Safety Precautions

Thank you for purchasing Shihlin Electric product. This user manual introduces how to install, wiring, inspect and operate Shihlin Servo Drive and Motor. Pay special attention to the safety precautions all the time for the correct and safe use of our product.

■ In this manual, safety precautions are categorized as "DANGER" and "CAUTION".

	May cause severe or fatal injuries to personnel if the instructions are not followed.
	May cause moderate injury to personnel, or lead to severe damage or even malfunction of the product if the instructions are not followed.

Sometimes, the CAUTION items may cause serious consequences. It is important to observe both.

■ The matters to be complied with are illustrated by the following graphic symbols.

	This symbol indicates the PROHIBITED items.
	This symbol Indicates the MANDATORY Items.

In this user manual, NOTE indicates the precautions which may not cause damage to the property or malfunction of the product.

Please read this manual carefully and keep it properly to make sure you can reach it in any time.

Safety Instruction

1. Electric Shock Prevention

DANGER

Do NOT operate the switch with wet hands, otherwise it may cause electric shock.

Wiring or inspections should be performed after the power has been turned off for more than 20 minutes, the charging indicator light has been turned off and a voltage test is done to check the residue voltage, otherwise it may cause electric shock.

Well ground the servo drive and motor.

Install the servo drive and motor before wiring, otherwise it may cause electric shock.

Do NOT damage the cable, apply excessive pressure, place heavy objects or squeeze the cable, otherwise it may cause electric shock.

Do NOT disassemble the servo drive front cover when the power is on or in operation, otherwise it may cause electric shock.

Do NOT open the front cover of the servo drive when it is powered on or in operation, otherwise exposed high voltage terminal and charging pins may cause electric shock.

Except for wiring and regular inspection, do NOT open the servo front cover, even if the power is turned off, due to the inside of the servo drive is charged, which may cause electric shock.

Make sure that ground the servo drive protection earth (PE) terminal (with ⏚ remark) to the protection earth (PE) of cabinet.

Insulate the power terminal connections to avoid electric shock.

2. Fire Disaster Prevention

CAUTION

Do NOT place the servo drive, motor, or external regenerative resistor on or nearby inflammable objects, otherwise, fire disaster may be caused.

In case of servo drive failure, disconnect the power supply on the servo drive side to avoid fire caused by high current flow.

Turn off the power with a regenerative abnormal signal when regenerative resistor is used. Failure of the regenerative transistor may cause overheat and fire disaster.

Never let below items go inside of the servo drive or motor. Including: flammable matter, such as oil, fat, etc. And conductive matter: such as screw, metal parts, etc.

Be sure to connect a non-fuse circuit breaker to the power supply of the servo drive.

3. Injury Prevention

CAUTION

Only specified voltage can be applied to each terminal, otherwise, a crack or damage may occur.

Do NOT mistake the terminal connections as this may cause crack or damage.

Do NOT mistake the positive and negative polarity (+ -), as it may cause crack or damage.

Do NOT touch the heat sink, regenerative resistor of the servo drive, servo motor and other components during power-on or after power-off, because it may get hot and cause injury.

4. Other cautions

Please pay full attention to below precautions, improper operation may cause malfunction, injury, electric shock, etc.

(1) Delivery & Installation

CAUTION

Please move the product in the correct way according to its weight.

Do NOT stack more than the limit.

When moving a servo motor, hold the whole motor instead of holding the cable or only the motor shaft and encoder.

Servo drive and motor must be installed in the location that can support their weight according to the instructions.

Do NOT stand or put heavy staff on the product.

Be sure to observe the correct installation method.

Leave the required distance for servo drive inside of the protective cabinet, or between other equipment.

Do NOT install or operate a servo drive or servo motor that is damaged or missing parts.

Do NOT block the vent of servo drive. Otherwise, it may cause a malfunction.

Do NOT drop and strong shock as servo drives and servo motors, they are precision machines.

When storing for a long period of time, please consult with Shihlin Electric Systems service personnel.

(2) Wiring

CAUTION

Make sure that the wiring is done correctly and carefully. Incorrect wiring may cause error on servo motor.

Do NOT install in-phase capacitors, surge absorbs, or EMI noise filters on the output side of the servo drive.

Connect the servo drive and motor correctly(terminal U,V,W). Incorrect connection may cause malfunction of servo motor.

Connect the servo drive output(terminal U,V,W)and servo motor input(terminal U,V,W) directly. Do NOT connect them by electromagnetic contactor, otherwise, it may cause error or malfunction.

Do NOT put the diode which control the output signal in wrong direction. Otherwise, it may cause malfunction: the signal cannot be output and the protection circuit is disabled.

Be sure to tighten the cable to the terminal block with the specified torque, otherwise the cable and the terminal block may get hot due to poor contact.

(3) Trial run and adjustment.


Check and adjust the program and parameters before operation. Unexpected movements may occur due to mechanical reasons. Abrupt adjustments and parameter changes may cause unstable movements, be sure to avoid them.

(4) Operation


Set an emergency stop circuit outside the drive, to turn off the power supply in urgent cases. Do NOT disassemble, repair, or modify the equipment. If the alarm is cleared, the motor may restart suddenly. Make sure that the operation signal is cleared before proceeding. Otherwise, an accident may occur. Use noise filter to minimize the influence of electromagnetic interference, otherwise, the electric device nearby might have electromagnetic interference. Do NOT burn or disassemble the servo drive, as toxic gases may be generated. Ensure to use the specified combination of servo drive and servo motor. The built-in electromagnetic brake is used to hold the motor shaft, not for normal braking operation.

(5) Maintenance and Inspection

CAUTION

Ensure the power LED indicator is off during maintenance or inspection.

Only qualified electricians can install, wire, repair and maintain the servo drive and servo motor.

Do NOT disassemble the servo motor as this may cause electric shock or injury.

Do NOT connect or disconnect the drive and motor UVW wires when the drive is powered on.

The built-in electromagnetic brake is designed to hold the motor shaft, do NOT use for normal braking operation.

Note: the content of this manual may be revised without prior notice. Please consult our distributors or download the latest version at ***http://www. seec. com. tw/en/***

1.Product and Model Introduction

1.1 Overview

Shihlin communication-type AC servo have two control modes: single mode and dual mode. The single mode includes the following three modes: EtherCAT communication mode, position mode (internal register), and speed mode, the dual mode is position mode (internal register)/speed mode.
Our product is widely used in the general machinery industry for high-precision positioning, smoothly speed control, master-slave control, or tension control.
Shihlin servo applies EtherCAT industrial Ethernet network as the communication medium, which can not only transmit more data, but also simplify the wiring and reduce the cost of the hardware. In addition, it is configured with the most convenient USB communication function on the market, and by using the computer installed with Shihlin communication software, you can quickly do the parameter setting, test operation, status monitoring, and the control gain adjustment.
Shihlin servo optimizes the original auto-tuning function so that the servo gain can be automatically adjusted in a faster and more accurately way to match the machine. And the encoder resolution of Shihlin servo has been increased to 24-bit pulse/rev, which provides higher precision control.

1.2 Product checklist

Please check below items before you start to use our product:

- Any loose or unlocked screw on motor or drive.
- Check if the product model name on nameplates of the motor and drive are align with your purchase order. For the model name, you can refer to the product model list in next section.
- Check the motor and drive for any cosmetic damage or scratch.
- Rotate the motor shaft by hand, if it runs smoothly, it means there is no abnormality in the motor shaft. But If it is a motor with electromagnetic brake, it is not possible to turn the motor shaft smoothly by hand.

If any above of problem arises, please contact the distributor.

A complete servo set includes:

(1) A servo drive and a servo motor.

(2) A UVW motor power cable, one end locked to the UVW terminal block, the other end is connected to the UVW female socket on the motor, and the green ground wire is locked to the ground of the drive. (Optional purchase)

(3) An encoder control signal cable: its one end connects to the CN2 of the controller, the other end is connected to the encoder socket of the motor.

(4) A USB cable for communication, its one end connects to CN4 on the drive, the other end to USB port of the computer. (Optional purchase)

(5) A 15 PIN connector for CN1. (Optional purchase)

(6) A 9 PIN connector for servo below 1KW (L1, L2, L3, P, C, N, U, V, W).

(7) A 3 PIN quick connector for servo under 3KW (U, V, W).

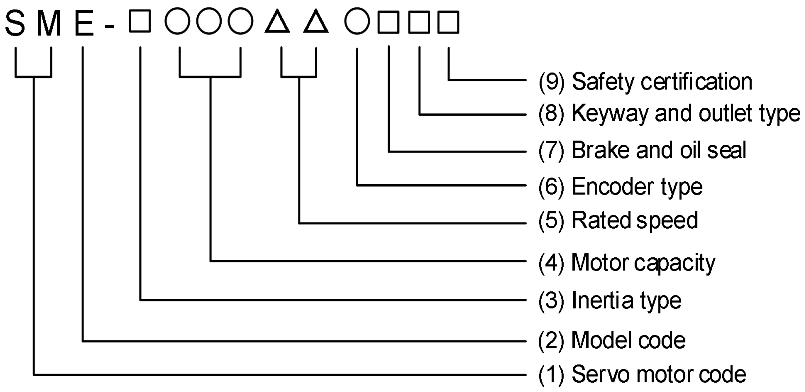
(8) An installation guide.

(9) A Shihlin servo user manual, it is also available online as an electronic file.

1.3 Product model name overview

1.3.1 Servo motor naming rule

1) Naming rule



2) Description of each item

(1) Servo motor code: SM indicates servo motor

(2) Model code: E

(3) Inertia type: coding according to motor inertia:

Code	Type
L	Low inertia
M	Middle inertia
H	High inertia

(4) Motor capacity: motor output power

Code	010	020	040	075	100
Motor power(W)	100	200	400	750	1000

(5) Rated speed: the rated motor speed

Code	15	20	30
Rated speed(rpm)	1500	2000	3000

(6) Encoder type: Shihlin servo motor encoder type

Code	T	N	S	M
Single turn resolution type	17bit	17bit	24bit	24bit
Number of revolutions	-	±15bit		±15bit

(7) Brake and oil seal: the following codes is to indicate whether the motor is equipped with brake and oil seal.

Code / Item	A	B	C	D
Brake	-	●	-	●
Oil seal	-	-	●	●

(8) Keyway and outlet type: Whether the motor has a keyway and wire outlet type is indicated by the following code.

Code / Item	A	B	C	D
Keyway	-	●	-	●
Back side cable	-	-	●	●

(9) Safety certification: the certified safety certification of the motor is indicated by the following code:

Code / Item	CE certification	Compliant with UL/CE certification
Code	-	U

Coding example:

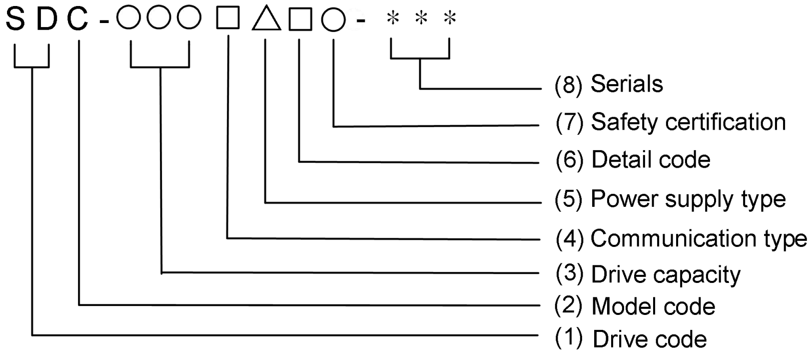
Example(1): for a 200W motor, low inertia, rated speed 3000rpm, without brake&oil seal& keyway, single turn absolute magnetic encoder, CE certified model, its model name is as follows: SME-L02030TAA.

Example(2): for a 750W motor, low inertia, rated speed 3000rpm, with brake, without oil seal, with keyway, multi-turn absolute magnetic encoder, back side cable, UL certified, its model name is SME-L07530NBDU.

Example(3): for a 1000W motor, low inertia, rated speed 3000rpm, without brake, with oil seal and keyway, with multi-turn absolute magnetic encoder, CE certified, its model name is SME-L10030NCB.

1.3.2 Servo drive naming rule

1) Coding Rule



2) Description of each coding item

(1) Servo drive code: SD means servo drive.

(2) Model code: C

(3) Drive capacity: motor output power.

Multiply the motor output power by 1/10 and then indicate it as a three-code number. For models above 1000W, uses the English letter K to represent 1000W in the third code. The example is as follows:

020 means 200W

100 means 1000W

(4) Communication types: There are different types of communication formats.

Code Item	A	E
Communication type	Modbus	EtherCAT

(5) Power supply type: Input power specifications.

2: AC220V power supply, single-phase or three-phase

4: AC440V power supply, three-phase

(6) Detail code: The drive application is categorized according to the following code.

Code Item	N/A	A
Model type	Normal type	

(7) Safety certification

Code Item	N/A	U
Safety certification	CE certified	UL/CE certified

(8) Serials

Item \ Code	N/A	T	SXX
Description	General type	STO with Entity Dynamic Brake	Customized special types or region

Example description:

Example (1): 200W drive, CE certified, single or three phase 200~240VAC, general type, then the code is as follows: SDC-020E2A

Example (2): 400W drive, UL and STO certified, single-phase or three-phase 200~240VAC, general type, customized for a customer, then the code is: SDC-040E2AU-TXX, where XX is a number.

1.3.3 Servo drive and motor

	Servo drive model	Servo motor model
100W	SDC-010E2□○-＊＊＊	SME-L01030○□□□ SM3-M01030○□□□
200W	SDC-020E2□○-＊＊＊	SME-L02030○□□□ SM3-M02030○□□□
400W	SDC-040E2□○-＊＊＊	SME-L04030○□□□ SM3-M04030○□□□ SM3-H04030○□□□
750W	SDC-075E2□○-＊＊＊	SME-L07530○□□□ SM3-M07530○□□□ SM3-H07530○□□□
1000W	SDC-100E2□○-＊＊＊	SME-L10030○□□□ SM3-M10030○□□□

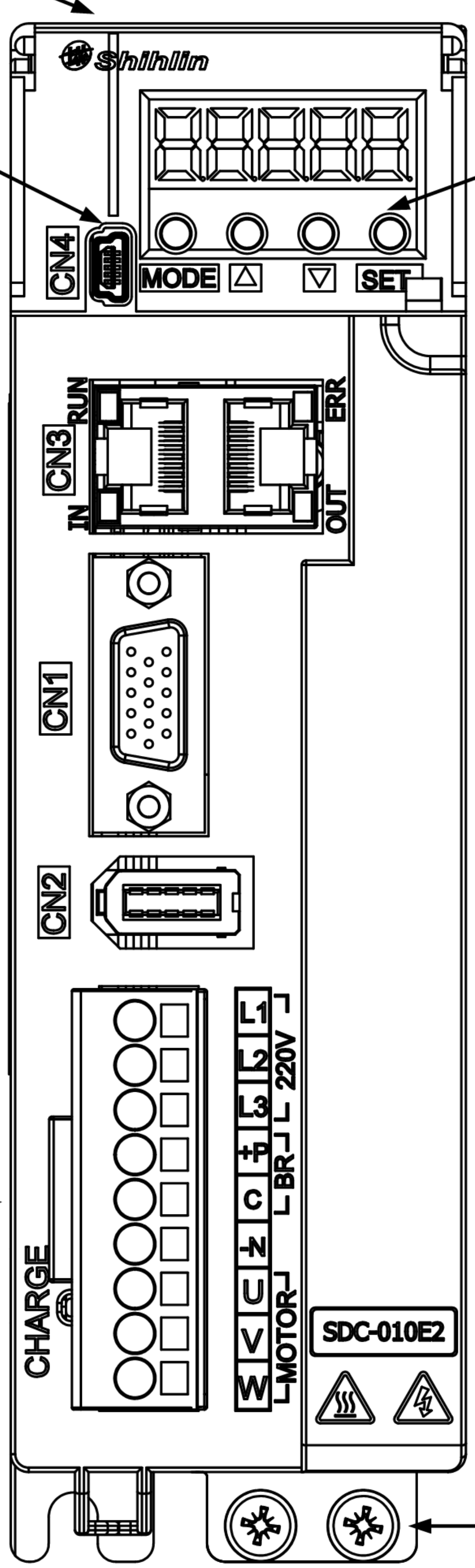
Note 1: □ in servo drive model name represents safety certification, and *** represents market definition/market/customer.

Note 2: ○ in servo motor model name represents encoder type, ○=T represents single-turn encoder, ○=N represents multi-turn encoder.

Note 3: Please refer to section 1.3.1 for the description of □□□ in servo motor.

1.4 Description of servo drive interfaces

1.4.1 Models below 1kW



1.4.2 Models above 1.5kW-3kW

No such capacity currently.

1.5 Servo drive operation mode introduction

Shihlin drive offers a variety of operation modes, which are detailed in the following table.

Mode name		Mode code	Description
Single mode	EtherCAT mode	CoE	The drive receives commands from the EtherCAT host controller and performs mode control accordingly. There are 8 types of control modes, including CSP, CSV, CST, PP, PV, PT, HM, IP.
	Position mode (internal register)	Pr	The drive receives position commands and runs the motor to the target position. Position commands are provided by internal registers (64 groups of registers), and it can be controlled by DI signals.
	Speed mode	S	The drive receives speed commands and runs the motor to the target speed, the speed commands are internal speed command (7 groups of registers).
Dual mode		Pr-S	Pr and S can be switched by DI signal.

- Mode selection is accomplished by setting parameter PA01. After setting the parameter, cycle power to the servo drive.
- If using the factory defined pin function, please set parameter PA01 to 1XXX.

1.6 Recommended specifications for circuit breakers and fuses

The specifications table of fuses and circuit breakers:

Drive model name	**Fuse**	**Circuit breaker**
SDC-010E2□	5A	5A
SDC-020E2□	5A	5A
SDC-040E2□	20A	10A
SDC-075E2□	20A	10A
SDC-100E2□	25A	15A

2.Installation

2.1 Precautions and storage

- Do not install on or near flammable materials.
- Do not pull the wires between the drive and motor too tightly.
- Do not place heavy objects on top of the drive.
- When fixing the drive, make sure that each fixing point is screwed firmly.
- Install the drive in a place where it can bear weight.
- The motor shaft center must be aligned with the equipment shaft.
- Do not mix the below objects in the drive, including metal sheets, screws and other conductive objects or flammable materials such as oil.
- If the drive is more than 20 meters away from the connected motor, you should thicken the U, V, W and Encoder connecting wires.
- The exhaust vent of the drive should not be blocked, otherwise it may cause failure.
- The drive should not be dropped or stroked.
- Do not force to run when the drive is damaged.
- Please refer to section 16.3.5 for the storage precautions of the drive and motor.

2.2 Installation environment

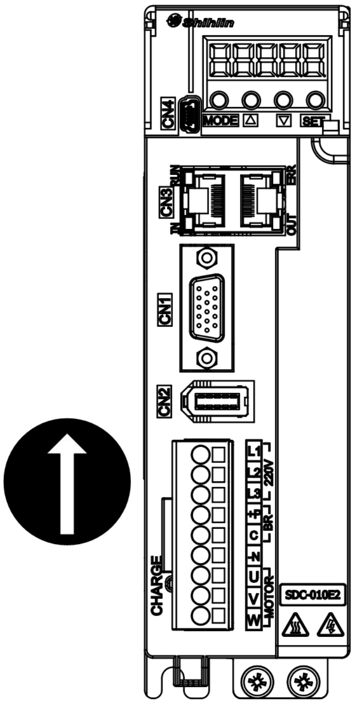
The applicable ambient temperature for Shihlin drive is between 0℃ ~ 55℃. If it exceeds 45℃, you should place the drive in a well-ventilated or air-conditioned room. It is recommended to keep the ambient temperature below 45℃ for long-term operation to ensure the reliable performance. If it is installed in a distribution box, check the size of the distribution box and its ventilation condition, make sure the internal electrical devices has no overheating risk, and you should note whether the vibration of the machine will affect the electronic devices in the distribution box. In addition, the conditions for the use of Shihlin servo include the following items:

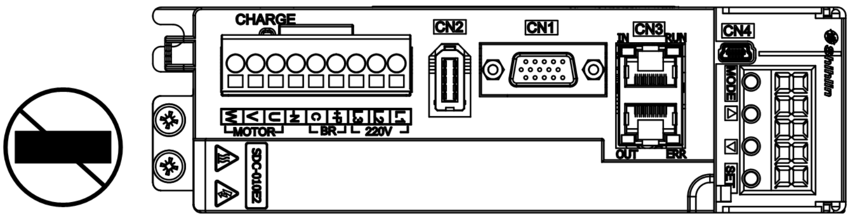
- locations without high-heat generating devices.
- locations without floating dust or metal particles.
- locations without corrosive, flammable gas or liquid.
- locations without water droplets, vapor, dust, or oily dust.
- locations without electromagnetic noise interference.
- locations without vibration.

2.3 Installation direction and clearances

Precautions:

Install the servo drive in the correct direction according to the requirement. Otherwise, it may cause malfunction. For better ventilation and cooling, when installing Shihlin AC servo drive, there must be sufficient clearance between its adjacent objects and the wall, otherwise overheating may result in machine malfunction. Do not block the ventilation holes of the servo drive, and the drive cannot be placed upside down, otherwise it will cause malfunctions.



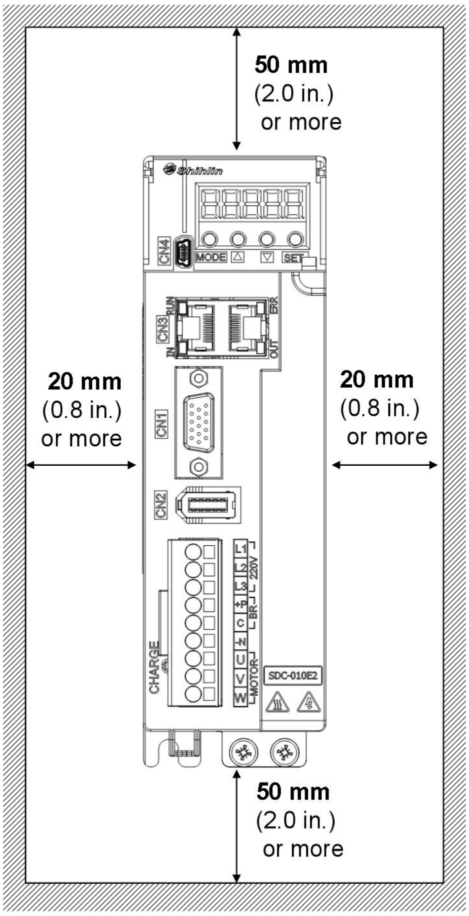


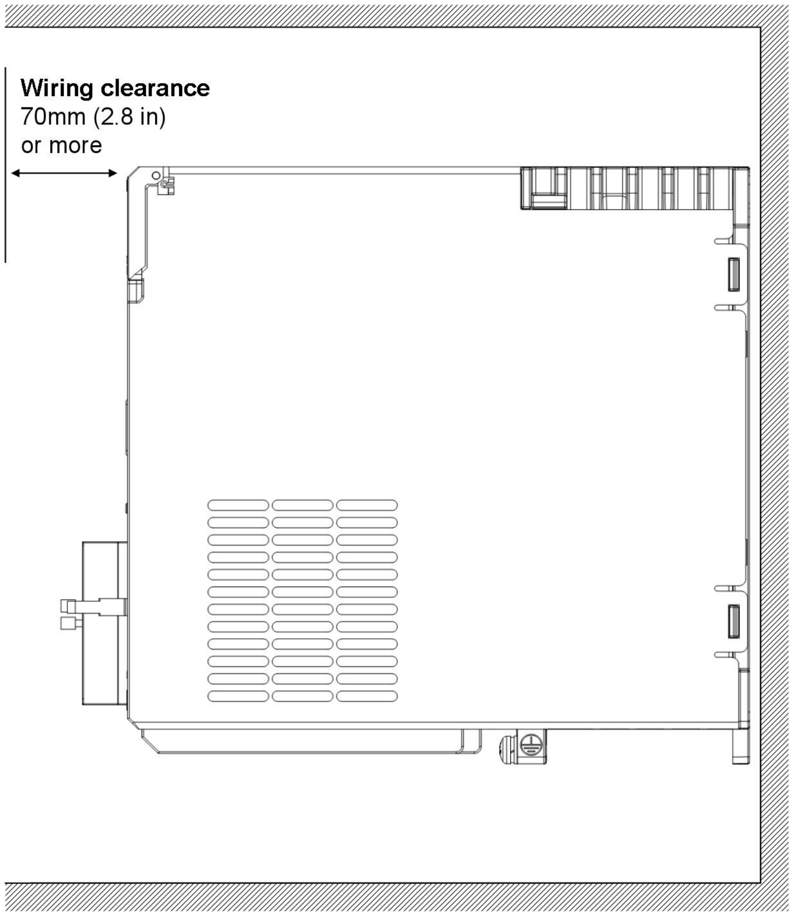
CORRECT

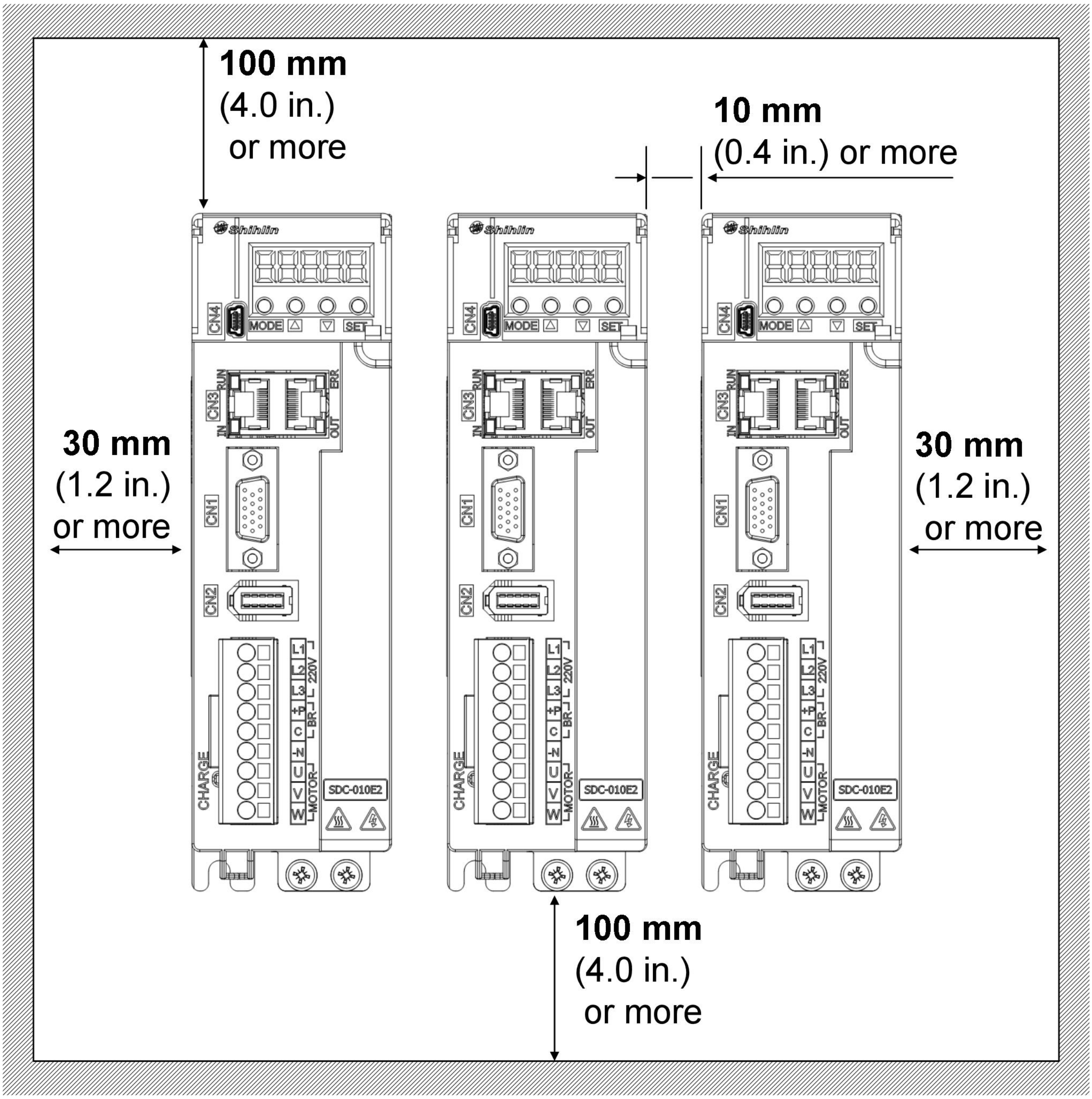
WRONG

Installation diagram:

In order to have adequate air flow for ventilation, you must observe the recommended clearance space between one and multiple AC servo drives (as shown in the figure below):





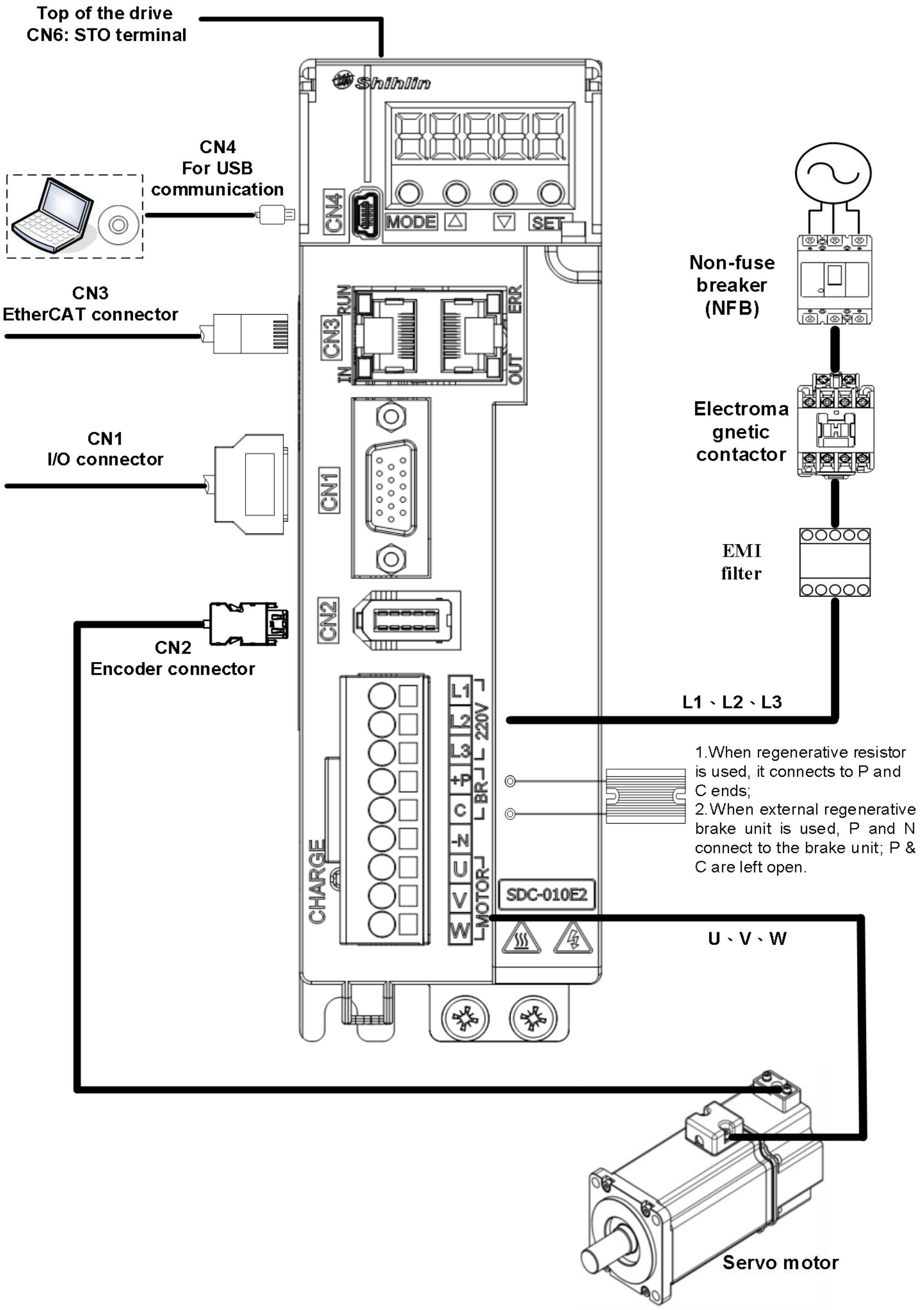


3.Wiring and Signal

This chapter introduces the wiring method of Shihlin servo drives, the definition of various signals, and the standard wiring diagrams in each control mode.

3.1 Connection of power supply and peripheral devices

3.1.1 Peripheral devices wiring diagram - below 1KW



※ For detailed EMI filter introduction, please refer to section 13.6 EMI Filter.

DANGER	● To prevent electric shock, the protection earth (PE) terminal (⏚ marked terminal) of the servo drive must be connected to the protection earth terminal of the controller

3.1.2 Peripheral devices wiring diagram - 1.5KW~3KW

No such capacity currently.

3.1.3 Description of drive connectors and terminals

<table>
<tr><th>Item</th><th>Code</th><th>Description</th></tr>
<tr><td>Power input</td><td>L1, L2, L3</td><td>Connect to three-phase AC power</td></tr>
<tr><td>Power input of motor</td><td>U, V, W, PE</td><td><table><tr><td>Terminal code</td><td>Wire color</td></tr><tr><td>U</td><td>Red</td></tr><tr><td>V</td><td>White</td></tr><tr><td>W</td><td>Black</td></tr><tr><td>PE</td><td>Green</td></tr></table></td></tr>
<tr><td>Regenerative resistor terminals</td><td>P, C</td><td><table><tr><td>Use an external resistor</td><td>Remove the existing wiring and connect to the regenerative resistor.</td></tr><tr><td>Use a built-in resistor</td><td>P and C ends connect to the internal regenerative resistor.</td></tr></table></td></tr>
<tr><td>Ground terminals</td><td>⏚</td><td>Connect to the ground wires of the power and servo motor, which is the green screw on the outside of the controller.</td></tr>
<tr><td>P: main circuit [+] terminal
N: main circuit [-] terminal</td><td>P, N</td><td>If brake unit is used, you should connect its [+] terminal to the [P] terminal of servo drive, and connect its [-] to the [N] terminal of servo drive.
The brake unit is optional purchase item, usually it is not required. It is used to absorb the regenerative energy when the huge regenerative power is generated by the servo motor.</td></tr>
<tr><td>I/O connector</td><td>CN1</td><td>Connect to the host controller.</td></tr>
<tr><td>Encoder connector</td><td>CN2</td><td>Connect to the motor encoder.</td></tr>
<tr><td>EtherCAT connector</td><td>CN3</td><td>Connect to EtherCAT host controller.</td></tr>
<tr><td>USB connector</td><td>CN4</td><td>Connect to USB slot of PC</td></tr>
<tr><td>Power connector for absolute encoder</td><td>CN5</td><td>Connect to battery pack of absolute encoder (optional purchase)</td></tr>
<tr><td>STO connector</td><td>CN6</td><td>Connect to the dedicated connector or application circuits corresponds to STO.</td></tr>
</table>

Pay special attention to the following items when wiring:

1.Separate R,S,T and U,V,W from other signal wires. The clearance should be at least 30cm.

2.When the power is off, do not touch L1,L2,L3 and U,V,W power cables, the large capacitor inside the drive contains a large amount of charge, wait until the charging light is off before touching.

3.If the encoder cable needs to be extended, please use a twisted signal cable with isolated grounding. Do not exceed 20 meters (65.62 ft.). If it exceeds 20 meters, please use a signal cable with twice diameter to ensure that the signal will not be attenuated too much.

4.If the power supply and the detector (encoder) of the servo motor are not fixed on the motor, it may shake and cause poor contact.

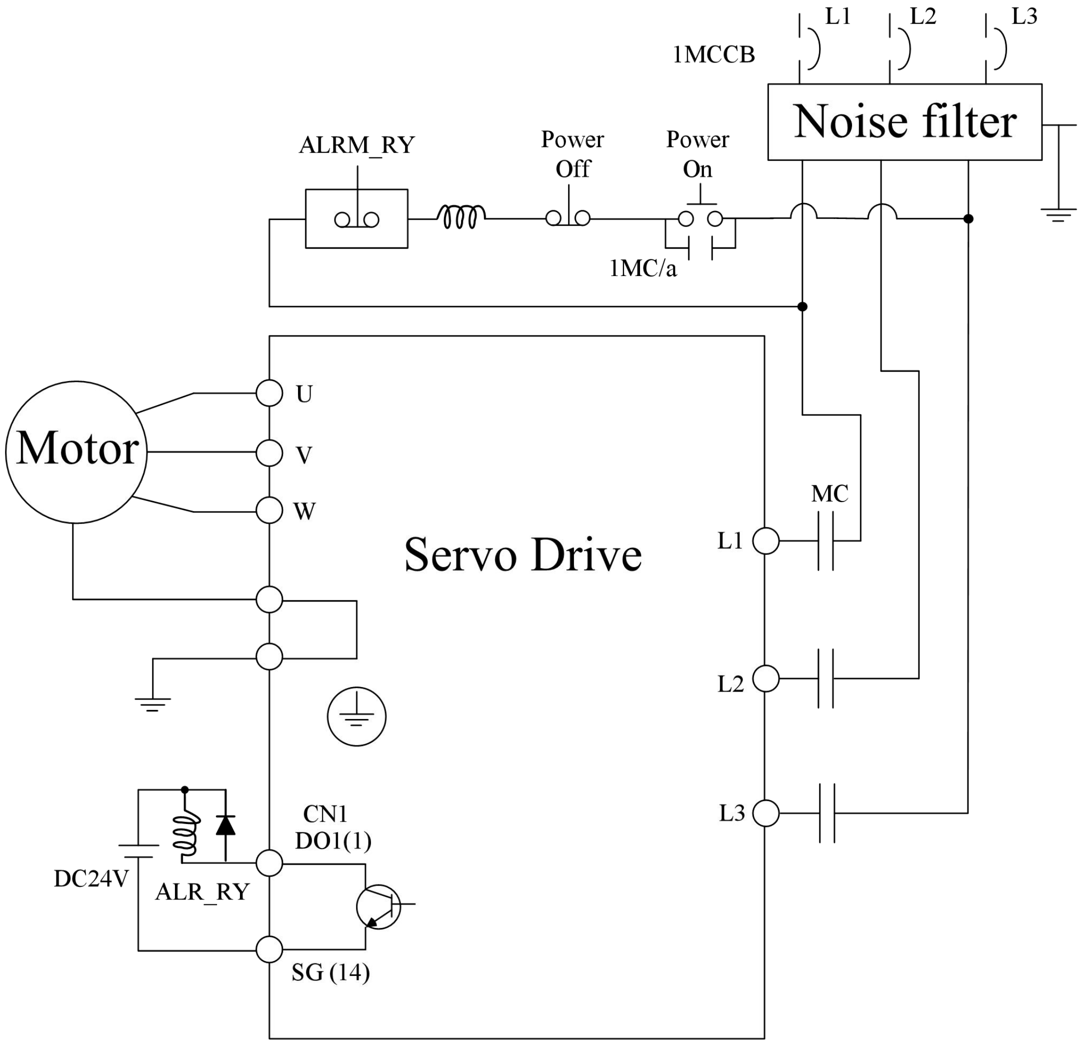
3.1.4 Wiring for power supply

DANGER	● Insulate the connections of the power supply terminals, otherwise there is a risk of electric shock.

CAUTION	● The power supply (U, V, W) of the servo motor and servo drive must be connected correctly, otherwise the servo motor will operate abnormally.

● The servo motor should not be connected to a commercial power supply, otherwise it will cause a malfunction.

The Shihlin servo drive power wiring is a three-phase power. In the following diagram, Power ON is A contact, Power OFF and Alarm Processing are B contact. 1MC/a is a self-retaining power supply and 1MC is an electromagnetic contactor.

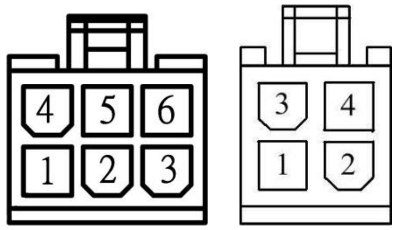


★ Note: Terminal P, N cannot be grounded.

3.1.5 Specifications for the UVW connectors of the motor

U, V, and W connector specifications for low and high inertia motors (female connector):

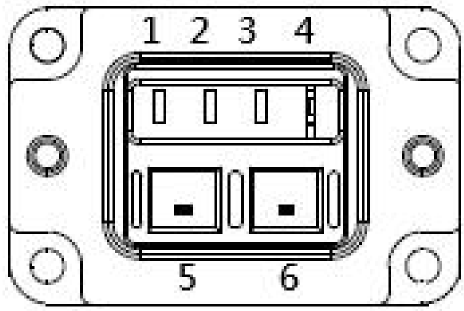
Drive capacity	Motor model
100W	SME-L01030○□□□
200W	SME-L02030○□□□
400W	SME-L04030○□□□
750W	SME-L07530○□□□
1kW	SME-L10030○□□□



With brake Without brake

U, V, and W connector specifications for medium and high inertia motors (female connector):

Drive capacity	Motor model
100W	SM3—M01030○□□□
200W	SM3—M02030○□□□
400W	SM3—M04030○□□□ SM3—H04030○□□□
750W	SM3—M07530○□□□ SM3—H07530○□□□
1kW	SM3—M10030○□□□



The following table shows the signals of UVW connectors for motors.

PIN	Signal	Wire color
1	U	Red
2	V	White
3	W	Black
4	PE	Green/yellow(green is base color)
5	B1	Black(for motor with electromagnetic brake)
6	B2	Black(for motor with electromagnetic brake)

★ Note: the above wiring is the connector of the motor.

3.1.6 Wire selection

Drive model	Wire[mm^2]			
	Power cable(AWG)			
	L1, L2, L3	U, V, W	P, C, N	B1, B2
SDC-010E2□	2(AWG14)	2(AWG14)	2(AWG14)	2(AWG14)
SDC-020E2□				
SDC-040E2□				
SDC-075E2□				
SDC-100E2□				

Drive model	Encoder cable (AWG)			
	Spec	Standard length	Number of core wires	Core wire size
SDC-010E2□	UL1332	2 m	10 wires	AWG26
SDC-020E2□	UL1332	2 m	10 wires	AWG26
SDC-040E2□	UL1332	2 m	10 wires	AWG26
SDC-075E2□	UL1332	2 m	10 wires	AWG26
SDC-100E2□	UL1332	2 m	10 wires	AWG26

- You should follow the recommended specifications or larger for wiring to avoid danger.
- The shield end of the isolation net should be grounded.
- Use twisted isolation wire to reduce noise interference when wiring encoders.
- American Wire Gauge (AWG) means American Wire Gauge standard.
- Use 600V vinyl wire as standard configuration, and the wiring distance should be less than 30m.
- If the wiring distance exceeds 30m, you should consider the voltage drop before selecting the wire size.
- For UL/C-UL (CSA) specifications, use UL-certified copper wires which is rated 75°C or higher for wiring.
- AWG14, 12in-lbs is required for grounding wire.

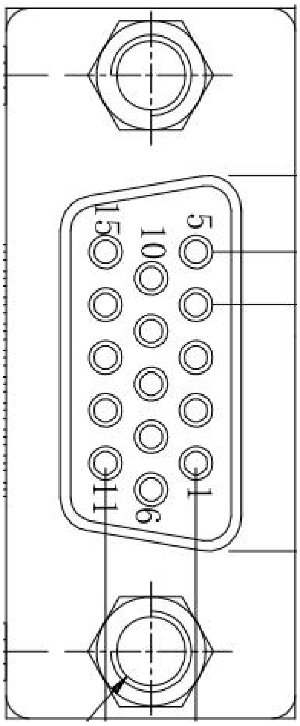
3.2 CN1 I/O signal wiring and description

3.2.1 CN1 terminal configuration diagrams

Shihlin servo drive provides user-defined 5 groups of digital inputs(DI) and 3 groups of digital outputs(DO), it is more flexible when connecting to the upper controller application and communicating with each other. The 5 digital inputs are parameters PD02~PD06 and the 3 digital outputs are parameters PD10~PD12, the pin diagram are as follows:

(1) CN1 connector(female)

Front view



Pin assignment

Pin	Code	Function	Pin	Code	Function	Pin	Code	Function
1	DO1	Digital output 1	6	DOCOM	Digital Output Power Supply	11	DI5	Digital input 5
2	DOCOM	Digital Output Power Supply	7	DI4	Digital input 4	12	NC	NA
3	DO2	Digital output 2	8	DI3	Digital input 3	13	COM+	Digital input Power Supply
4	DOCOM	Digital Output Power Supply	9	DI2	Digital input 2	14	SG	Digital Power Ground
5	DO3	digital input 3	10	DI1	Digital input 1	15	Vdd (24V)	Internal power supply +24V output

3.2.2 Description of CN1 terminal signals

This section introduces the signals which listed in the previously section.

1.CN1 terminal signal

The details of each signal in CN1 15Pin are as follows:
The control mode symbols in below table are as follows:
CoE: EtherCAT communication mode
Pr: Position control mode (Internal register)
S: Speed control mode

Signal name	Code	Pin NO	Function	Control mode
Digital Power Ground	SG	CN1-14	Common terminal for DI, such as SON, EMG, etc. Each pin is connected internally but separated from LG.	ALL
Digital power	COM+	CN1-13	Input DC24V for the input connector. Please connect to the positive terminal of the external power supply DC24V.	ALL
Internal power supply +24V output	VDD (24V)	CN1-15	Output +24V±10% between VDD-SG. Please connect to COM+ when used as a power supply for digital interface.	ALL

The signals of DI and DO will be introduced in detail in the following sections.

2.Shihlin servo CN1 I/O

Shihlin servo CN1 I/O, DI/DO name & abbreviation table are as follows:

Abbreviation	Signal name	Abbreviation	Signal name
SON	SERVO ON	CTRG	Position command trigger
LSP	Limit of forward rotation	PC	Proportion control
LSN	Limit of reverse rotation	CAM	E-CAM engaging control
CR	Clear	RD	Ready
SP1	Speed option 1	POS3	Position command option 3
SP2	Speed option 2	POS4	Position command option 4
SP3	Speed option 3	POS5	Position command option 5
ST1	Forward rotation activated	ZSP	Zero speed detection
ST2	Reverse rotation activated	INP	In-position ready
TL	Torque limit option	SA	Speed attained
RES	Reset	ALM	Alarm
EMG	External emergency stop	SG	DC24V power ground
LOP	Control mode switch	VDD	The positive terminal of the internal power supply DC24V
POS1	Position command option 1	COM +	The positive terminal of the external power supply DC24V
POS2	Position command option 2	POS6	Position command option 6

3. Detailed explanation for DI and DO signals

Digital input(DI) Wiring

A total 31 groups of DI function for manually parameter setting, see the table below for details.

