
Index 2018h (P24): Linear motor parameters							
P24.00	01h	Magnetic pole identification mode selection	0: Reserved 1: Pre-positioning identification 2: Micro-motion	1	0	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			identification (This parameter is applicable for scenarios without Hall-effect sensors)				
P24.01	02h	Non-static Hall-effect magnetic pole identification	0: Manual identification 1: Automatic identification at power-on (reserved) 2: Identification enabled by servo 3: Identification via bus control word (reserved)	1	0	Immediate	At stop
P24.02	03h	Delay of automatic identification at power-on	0 to 65535 ms	1 ms	10	Immediate	At stop
P24.03	04h	Withdrawal enable in pre-positioning	0: Disable 1: Enable (once enabled, the system will automatically draw back for a certain amount of distance after the completion of pre-positioning angle identification)	1	0	Immediate	At stop
P24.04	05h	Position feedback action enable	0: Disable 1: Enable (once enabled, the position feedback will be aligned with the pre-identification position after the completion of the angle identification)	1	0	Immediate	At stop
P24.05	06h	Incremental homing method	0: Z signal direct pass 1: Direct pass only at the first time (This parameter	1	1	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
			determines the choice of the Z signal during Z signal homing for incremental encoders. The value 0 indicates direct pass of the Z signal; the value 1 indicates position latch after direct pass at the first time; the width of the Z signal is determined by "Homing signal width")				
P24.06	07h	Homing signal width	0 to 65535	1	800	Immediate	At stop
P24.07	08h	Maximum reference current for micro-motion angle identification	10.0 to 300.0%	0.1%	100.0	Immediate	At stop
P24.08	09h	Increase slope of the injected current for micro-motion identification	0.001 to 20.000 deg	0.001 deg	0.200	Immediate	At stop
P24.09	0Ah	Motor-in-action judgement threshold for micro-motion angle identification (DDL)	0.001 to 20.000 mm	0.001 mm	0.200	Immediate	At stop
P24.10	0Bh	Static motor judgement threshold for micro-motion angle identification (DDL)	0.1 to 100.0 mm/s	0.1 mm/s	1.0	Immediate	At stop
P24.11	0Ch	Manual	Hall-effect signal	1	0	Immediate	At stop

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		adjustment of Hall-effect UVW signal	effective level setting bit0: 0- U active high 1- U active low bit1: 0-V active high 1-V active low bit2: 0-W active high 1- W active low				
P24.12	0Dh	Filter times of Hall-effect UVW signal	0 to 32	1	0	Immediate	At stop
P24.13	0Eh	Speed at Hall-effect closed-loop locked rotor	0 to 65535 [rpm] / [mm/s]	1 [rpm] / [mm/s]	2	Immediate	At stop
P24.14	0Fh	Current at Hall-effect closed-loop locked rotor	0 to 300.0%	0.1%	120.0	Immediate	At stop
P24.15	10h	Hall-effect closed-loop locked rotor time window	0 to 2000 ms	1 ms	10	Immediate	At stop
P24.16	11h	Hall-effect closed-loop inertia ratio	0 to 12.00	0.01	0	Immediate	At stop
P24.17	12h	Hall-effect closed-loop rigidity	4 to 31	1	16	Immediate	At stop
P24.18	13h	Mark of saved Hall-effect electrical angle	0: Not saved 1: Saved	1	0	Immediate	At stop
P24.19	14h	Hall-effect signal UVW state electrical angle 1	0 to 65535	1	0	-	Display parameter
P24.20	15h	Hall-effect signal UVW state electrical angle 2	0 to 65535	1	0	-	Display parameter
P24.21	16h	Hall-effect signal UVW state	0 to 65535	1	0	-	Display parameter

Function code	Sub -index	Name	Range	Min. unit	Default	Effective time	Property
		electrical angle 3					
P24.22	17h	Hall-effect signal UVW state electrical angle 4	0 to 65535	1	0	-	Display parameter
P24.23	18h	Hall-effect signal UVW state electrical angle 5	0 to 65535	1	0	-	Display parameter
P24.24	19h	Hall-effect signal UVW state electrical angle 6	0 to 65535	1	0	-	Display parameter
P24.25	1Ah	Acceleration compensation percentage	0.0 to 100.0%	0.1	0.0	Immediate	At stop
P24.26	1Bh	Motor overheat protection	-150.0 to 150.0℃	0.1℃	100.0	Immediate	During running
P24.27	1Ch	Current loop feedforward gain (%)	0 to 300%	1	0	Immediate	During running
P24.28	1Dh	Current feedforward low-pass filter (ms)	0 to 6553.5 ms	0.1 ms	20	Immediate	During running
P24.29	1Eh	Carrier frequency (8/16 kHz)	8 Hz, or 16 Hz		8	Effective upon restart	At stop
P24.30	1Fh	Square of sin/cos encoder Vpp	0 to 655.35 V^2	0.01 V^2	0.00	-	Display parameter
P24.31 to P24.39	20h to 28h	Reserved					

8.2 CiA 402 object dictionary list

Index	Data structure	Name	Data type	Accessibility	Mapping type	Unit
603Fh	VAR	Error Code	UINT16	RW	TPDO	-
6040h	VAR	Control word	UINT16	RW	RPDO	-

Index	Data structure	Name	Data type	Accessibility	Mapping type	Unit
6041h	VAR	Status word	UINT16	RO	TPDO	-
605Ah	VAR	Quick stop option code	INT16	RW	RPDO	-
605Bh	VAR	Shutdown option code	INT16	RW	RPDO	-
605Ch	VAR	Disable operation option code	INT16	RW	RPDO	-
605DH	VAR	Halt option code	INT16	RW	RPDO	-
6060h	VAR	Modes of operation	INT8	RW	RPDO	-
6061h	VAR	Modes of operation display	INT8	RO	TPDO	-
6063h	VAR	Position actual value* (motor unit)	INT32	RO	TPDO	p
6064h	VAR	Position actual value (user-defined unit)	INT32	RO	TPDO	Command unit
6065h	VAR	Following error window	UINT32	RW	RPDO	Command unit
6066h	VAR	Following error window time	UINT16	RW	RPDO	ms
6067h	VAR	Position window	UINT32	RW	RPDO	Command unit
6068h	VAR	Position window time	UINT16	RW	RPDO	ms
6069h	VAR	Velocity sensor actual value	INT32	RO	TPDO	[rpm] / [mm/s]
606Bh	VAR	Velocity demand value	INT32	RO	TPDO	[rpm] / [mm/s]
606Ch	VAR	Velocity actual value	INT32	RO	TPDO	Command unit / s
606Dh	VAR	Velocity window	UINT16	RW	RPDO	[rpm] / [mm/s]
606Eh	VAR	Velocity window time	UINT16	RW	RPDO	ms
606Fh	VAR	Velocity threshold	UINT16	RW	RPDO	[rpm] / [mm/s]
6070h	VAR	Velocity threshold time	UINT16	RW	RPDO	ms

Index	Data structure	Name	Data type	Accessibility	Mapping type	Unit
6071h	VAR	Target torque	INT16	RW	RPDO	0.1%
6072h	VAR	Max. Torque	UINT16	RW	RPDO	0.1%
6074h	VAR	Torque demand	INT16	RO	TPDO	0.1%
6077h	VAR	Torque actual value	INT16	RO	TPDO	0.1%
607Ah	VAR	Target position	INT32	RW	RPDO	Command unit
607Ch	VAR	Home offset	INT32	RW	RPDO	Command unit
607Dh	ARRAY	Software position limit	INT32	RW	RPDO	Command unit
607Eh	VAR	Polarity	UINT8	RW	RPDO	-
607Fh	VAR	Max. profile velocity	UINT32	RW	RPDO	Command unit/s
6080h	VAR	Max. motor velocity	UINT32	RW	RPDO	[rpm] / [mm/s]
6081h	VAR	Profile velocity	UINT32	RW	RPDO	Command unit/s
6083h	VAR	Profile acceleration	UINT32	RW	RPDO	Command unit / s^2
6084h	VAR	Profile deceleration	UINT32	RW	RPDO	Command unit / s^2
6085h	VAR	Quick stop deceleration	UINT32	RW	RPDO	Command unit / s^2
6087h	VAR	Torque slope	UINT16	RW	RPDO	0.1% / s
6091h	ARRAY	Gear ratio factor	UINT32	RW	RPDO	-
6098h	VAR	Homing method	INT8	RW	RPDO	-
6099h	ARRAY	Homing speeds	UINT32	RW	RPDO	
609Ah	VAR	Homing acceleration	UINT32	RW	RPDO	
60B8h	VAR	Touch probe function	INT16	RW	RPDO	-