<table>
<tr><th>Signal name</th><th>Code</th><th>Function</th><th>Control mode</th></tr>
<tr><td>Servo ON</td><td>SON</td><td>Turn SON ON, the basic circuit connects to the power and the servo is ready to be operated (servo ON status).
Turn SON OFF, the basic circuit is cut off and the servo motor is switch to free run status(servo OFF status).</td><td>ALL</td></tr>
<tr><td>Reset</td><td>RES</td><td>Perform alarm reset after RES is turned on for over 50 ms, but sometimes the alarm may not able to be cleared (refer to section 13.1), the circuit cannot be cut off if one parameter is set to XXX1.</td><td>ALL</td></tr>
<tr><td>Proportion control</td><td>PC</td><td>Turn PC on, the speed controller is switched from proportion integral type to proportion type. When the servo motor stops, it will output torque to resist the external disturbance which even only 1 pulse revolution. Once the positioning is done, please turn PC on to prevent from unnecessary torque.
When locking for a long time, turn the torque control signal (TL) and the proportion control signal on to limit the output torque.</td><td>Pr, S</td></tr>
<tr><td>Torque limit option</td><td>TL</td><td><u>The options of TL are showing in the table below:</u>
<table>
<tr><th>TL - SG</th><th>Torque limit</th></tr>
<tr><td>Open</td><td>Torque limit =PA 05</td></tr>
<tr><td>Short</td><td>If PC25 setting > PA05 setting => TL=PA05
If PC25 setting < PA05 setting => TL=PC25</td></tr>
</table></td><td>ALL</td></tr>
<tr><td>Origin position</td><td>ORGP</td><td>In internal position register mode or CoE mode, the servo takes this position as the origin when ORGP is on. Servo starts homing when SHOM is ON or executing homing of CoE mode.</td><td>Pr, CoE</td></tr>
<tr><td>Forward rotation activated</td><td>ST1</td><td rowspan="2">When start the servo motor, it runs in the following directions:
<table>
<tr><th colspan="2">Input signal</th><th rowspan="2">Running direction</th></tr>
<tr><th>ST2</th><th>ST1</th></tr>
<tr><td>0</td><td>0</td><td>Stop(servo locked)</td></tr>
<tr><td>0</td><td>1</td><td>CCW</td></tr>
<tr><td>1</td><td>0</td><td>CW</td></tr>
<tr><td>1</td><td>1</td><td>Stop(servo locked)</td></tr>
</table>
If both ST1 and ST2 are switched on or off during operation, the servo decelerates to stop and then locks. If the analog speed</td><td rowspan="2">S</td></tr>
<tr><td>Reverse rotation activated</td><td>ST2</td></tr>
</table>

<table>
<tr><td></td><td></td><td>command (VC) is at 0V, the motor will not be locked, even the running signal is on.</td><td></td></tr>
<tr><th>Signal name</th><th>Code</th><th>Function</th><th>Control mode</th></tr>
<tr><td>Speed option 1</td><td>SP1</td><td rowspan="3">To select the rotation speed in speed mode.
When using SP3, make it usable by setting internal parameters.
<table>
<tr><th rowspan="2">Parameter setting</th><th colspan="3">Input signal</th><th rowspan="2">Speed command</th></tr>
<tr><th>SP3</th><th>SP2</th><th>SP 1</th></tr>
<tr><td rowspan="4">When speed option (SP3) is invalid. (initial status)</td><td></td><td>0</td><td>0</td><td>Speed command is 0</td></tr>
<tr><td></td><td>0</td><td>1</td><td>Inner speed command 1</td></tr>
<tr><td></td><td>1</td><td>0</td><td>Inner speed command 2</td></tr>
<tr><td></td><td>1</td><td>1</td><td>Inner speed command 3</td></tr>
<tr><td rowspan="8">When speed option (SP3) is valid.</td><td>0</td><td>0</td><td>0</td><td>Speed command is 0</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>Inner speed command 1</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>Inner speed command 2</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>Inner speed command 3</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>Inner speed command 4</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>Inner speed command 5</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>Inner speed command 6</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>Inner speed command 7</td></tr>
</table></td><td rowspan="3">S</td></tr>
<tr><td>Speed option 2</td><td>SP2</td></tr>
<tr><td>Speed option 3</td><td>SP3</td></tr>
<tr><td>Start Home moving</td><td>SHOM</td><td>In the internal position register mode, turn SHOM ON to start the searching origin.</td><td>Pr</td></tr>
<tr><td>Electronic gear option 1</td><td>CM1</td><td rowspan="2">When CM1 and CM2 are used, the combination of CM1 and CM2 can be used for selecting the E-gears, and the numerator with 4 kinds of electronic gear ratios can be set in parameters. CM1 and CM2 cannot be used in the absolute position detection system.
<table>
<tr><th colspan="2">Input signal</th><th rowspan="2">E-gear numerator</th></tr>
<tr><th>CM2</th><th>CM1</th></tr>
<tr><td>0</td><td>0</td><td>PA06(CMX)</td></tr>
<tr><td>0</td><td>1</td><td>PC32(CMX2)</td></tr>
<tr><td>1</td><td>0</td><td>PC33(CMX3)</td></tr>
<tr><td>1</td><td>1</td><td>PC34(CM)</td></tr>
</table></td><td rowspan="2">Pr</td></tr>
<tr><td>Electronic gear option 2</td><td>CM2</td></tr>
<tr><td>Clear</td><td>CR</td><td>To clear the position control counter deviation pulses on its rising edge when CR is ON. The pulse width should be over 10ms.
When the PD18 is set to xxx1, the pulse is always cleared if CR is on.</td><td>Pr</td></tr>
<tr><td>Gain switching option</td><td>CDP</td><td>Turn CDP on to switch each gain values to the multiplier of parameter setting value.</td><td>ALL</td></tr>
</table>

<table>
<tr><th>Signal name</th><th>Code</th><th>Function</th><th>Control mode</th></tr>
<tr><td>Control mode switch</td><td>LOP</td><td>To select the control mode in the position/speed control switching mode
<table><tr><th>LOP</th><th>Control mode</th></tr><tr><td>0</td><td>Position</td></tr><tr><td>1</td><td>Speed</td></tr></table></td><td>Refer to the different control modes description</td></tr>
<tr><td>External emergency stop</td><td>EMG</td><td>Turn EMG on to bring the motor to an emergency stop state, the servo is off and brake is enabled. Turn EMG on in the emergency stop state to release the EMG state. Set PD01 to 1XXX, this signal would be automatically on(always ON).</td><td>ALL</td></tr>
<tr><td>Position command 1</td><td>POS1</td><td rowspan="6"><table><tr><th>Position command</th><th>POS6</th><th>POS5</th><th>POS4</th><th>POS3</th><th>POS2</th><th>POS1</th><th>CTRG</th></tr><tr><td>P0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>↑</td></tr><tr><td>P1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>↑</td></tr><tr><td>~</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>P50</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>↑</td></tr><tr><td>P51</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>↑</td></tr><tr><td>~</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>P63</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>↑</td></tr></table></td><td rowspan="6">Pr</td></tr>
<tr><td>Position command 2</td><td>POS2</td></tr>
<tr><td>Position command 3</td><td>POS3</td></tr>
<tr><td>Position command 4</td><td>POS4</td></tr>
<tr><td>Position command 5</td><td>POS5</td></tr>
<tr><td>Position command 6</td><td>POS6</td></tr>
<tr><td>Position command trigger</td><td>CTRG</td><td>In Pr mode, when CTRG is on, read the position command selected by POS1~6 into the controller.</td><td>Pr</td></tr>
<tr><td>Limit of forward rotation</td><td>LSP</td><td>Turn LSP on, the motor can perform forward rotation.</td><td>CoE, Pr, S</td></tr>
<tr><td>Limit of reverse rotation</td><td>LSN</td><td>Turn LSN on, the motor can perform reverse rotation.</td><td>CoE, Pr, S</td></tr>
</table>

Signal name	Code	Function	Control mode
Event trigger Pr command1	EV1	The EV1~EV4 status change is set as trigger event, it can be activated by parameter PF83 or PF84 setting. Application: Connecting sensors, and triggering default programs.	Pr
Event trigger Pr command 2	EV2		
Event trigger Pr command 3	EV3		
Event trigger Pr command 4	EV4		
Motor stop signal in Pr mode	STOP	In internal position register mode, turn STOP on and the motor will stop.	Pr

NOTE

1.ST1/RS2 and ST2/RS1 will be switched internally when parameter PA01 is in speed mode (ST1) or torque mode (RS2).

2.Only when set PA01 to 0□□□, you can manually arrange the terminal. If PA01= 1□□□, the DI/DO recommended setting will be used as its setting value.

Digital output(DO)

A total 28 groups of DO functions can be manually arranged, see the table below for details.

Signal name	Code	Function	Control mode
Ready	RD	RD turns ON when servo is ON and ready to operate.	ALL
Alarm signal output	ALM	ALM turns ON when the power supply is OFF or when the protection circuit is enabled to cut off the main circuit. When no alarm occurs, ALM turns ON one second after power is turned on.	ALL
In-position ready	INP	INP turns ON when the servo is in the setting in-position range. This range can be adjusted. When the setting is large, the INP may be turned ON often during low speed operation.	Pr

Signal name	Code	Function	Control mode
Speed attained	SA	SA turns ON when the servo motor speed is close to the setting speed. If the setting speed is 50r/min or less, it may be turned ON often.	S
Home moving completion	HOME	Home turns ON after homing is completed.	Pr
Torque limiting control	TLC	TLC turns ON when torque reaches internal torque limit 1 (parameter PA05), and TLC turns OFF when SON signal is OFF.	Pr, S
Electromagnetic brake interlock	MBR	Set PA01=□1□□□ to enable the electromagnetic brake motor. MBR turns OFF if the servo is OFF or an alarm occurs. MBR is ON if the servo turns ON.	ALL
Warning	WNG	WNG turns ON when a warning occurs and WNG turns OFF when no warning occurs	ALL
Zero speed detection	ZSP	ZSP turns ON when the servo motor speed is below zero speed (50 r/min), and the range of zero speed can be changed by parameter.	ALL
Pr command completion output	CMDOK	CMDOK turns ON when the internal position command is completed or stopped	Pr
Overload output warning	OLW	When the motor reaches overload level setting, the OLW is ON.	ALL
Internal position reached	MC_OK	When both DO CMD_OK and INP are ON, MC_OK is ON. Otherwise, it is OFF.	Pr
Position command overflow	OVF	The OVF signal is ON when the position command overflows.	Pr
Software positive limit	SWPL	When the number of motor feedback pulses is greater than the software positive limit (PF86), the SWPL is ON, otherwise it is OFF.	Pr
Software negative limit	SWNL	When the number of motor feedback pulses is less than the software reverse limit (PF87), the SWNL is ON, otherwise it is OFF.	Pr
STO module abnormal	STO_FB	When STO1 and STO2 modules are in error, STO_FB is ON, otherwise it is OFF.	ALL
Software DO 1	S_DO0	Output bit00 of PD33.	ALL
Software DO 2	S_DO1	Output bit01 of PD33.	ALL
Software DO 3	S_DO2	Output bit02 of PD33.	ALL

Signal name	Code	Function	Control mode
Software DO4	S_DO3	Output bit03 of PD33	ALL
Software DO 5	S_DO4	Output bit04 of PD33	ALL
Software DO 6	S_DO5	Output bit05 of PD33	ALL
Software DO 7	S_DO6	Output bit06 of PD33	ALL
Software DO 8	S_DO7	Output bit07 of PD33	ALL
Software DO 9	S_DO8	Output bit08 of PD33	ALL
Software DO 10	S_DO9	Output bit09 of PD33	ALL
Software DO 11	S_DOA	Output bit10 of PD33	ALL
Software DO 12	S_DOB	Output bit11 of PD33	ALL

NOTE

1.INP and SA will be switched automatically when parameter PA01 is in speed mode or position mode.

2.TLC and VLC will be switched automatically when parameter PA01 is in speed mode or position mode.

You can assign DI/DO function by setting parameters PD02~PD06 and PD10~PD12.

The terminal function changes according to the control mode, please refer to the following table.

DI functions and recommended setting value

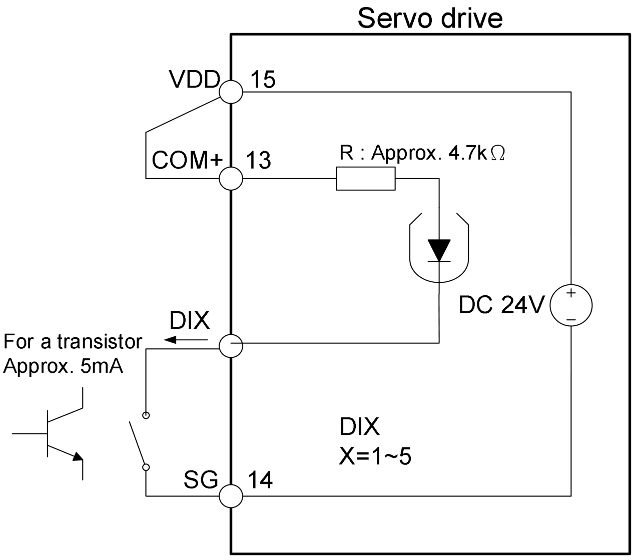
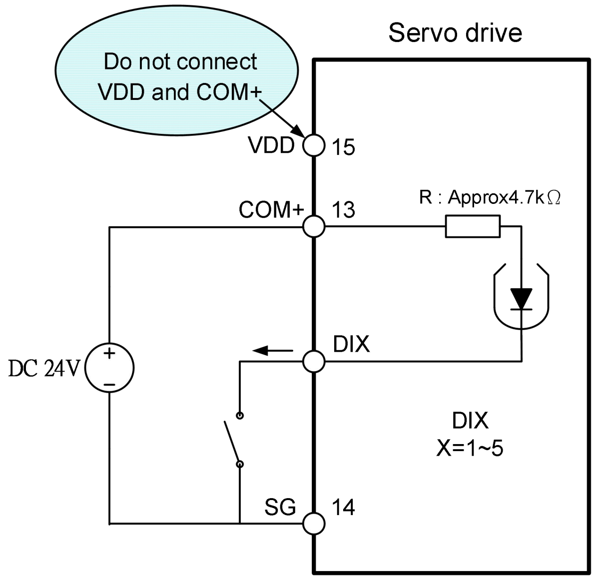
DI code	Name	Function	CoE	Pr	S
0x01	SON	Servo ON	DI1	DI1	DI1
0x02	RES	Reset			
0x03	PC	Proportion control			
0x04	TL	Torque limit option			
0x06	SP1	Speed option 1			DI2
0x07	SP2	Speed option 2			
0x08	SP3	Speed option 3			
0x09	ST1	Forward rotation activated			DI3
0x0A	ST2	Reverse rotation activated			DI4
0x0A	RS1	Forward rotation option			
0x09	RS2	Reverse rotation option			
0x0B	ORGP	Origin position	DI2		
0x0C	SHOM	Start Homing			
0x0D	CM1	Electronic gear option 1			
0x0E	CM2	Electronic gear option 2			
0x0F	CR	Clear			
0x10	CDP	Gain switching option			
0x11	LOP	Control Mode Switch			
0x12	EMG	External emergency stop	DI5	DI5	DI5
0x13	POS1	Position command option 1		DI2	
0x14	POS2	Position command option 2		DI3	
0x15	POS3	Position command option 3			
0x16	CTRG	Position command trigger		DI4	
0x18	LSP	Limit of forward rotation	DI3		
0x19	LSN	Limit of reverse rotation	DI4		
0x1A	POS4	Position command option 4			
0x1B	POS5	Position command option 5			
0x1C	POS6	Position command option 6			
0x1D	INHP	Inhibit pulse input			
0x1E	EV1	Event trigger Pr command 1			
0x1F	EV2	Event trigger Pr command 2			
0x20	EV3	Event trigger Pr command 3			
0x21	EV4	Event trigger Pr command 4			
0x24	STOP	Motor stop signal in Pr mode			

DO functions and recommended setting value

DO code	Name	Function	CoE	Pr	S
0x01	RD	Ready	DO2	DO2	DO2
0x02	ALM	Alarm signal output	DO3	DO3	DO3
0x03	INP	In-position ready		DO1	
0x03	SA	Speed attained			DO1
0x04	HOME	Home moving completion			
0x05	TLC	Torque is limiting			
0x05	VLC	Speed is limiting			
0X06	MBR	Electromagnetic brake interlock			
0x07	WNG	Warning			
0x08	ZSP	Zero speed detection			
0x09	CMDOK	Internal position command completion			
0x0A	OLW	Overload output warning			
0x0B	MC_OK	CMDOK and INP are both ON.			
0x0C	OVF	Position command overflow			
0x0D	SWPL	Software positive limit is reached			
0x0E	SWNL	Software negative limit is reached			
0x1F	STO_FB	STO module abnormal			
0x20	S_DO0	Software DO 1			
0x21	S_DO1	Software DO 2			
0x22	S_DO2	Software DO 3			
0x23	S_DO3	Software DO 4			
0x24	S_DO4	Software DO 5			
0x25	S_DO5	Software DO 6			
0x26	S_DO6	Software DO 7			
0x27	S_DO7	Software DO 8			
0x28	S_DO8	Software DO 9			
0x29	S_DO9	Software DO 10			
0x2A	S_DOA	Software DO 11			
0x2B	S_DOB	Software DO 12			

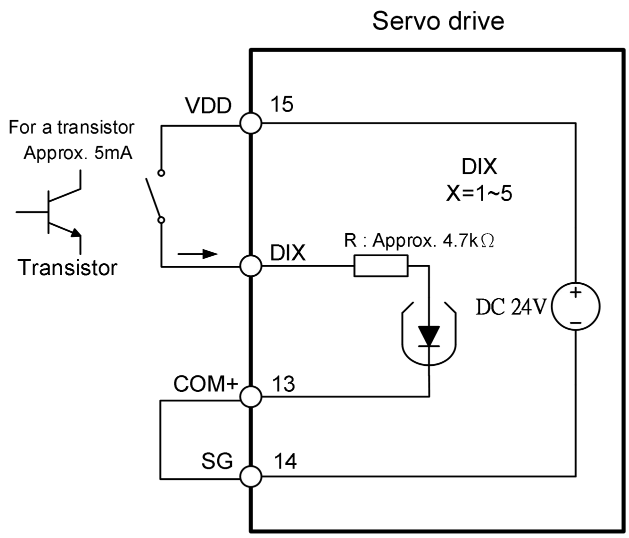
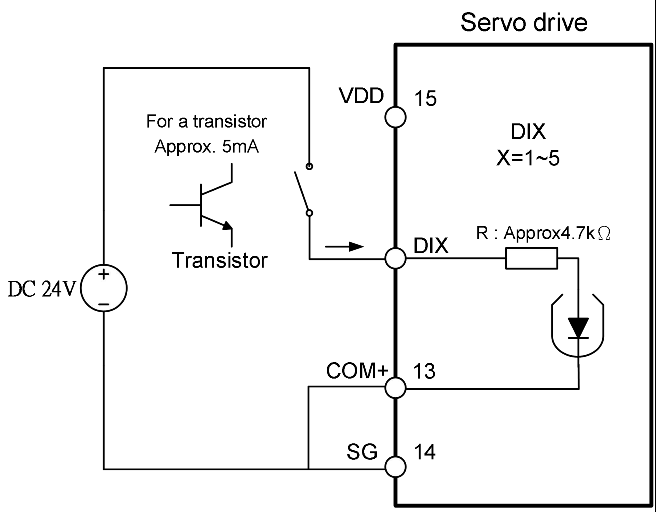
3.2.3 Wiring diagrams

(1) DI in SINK type

With internal power supply	With external power supply
 	

(2) DI in Source type

When DI is using Source type, all the DI signals will be in Source type. Output cannot be in Source type.

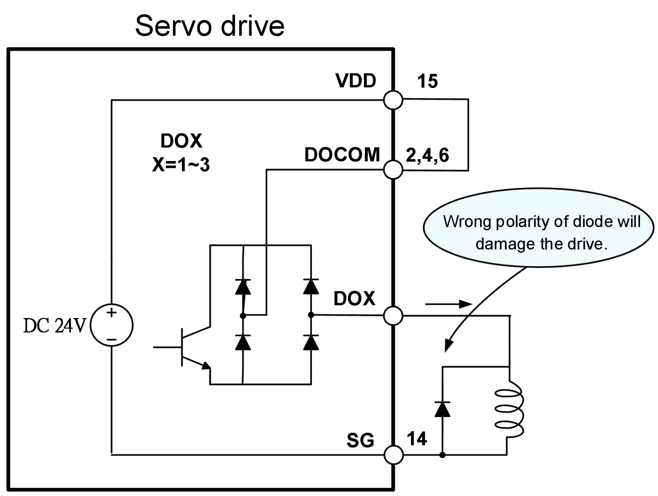
With internal power supply	With external power supply
 	

(3) Digital output(DO)

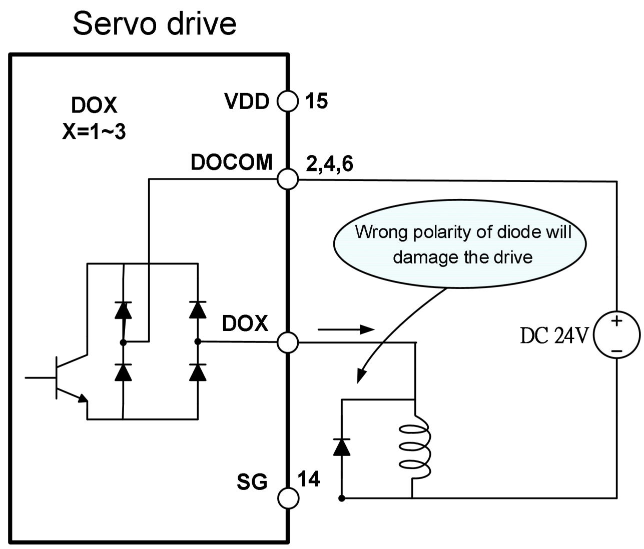
It can drive lamp, relay and photocoupler. When a relay is loaded, a diode is required, and when an external lamp is loaded, a resistor to suppress the surge current is required. (Allowable current: 40mA or less, surge current: 100mA or less)

DO in Source type

Relay load
With internal power supply

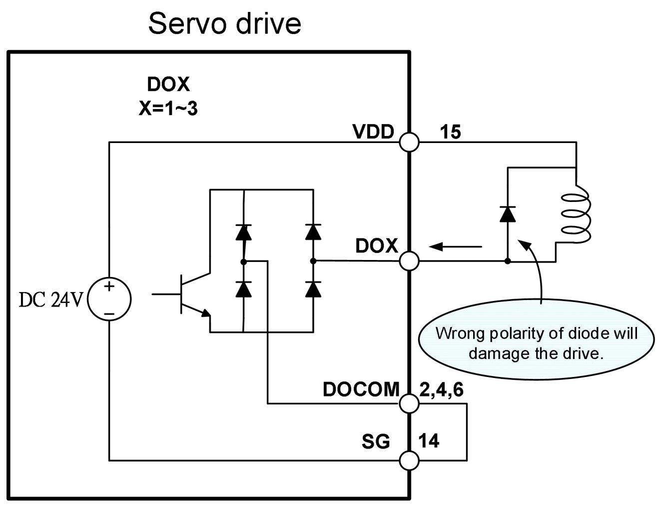


Relay load
With external power supply

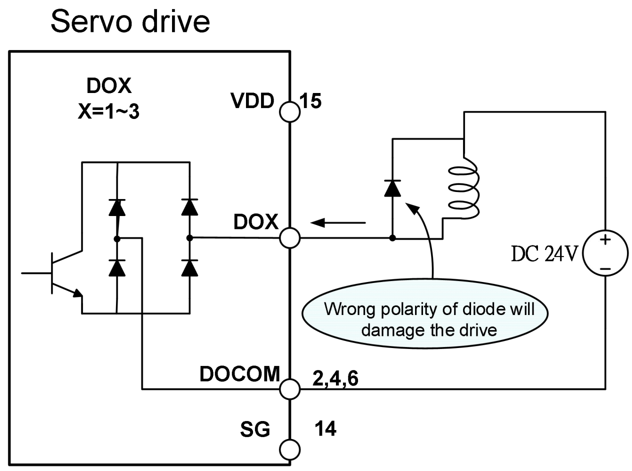


DO in Sink type

Relay load
With internal power supply



Relay load
With external power supply



3.2.4 DI and DO signals for manual set

The default DI and DO signals of Shihlin servo are the signals of the position mode. If the default DI/DO signals or the operating mode are not the required one, you can manually change the signals of DI/DO. The functions of DI1 ~ DI5 and DO1 ~ DO3 are determined by the PD02 ~ PD06 and PD10 ~ PD12 respectively. You can input DI code or DO code in the corresponding parameters. The following describes the CN1 Pin for DI/DO signals and the corresponding parameters.

CN1 Pin	Signal name	Parameter
CN1-10	DI1	PD02
CN1-9	DI2	PD03
CN1-8	DI3	PD04
CN1-7	DI4	PD05
CN1-11	DI5	PD06

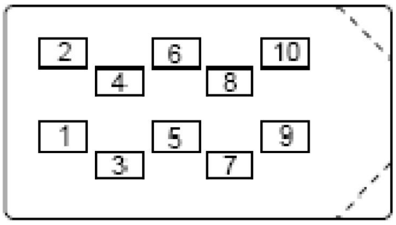
CN1 Pin	Signal name	Parameter
CN1-1	DO1	PD10
CN1-3	DO2	PD11
CN1-5	DO3	PD12

3.3 Encoder/Linear scale signal wiring and description

3.3.1 CN2 encoder signal wiring and description

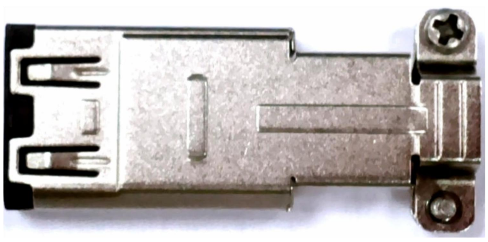
The pin assignment of CN2 and its appearance are as follows:

(1) CN2 connector(Female)

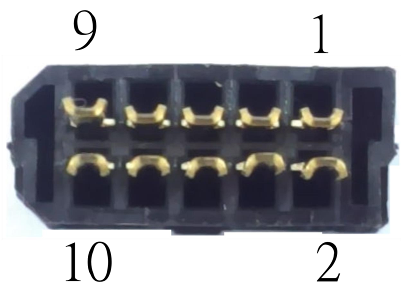


3M connector rear view

(2)CN2 connector (Male)



Connector side view



Molex connector rear view

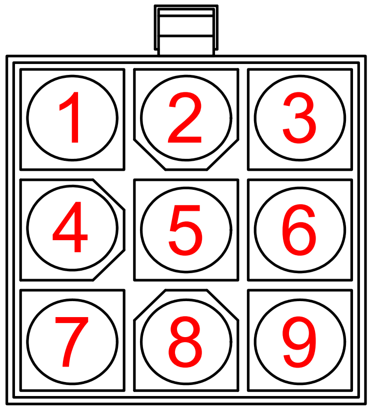
CN2 signal list for incremental/absolute encoder

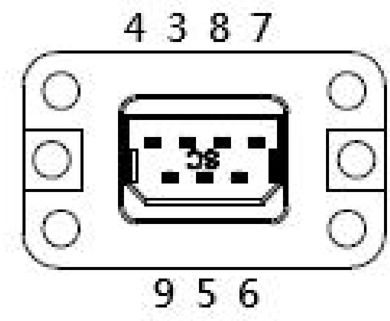
Pin	Pin marking	Signal
1, 3	Vcc(5V)	Encoder 5V power supply
2, 4	GND	Encoder ground terminal
	GND	Battery ground terminal
5	Vcc(3.6V)	Battery 3.6V power
6	ENCP	Encoder communication(+)
7	ENCN	Encoder communication(-)
8	--	--
9	--	--
10	--	--
Casing	Shielding	Shielding

3.3.2 Specifications for the encoder connectors

Low capacity motor

Applicable servo drive capacities are shown in the table below

Drive capacity	**Motor model name**	
100W	SME-L00530○□□ SME-L01030○□□	
200W	SME-□02030○□□	
400W	SME-□04030○□□	
750W	SME-□07530○□□	

Drive capacity	**Motor model name**	
100W	SM3—M01030○□□□	
200W	SM3—M02030○□□□	
400W	SM3—M04030○□□□ SM3—H04030○□□□	
750W	SM3—M07530○□□□ SM3—H07530○□□□	
1kW	SM3—M10030○□□□	

Pin	Pin marking	Signal
1	--	--
2	--	--
3	Vcc(3.6V)	Battery power 3.6V
4	GND	Battery ground terminal
5	ENCN	Encoder communication(-)
6	ENCP	Encoder communication(+)
7	Vcc(5V)	Encoder 5V power
8	GND	Encoder ground terminal
9	Shielding	Shielding

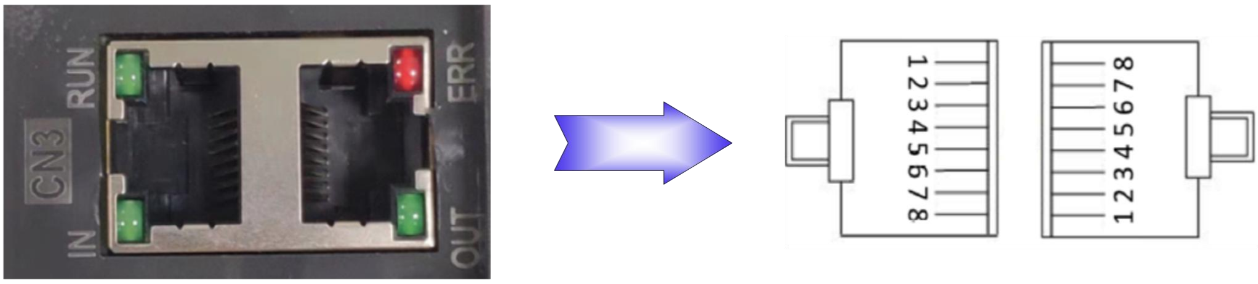
- Note: The above wiring are the connectors from the motor itself.
- The meaning of □□□ is shown in P13.