Index	Data structure	Name	Data type	Accessibility	Mapping type	Unit
60B9h	VAR	Touch probe status	UINT16	RO	TPDO	-
60BAh	VAR	Touch probe Pos1 pos value	INT32	RO	TPDO	Command unit
60BBh	VAR	Touch probe Pos1 neg value	INT32	RO	TPDO	Command unit
60BCh	VAR	Touch probe Pos2 pos value	INT32	RO	TPDO	Command unit
60BDh	VAR	Touch probe Pos2 neg value	INT32	RO	TPDO	Command unit
60E0h	VAR	FWD torque Limit	UINT16	RW	RPDO	0.1%
60E1h	VAR	REV torque Limit	UINT16	RW	RPDO	0.1%
60F4h	VAR	Following error actual value	INT32	RO	TPDO	Command unit
60FDh	VAR	Digital inputs	UINT32	RO	TPDO	-
60FEh	ARRAY	Digital outputs	UINT32	RW	RPDO	-
60FFh	VAR	Target velocity	INT32	RW	RPDO	Command unit / s

Chapter 9 Fault Diagnosis and Removal

The drive has two protection levels: Fault and Alarm. When the drive fault or alarm occurs, the high byte of 0x603f is 0xff, and the low byte is the drive fault code or alarm code. For details, see P10.18. Please refer to bit7 of 0x6041 to determine whether it is a fault or alarm. When bit7 = 1, it indicates an alarm; otherwise, it is a fault.

603Fh	VAR	Error code	UINT16	RW	TPDO	-

All possible fault types, fault causes, and solutions for M6-L series are summarized as shown in table 9-1.

Tabel 9-1 Fault record table

Fault code	Fault type	Cause	Confirmation method	Solution
Er.001	Drive overcurrent	The motor cables are in poor contact	Check whether the cable connector is loose.	Reliably fasten the cable connector.
		The motor cables are grounded.	Check the insulation resistance between the UVW and the grounding cable of the motor.	Replace the motor if the insulation is poor.
		Short circuit occurs among the motor UVW phases.	Check whether the motor UVW interphase short circuit occurs.	Connect the motor cables correctly.
		The motor is burned out and damaged.	Check whether the resistances between the motor cables are balanced.	Replace the motor if the resistances are unbalanced.
		The gain setting is improper and the motor oscillates.	Check whether the motor oscillates or generates abnormal noise, or check the running graphs.	Re-adjust the gain.
		The encoder is incorrectly wired, its cables are aged and corroded, or the connection becomes loose.	Check whether the encoder wiring is correct, whether the cables are aged, and whether the connection is reliable.	Re-weld or fasten the encoder cables.
Er.002	Drive main circuit overvoltage	The main circuit input voltage exceeds the specified range.	Measure the input power line voltage range.	Adjust the input power voltage according to the specifications.
		The braking resistor fails.	Measure the resistance between P and PB.	If the resistor is open, replace the external braking resistor.

Fault code	Fault type	Cause	Confirmation method	Solution
		The resistance of the external braking resistor does not match (the resistance is too large, resulting in the insufficiency of the energy absorption during braking.	Confirm the resistance of the braking resistor.	Select braking resistors with proper resistance according to the operation conditions and the load.
		The motor is in the full acceleration/deceleration state.	Check the deceleration ramp time during running, and monitor the bus voltage P11.09.	Increase the acceleration/deceleration time within the allowed range.
Er.003	Drive control power overvoltage	The control power voltage exceeds the input voltage range.	Measure the control power line voltage range.	Adjust the control power voltage according to the specifications.
Er.004	Motor locked rotor occurs.	Output UVW phase loss or incorrect phase sequence occurs.	Perform noload motor trial running, and check the motor wiring.	Re-wire correctly, and replace the cables.
		UVW output disconnection occurs.	Check the UVW wiring.	Re-wire correctly, and replace the cables.
		The locked rotor is caused by mechanical factors.	Check the running command and the motor speed.	Check and remove the mechanical factors that cause the locked rotor.
Er.006	Input side phase loss	Phase loss occurs in input L1, L2, or L3.	Check the input wiring and the input power.	If the input power is single-phase 220 V, set P10.00 to 1; if the input power is three-phase 220V, check whether phase loss occurs in the input power, and replace the cables if needed.
Er.007	Output side phase loss	Phase loss occurs in output UVW.	Check the output wiring, the motor, and the cables.	Replace the wiring cables.
Er.008	Drive overheat	Ambient temperature is excessively high.	Check the cooling conditions around the drive.	Improve the servo drive cooling conditions, and reduce the ambient temperature.

Fault code	Fault type	Cause	Confirmation method	Solution
		Overload operation for excessive times	Check whether any overload fault is reported in the fault record.	To reset, wait for 60 s after overload occurs; increase the capacity of the drive and motor; increase the acceleration/deceleration time; reduce the load.
		The fan is damaged.	Check whether the fan is running during drive operation.	Replace the fan.
Er.009	Braking resistor overload	The external braking resistor is in poor wiring, its connection is loose, or the cables are disconnected.	Check whether the braking resistor is reliably wired.	Re-wire the external braking resistor according to the correct wiring diagram.
		The jumper wire across the power terminals P and PB is disconnected when the internal braking resistor is used.	Check whether the jumper wire across the power terminals is reliably connected.	Correctly and reliably connect the jumper wire.
		Insufficient capacity of the servo drive or the braking resistor	Calculate the maximum braking energy.	Increase the braking resistor capacity; increase the servo drive capacity; increase the acceleration/deceleration time.
		The load's moment of inertia is beyond the range of the allowable moment of inertia.	Check the value of the load's moment of inertia.	Increase the capacity of the drive, motor, and the resistor.
Er.010	Power module protection	Interphase short circuit or short circuit to ground occurs in the output three phases.	Check the insulation of the cable and the output motor.	Replace the cable or the motor.
		Instantaneous overcurrent of the drive	See overcurrent solutions.	See overcurrent solutions.
		The auxiliary power supply is damaged; the drive voltage is insufficient.	Seek technical assistance.	Seek technical assistance.
		Inverter shoot-through	Seek technical assistance.	Seek technical assistance.

Fault code	Fault type	Cause	Confirmation method	Solution
		Abnormal control board	Seek technical assistance.	Seek technical assistance.
		Brake pipe is damaged.	Seek technical assistance.	Seek technical assistance.
Er.011 Er.012	Er.011: Servo drive overload Er.012: Motor overload	Incorrect wiring of the motor and the encoder	Check whether the wiring is correct according to the correct wiring diagram.	Re-wire according to the correct wiring diagram; replace the cables.
		The load is excessively heavy, and the motor keeps outputting effective torque higher than the rated value for a long time.	Check the overload characteristics and the running commands of the motor or drive.	Increase the capacity of the drive and motor; reduce the load; increase the acceleration/deceleration time.
		The acceleration/deceleration is excessively frequent, or the load inertia is excessively large.	Check the inertia ratio and the start-stop cycle.	Increase the acceleration/deceleration time.
		The gain adjustment is improper; there is excessive rigidity; the motor vibrates; the sound is abnormal.	Check whether the motor vibrates and whether the sound is abnormal during motor running.	Re-adjust the gain.
		The servo drive or motor model is set incorrectly.	Check the setting of the motor model.	Correctly set the motor model.
		Overload during running resulted from locked rotor which is caused by mechanical factors	Check the running commands and the motor speed via the commissioning platform or the panel display.	Remove the mechanical factors causing the locked rotor.
		Note: To clear the fault or power on again, wait for 60 s after the occurrence of the overload fault.		
Er.013	EEPROM read/write fault	Parameter read/write error	Check whether an instantaneous power failure occurs during parameter writing.	Restore to the default setting (P02.22=2), and reset the parameter.