The wiring ends of drive and motor are summarized as follows:

Drive front end			Motor wiring end	
Pin No.	Pin marking	Signal	Quick connector (low capacity) Pin No.	Military connector (medium capacity) Pin No.
1, 3	Vcc(5V)	Encoder 5V power	7	B
2, 4	GND	Battery ground terminal	4	A
	GND	Encoder ground terminal	8	F
5	Vcc(3.6V)	Battery 3.6V power	3	H
6	ENCP	Encoder communication (+)	6	D
7	ENCN	Encoder communication (-)	5	E
-	Shielding	Shielding	9	I

3.4 CN3/CN3L communication port wiring and description

CN3 is an interface for EtherCAT communication. You can connect the drive to a computer via a standard network cable and then utilize a host controller which supports EtherCAT communication for servo control. After connected by CN3, you need to set the EtherCAT mode with parameter PA01, and then the servo can read the online signal. For long distance data transmission via EtherCAT mode, the max distance between axes is 50 meters. Otherwise, you should consider the signal attenuation phenomenon and multiple drives connection at the same time.



Description of CN3 port

Pin NO	Pin marking	Function
1	TX +	Transmit +
2	TX -	Transmit -
3	RX +	Receive +
4	-	-
5	-	-
6	RX -	Receive -
7	-	-
8	-	-

※ Be sure to use shielded twisted pair (STP) cable that meets the TIA/EIA-568 5e standard specifications or above.

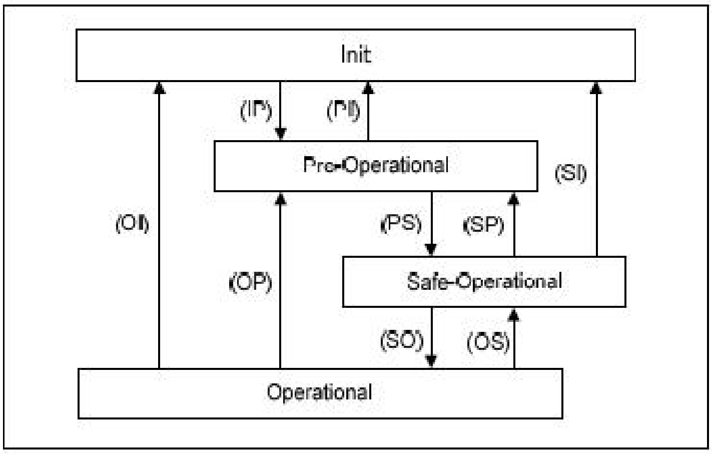
There are some LED indicators on the communication port, such as network status indicator, EtherCAT online status indicator (RUN) and EtherCAT error indicator (ERR). The indicators show the current communication port online status, EtherCAT state machine status and any communication error, the following tables illustrate the display of the indicators.

CN3 Port indicator description

Indicator	Status	Function	Description
On	On	Connection is established.	. Connection is established but no data transmission.
Blink	Blink	Connection is established and in data transmission.	Data is in transmission
Off	Off	No connection.	Connection is not established.

EtherCAT RUN indicator description

Indicator	Status	Function	Description
Off	Off	Initial	After power-on, EtherCAT initialization is finished and communication has not yet begun, but the upper controller can access the register.
On	On	Operational	SDO, TxPDO, and RxPDO data packets can be transmitted.
Blinking	Blinking	Pre-Operational	The upper controller can exchange data through the mailbox
Single Flash	Single Flash	Safe-Operational	The servo drive can use the SDO and TxPDO data packets to exchange data with the upper controller.



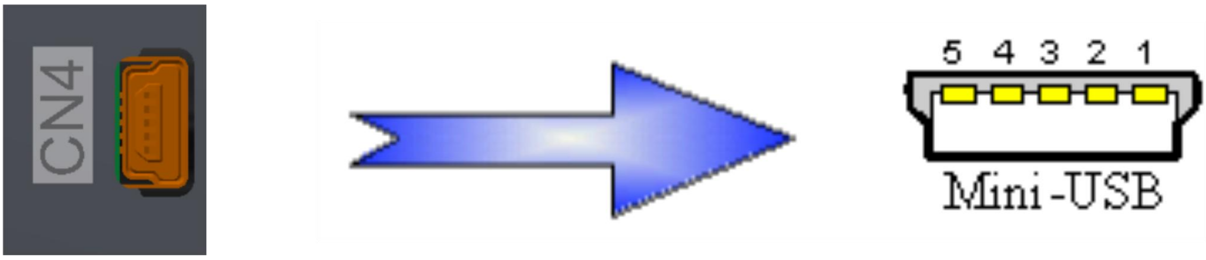
State Machine Switching Diagram

EtherCAT ERR indicator description

Indicator	Status	Function	Description
Off	Off	No error	No error occurs.
On	On	PDI Watchdog timeout	Clear the alarm as per instruction, if the issue persists, contact the distributor.
Blinking	Blinking	State change error	The system is unable to switch states due to incorrect parameter settings. Please check the upper controller program.
Single Flash	Single Flash	Synchronization error or SyncManager error	Failure of synchronization between the upper controller and the device or loss of data during data reception.

3.5 CN4 USB communication port

Shihlin servo drive is equipped with USB socket(CN4). By connecting CN4 to PC with the universal Mini-USB, you can perform parameter setting, status monitoring, test operation and etc with Shihlin communication software.
Mini-USB is a common component in the market and very easy to buy, which greatly increases the convenience.

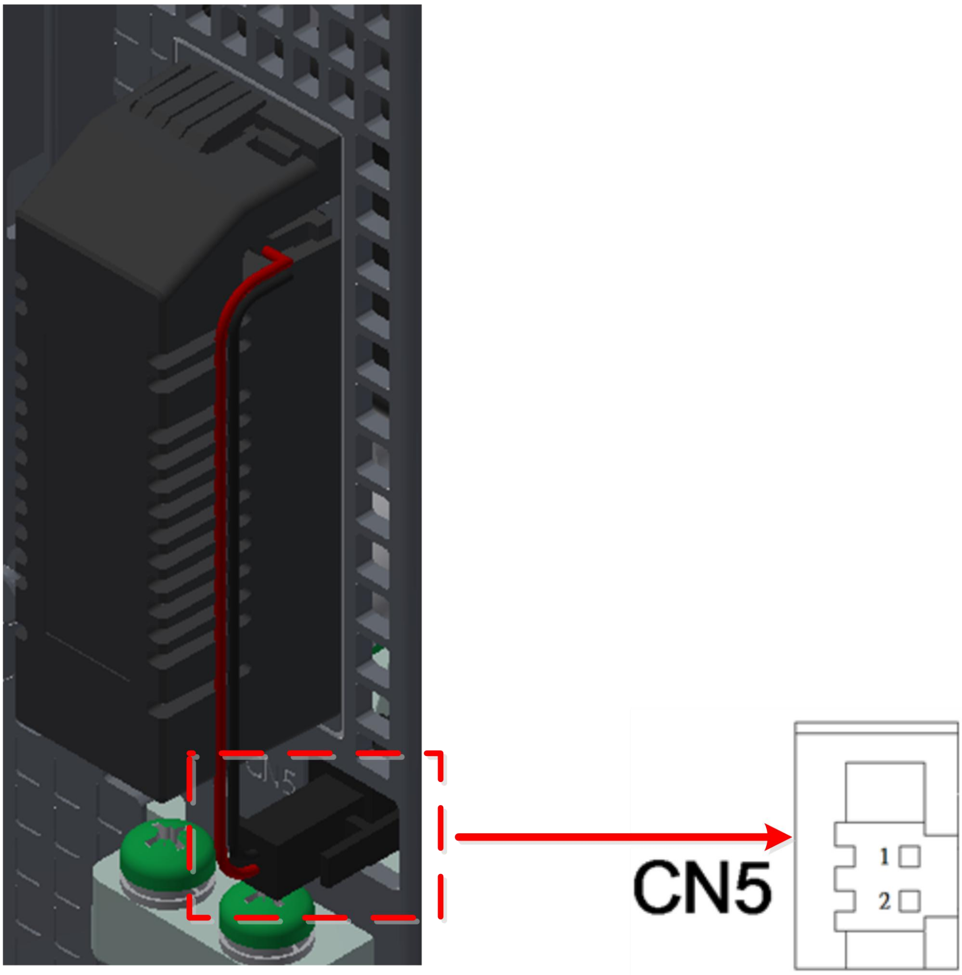


The following table lists Mini-USB standard pin assignment:

Pin NO	Pin function
1	+5V
2	D-
3	D+
4	NC
5	GND

3.6 CN5 battery socket for absolute encoder

When using an absolute servo motor, an external battery box is required. After connecting to battery by plug in CN5, you can set the parameters.

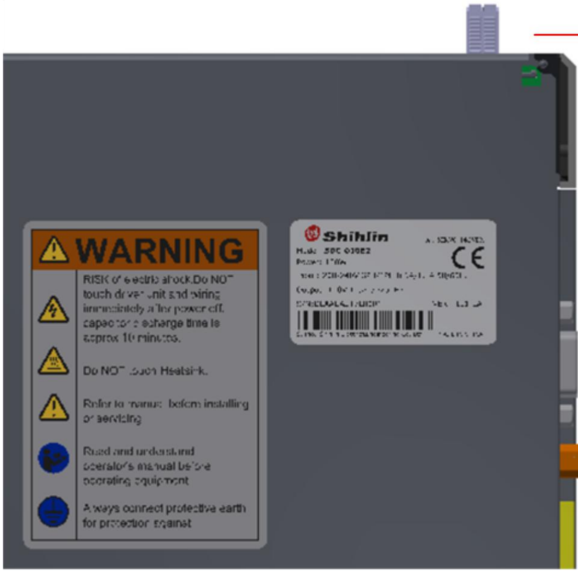


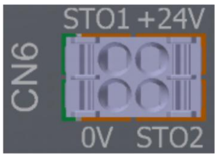
The following table shows the pin assignment of CN5.

Pin NO	Pin function	Description
1	Vcc(3.6V)	Battery 3.6V power
2	GND	Battery ground terminal

3.7 CN6 Safe Torque Off (STO) connector description

The pin assignment of the connector (CN6) are as follows:



Terminal name	Connector and its pin assignment		
			
	Pin sign	Signal name	Function
STO (CN6)	1	+24V	Drive internal +24V power
	2	STO1	STO input 1
	3	STO2	STO input 2
	4	0V	STO reference ground

The following table describes the functions of the STO related terminals:

Terminal name	Function	Description
+24V	Internal +24V power supply	Output Voltage Range: +24V±10% Output Current Range: below 200mA
STO1	STO input 1	STO1/STO2 Rated Input Voltage: +24V±10% STO action mode Input voltage level: 0~5V STO response time: <=8mS STO cut-off mode Input voltage level: 18~30V
STO2	STO input 2	
0V	STO reference ground	

STO related terminal function description

The STO action principle is illustrated in the following table

STO1 input	STO2 input	Drive status
H	L	PWM signal is disabled, torque output stops.
L	H	PWM signal is disabled, torque output stops.
L	L	PWM signal is disabled, torque output stops.
H	H	Normal

STO action principle

If any one of the STO1 signal input and STO2 signal input is L (the input voltage is less than 5V), it indicates that the safety circuit is abnormal. Only when they are both H (the input voltage is more than 18V and less than 30V) means the safety circuit is normal.

3.8 Standard wiring instruction

DANGER

● Only professional technician can do the wiring.

● Wiring must be done at least 20 minutes after the power is turned off and the voltage is checked with a meter, otherwise it may cause electric shock

●The servo drive and servo motor must be grounded.

● Wiring should be done only after the servo drive and servo motor are installed, otherwise electric shock may occur.

●Don’t scratch or apply excessive stress on the cable or press it with heavy objects.

CAUTION

●The wiring should be correct, otherwise overshoot may occur.

●The terminals wiring should be correct, otherwise it may cause damage or abnormal operation.

●The polarity (+/-) must be correct, otherwise it may cause damage or abnormal operation.

●The polarity of the surge absorbing diode, which is installed on the output controlling DC relay, cannot be reversed, otherwise the alarm signal and emergency stop protection circuit will be disabled.

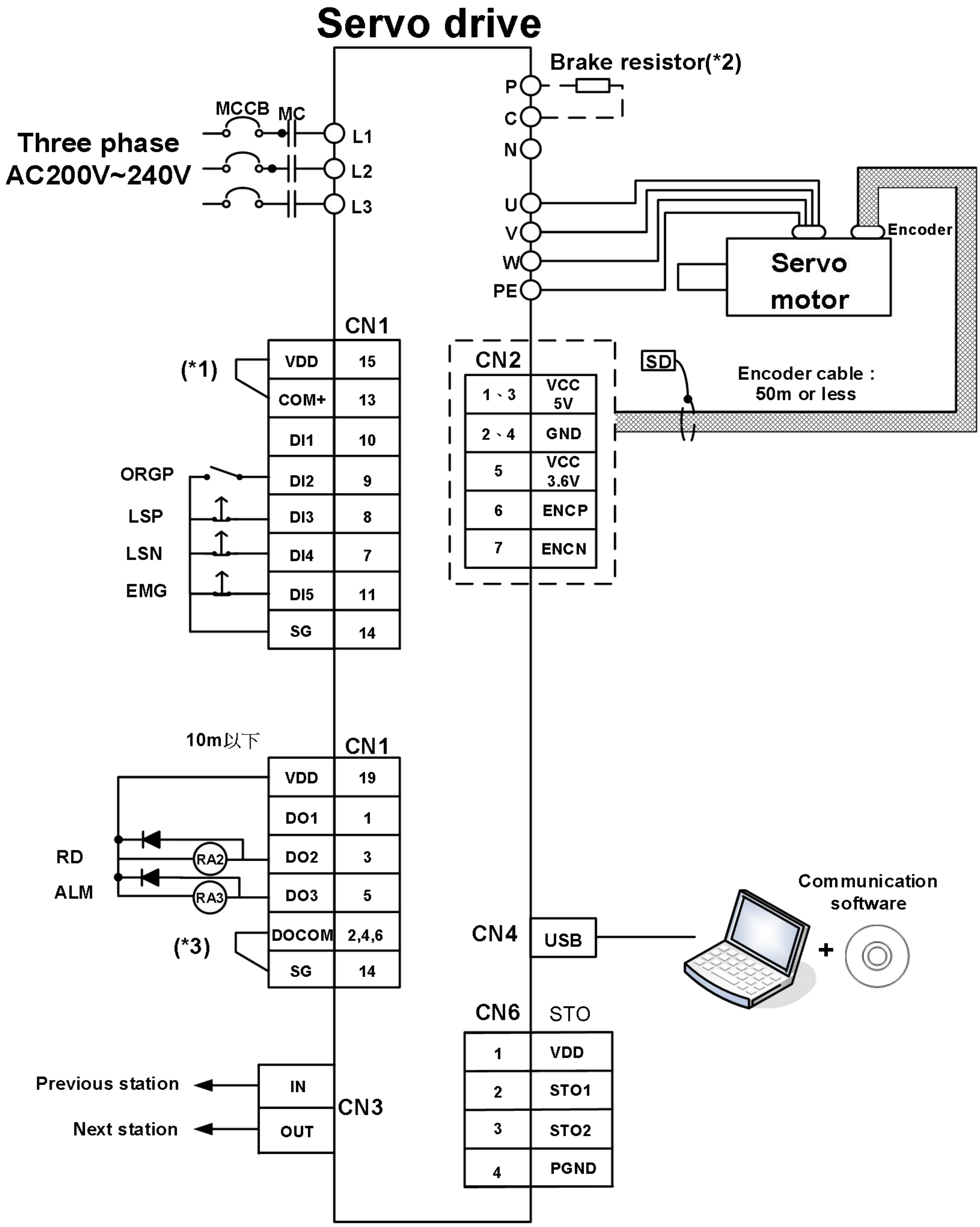
●The electric device nearby the servo drive may have electromagnetic interference, please use the EMI suppression filter to reduce.

●Don’t install in-phase capacitor, surge absorber, or EMI noise suppression in the power cable of the servo motor.

●When using a regenerative resistor, you should cut off power by regenerative abnormal signal. Otherwise, it may cause a fire by the overheated regenerative resistor.

●Do not modify the servo drive or servo motor by yourself.

3.8.1 Wiring diagram for EtherCAT control (CoE mode)

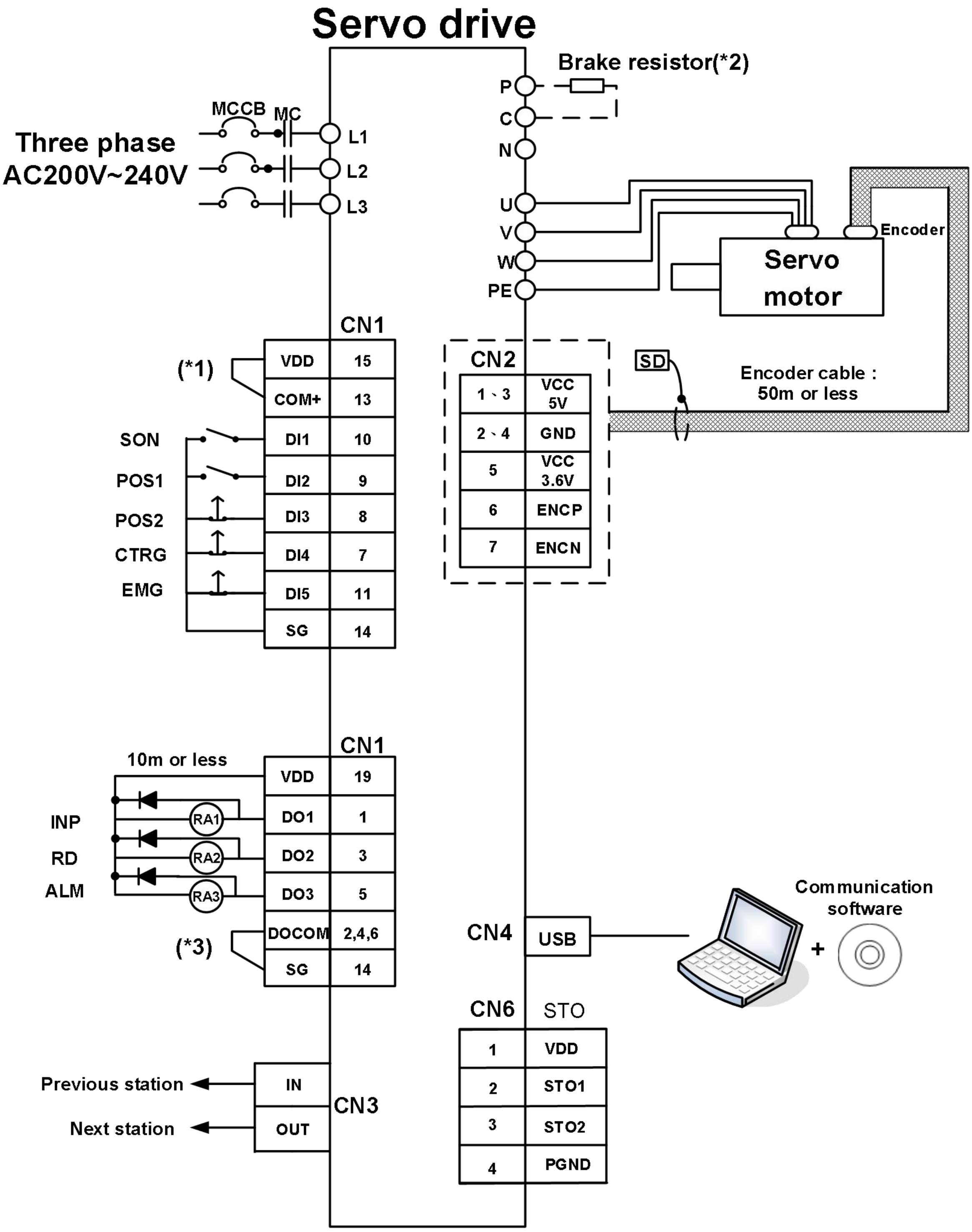


Note1: If an external power supply is used, VDD and COM+ cannot be connected.

Note2: Refer to section 3.1.3 for wiring of regenerative resistor and brake unit.

Note3: For DO Sink type or Source type, please refer to section 3.2.3 for wiring.

3.8.2 Wiring diagram for position control (Pr mode)

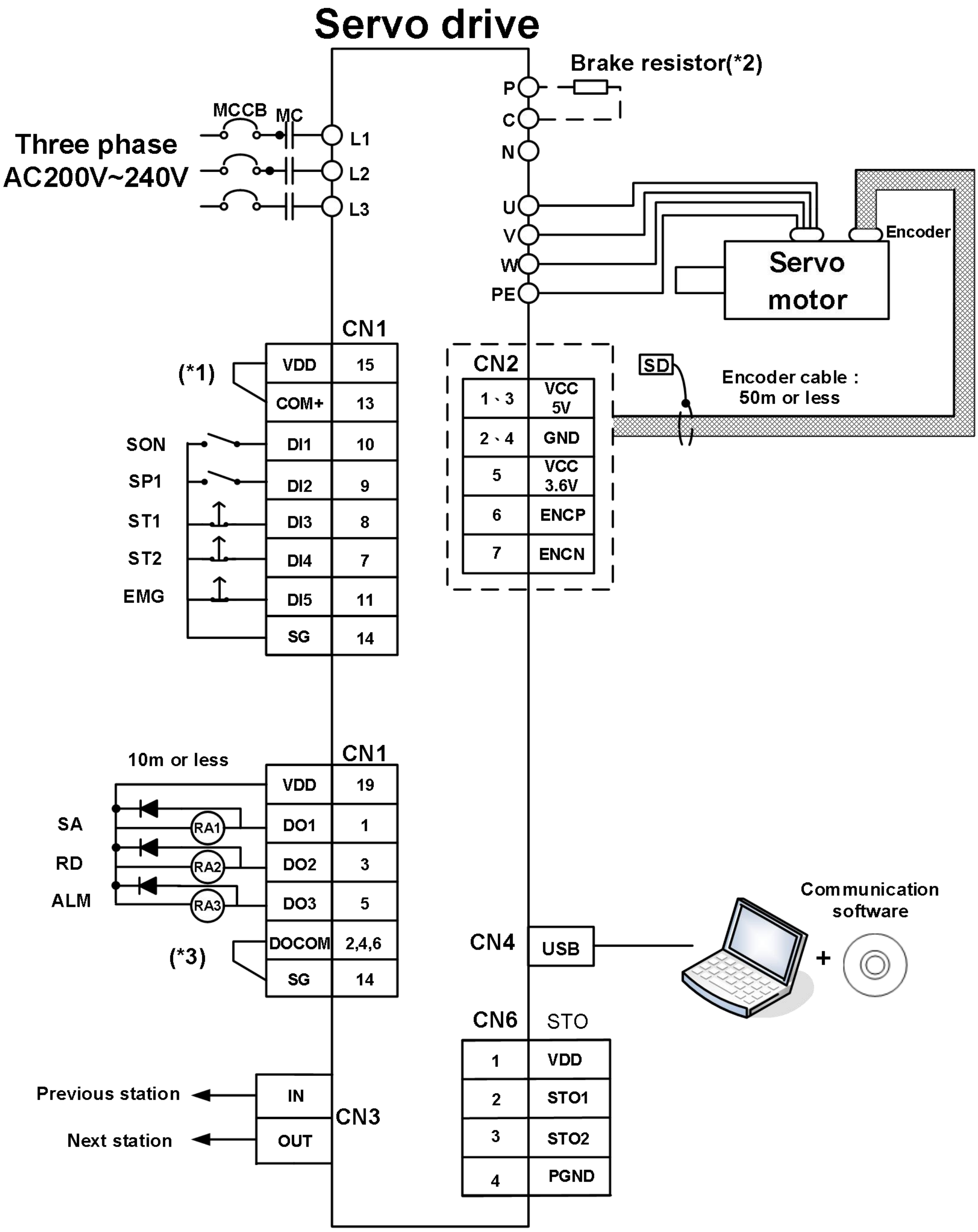


Note1: If an external power supply is used, VDD and COM+ cannot be connected.

Note2: Refer to section 3.1.3 for wiring of regenerative resistor and brake unit.

Note3: For DO Sink type or Source type, please refer to section 3.2.3 for wiring.