Fault code	Fault type	Cause	Confirmation method	Solution
		The number of times of parameter writing within a certain amount of time exceeds the maximum.	Check whether the host device frequently modifies the parameters.	Change the parameter writing method and write again.
Er.014	Abnormal communication of serial port	Improper setting of communication parameters	Check the function code settings.	Correctly set the baud rate and the communication data format.
		The communication wiring is incorrect, or the cable is unreliably connected or disconnected.	Check whether the communication wiring is correct and whether the connection is reliable.	Wire the communication cables again, or replace the communication cables.
		Improper setting of fault parameters.	Check whether the setting of P15.02 is excessively short.	Correctly set P15.02.
		The host device does not work.	Check the signal of the host system.	Check whether the host device is working.
Er.015	Resistance of the external braking resistor is excessively small.	The resistance of the external braking resistor is smaller than the minimum value required by the servo drive.	Measure the resistance and check with function code P02.20	A braking resistor of which the resistance meets the requirement shall be applied; change the setting of the function code P02.20.
Er.016	The current detection circuit is abnormal.	The cable connection or the plug-in unit of the control board is loose.	Check whether the cable connection or the plug-in unit of the control board is loose.	Check the wiring, and re-wire.
Er.018	Poor auto-tuning	The motor parameter setting is incorrect.	Check the parameters on the motor nameplate.	Correctly set the motor parameters.
		Reverse rotating auto-tuning is performed when reverse running is prohibited.	Check whether the reverse running prohibit function is enabled.	Disable the reverse running prohibit function.
		Incorrect wiring of motor	Check the motor wiring.	Make sure the power line UVW is properly connected, and the sequence is correct.
Er.019	Encoder fault	Encoder type error	Check the setting of the encoder type.	Correctly set the encoder type parameter.
		Encoder disconnection	Check the encoder cables.	Replace the encoder cables.

Fault code	Fault type	Cause	Confirmation method	Solution
Er.020	Undervoltage during main circuit operation	Voltage drop of the power grid	Measure the voltage and check whether the voltage of the input grid power is abnormal.	Improve the input of grid power.
		Overload or mismatching between the motor and the drive	Check the load and whether the drive and motor match.	Select the appropriate drive and motor.
Er.022	Incorrect setting of control mode parameters	Parameter auto-tuning in the non-VC control mode	Check the setting of the control mode parameters.	Make sure the control mode parameters are correctly set.
Er.025	Temperature sampling disconnection protection	The temperature sampling circuit is abnormal.		Seek technical assistance.
		The temperature sensor or signal cable is abnormal.		Seek technical assistance.
Er.027	Servo motor overspeed	The initial angle of the encoder is incorrect.	Check the initial angle of the encoder P01.22.	Perform the encoder angle auto-tuning again.
		The actual speed of the servo motor exceeds the overspeed threshold.	Check whether the overspeed threshold is set appropriately. (The overspeed threshold is set via P10.12; when P10.12 is set to 0, the overspeed threshold is 1.2 times of the motor maximum speed; when P10.12 is set to a non-0 value, the overspeed threshold is the minimum between P10.12 and the value of 1.2 times of the motor maximum speed)	Correctly set the overspeed threshold.
		Incorrect UVW phase sequence of the motor wiring	Check the wiring of the servo motor.	Make sure the motor wiring is correct.
		The input reference value exceeds the overspeed range.	Check the input reference.	Decrease the value of the reference, or adjust the gain.

Fault code	Fault type	Cause	Confirmation method	Solution
		The motor speed overshoots.	Check the waveform of the motor speed.	Decrease the regulator gain; adjust the servo gain, or adjust the operating conditions.
		Servo drive fault	Check whether the fault is reported again when the system is powered off and powered on again.	Replace the servo drive.
Er.031	Encoder multi-turn count overflow	The multi-turn count exceeds 65535.	Check whether the value of P11.33 exceeds the maximum number of encoder turns.	Operate the motor in the speed mode to make the multi-turn count avoid the overflow judgement value 65535; shield the multi-turn overflow fault.
Er.032	Excessive position deviation	The position deviation exceeds the set value of P05.21.	Check whether the position deviation detection range P05.21 is excessively small, or whether the position gain P08.02 is excessively small.	Increase the position loop gain P08.02.
Er.033	Abnormal pulse input	The pulse frequency exceeds the setting value of P10.13.	Check whether the maximum position pulse frequency P10.13 is excessively small.	Reset P10.13 according to the maximum position pulse frequency needed for normal mechanical running. If the output pulse frequency of the host device exceeds 4 MHz, it is necessary to reduce the output pulse frequency of the host device.
Er.034	Fully-closed loop position deviation is excessively large.	The position deviation of the external encoder and the internal encoder is excessively large.	Check whether the setting of P13.01 external encoder pulses per motor revolution is correct, and whether P13.04 the increase in threshold of excessive fully-closed loop position deviation judgement is excessively small.	Increase the threshold of excessive fully-closed loop position deviation judgement P13.04.