3.8.3 Wiring diagram for speed control (S mode)



Note1: If an external power supply is used, VDD and COM+ cannot be connected.

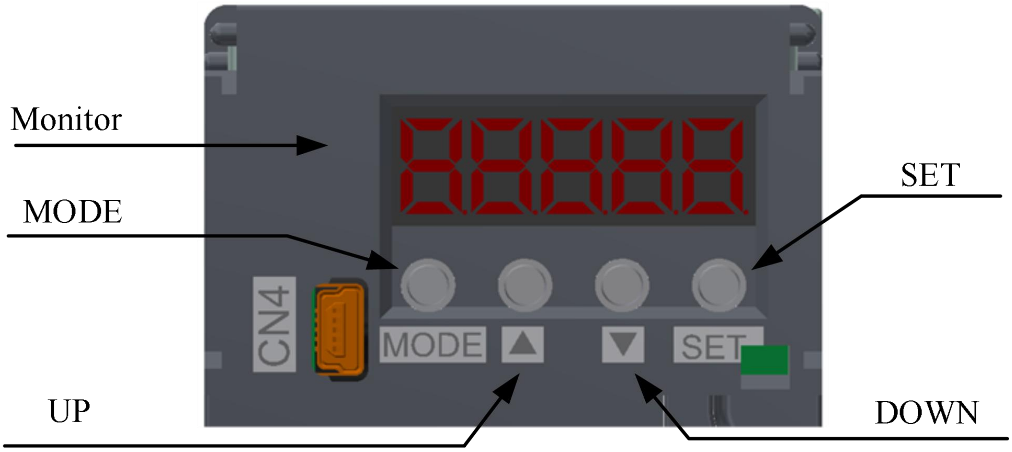
Note2: Refer to section 3.1.3 for wiring of regenerative resistor and brake unit.

Note3: For DO Sink type or Source type, please refer to section 3.2.3 for wiring.

4.Panel Display and Operation

This chapter describes the panel status of the Shihlin servo drive and its operation instructions.

4.1 Panel description



Name	Function
Display	5-digit, 7-segment LED displays the monitoring values, parameter numbers, setting values, etc.
MODE key	It enters in or exit parameter mode, alarm mode, monitor mode and setting mode. When writing parameter, this key is use as shift function.
UP key	scroll up the parameter code or setting value.
Down key	scroll down the parameter code or setting value.
SET Key	displays and stores the setting value.
Charge LED indicator	Indicates power capacity when charging.

4.2 Display procedure

Press "MODE" key once to shift to the next display mode. Refer to section 4.4 and later for related display. To read or set the extension parameters, make them valid with the PA42 setting.

Display process	Initial Screen	Function description	Reference
Status ↓ MODE		Servo status display This message appears at power-on	Section 4.3
One touch auto-tuning ↓ MODE		One touch auto tuning function	Section 4.4
Alarm ↓ MODE		Display current alarm and history records	Section 4.5
Diagnosis ↓ MODE		Sequence display, external signal display, DO forced output, test operation, inertia estimated, software version display.	Section 4.6
Basic parameters ↓ MODE		Display and setting of basic parameters.	Section 4.7
Gain/Filter parameters ↓ MODE		Display and setting of Gain/Filter parameters.	
Extended parameters ↓ MODE		Display and setting of extended parameters.	
I/O setting parameters ↓ MODE		Display and setting of I/O related parameters.	
Pr related parameters ↓ MODE		Pr mode related parameters group 1	
Pr related parameters		Pr mode related parameters group 2	

4.3 Status display

- The servo operation status displays on the 5-digit 7-segment LED display.
- The content can be changed as request by pressing the UP or DOWN button.
- When the power is turned on, select the displayable symbol and press the SET button to show its data.
- The 7-segment LED display shows the last 5 digits of the 16 items data such as motor rotation speed.
- If the displayed value is 5 digits, the negative value is shown as 5 seven-segment display lightening decimal point. If the displayed value is 4 digits or less, the negative value is displayed on the leftmost seven-segment display.

⊡ Example

Examples are listed in the following table.

Item	**Status**	**Display** **In 7-segment LED display**
Motor rotation speed	Forward rotation at 2500r/m	2500
	Reverse rotation at 3000r/m	-3000
Load to motor inertia ratio	15.5 times	15.5
Motor feedback pulse number(high 5-digit)	The value is 1234567890 High 5-digit➔1234.5	1234.5
Motor feedback pulse number(low 5-digit)	The value is 1234567890 Low 5-digit➔67890.	67890.
Parameter wiring is completed	Write successfully	-End-
Parameter writing failure	Writing fail when SON is ON.	Error Rewrite after turning the SON off.
Parameter writing value is out of range	Parameter writing value is out of range	oU-rn Rewrite parameter setting value

PS: For detailed display of panel data values, please refer to section 4.7 for parameter value display examples.

Note: When setting parameters via panel, each parameter has the upper and lower limits.

(a) When the decimal data is modified, the modification should be within the upper and lower limits.

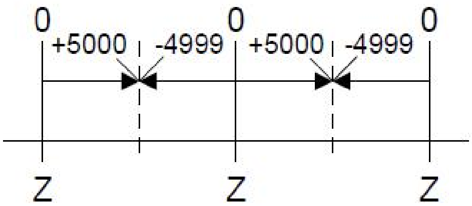
(b) When the hexadecimal data is modified, each Hex value has its upper and lower limits.

➢ Status display overview

The servo status that can be indicated are as follows:

Status display	Symbol	Unit	Content	Range
Motor feedback pulse number (High 5-digit) (Before E-gear ratio)	FPH.I	pulse	It displays motor feedback pulse number (High 5-digit)(Before E-Gear ratio). Ex: if the value is 123456789 pulse, it displays 1234 (Note 1).	-21474~ 21474
Motor feedback pulse number (Low 5-digit) (Before E-Gear ratio)	FPL.I	pulse	It displays motor feedback pulse number (Low 5-digit)(Before E-Gear ratio). Ex: if the value is 123456789 pulse, it displays 56789 (Note 1).	-99999~ 99999
Number of pulse commands input (High 5-digit) (before E-Gear ratio)	CPH.I	pulse	It displays the number of pulse commands input (High 5-digit) (Before E-Gear ratio). If the value is 123456789 pulse, it displays 1234 (Note 1).	-21474~ 21474
Number of pulse commands input (Low 5-digit) (Before E-Gear ratio)	CPL.I	pulse	It displays the number of pulse commands input (Low 5-digit) (Before E-Gear ratio). Ex: if the value is 123456789 pulse, it displays 56789 (Note 1).	-99999~ 99999
Deviation pulse number (Before E-Gear ratio)	E. I	pulse	It displays deviation number between pulse command and feedback pulse(Before E-Gear ratio) It displays the last 5 digits of the actual value.	-99999~ 99999
Motor feedback pulse number (High 5-digit) (After E-Gear ratio)	FPH.O	pulse	It displays motor feedback pulse number (High 5-digit) (After E-Gear ratio). If the value is 123456789 pulse, it displays 1234 (Note 1).	-21474~ 21474
Motor feedback pulse number (Low 5-digit) (After E-Gear ratio)	FPL.O	pulse	It displays motor feedback pulse number (Low 5-digit)(After E-Gear ratio). Ex: if the value is 123456789 pulse, it displays 56789 (Note 1).	-99999~ 99999
Number of pulse commands input (High 5-digit) (After E-Gear ratio)	CPH.O	pulse	It displays the number of pulse commands input (High 5-digit) (After E-Gear ratio). If the value is 123456789 pulse, it displays 1234 (Note 1).	-21474~ 21474

Status display	Symbol	Unit	Content	Range
Number of pulse commands input (Low 5-digit) (After E-Gear ratio)	CPL.O	pulse	It displays the number of pulse commands input (Low 5-digit) (After E-Gear ratio). If the value is 123456789 pulse, it displays 56789 (Note 1).	-99999~ 99999
Deviation pulse number (After E-Gear ratio)	E. O	pulse	It displays deviation number between pulse command and feedback pulse (After E-Gear ratio) It displays the last 5 digits of the actual value.	-99999~ 99999
Pulse command input frequency	CPF	kHz	It displays external pulse command input frequency.	-6000~ 6000
Current motor speed	R	rpm	it displays current motor feedback speed.	-6000~ 6000
Effective load rate	J	%	It displays the load ratio of continuous torque, and take rated torque as 100%.	0~300
Peak load rate	B	%	It displays the maximum peak torque occurring at 100% of the rated torque, showing the highest value in the last 15 seconds.	0~300
DC bus voltage	Pn	V	It displays the P-N voltage of the main circuit. “Lo-dC” is displayed if it is less than normal value.	0~500
Load to motor inertia ratio	dC	times	It displays load/motor inertia ratio.	0.0~120.0
Instantaneous torque	T	%	It displays the Instantaneously generated torque. Taking the rated torque as 100%, the generated torque is displayed in real time.	0~100
Regenerative load ratio	L	%	It displays the power ratio of allowable regenerative power in %.	0~100
The absolute pulse number relative to encoder Z phase	ZP	pulse	It displays the absolute pulse number relative to encoder Z phase, Z phase is 0. It is +5000 or -5000 pulses when the motor rotates in the forward or reverse direction as below picture shows:	-4999 ~ 5000



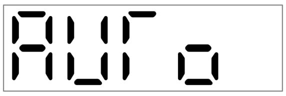
Note 1: When the panel is displaying the value, pressing the SET key will clear the number of pulse command input, motor feedback pulse, and pulse deviation (before and after the electronic gear ratio). This function is the same as the communication address 0x0951.

➢ **Change the display content**

By changing parameter PA01, you can change the status of the 7-segment LED, and the initial display items is changed according to the control mode.

Control mode	Display items
Position	Motor feedback pulse number (Low 5-digit)
Position/speed	Motor feedback pulse number (Low 5-digit)/Current motor speed
Speed	Current motor speed

4.4 One-touch tuning function

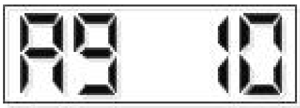
Name	Display	Description
One-touch Tuning		You can perform One-touch Tuning. For details, refer to section 6.2.

4.5 Alarm mode

It indicates the current alarm and alarm history.

The last 2 digits show the number of alarms. (The following is an alarm diagram. For a detailed description of the alarms, refer to Chapter 12)

Name	Display	Description
Current alarm	AL --	No alarm occurs
	AL 01	The screen flashes when an over voltage (AL01) alarm occurs.
Alarm record	A0 01	The last alarm in the past is over voltage (AL.01).
	A1 02	The 2nd alarm in the past is under voltage(AL.02).
	A2 03	The 3rd alarm in the past is over current(AL.03).
	A3 04	The 4th alarm in the past is regeneration error(AL.04).
	A4 05	The 5th alarm in the past is overload(AL.05).
	A5 06	The 6th alarm in the past is over speed(AL.06).
	A6 07	The 7th alarm in the past is abnormal pulse control(AL.07)
	A7 08	The 8th alarm in the past is excessive deviation of position (AL.08).
	A8 09	The 9th alarm in the past is serial communication error (AL.09)

		The 10th alarm in the past is overload 2(AL.10)

Function when alarm occurs:

A: Regardless the mode, the screen can display the current alarm in any mode.

B: Other screens can still be read when an alarm occurs, and the fourth LED decimal point will blink (counting from the right) in this case.

C: After troubleshooting, the alarm can be cleared by one of the following methods:

(a). Cycle the power.

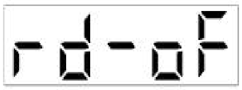
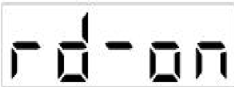
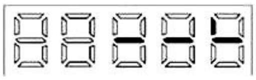
(b). Press SET key in the alarm screen.

(c). Turn on the reset signal(RES).

D: Use UP or DOWN key to move to the next alarm record.

4.6 Diagnosis mode

The following table shows how to operate in diagnosis mode

Name	Display	Description
Control status		Servo is not ready yet. It means the servo is initializing, alarm occurs, or SON terminal is off.
		Servo is ready. It means the drive is ready for operation.
External I/O signal		It indicates the ON/OFF status of external I/O. The upper part of each segment shows the input signal, and the lower part shows the output signal. The I/O signal can be changed by the parameters of PD group.
DO forced output		DO signal can be forced ON/OFF.
JOG test operation		When there is no command from an external device, JOG can be executed.
Positioning test operation		When there is no command from an external device, positioning operation can be executed once. This function is not available in the panel, you should connect it to the communication software by RS-485/USB to test.
Inertia estimation test operation		It enables automatic load inertia ratio and the associated gain value estimation. This operation is not available in the panel, you should connect it to the communication software by RS-485/USB to test.

Name	Display	Description
Auto-offset of analog input		When setting the analog speed command or analog speed limit, if the motor still rotates slowly when the voltage is adjusted to 0V by an external analog circuit, the offset can be set automatically. During the operation, PC26 will be set automatically. Please operate as per following steps: 1).Enter the automatic offset screen of the diagnosis mode. 2).Press the SET key. 3).Press the UP / DOWN key and select 1 4).Press SET key.
Software version	SP102	It indicates the version number of the SERVO software.

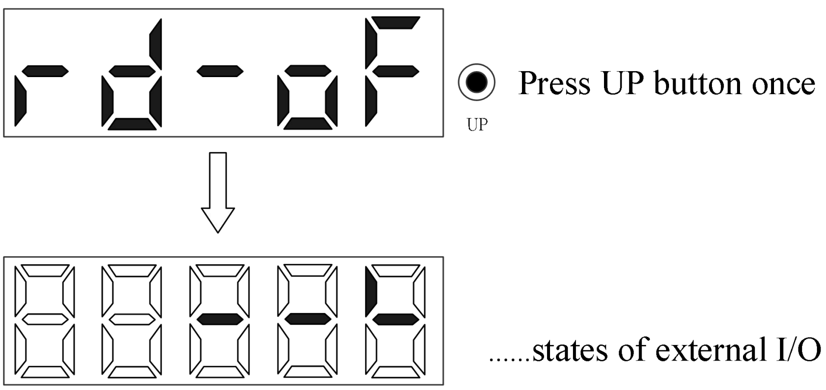
The following section will introduce how to use the diagnosis mode.

4.6.1 Indication of external I/O signals

This display is used to verify the ON/OFF status of the SERVO AMP digital I/O signals.

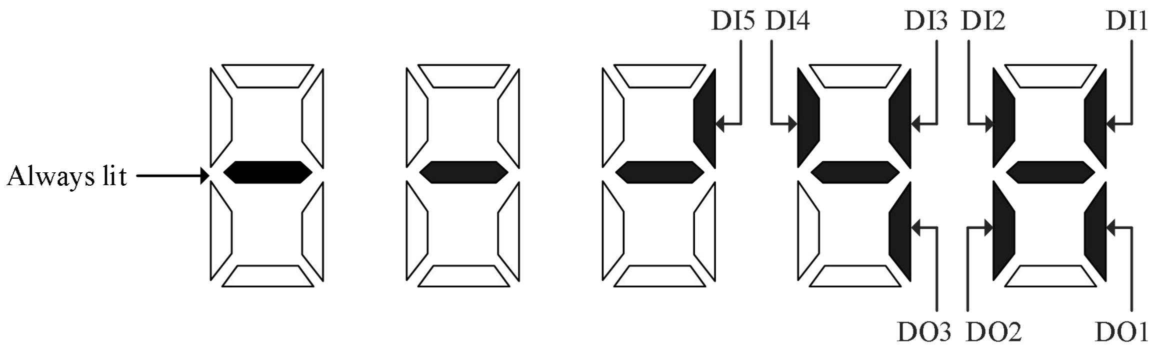
(1) Operation

When the power is applied, you can use the MODE button to go to the diagnostic screen.



(2) Display content

Display of I/O pin definition



The above figure shows ON/OFF in a 7-segement LED, the upper part is the input signal (DI1~DI5), the lower part is the output signal (DO1~DO3) and OP. When OP is ON, it means that the motor is in the Z-phase position.

4.6.2 DO forced output

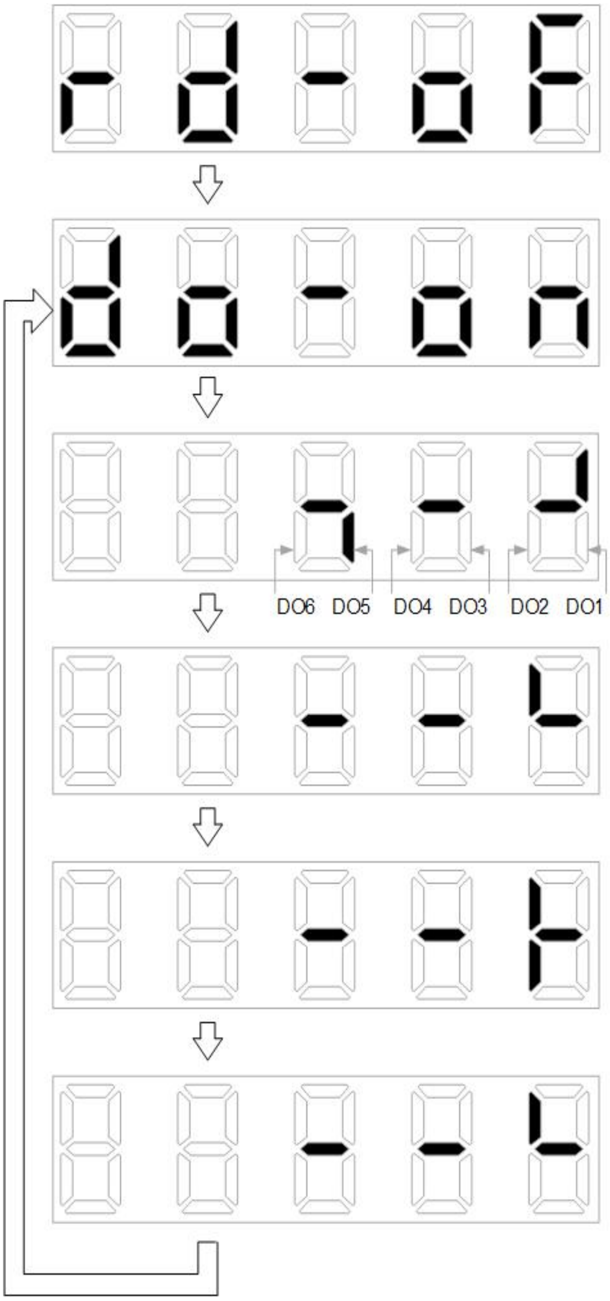
The output signals which does not affect SERVO status can be forced ON/OFF. This function can be used for output signal wiring inspection, etc.

- ★ When it is confirmed that there is no external command device and no alarm message, positioning test operation can be performed.
- ★ Ensure that SON-SG is open-circuited during the test.

Operation

When the power is applied, you can use the MODE button to go to the diagnostic screen.

It indicates the screen of the display after power-on, press the “MODE” key to go to the diagnostic screen:



Press "UP" twice.

Press "SET" for longer than 2 seconds.

Switch on/off the signal below the lit segment.

Indicates DO on/off status. The correspondence between segments and signals are shown.

Press "MODE" once.

Shift to the upper segment of DO2.

Press "UP" once.

DO2 would light up.

Press "DOWN" once.

DO2 would light off.

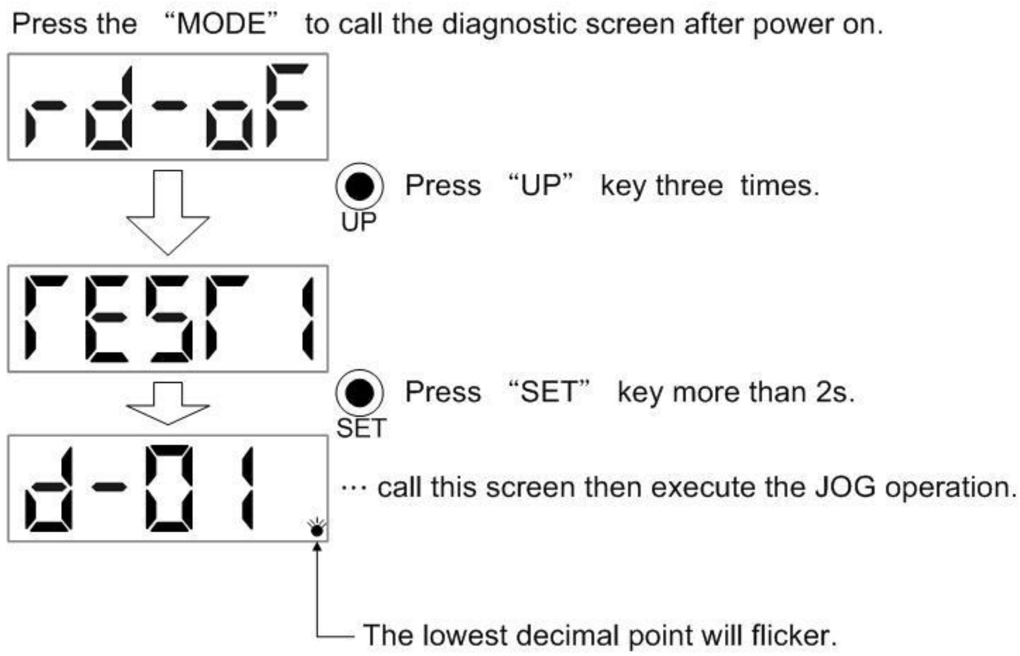
Press "SET" more than 2 seconds.

4.6.3 JOG operation

- ★ JOG operation can be performed when no alarm or warning message occurs.
- ★ Ensure that SON-SG is open-circuited during the test.

Set JOG speed command by PC04, and set the acceleration time constant by PC01 and the deceleration time constant by PC02. Below picture shows the display screen after power-on. Select JOG operation, positioning test operation, test estimation inertia analysis operation in following sequence.

Press the MODE button to go to the diagnosis screen.



(1) Operation

To perform JOG operation, connect VDD and COM+ if internal power supply is used between EMG-SG. Hold the UP or DOWN button to run the motor and release it to stop. The operation condition can be changed by communication software. The initial operating conditions and setting ranges are shown in the table below.

Item	Setting value	Default value	Setting range
Rotation speed [r/min]	PC04	300	-6000~6000
Acceleration and deceleration time constant	PC01, PC02	200	0~20000

Note: The JOG speed can be set by PC04 in panel. When using the communication software, the speed setting value is determined by the other communication address.

Button description is as follows:

Button	Content
UP	Hold UP button to rotate in CCW direction. Release to stop.
DOWN	Hold DOWN button to rotate in CW direction. Release to stop.

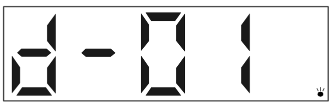
When using the communication software for JOG operation, the servo motor will decelerate to stop if the communication cable is disconnected.

(2) Status display

You can verify the servo status during JOG operation.
Press the MODE button to display the status when the JOG is ready. Execute JOG operation by UP or DOWN button. Pressing the MODE button once will move to the next screen, and it will return to the JOG operation screen after one cycle. Refer to section 4.3 for details on the status display.
The status screen cannot be changed by the UP and DOWN buttons during JOG operation.

(3) Exit JOG operation

During JOG operation, turn off the power or hold the SET button for more than 2 seconds in the test operation screen to exit the JOG operation mode.



4.6.4 Positioning test operation

★ You can utilize this function after connecting to Shihlin communication software by USB.

★ Make sure that there is no external command device and no alarm message from the servo before positioning test operation.

★ Ensure SON is OFF during the test.

Operation

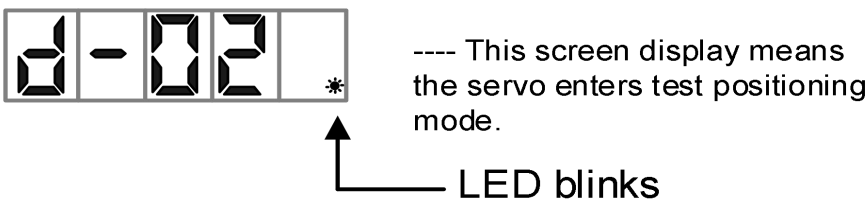
Make sure the motor is wired correctly before the positioning test operation. Select positioning test operation in Shihlin communication software and press Forward or Reverse key, the motor will rotate as per the setting and then stop. The rotation setting can be changed by Shihlin communication software. The initial value and setting range show in the following table.

Item	Default value	Setting range
Motor speed(rpm)	200	0~6000
Acceleration and deceleration time(ms)	1000	0~20000
Number of revolutions(10kpulse)	10	0~512
Number of pulses(pulse)	0	0~2^{22}-1

Description of buttons:

Button Name	Function
Forward	Press the button to rotate the motor in the forward direction.
Reverse	Press the button to rotate the motor in the reverse direction.
Pause	Press Pause to stop the running motor. The motor will run the remaining distance if the same button is pressed. If the pause is pressed twice consecutively during operation, the remaining distance will be cleared.
Close	Turn off the positioning test operation function.

- If the communication cable is disconnected during operation, the motor will stop immediately.
- When the communication software enters the positioning test mode, the panel will show as below:



4.6.5 Inertia estimation and tuning by communication software

★ The positioning test operation can only be used after connecting the Shihlin communication software via USB.

★ Make sure that there is no external command device and no alarm message from the servo before positioning test operation.

Operation

Before running the inertia estimation analysis, make sure the motor is wired correctly and then select the auto-gain tuning function in the Shihlin communication software.
The instructions for auto-gain tuning function are as follows:
(1) Check Auto Tuning Control Panel option.