Fault code	Fault type	Cause	Confirmation method	Solution
Er.035	Fully-closed loop function parameters setting error	In the fully-closed loop position mode, the source of position command is the internal position command. However, the internal/external loop switchover mode is applied.	Check whether P13.03 is set to 2, and whether the source of position command is the internal position command (multi-segment position command, and interrupt positioning)	Use the external encoder feedback mode only (i.e. set P13.03 to 1 only) when the fully-closed loop function is applied and the source of position command is the internal position command.
Er.036	EtherCAT communication is interrupted.	Communication interruption timeout between controller and servo	Check the connection between controller and servo.	Connect the cables again, or set appropriate disconnection detection time P16.03 according to the communication cycle.
Er.037	Homing timeout	After homing is enabled, the home position is not located within the time set by P12.09.	Check the settings of the homing mode and the homing timeout detection time P12.09.	Properly set the homing timeout detection time according to the homing motion profile.
Er.039	Positive over-travel	The motor exceeds the positive limit switch during running.	Check whether the mechanical device comes in contact with the limit switch.	Reverse the motor running to detach the device from the limit switch.
Er.040	Negative over-travel	The motor exceeds the negative limit switch during running.	Check whether the mechanical device comes in contact with the limit switch.	Reverse the motor running to detach the device from the limit switch.
Er.043	External fault	Action of the external fault terminal	Check whether the fault terminal is triggered by mistake.	Check the external wiring.
Er.046	Short circuit to ground upon power-on	The power output cables (UVW) of the drive are short circuited to ground.	Disconnect the UVW cables on the motor side, and check whether the power cables are short circuited to ground.	Re-wire, or replace the cables.
		The motor is short circuited to ground.	Disconnect the UVW cables on the motor side, and check whether the motor internal power cables are short circuited to the motor grounding wire.	Replace the motor.

Fault code	Fault type	Cause	Confirmation method	Solution
Er.047 Er.048 Er.049	Internal logic error	...	...	Seek technical assistance.
Er.050	ASIC initialization error	Abnormal ASIC communication	Restart the drive.	Restart the drive; if the fault can not be reset, replace the drive.
Er.051	Internal fault 51	...	...	Seek technical assistance.
Er.052	Interpolation cycle error	The interpolation cycle set by P20.10 is invalid.	Check the synchronization cycle of the master and the interpolation cycle.	When the master synchronization cycle is consistent with the interpolation cycle, set P20.10 to 0; when inconsistent, P20.10 is the same as the interpolation cycle of the master.
Er.053	The position reference command of the controller is excessively large.	The position reference command of the controller is excessively large.	Check the position reference command of the controller.	Reduce the deviation of the position reference command of the controller.
Er.054 Er.055 Er.056	Internal fault	...	...	Seek technical assistance.
Er.057	Phase auto-tuning error	Phase auto-tuning error during motor installation	...	Check whether the motor parameters are correct and whether the motor wiring is correct.
Er.058	Magnetic pole identification error			
Er.059	Magnetic pole identification is not performed after power-on.	The drive is in the manual identification mode (P01.24=0) after power-on.	...	Set P01.20 to 1, and manually perform the magnetic pole identification. Otherwise, set the magnetic pole identification to non-manual mode, and power-on again.
Er.060	Motor overheat	Excessively high ambient temperature		Reduce the ambient temperature.

Fault code	Fault type	Cause	Confirmation method	Solution
		The motor is running with heavy load for excessively long time.		Improve the motor heat dissipation. Select an appropriate motor model according to the actual working conditions.
Er.061	Electronic gear ratio setting error	Electronic gear ratio setting error	Check whether the electronic gear ratio parameter is set appropriately.	Correctly set the electronic gear ratio parameter.
Er.063 Er.064	Internal fault	...	...	Seek technical assistance.
Er.065	ASIC EEPROM is not burned.	ASIC EEPROM is not burned by the controller.	The controller burns the EEPROM according to the description file.	If the fault can not be reset, the controller needs to burn the EEPROM according to the description file.
Er.066	Homing logic error	The homing parameters are set improperly, or homing command is executed during positioning.	Check whether the homing parameters, including the home position search acceleration/deceleration time, and the homing method, are set correctly.	Properly set the homing parameters according to the actual homing method, or perform homing after the completion of positioning.
Er.070	The setting of matching motor number is invalid or incorrect.	The set motor number is invalid.	Check with the correct motor number, and reset.	Correctly set the motor number parameter P01.00.
Er.071	Hall-effect UVW state error	Hall-effect UVW state is invalid.	Re-connect the Hall-effect terminal, power off and power on for several times, and check whether the fault remains.	Check the Hall-effect wiring, or replace the Hall-effect sensors.
Er.072	Program burning error	The software program is inconsistent with the hardware.	Check whether the hardware model matches the software model.	Seek technical assistance.

Fault code	Fault type	Cause	Confirmation method	Solution
Er.073	Bootstrapping failure	When enabling the 220 V drive, the motor speed is excessively high (exceeding 100 rpm).	Check whether the motor is rotating before enabling the drive.	Enable the drive when the motor is static or its speed is lower than 100 rpm.
Er.074	STO fault	Abnormal STO input	Check the status of the STO input signal	Configure the STO terminal input correctly.
Er.075	Absolute encoder battery undervoltage	The absolute encoder battery voltage is lower than 3.1 V when the drive is powered on.	Check whether the battery voltage is lower than 3.1 V.	Replace the encoder cable or encoder battery.
Er.076	Absolute encoder battery disconnection	The absolute encoder battery is disconnected, or the battery voltage is lower than 2.75 V during drive power failure.	Check whether the encoder battery is disconnected during drive power failure; check whether the battery voltage is excessively low.	If Er.076 is reported after the drive is powered on for the first time, press the reset button to clear the fault. If the fault remains after several times of resetting, replace the encoder cable or battery.
Er.077	Incorrect setting of encoder type	The actual encoder type is inconsistent with that read by P01.00.	Check whether the required encoder type of P01.00 is consistent with the actual encoder type.	Confirm the motor model, and modify the value of P01.00 if necessary.
Er.078	No parameter stored in the absolute encoder EEPROM	There is no parameter in the absolute encoder EEPROM when P01.00 is reading EEPROM.	Check whether any parameter has been written into the absolute encoder EEPROM.	Seek technical assistance.
Er.079	Absolute encoder EEPROM parameter write error	Error occurs when writing parameters into the absolute encoder EEPROM.	Check whether parameters can be re-written after power-off and power-on again.	Check the encoder type; replace the encoder or the motor if necessary.
Er.080	Control circuit undervoltage	Control circuit power failure or undervoltage; USB power only.	Measure the control circuit power supply voltage and check whether the value is within the required range; check whether the control circuit power wiring is correct.	Check the power wiring, and replace the control circuit power supply if necessary.

Fault code	Fault type	Cause	Confirmation method	Solution
Er.081 Er.082 Er.083 Er.084 Er.085	Internal fault	...	...	Seek technical assistance.

Possible alarm types, causes, and solutions of the M6-L series are summarized as shown in table 9-2.

Tabel 9-2 Alarm code table

Alarm code	Alarm type	Cause	Confirmation method	Solution
AL.012	Motor overload	Incorrect wiring of motor or encoder	Check the wiring according to the correct wiring diagram.	Properly re-wire according to the correct wiring diagram; replace the cables.
		The motor outputs effective torque exceeding the rated value for an extended period, which is resulted from excessive overload.	Check the overload characteristics and the running commands of the motor or drive.	Increase the capacity of the drive and the motor; reduce the load; increase the acceleration/deceleration time.
		Acceleration/Deceleration is excessively frequent, or the load inertia is excessively large.	Check the inertia ratio and the start/stop cycle.	Increase the acceleration/deceleration time.
		The gain adjustment is inappropriate; there is excessive rigidity; the motor vibrates and generates abnormal sound.	Check whether the motor vibrates and generates abnormal sound during running.	Re-adjust the gain.
		Incorrect setting of the drive/motor model	Check the setting of the motor model.	Correctly set the motor model.
		Overload during running resulted from locked rotor which is caused by mechanical factors	Check the running commands and the motor speed via the commissioning platform or the panel display.	Remove the mechanical factors causing the locked rotor.