(2) Set speed acceleration/deceleration time, S acceleration/deceleration time, and JOG speed value, if there is no alarm, click [Setup] to modify the parameters mentioned above.

(3) Click [Servo ON] then the motor would be magnetized.

(4) Click the JOG ← or JOG → key to rotate the motor forwardly or reversely, when it reaches the destination, click Position 1, then click JOG key and set Position 2.

(5) After Position 1 and Position 2 are set, click Start key to run the motor between the 2 position cyclically for the inertia and gain estimation.

(6) During operation, you can directly set the response level in menu if the response is not enough, but it is not recommended to set the response too large at once, and it should increase gradually.

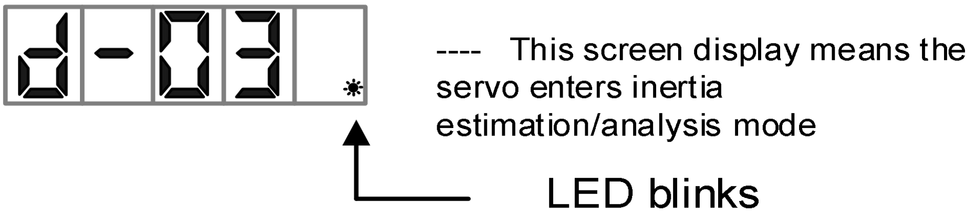
(7) If the load inertia ratio is converged, or the machine features meet requirement, you can press Stop to complete the preliminary inertia estimation and gain tuning.

(8) Uncheck Auto Tuning Control Panel option.

The gain value will be estimated automatically during the process, and the following table shows the related parameters:

Name	Name Abbr	Pr.No	Setting range	Unit	Default value	Control mode
Resonance suppression low-pass filter	NLP	PB03	0~10000	0.1ms	10	CoE, Pr, S
Position feed-forward gain value	FFC	PB05	0~200	%	0	CoE, Pr
Load inertia ratio	GD1	PB06	0~1200	0.1 times	70	CoE, Pr, S
Position loop gain	PG1	PB07	4~1024	rad/s	45	CoE, Pr
Speed loop gain	VG1	PB08	40~9000	rad/s	183	CoE, Pr, S
Speed integral gain value	VIC	PB09	1~1000	ms	34	CoE, Pr, S

- When the communication software enters the inertia estimation mode, the panel will display as below:



4.7 Parameter mode

4.7.1 16 Bit parameter setting instruction

Some parameter changes become valid after power cycling.

(1) Operation instruction

The following is an example to illustrate when the control mode (PA01) is changed to speed control mode, how to operate after power cycling.
Example 1: Control mode (PA01) is changed to the speed control mode.
Use the MODE button move to the PA01 screen.

Indicates PA01

UP DOWN Press UP or down button to change PA01

SET Press SET button twice

The rightmost parameter shows on the LED keeps blinking

UP Press UP button twice

Change the setting value during blinking

UP DOWN Use UP Down button to change the setting

SET press SET button to activate the setting

Parameter setting is completed

Press the UP/ DOWN button to move to the next parameter.
PA01 changes become valid after power cycling.

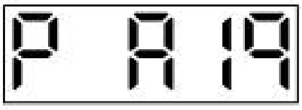
- The MODE key is use as shift function when setting the parameters.

Next section will introduce how to use the MODE, UP and DOWN buttons to operate.

4.7.2 32 Bit parameter setting instruction

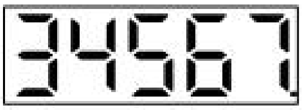
- <u>Decimal parameter reading and writing method (positive number)</u>

Example: PA19 is 1234567, then to change to 1434567.



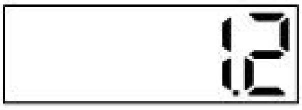
Press "SET" once.

The lower 5 digits of PA19 are shown and the lowest decimal point indicates that this is low screen.



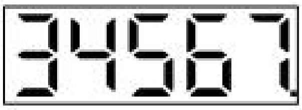
Press "MODE" once

The higher 2 digits of PA19 are shown and the second decimal point indicates that this is high screen.



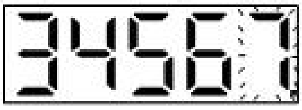
Press "MODE" once

The screen is returned to the low screen.



Press "SET" once

The lowest digit display would be flickering.



Press "MODE" for 5 times.

The flickering digit would shift left to the second high digit.

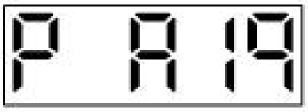
Press "UP" twice.

The flickering digit would be changed to "4".

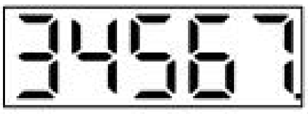
Press "SET" once to store the modification.

- <u>Decimal parameter reading and writing method (negative number)</u>

Example: PA19 is 1234567, then to change to -1434567.

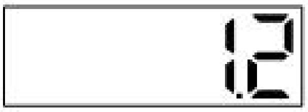


Press "SET" once.



The lower 5 digits of PA19 are shown and the lowest decimal point indicates that this is low screen

Press "MODE" once.

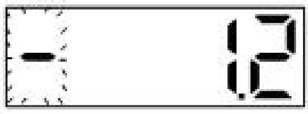


The higher 2 digits of PA19 are shown and the second decimal point indicates that this is high screen.

Press "SET" once.

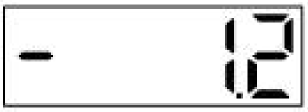
The lowest digit of this screen would be flickering.

Press "MODE" twice.



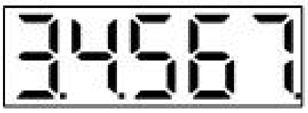
The flickering digit shifts to the highest digit and the "-" sign appears.

Press "SET" once.



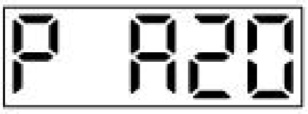
This screen will show "-1.2".The PA19 is -1234567 now.

Press "MODE" once.



Return to the screen of -1234567 lower 5 digits. The left 2 decimal points indicate that this number is negative.

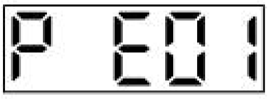
Press "UP" once.



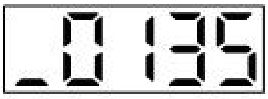
Scroll to the next parameter. (PA20)

- Hex parameter reading and writing method

Example: PE01 is 0x3760135 and then to change to 0x03740135.

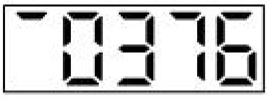


Press “SET” once.



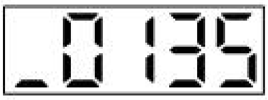
The lower 4 digits of PE01 are shown and the underline of highest digit indicates that this is low word.

Press “MODE” once.



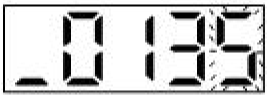
The higher 4 digits of PE01 are shown and the up segment of highest digit indicates that this is high word.

Press “MODE” once.



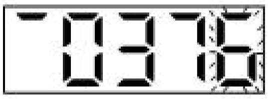
It shows the lower word again.

Press “SET” once.



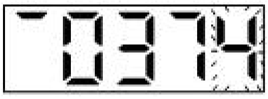
The lowest digit of PE01 would be flickering.

Press “SET” 4 times.



This flickering digit shifts to the lowest digit of high word.

Press “DOWN” twice.



The display shows the modification.

Press “SET” once to store the modification.

5.Running Operation

5.1 Checklist before running

Before running the motor, you should check the following items in detail to avoid unnecessary damage to the motor.

- Whether the power terminals (R, S, T, L1, L2) of the servo drive are wired correctly.
- The power terminals (U, V, W) of the servo motor and the U, V, W wiring of the servo drive should be consistent.
- Check if the servo drive is properly grounded.
- Check if any conductive or inflammable material in or nearby the drive.
- Make sure the voltage of the power supply is correct.
- Check if the control switch is OFF.
- Do not apply heavy stress on the drive or wiring.
- Use twisted wires to connect the regenerative resistor.
- Check if the drive is visibly damaged.

DANGER	●Do not operate the switch with wet hands, otherwise it may cause electric shock.

CAUTION

●Check each parameter before running, otherwise it may cause unexpected motions.

●Do NOT touch the heat sink, regenerative resistor, servo motor and other components during power-on or in a short period of time after power off, because it may get hot and cause injury.

5.2 Test without load

Please remove all the loads connected to the servo motor first before test (e.g., couplings and related accessories on the machine or the servo motor shaft, etc.). Confirm the servo motor can operate normally according to normal operation procedures, and then connect the loads to the servo motor again. The following describes the test of the motor without load.

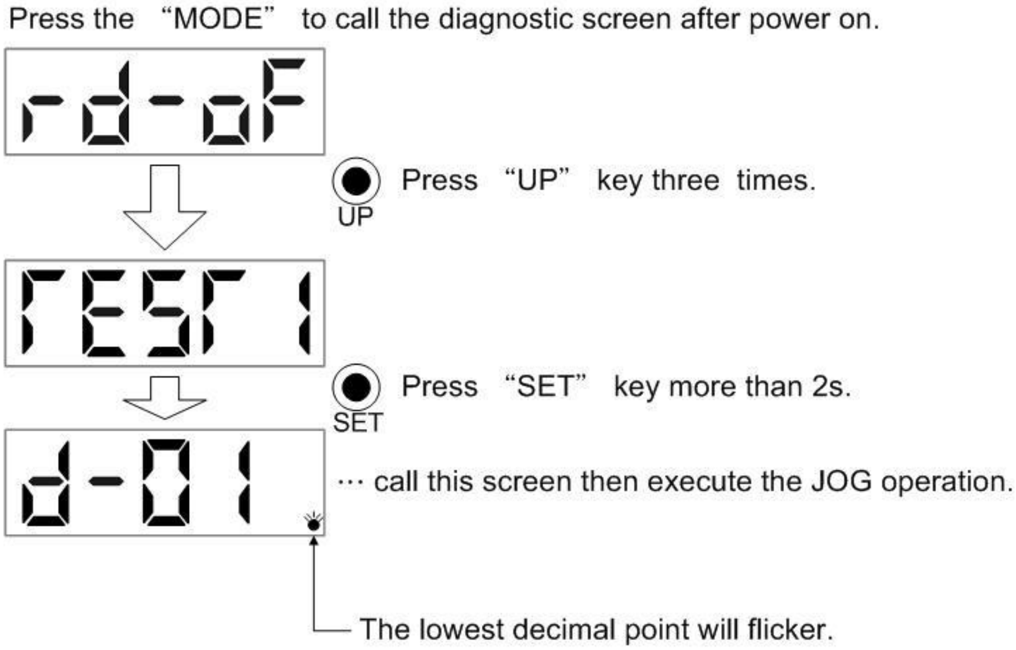
5.2.1 JOG test without load

- ★ Make sure there is no alarm or warning message from the servo before JOG test.
- ★ Ensure that SON-SG is open-circuited (SON OFF) during the test.

You can perform the no-load JOG operation by the drive panel or Shihlin communication software, which is to confirm whether the motor speed and direction are as expected. The motor speed cannot be modified by panel during JOG test, it only can be modified by Shihlin communication software, and it is recommended to run JOG test at a low speed. The JOG operation by panel will be introduced as follows:

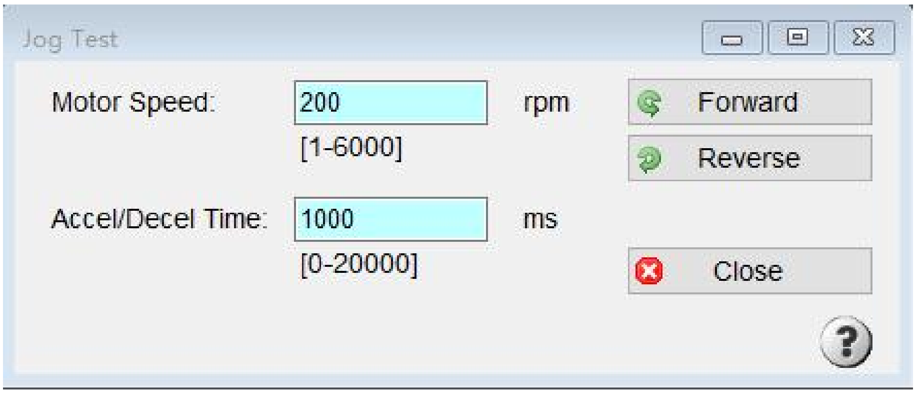
Step 1: Connect servo drive and motor correctly, and then power on the servo drive.

Step 2: Call the diagnosis screen by the MODE button, and then press the UP button 3 times to display the TEST1 (JOG mode). Hold SET button for 2 seconds to move to d-01. screen (JOG test operation).



Step 3: Run the JOG test. Press the UP button to run the motor in CCW direction, and press DOWN button to run the motor in CW direction. Release the button to stop. The running speed of JOG test can be modified by PC04.

When using Shihlin communication software, the setting value and range are as follows:

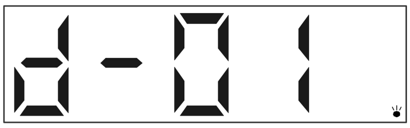


Note: When using the communication software, if the communication cable is disconnected during JOG test, the servo motor will decelerate and stop.

The description of buttons is as below:

Button	Function
Forward	Press and hold the button to runs the motor in CCW
Reverse	Press and hold the button to runs the motor in CW
Close	Stop JOG test

Step 4: if the JOG operation is completed, turn off the power or hold the SET button for more than 2 seconds in the test operation screen (d-01.) to exit the JOG mode.



5.2.2 Positioning test without load

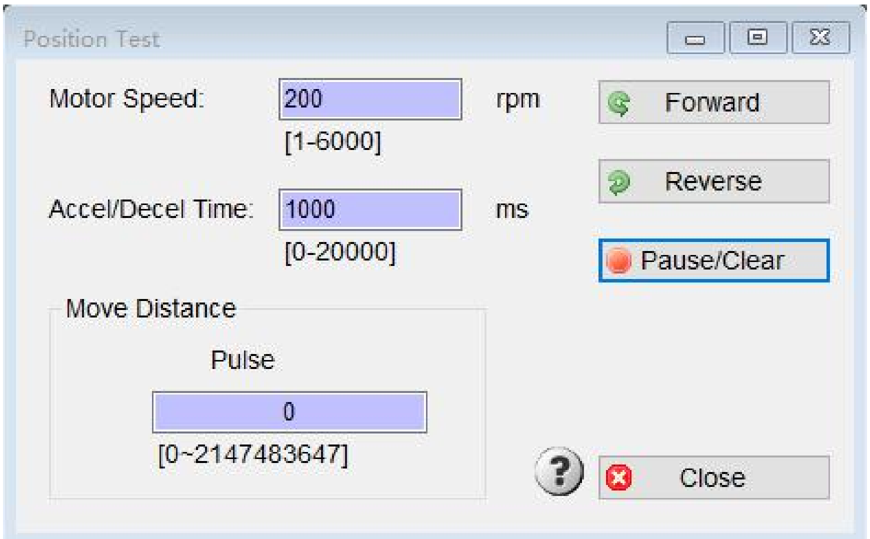
For positioning test without load, please use USB connect to Shihlin communication software to check whether the motor speed and direction are as expected. It is recommended to run at low speed. You need to set the number of revolutions and pulses, For example: if the motor takes 22-bit pulse(that is 4194304 pulse) to rotate 1 circle, the pulse number setting should be 44040192 pulse to reach 10 and 1/2 circles. The following content explains positioning operation steps:

Step 1: Connect the servo drive and servo motor correctly, and then turn on the power of servo drive.

Step 2: Connect the computer to the CN4 terminal of the servo drive with a standard Mini USB cable, and select the USB communication and the correct address by Shihlin communication software.

Step 3: Select Test/Position Test at the top of the communication software and enter the positioning test screen.

Step 4: Run the positioning test. First set the number of revolutions and pulse number. When clicking the Forward button, the servo motor will rotate in the CCW direction until reaches target number of revolutions and pulses. On the other hand, when the Reverse button is clicked, the servo motor will rotate in the CW direction until reaches target number of revolutions and pulses. The initial conditions and setting range of operation are as follows.



The description of buttons is as below:

Button	Content
“Forward”	Press it once, the motor will run in CCW direction until reaches target number of revolutions and pulses.
“Reverse”	Press it once, the motor will run in CW direction until reaches target number of revolutions and pulses.
“Pause/Clear”	Press it once, the motor will stop temporarily when the motor does not reach the target number of revolutions and pulses. If you press the same operation button again, the motor will run the remaining distance. If you press the pause button twice, the remaining number of revolution and pulse will be cleared.
“Close”	Stop the test

Step5: If the positioning test is completed, press the Close button to exit.

5.3 Parameter setting and operation in speed mode

(1) Power on

After the servo drive is powered on, you should switch off the SON signal. The panel of the servo drive automatically displays servo motor rotation speed after 2 seconds.

(2) Test Operation

Use JOG test to verify the servo is running normally.

(3) Parameter setting

After wiring is completed in speed mode, the following parameters need to be set before performing basic speed control.

Pr.No	Name	Setting value	Content
PA01(Note 1)	Control mode option	□□□2	Speed mode
PC05	Internal speed command 1	1000	Set to 1000 rpm
PC06	Internal speed command 2	1500	Set to 1500 rpm
PC07	Internal speed command 3	2000	Set to 2000 rpm
PC01	Acceleration time constant	1000	Set to 1000ms
PC02	Deceleration time constant	500	Set to 500ms
PC03	S-curve acceleration/deceleration time constant	0	N/A
PD15(Note1)	External input terminal filter time selection	□□□2	Filter time constant for external terminals are 4ms

Note 1: Parameter changes become valid after power cycling.

(4) Servo ON

Below is the procedure to execute SERVO ON.

(a) The control power of the servo is turned on.

(b) Turn on the SON signal(SON-SG is short-circuited).
Servo is ready when SON is ON, and servo motor switches to SERVO LOCK immediately.

(5) Start

Select the motor speed by SP1 or SP2 signal, and the options are as follows:

(Note)External input signal		Speed command
SP2	SP1	
0	0	Speed command is 0
0	1	Inner speed command 1(PC05)
1	0	Inner speed command 2(PC06)
1	1	Inner speed command 3(PC07)

After selecting the speed, the servo motor rotates when ST1 or ST2 is ON. and the instruction of forward and reverse rotation is shown below:

(Note)Rotation direction with external input		Rotation direction
ST2	ST1	Inner speed command
0	0	Stop(servo locked)
0	1	CCW
1	0	CW
1	1	Stop(servo locked)

NOTE: 0: OFF(STx-SG is open-circuited)   1: ON(STx-SG is short-circuited)

First, check the direction of rotation at low speed, and check the input signal if needed. You can monitor the servo motor speed, command pulse number, load ratio, etc. on the status display screen.

You can use the auto-tuning function or manually set the controller parameters, but you should note the resonance phenomenon caused by the machine, and adjust PA03 to get the best response of the servo motor speed.

(6) Stop

You can follow below steps to stop the motor.

(a) Servo ON signal (SON) is off

The base circuit is disconnected and the servo will switch to an unlocked free run state.

(b) Alarm occurs

When alarm occurs, the base circuit is disconnected and the dynamic brake is activated to stop the servo motor immediately.

(c) Emergency (EMG) is OFF

The base circuit is disconnected, and the dynamic brake is activated to stop the servo motor immediately. and the ALARM appears.

(d) The LSP and LSN is OFF.

If LSP is ON, motor rotates forwardly. If LSN is on, the motor rotates reversely. and if they are OFF, it stops the servo motor, and the servo is locked.

(e) When both ST1 and ST2 signal are turned ON or OFF at the same time, the servo decelerates to stop.

6.Tuning Procedure

CAUTION	●Please do not perform extreme adjustments and changes in parameters, which may cause unstable running.

6.1 Tuning method and type

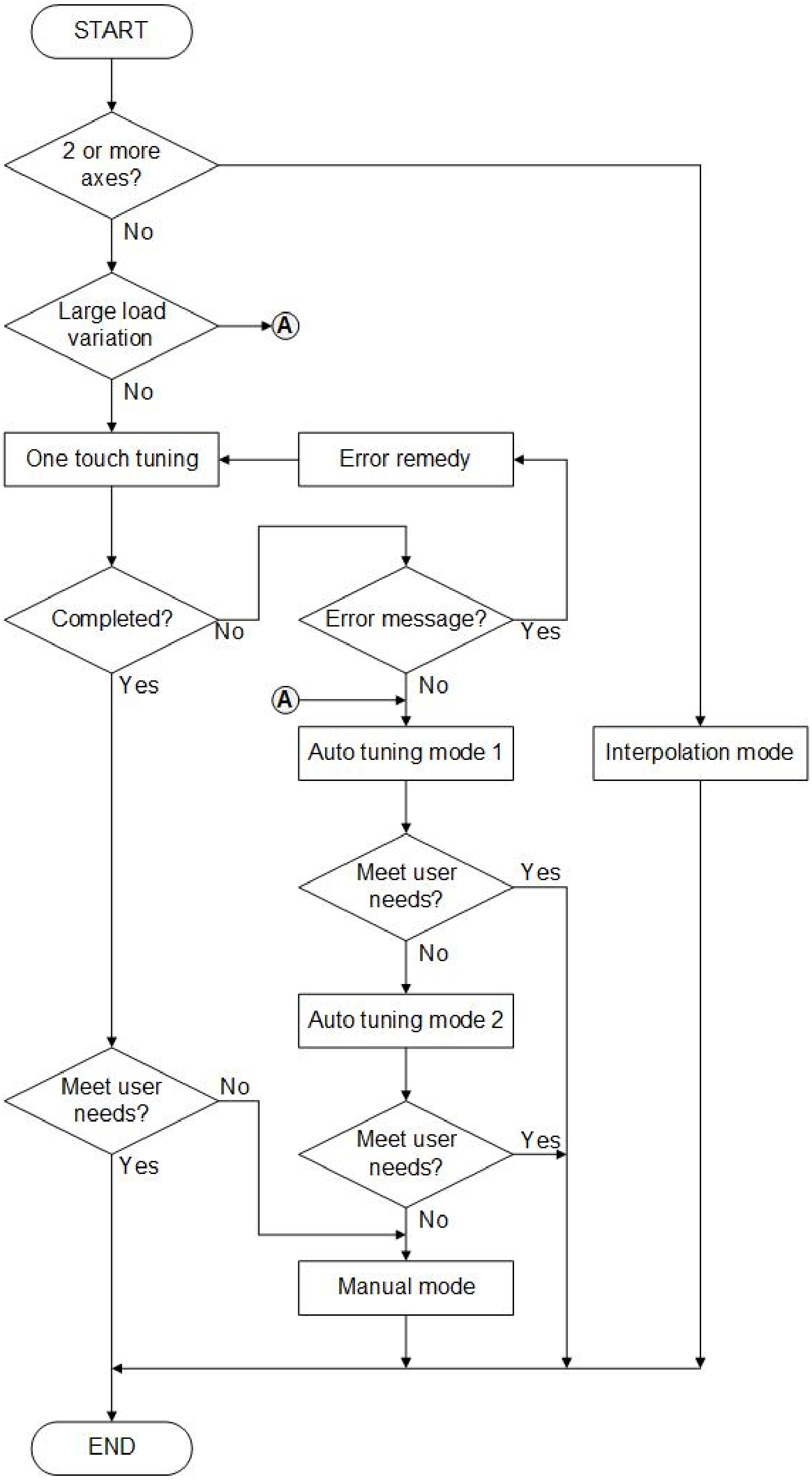
Auto-gain tuning function can quickly and accurately estimate load inertia and search for servo gain under different loads. If the auto-gain tuning mode cannot meet the requirement, manual mode can be used.

The description of gain tuning mode are as follows:

Tuning mode	PA02 setting value	Load inertia estimation method	Auto-estimate parameters	Manually set parameters
Manual mode (PI control)	0000 0001	Fixed as value of PB06		GD1(PB06) PG1 (PB07) VG1 (PB08) VIC (PB09)
Auto mode 1	0002	Continuously estimation	GD1(PB06) PG1 (PB07) VG1 (PB08) VIC (PB09)	ATUL(PA 03)
Auto mode 2	0003	Fixed as value of PB06	PG1 (PB07) VG1 (PB08) VIC (PB09)	ATUL(PA03) GD1(PB06)
Interpolation mode 1	0004	Continuously estimation	GD1(PB06) VG1 (PB08) VIC (PB09)	ATUL(PA03) PG1 (PB07)
Interpolation mode 2	0005	Fixed as value of PB06	VG1 (PB08) VIC (PB09)	ATUL(PA03) GD1(PB06) PG1 (PB07)

Parameter PA02 cannot be written when SON-SG is short-circuited, please open SON-SG circuit before setting.

Please refer to the below table for recommendations on the tuning sequence and mode.



If the servo is being used for the first time, a JOG test is required to confirm no abnormal before using the auto-tuning function. In auto-tuning mode, the servo needs to accelerate/ decelerate for several times, and after the inertia ratio estimation turns to a steady state, the purpose of inertia ratio estimation and bandwidth search can be achieved.