Alarm code	Alarm type	Cause	Confirmation method	Solution
AL.025	Temperature sampling disconnection protection	The temperature sampling circuit is abnormal.		Seek technical assistance.
		The temperature sensor or signal cable is abnormal.		Seek technical assistance.
AL.038	DI emergency brake alarm	Action by emergency brake terminal	Set P02.09 to 1 to enable the emergency brake. An alarm will be reported upon any action by the emergency brake terminal when the drive is in the running state.	Set the reference according to normal logic.
AL.039	Positive over-travel alarm	The drive position exceeds the positive limit switch when P10.04 is set to 0 or 1.	Check whether the DI terminal is set to function 35 in group P03. Check the DI terminal logic validity of the bit corresponding to the input signal monitoring P11.12.	Check the running mode. Under the premise of safety, make the terminal logic of the positive limit switch invalid by implementing a reverse command or rotating the motor.
AL.040	Negative over-travel alarm	The drive position exceeds the negative limit switch when P10.04 is set to 0 or 1.	Check whether the DI terminal is set to function 36 in group P03. Check the DI terminal logic validity of the bit corresponding to the input signal monitoring P11.12.	Check the running mode. Under the premise of safety, make the terminal logic of the negative limit switch invalid by implementing a reverse command or rotating the motor.
AL.062	Interrupt positioning alarm	The interrupt positioning is enabled during zero-speed running.	Check the servo running state.	Perform the interrupt positioning in non-zero speed state.

Alarm code	Alarm type	Cause	Confirmation method	Solution
AL.075	Absolute encoder battery undervoltage	The absolute encoder battery voltage is lower than 3.1 V when the drive is powered on.	When operation is enabled, an alarm of LOW is reported. When not enabled, AL.075 is reported; measure the battery voltage and check whether it is lower than 3.1 V.	Replace the encoder cable or battery.

Appendix I Warranty and Service

Megmeet rigorously adheres to the ISO 9001:2015 standard in manufacturing motor drive products. If any irregularities occur with our products, please contact the product supplier or the headquarters directly. Megmeet is committed to delivering comprehensive technical support services to all our clients.

1. Warranty period

The warranty period for the product is 18 months from the date of purchase, but not exceeding 24 months after the manufacturing date recorded on the nameplate.

2. Warranty scope

During the warranty period, any abnormalities arising from the responsibility of our company can be repaired or replaced free of charge by our company. However, a certain amount of repair charges may apply even within the warranty period under the following circumstances:

(1) Damage caused by fire, flood, severe lightning strikes, or similar reasons;

(2) Man-made damage caused by users' unauthorized modifications;

(3) Damage due to dropping or transportation after purchase;

(4) Damage caused by usage beyond the standard specifications or requirements;

(5) Damage resulting from operation/use not in accordance with the user manual.

3. After-sales service

(1) If there are special requirements for the installation and commissioning of the drive product, or if the product's performance or functionality is not satisfactory, please contact the product distributor or Megmeet.

(2) In case of any abnormalities, please seek assistance by contacting the product supplier or Megmeet.

(3) During the warranty period, any abnormalities caused by manufacturing and design defects will be repaired free of charge by our company.

(4) Beyond the warranty period, repairs will be conducted at the customer's request and charged by our company.

(5) Service fees are calculated based on actual costs. Any agreements in place will take precedence.

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Parameter Recording Table

Shenzhen Megmeet Electrical Co., Ltd.

M6-L Series Servo Drive Warranty Bill

Customer company:	
Detailed address:	
Zip code:	Contact:
Tel:	Fax:
Machine model:	
Power:	Machine No.:
Contract No.:	Purchase date:
Service unit:	
Contact:	Tel:
Maintenance person:	Tel:
Maintenance date:	

Comment on service:

☐ **Excellent** ☐ **Good** ☐ **Fair** ☐ **Unsatisfactory**

Other comment:

User's signature: Date:

Customer Service Center follow-up record:

☐ **Follow-up phone call** ☐ **Follow-up letter**

Other:

Signature of the technical support engineer: Date:

Note:

This bill becomes invalid if the user can not be visited.

Shenzhen Megmeet Electrical Co., Ltd.

M6-L Series Servo Drive Warranty Bill

Customer company:	
Detailed address:	
Zip code:	Contact:
Tel:	Fax:
Machine model:	
Power:	Machine No.:
Contract No.:	Purchase date:
Service unit:	
Contact:	Tel:
Maintenance person:	Tel:
Maintenance date:	

Comment on service:

☐ **Excellent** ☐ **Good** ☐ **Fair** ☐ **Unsatisfactory**

Other comment:

User's signature: Date:

Customer Service Center follow-up record:

☐ **Follow-up phone call** ☐ **Follow-up letter**

Other:

Signature of the technical support engineer: Date:

Note:

This bill becomes invalid if the user can not be visited.