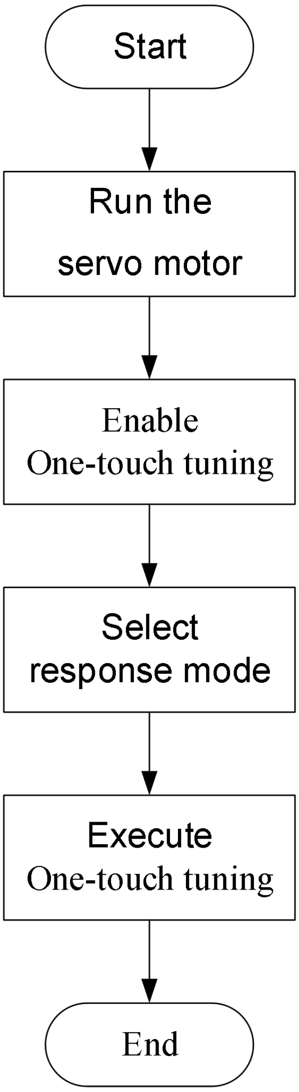
6.2 One-touch tuning function

The one-touch gain tuning function can be performed by using the communication software or the panel, and the related parameters which can be set automatically by the one-touch tuning function are shown in the table below.

Pr.No	Name Abbr	Parameter name
PA03	ATUL	Auto-tuning response level setting
PB01	NHF1	Frequency of machine resonance suppression filter 1
PB02	NHD1	Attenuation rate of machine resonance suppression filter 1
PB03	NLP	Time constant of resonance suppression low-pass filter
PB06	GD1	Load to motor inertia ratio
PB07	PG1	Position loop gain
PB08	VG1	Speed loop gain
PB09	VIC	Speed integral gain
PB21	NHF2	Frequency of Machine resonance suppression filter 2
PB22	NHD2	Attenuation rate of Machine resonance suppression filter 2
PB27	ANCF	Auto resonance suppression mode setting
PB28	ANCL	Auto resonance detection level
PB29	AVSM	Auto low-frequency vibration suppression mode setting
PB30	VCL	Low-frequency vibration detection level
PB31	VSF1	Low-frequency vibration suppression frequency 1
PB32	VSG1	Low-frequency vibration suppression gain 1
PB33	VSF2	Low-frequency vibration suppression frequency 2
PB34	VSG2	Low-frequency vibration suppression gain 2
PB35	FRCL	Friction compensation level
PB36	FRCM	Friction compensation smoothing time constant
PB45	NHF4	Frequency of machine resonance suppression filter 4
PB46	NHD4	Attenuation rate of Machine resonance suppression filter 4

6.2.1 One-touch tuning procedure

One-touch tuning has simple operation procedure and offers 2 ways to perform it. In addition, This function can only be performed when the servo system is in normal operation.



Send control command by host or internally to run the servo motor. (if servo motor is off, the one touch tuning function is invalid)

There are 2 ways to operate:

1. Use the communication software one touch tuning function.
2. Panel operate(it will introduce in next section)

1. You can choose high response, middle response, and low response by communication software.
2. Select AUTO H, AUTO, AUTO L by up and down button in the display panel.

Communication software: press START to execute.

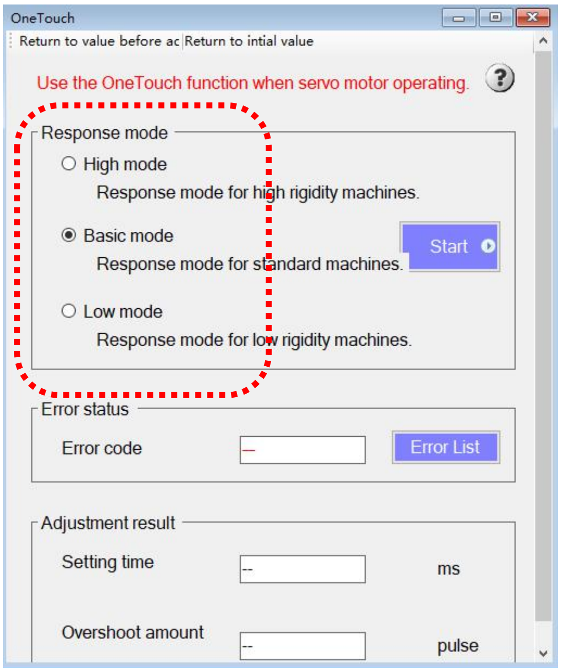
Panel: press SET button to execute.

And the motor must keep running during execution, when execution completed, the relevant parameters listed in previous section will be updated.

6.2.2 One-touch tuning display conversion and operation steps

6.2.2.1 Operating with communication software

(a) Three response modes can be selected in the one-touch tuning window from the communication software.

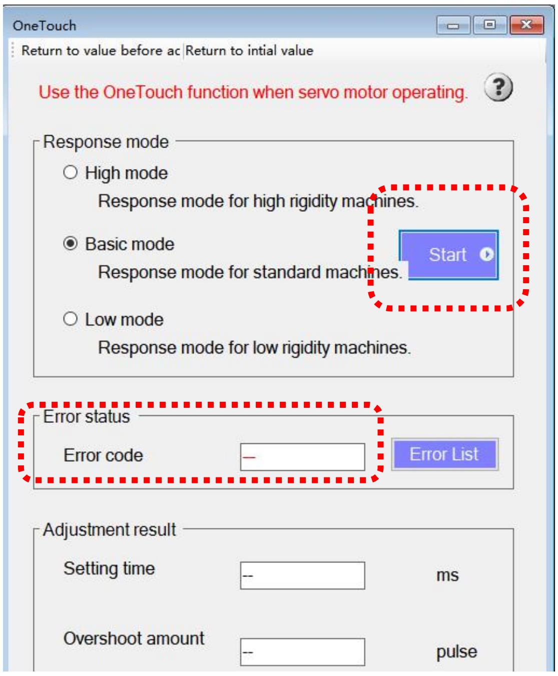


You can refer to below table for response mode selection.

Response mode	Description
High mode	For high rigidity systems
Basic mode	For standard systems.
Low mode	For low rigidity systems.

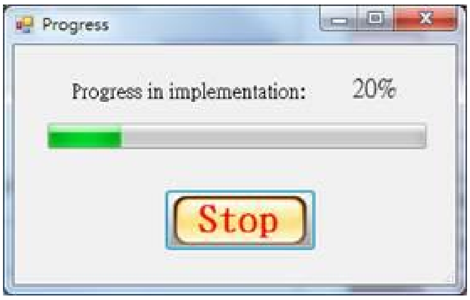
(b) One-touch tuning execution

After selecting the response mode, press Start to execute immediately.



If there is an error code, it will be displayed on the error status of the window.

The progress of the one-touch tuning execution will be presented in the status window, and the execution completion will be 100%.

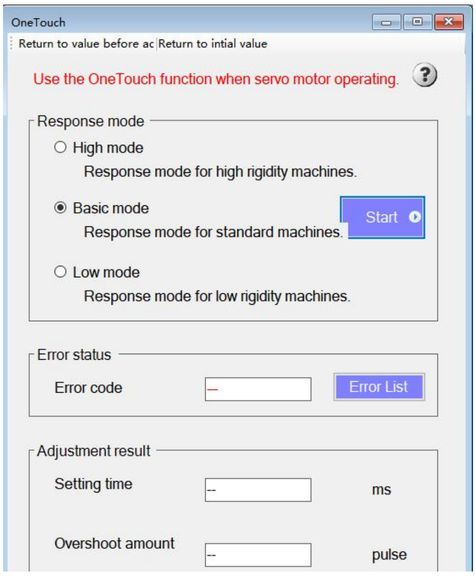


(c) Clear and Restore

This function provides two ways for clearing and restoring tuning-related parameters.

I. Clear: Gain parameters are returned to the factory default values.

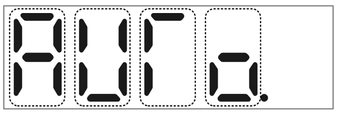
II. Restore: Gain parameters are restored to the previously value before one-touch tuning process.



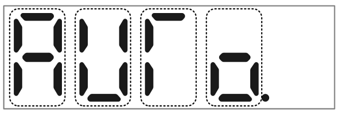
6.2.2.2 Operating with Panel

(a) There are two ways to access the one-touch gain tuning function from the panel:

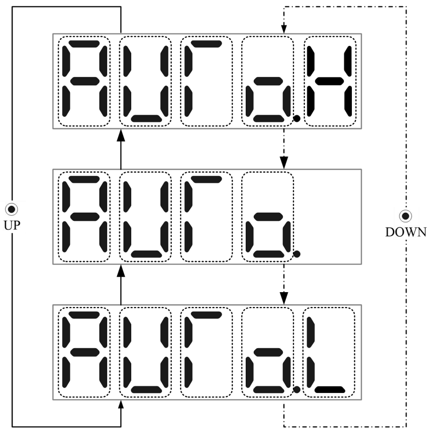
I. Press the MODE key move to the one-touch tuning screen (AUTo is displayed), then hold the SET key for 2 seconds and the screen flashes.



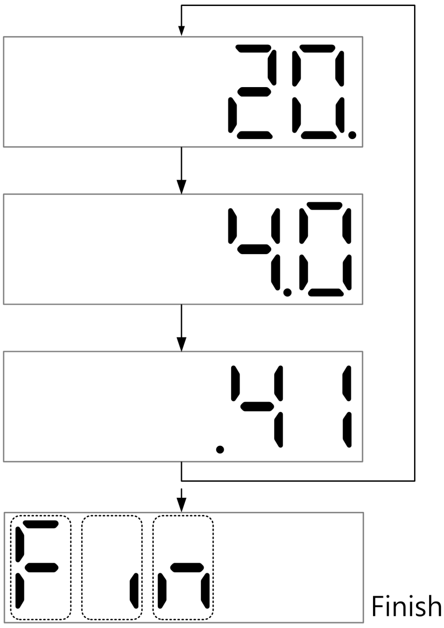
II. In any screen, hold the MODE and UP buttons at the same time for more than 3 seconds to enter the AUTo screen and the screen flashes.



(b) Press UP or DOWN key to select one-touch tuning response mode

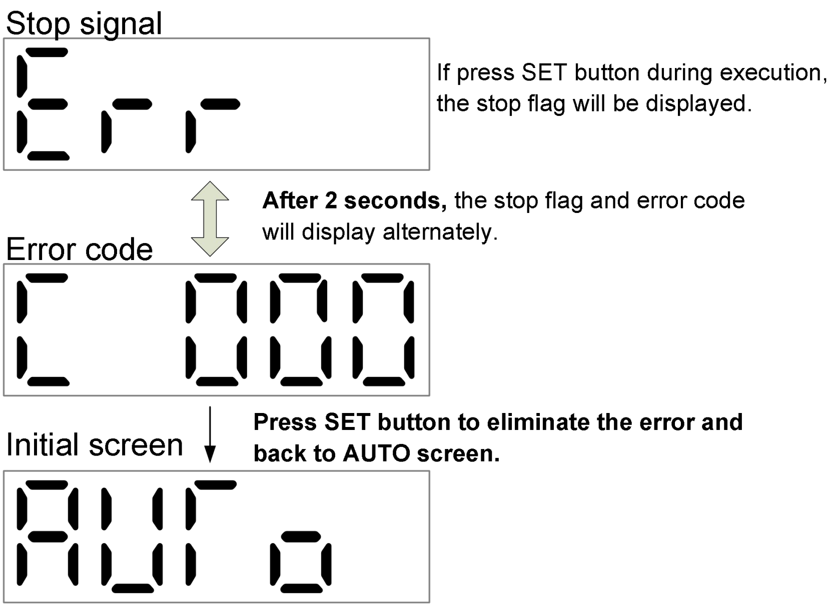


(c) After selecting the response mode and pressing the SET button, One-touch tuning function will be executed and the panel will show the progress.

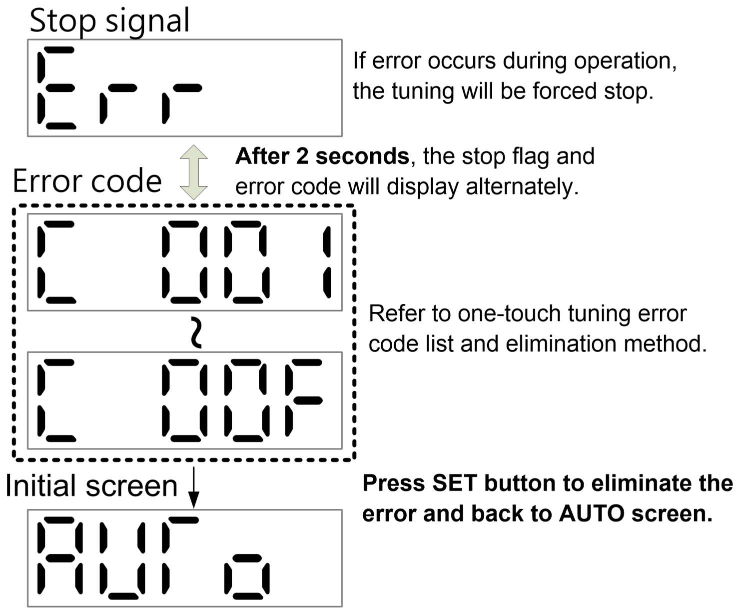


(d) If you want to terminate the process during tuning, press the SET key to stop, the panel display and the troubleshooting process are as follows:

(e)



(f) If an error occurs during the tuning process, the panel display and troubleshooting methods are as follows:

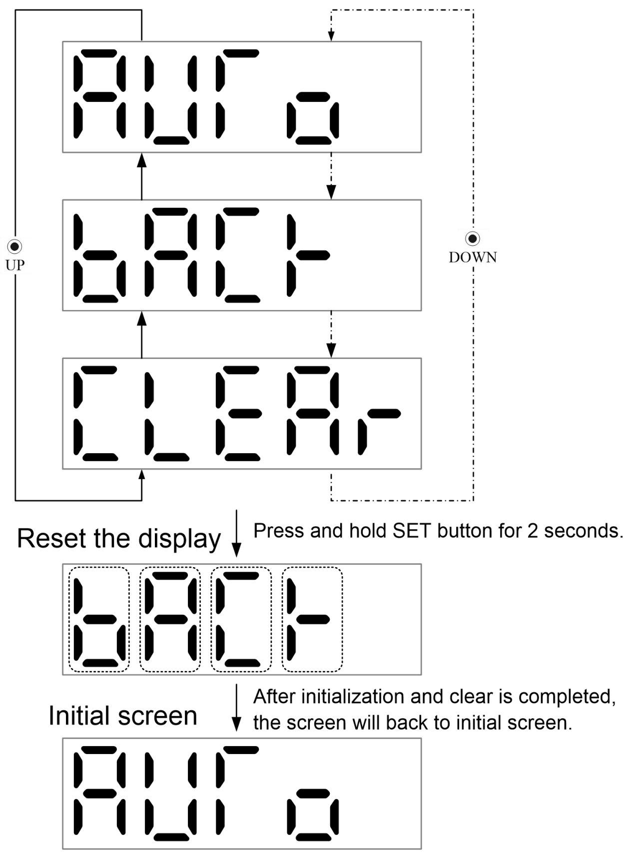


(g) There are two modes for clearing and restoring One-touch tuning related parameters:

I. Restore to default value (clear mode)

II. Restore to the previous value (back mode).

Press the MODE button to go to the One-touch tuning screen (displaying AUTo), then press UP or DOWN button to select clearing or restoring mode, press SET key for 2 seconds, the servo will execute the setting after blinking for 3 seconds.



6.2.3 List of one-touch tuning error codes and troubleshooting methods

Display	Error code name	Description	Troubleshooting Method
C000	Cancellation during tuning	Press the stop button or SET button during tuning.	
C001	Position overshot excess	Position overshot exceeds [PA12_INP] position attained range.	Increase [PA12_INP] setting value.
C002	SON-OFF	Execute one-touch tuning when SON is OFF.	Execute one touch tuning when SON is on.
		Try to turn SON OFF during one-touch tuning.	Don’t turn SON OFF during tuning.
C003	Control mode abnormal	Execute one-touch tuning in torque mode.	Switch to position or speed mode.
		Switch control modes during one-touch tuning.	Do not switch mode during tuning.
C004	Time out	Operation cycle time exceeds 30 seconds(the interval between current start command and next start command)	Set the rotation cycle to less than 30 seconds.
		Motor speed is too low	The motor speed should be more than 100rpm.
		Operation interval is too short	Operation interval should be more than 500ms.
C005	Load inertia estimation abnormal	Load inertia estimation failure during one-touch tuning	● Acceleration and deceleration times need to be less than 2 seconds for 2000rpm and less than 3 seconds for 3000rpm. ● The motor speed must be above 250rpm. ● The load inertia must not exceed 100 times the rotor inertia of the motor. ● This mode is not suitable for applications where external forces or inertia ratios change drastically. ● The acceleration and deceleration torque are 10% or more of the rated torque.
		When vibration affects the load inertia estimation or when the inertia ratio changes drastically.	Set to semi-auto gain tuning mode without load inertia estimation, and then perform one-touch tuning again. ● Select [PA02_ATUM] ● Set[PB06_GD1] to manually set load inertia ratio.
C00F	One-touch tuning function invalid	In [PA38_AOP3] setting, the one-touch tuning function is disabled.	modify [PA38_AOP3] setting

6.3 Auto-tuning mode

The auto-tuning function estimates the load inertia ratio for the servo drive in real time, and uses this value to automatically set the optimal gain (GAIN value). With this auto-tuning function, you can perform servo drive gain tuning in an easy and fast way.

6.3.1 Auto-tuning function

(a) .Auto-gain tuning mode 1

This mode is the servo factory default setting, if the servo is set to this function (PA02=0002), the load inertia ratio will be continuously evaluated and the servo gain value will be set automatically, the only parameter that can be manually modified is PA03.

The related parameters and settings are as follows:

Pr.No	Name Abbr	Name	Modifiable or auto-estimated
PA03	ATUL	Auto-tuning response level setting	Modifiable
PB06	GD1	Load to motor inertia ratio	Auto-estimate
PB07	PG1	Position loop gain	Auto-estimate
PB08	VG1	Speed loop gain	Auto-estimate
PB09	VIC	Speed integral gain	Auto-estimate

When the servo is set to auto-gain tuning mode 1, the following conditions must be met.

① The acceleration and deceleration time should be less than 2 seconds when reaching 2000rpm and less than 3 seconds when reaching 3000rpm.

② The motor speed must be higher than 250rpm.

③ Load inertia must not exceed 100 times the rotor inertia of the motor.

④ This mode is not suitable for applications where the external force or inertia ratio changes drastically.

⑤ Acceleration and deceleration torque are 10% or more of the rated torque.

(b).Auto-gain tuning mode 2

If auto-gain tuning mode 1 cannot estimate the inertia correctly, you can use auto-gain tuning mode 2. By setting PA02 to 0003 in this mode, the load inertia ratio will not be estimated automatically, you should manually set PB06.

The related parameters and settings are shown below:

Pr.No	Name Abbr	Name	Modifiable or auto-estimated
PA03	ATUL	Auto-tuning response level setting	Modifiable
PB06	GD1	Load to motor inertia ratio	Modifiable
PB07	PG1	Position loop gain	Auto-estimate
PB08	VG1	Speed loop gain	Auto-estimate
PB09	VIC	Speed integral gain	Auto-estimate

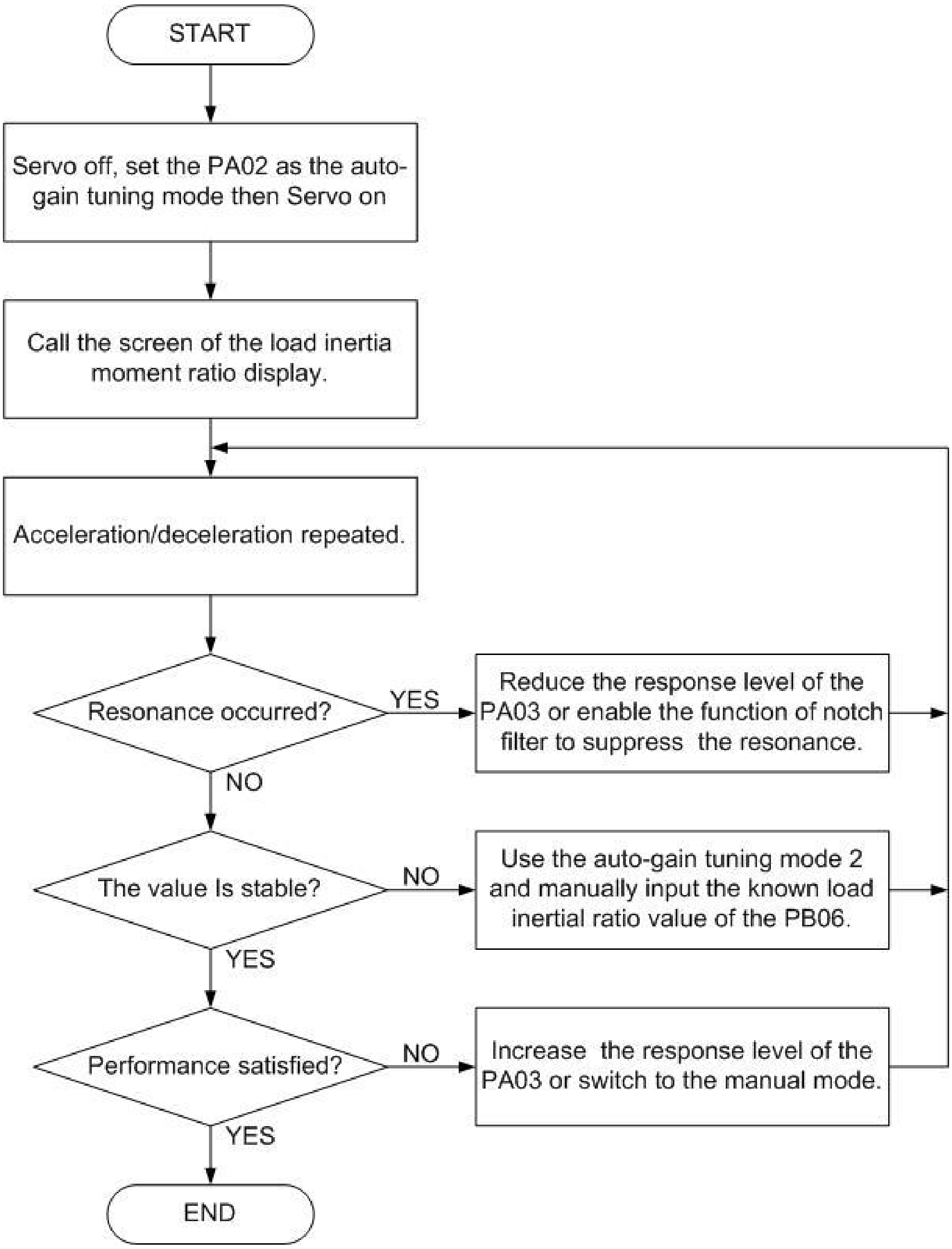
Please refer to the following key points to enable the auto-gain tuning mode.

① When setting to the auto-gain tuning mode 1, the motor accelerates or decelerates at first, and then the inertia ratio is estimated according to motor current and speed, this value will be updated to PB06 and written into the EEPROM (every 30 minutes).

② If the load inertia ratio is known, or if the inertia ratio cannot be accurately estimated (in cases where the inertia ratio changes drastically), you can set PA02 to auto-gain tuning mode 2, and manually write the known inertia ratio into PB06. During the time, the gain value will be kept searching.

③ The controller gain will be optimized according to the inertia ratio and response level setting value during acceleration and deceleration. When the power is turned on, the gain search result is written to the EEPROM every 30 minutes, and it will be used as the initial value for tuning.

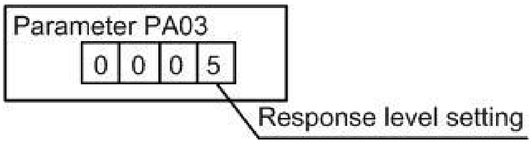
Shihlin servo has set auto-gain tuning mode 1 as default setting, so that the controller gain will be set automatically as long as the motor is accelerated or decelerated. You only need to manually set the required response level to complete the whole process, the sequence is shown in the figure below.



6.3.1.2 Manual Tuning Mode

PA03 (Response Level Setting) is used to set the overall response level of the servo, which affects the bandwidth of the entire system. Increasing response setting will improve the command traceability and shorten the settling time. But if the setting is too high, the system maybe vibrate. It is recommended to set the response level within the non-vibrate range.

If the machine resonates at the required bandwidth and you do not want to change the bandwidth, then the mechanical resonance suppression filter (PB01, PB02, PB21, PB22) and the resonance suppression low-pass filter (PB03) can be used to suppress the resonance effectively. Response can also be set to a higher setting at this time. For the mechanical resonance suppression filter and resonance suppression low-pass filter, refer to section 7.2.5.



Setting value	Response level	Speed loop response frequency(Hz)
1		10.0
2		11.3
3		12.7
4		14.3
5		16.1
6		18.1
7		20.4
8	Low response	23.0
9		25.9
10	Basic response	29.2
11		32.9
12		37.0
13		41.7
14		47.0
15		52.9
16		59.6

Setting value	Response level	Speed loop response frequency(Hz)
17		67.1
18		75.6
19	Basic response	85.2
20		95.9
21	High response	108.0
22		121.7
23		137.1
24		154.4
25		173.9
26		195.9
27		220.6
28		248.5
29		279.9
30		315.3
31		355.1
32		400.0

- For the response level setting, it is recommended to begin with low response level and slowly adjust to a higher level. If the initial value is set too high, the possibility of resonance will be greatly increased.
- The applicable load inertia ratio is just for reference, it needs to adjust according to different system environments.

6.3.2 Tuning in manual mode

If the auto-tuning function cannot meet the requirement, the manual mode can be used.

Adjustment of manual mode

In position and speed mode, the rigidity of the machine and the environment greatly impact the bandwidth selection. You will set a high frequency system response to get high machining accuracy, but high response level might cause mechanical resonance. Therefore, highly response applications require highly rigid machines to avoid machine resonance.
When the response bandwidth is unknown, you should set a small gain value first, gradually increase it until the resonance occurs, and then decrease the gain setting. Parameters value for each control mode can be found in the following table:

Name	Name Abbr	Pr.No	Setting range	Unit	Default value	Control mode
Resonance suppression low-pass filter	NLP	PB03	0~10000	0.1ms	10	ALL
Position feed-forward gain	FFC	PB05	0~200	%	0	Pt, Pr
Load to motor inertia ratio	GD1	PB06	0~1200	0.1 times	70	ALL
Position loop gain	PG1	PB07	4~1024	rad/s	45	Pt, Pr
Speed loop gain	VG1	PB08	40~9000	rad/s	183	ALL
Speed integral gain	VIC	PB09	1~1000	ms	34	ALL
Speed feed-forward gain	VFG	PB10	0~200	%	0	S, T

➢ Position loop gain(PG1)

This parameter determines the response of the position loop. The larger PG1 setting value is, the higher the response frequency of the position loop will be. It means the better position command response, the shorter settling time and the fewer position deviation. However, if the value is too large, it may cause vibration or overshoot. The calculation of the setting is as follows:

$$PG1\ setting\ value \le \frac{VG1\ setting\ value}{1 + ratio\ of\ load\ inertial\ to\ motor\ shaft} \times \frac{1}{4}$$

$$PG1\ setting\ value \approx speed\ loop\ bandwidth \times \frac{1}{4}$$

➢ Speed loop gain(VG1)

This parameter determines the response level of the speed loop. The larger the VG1 setting value is, the higher the response frequency and better speed command response will be. But too large setting may cause resonance. The speed loop gain setting is usually 4~6 times of the position loop gain. When the position loop gain is larger than the speed loop gain, the machine may resonate or overshoot. The calculation of the speed loop gain is shown in the following formula:

$$Speed\ loop\ response\ frequency(Hz) = \frac{VG1\ setting\ value}{(1+ ratio\ of\ load\ inertial\ to\ motor\ shaft) \times 2\pi}$$

➢ Speed integral gain(VIC)

This parameter is to clear fixed deviation of the corresponding command. The smaller the VIC setting value is, the better to clear fixed deviation will be. However, in the case of large load inertia and mechanical vibration, small setting may easily generate resonance.

You can refer to the following formula for the setting value:

$$VIC\ setting\ value(ms) \ge \frac{3000\text{\textasciitilde}5000}{VG1\ setting\ value / (1+ GD1\ setting\ value \times 0.1)}$$

➢ Low-pass filter for resonance suppression(NLP)

The larger the load inertia is, the lower the bandwidth of the system will be. If you want to maintain a higher bandwidth, you needs to increase the gain value. However, Increasing the gain value might cause mechanical resonance. To avoid this, you can use resonance suppression low-pass filter parameters to eliminate the resonance. The larger the setting is, the lower high-frequency noise will be. But too large setting will also cause the instability of the entire system, because the large setting will worsen the phase lag. The recommended setting value can be referred to the following formula:

$$\text{NLP setting value(Hz)} = \frac{\text{VG1 setting value} * 10}{2\pi * (1 + \text{GD1 setting value} * 0.1)}$$

- Position feed-forward gain(FFC)

It can reduce position deviation and shorten the position settling time. But too large setting will cause positioning overshoot during sudden acceleration and deceleration, and if the E-gear ratio is set too large, it will also generate noise.

- Speed feed-forward gain(VFG)

VFG can shorten the speed command following time, but too large setting may cause overshoot during sudden acceleration and deceleration.

6.3.3 Interpolation mode

This mode is applicable on 2 or more axis servo drives, the controller gain parameter keeps in the automatic tuning function, the main content is as follows:

Interpolation mode 1: only the position gain value (PB07) can be set manually. The remaining gains (PB06, PB08, PB09) are automatically adjusted with PA03 settings.

Interpolation mode 2: The position gain (PB07) and load inertia ratio (PB06) can be adjusted manually, and the other gains (PB08, PB09) are automatically adjusted with the setting of PA03.

7.Control Mode

7.1 Control mode selection

Shihlin servo drives have three basic control modes, including communication mode, position (internal register) mode, and speed mode. The drive supports single mode, which is one fixed mode, or dual modes. The descriptions of control modes are shown in the following table:

Mode name		Mode code	PA01 setting	Description
Single Mode	EtherCAT Communication Mode	CoE	0020	In EtherCAT communication mode, the drive receives commands from the upper controller and runs the motor to the target position, speed, or torque to complete the task.
	Position Mode (Internal Register)	Pr	0010	The drive receives position commands and runs the motor to the target position. Position commands are provided by internal registers (63 groups of registers), and the register number can be assigned by the DI signal.
	Speed Mode	S	0012	The drive receives speed commands and runs the motor to the target speed. You can use DI signal to select between analog voltage commands or internal speed commands (7 groups of register).
Dual Mode	Position Mode (Internal Register) -Speed Mode	Pr-S	0011	Pr/S can be switched via the DI signal (LOP).

✦ PA01 changes become valid after power cycling.

7.2 Speed control mode

7.2.1 Speed command selection

Shihlin servo provides 8 groups of speed command, and 7 of them can be set by internal parameters.

<table>
<tr><th rowspan="2">DI options</th><th rowspan="2">Speed command code</th><th colspan="3">(Note) Input signal</th><th rowspan="2">Speed command</th><th rowspan="2">Range</th><th rowspan="2">Related parameters</th></tr>
<tr><th colspan="2">SP2</th><th>SP1</th></tr>
<tr><td rowspan="4">SP3 is disabled
(Initial status)</td><td>VCM</td><td colspan="2">0</td><td>0</td><td>Servo stops</td><td>-</td><td>-</td></tr>
<tr><td>SC1</td><td colspan="2">0</td><td>1</td><td>Internal speed command 1</td><td>-6000 ~ 6000</td><td>PC05</td></tr>
<tr><td>SC2</td><td colspan="2">1</td><td>0</td><td>Internal speed command 2</td><td>-6000 ~ 6000</td><td>PC06</td></tr>
<tr><td>SC3</td><td colspan="2">1</td><td>1</td><td>Internal speed command 3</td><td>-6000 ~ 6000</td><td>PC07</td></tr>
<tr><td rowspan="9">SP3 is enabled</td><th>Speed command code</th><th>SP3</th><th>SP2</th><th>SP1</th><th>Speed command</th><th>Range</th><th>Related parameters</th></tr>
<tr><td>VCM</td><td>0</td><td>0</td><td>0</td><td>Servo stops</td><td>-</td><td>-</td></tr>
<tr><td>SC1</td><td>0</td><td>0</td><td>1</td><td>Internal speed command 1</td><td>-6000 ~ 6000</td><td>PC05</td></tr>
<tr><td>SC2</td><td>0</td><td>1</td><td>0</td><td>Internal speed command 2</td><td>-6000 ~ 6000</td><td>PC06</td></tr>
<tr><td>SC3</td><td>0</td><td>1</td><td>1</td><td>Internal speed command 3</td><td>-6000 ~ 6000</td><td>PC07</td></tr>
<tr><td>SC4</td><td>1</td><td>0</td><td>0</td><td>Internal speed command 4</td><td>-6000 ~ 6000</td><td>PC08</td></tr>
<tr><td>SC5</td><td>1</td><td>0</td><td>1</td><td>Internal speed command 5</td><td>-6000 ~ 6000</td><td>PC09</td></tr>
<tr><td>SC6</td><td>1</td><td>1</td><td>0</td><td>Internal speed command 6</td><td>-6000 ~ 6000</td><td>PC10</td></tr>
<tr><td>SC7</td><td>1</td><td>1</td><td>1</td><td>Internal speed command 7</td><td>-6000 ~ 6000</td><td>PC11</td></tr>
</table>

(Note) 0: OFF(SCx-SG is open-circuited) 1: ON (SCx-SG is short-circuited)

◆ To use the function of SC4~SC7, please enable SP3 signal with parameters PD02~PD06.

7.2.2 Smooth speed command

If the motor speed command changes rapidly, it might cause motor vibration, noise, or overshoot. Shihlin servo provides three types of smooth operation parameters to suppress the negative effects caused by rapid changes in speed command. First, the speed acceleration time constant adjusts the slope of acceleration, the speed deceleration time constant adjusts the slope of deceleration, and the S-curve acceleration and deceleration time constant improves the motor stability when it starts and stops.

Name	Name Abbr	Pr.No	Setting range	Unit	Default value	Control mode
Acceleration time constant	STA	PC01	0~20000	ms	200	S
Deceleration time constant	STB	PC02	0~20000	ms	200	S
S-curve acceleration / deceleration time constant	STC	PC03	0~10000	ms	0	Pr, S

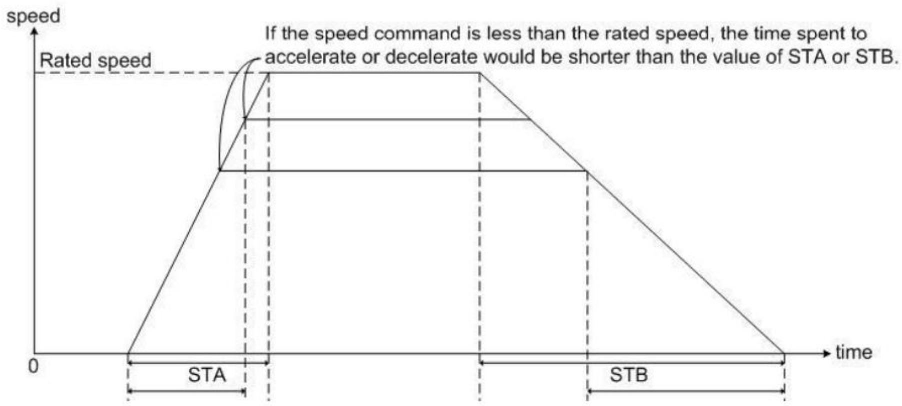
The description of the three parameters are as follows:

Speed acceleration time constant:

The acceleration time constant is the acceleration time from 0rpm to the motor rated speed. For example, if the rated speed of the servo motor is 3000rpm, and this parameter is set to 3000(3s), then the acceleration time from 0rpm to 3000rpm would take 3 seconds. If the speed command is set to 1000rpm, it would take 1 second to accelerate the motor from 0rpm to 1000rpm.

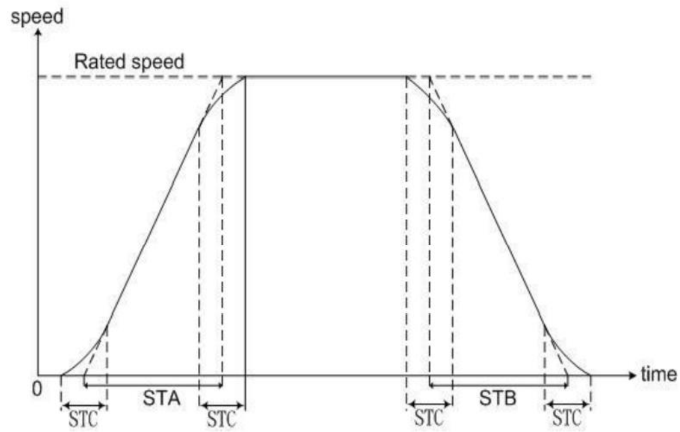
Speed deceleration time constant:

The deceleration time constant is the deceleration time from rated speed to 0rpm. For example, if a servo motor is running at 3000rpm and this parameter is set to 3000(3s), the deceleration time from 3000rpm to 0rpm would take 3 seconds. If the motor is running at 1000rpm, it would take 1 second to decelerate from 1000rpm to 0rpm.



S-curve acceleration / deceleration:

The S-curve acceleration and deceleration constant applies a three-stage acceleration and deceleration curve to smooth the motor starting and stopping process. Appropriate setting of the STC improves the stability of the motor when starting and stopping. The initial S-curve acceleration/deceleration time constant is 0. It is recommended to enable this function when using the speed mode.

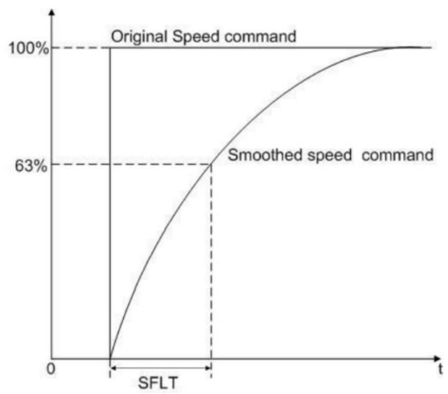


- The above parameters will offer acceleration/deceleration protection function either in internal speed command or in analog speed command.
- STA, STB, and STC can be set independently. Even if STC is set to 0, the acceleration and deceleration still follow a trapezoid-curve.

Speed command low-pass filter time constant:

Name	Name Abbr	Pr.No	Setting range	Unit	Default value	Control mode
Speed command low-pass smooth filter time constant	SFLT	PB18	0~1000	ms	0	CoE. S

Increasing this parameter value will improve smoothness of command curve, and decrease the response level as well. If it is set to 0, it means that this function is disabled.



7.2.3 Torque limit of speed control mode

When using the speed mode, the main parameters related to the torque limit are PA05 and PC25. The table below introduces these two parameters:

Name	Name Abbr	Pr.No	Setting range	Unit	Default value	Control mode
Internal torque limit value 1	TL1	PA05	0~100	%	100	CoE, Pr, S
Internal torque limit value 2	TL2	PC25	0~100	%	100	CoE, Pr, S

You should set parameters PD02~PD06 to enable TL signal. And if TL-SG is open-circuited, it means PA05 is valid.

The options of TL is as follow:

(Note) DI signal	Valid torque limit value
TL	
0	PA05
1	If PC25 > PA05 => TL value = PA05 If PC25 < PA05 => TL value = PC25

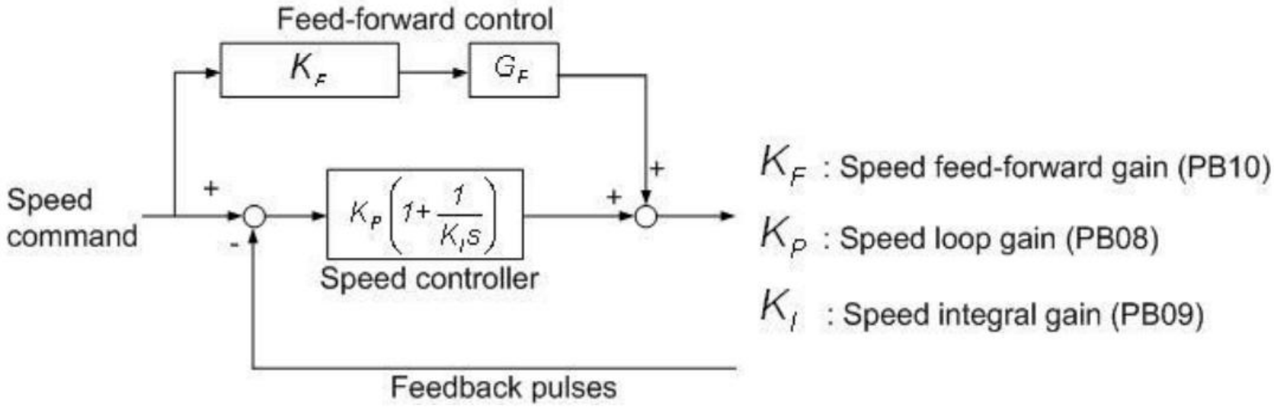
Note 0: OFF(TL-SG is open-circuited)   1: ON (TL-SG is short-circuited)

TLC-SG becomes conductive when the torque generated by the servo motor reaches the setting of PA05, PC25 or the analog torque limit. TLC is a DO signal.

Name	Name Abbr	Description	Control mode
Torque limiting control	TLC	When the torque reaches the setting of the Inner torque limit 1(PA05), TLC-SG will be conductive. TLC-SG will not be conductive when SON is off.	CoE, Pr, S

7.2.4 Gain adjustment of speed loop

In the speed loop, you can manually set some gain parameters. Use PA02 to set the gain adjustment mode as manual or automatic. If automatic adjustment is set, the inertia ratio and gain values will be estimated continuously. If manual mode is set, you should manually input the correct load inertia and gain values of the system, and all automatic or auxiliary functions will be disabled. The diagram of the speed loop is shown below:



The gain adjustment related parameters in speed control loop are summarized as follows:

Name	Name Abbr	Pr.No	Setting range	Unit	Default value	Control mode
Auto-tuning mode setting	ATUM	PA02	0000h~0004h	N/A	0002h	CoE, Pr, S
Auto-tuning response level setting	ATUL	PA03	1~32	N/A	10	CoE, Pr, S
Speed loop gain	VG1	PB08	40~9000	rad/s	183	CoE, Pr, S
Speed integral gain	VIC	PB09	1~1000	ms	34	CoE, Pr, S
Speed feed-forward gain	VFG	PB10	0~200	%	0	CoE, Pr, S

Auto mode:

The servo drive optimize controller gain during acceleration and deceleration. A detailed description can be found in section 6.3.1.

Manual mode:

When parameter PA02 is set to 0000 or 0001, the manual mode is enabled. And the three main related gain are the speed loop gain (PB08), the speed integral gain value (PB09), and the speed feed forward gain value (PB10).

Parameters need to set in manual mode

Speed loop gain:
Increasing the value of this parameter will increase the bandwidth of the speed loop, but if the setting is too large, it will cause the system oscillation. It is recommended to estimate a base value in the auto mode, slowly increase the value if it fails to meet the requirement in the manual mode. and return to the previous setting value once the system has generated oscillations.

Speed integral gain:
Decreasing this parameter setting value will increase the low-frequency rigidity of the speed loop and reduce the steady state deviation. But if the setting is too low, it may worsen the phase lag and may cause system instability.

Speed feed-forward gain:
Speed feed-forward gain can reduce the phase lag deviation and improve the ability to follow command trajectories. When the setting value is close to 100, the system would have very small dynamic tracking deviation and the most complete pre-compensation. If the setting is too low, it cannot obviously improve the system, and if the setting is too large, the system is easy to oscillate.

7.2.5 Resonance suppression unit

(1) Auto high-frequency resonance suppression

When the response bandwidth of the control system is too high, it may cause resonance of the mechanism, or even cause the damage of the mechanism. Usually it can be improved by strengthening the rigidity of the mechanism or reducing the bandwidth of the system, but it will increase the cost and reduce the response. To suppress resonance without increasing the cost and without reducing the bandwidth, the SDC servo drive provides Auto High-frequency Resonance Suppression, its relevant parameters, setting range, the initial value are shown in the table below. It mainly provides five groups of resonance suppression filters and one group of low-pass filter to suppress resonance, you can manually or automatically operate as below instructions.

Name	Name Abbr	Pr.No	Setting range	Unit	Default value	Control mode
Auto resonance suppression mode	ANCF	PB27	0~2	N/A	1	CoE, Pr, S
Auto resonance detection level	ANCL	PB28	1~300	%	50	CoE, Pr, S
Machine resonance suppression frequency(1)	NHF1	PB01	10~4000	Hz	1000	CoE, Pr, S
Machine resonance suppression attenuation rate(1)	NHD1	PB02	0~32	dB	0	CoE, Pr, S
Machine resonance suppression frequency(2)	NHF2	PB21	10~4000	Hz	1000	CoE, Pr, S
Machine resonance suppression attenuation rate(2)	NHD2	PB22	0~32	dB	0	CoE, Pr, S
Machine resonance suppression frequency(3)	NHF3	PB25	10~4000	Hz	1000	CoE, Pr, S
Machine resonance suppression attenuation rate(3)	NHD3	PB26	0~32	dB	0	CoE, Pr, S
Machine resonance suppression frequency(4)	NHF4	PB45	10~4000	Hz	1000	CoE, Pr, S
Machine resonance suppression attenuation rate(4)	NHD4	PB46	0~32	dB	0	CoE, Pr, S
Machine resonance suppression frequency(5)	NHF5	PB47	10~4000	Hz	1000	CoE, Pr, S
Machine resonance suppression attenuation rate(5)	NHD5	PB48	0~32	dB	0	CoE, Pr, S
Resonance suppression low-pass filter	NLP	PB03	0~10000	0.1ms	10	CoE, Pr, S

Manual mode:
The drive provides five groups of filters and one group of low-pass filters to perform manual resonance suppression. The first group is PB01, PB02, the second group is PB21, PB22, the third group is PB25, PB26, the fourth group is PB45, PB46, the fifth group is PB47, PB48, and the low-pass filter is PB03, in which PB01, PB21, PB25, PB45, and PB47 are the suppression frequencies, PB02, PB22, PB26, PB46, and PB48 are the resonance attenuation rates, and PB03 is the time constant.

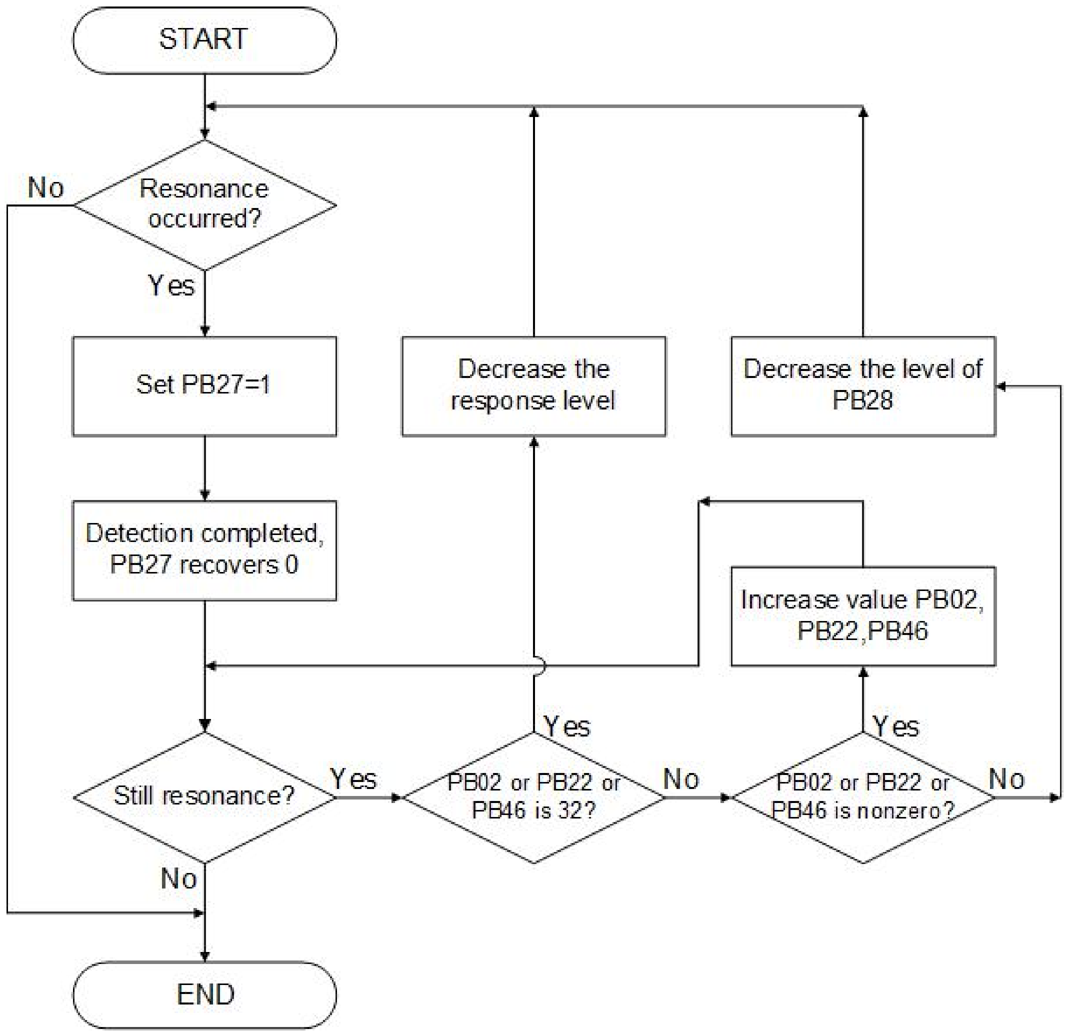
If the resonance frequency is known, you can manually set the frequency of the filter and increase the attenuation rate gradually (Note 2), or slowly increase the low-pass filter time constant (reduce the low-pass filter bandwidth) until no resonance occurs, but this method will reduce the response bandwidth of the system.

Auto mode:
The drive provides three groups of filters to perform auto resonance suppression. The first group is PB01 and PB02, the second group is PB21 and PB22 and the fourth group is PB45 and PB46, where PB01, PB21 and PB45 are the suppression frequencies and PB02, PB22 and PB46 are the resonance attenuation rates.

When resonance occurs, you can set PB27 to 1 or 2 to turn on the auto suppression function if the resonance frequency is unknown. At this time, the drive will automatically detect the resonance frequency and attenuation rate, and set the detected results to the first, second, and fourth group of filters sequentially (Note 1). If PB27 is set to 1, PB27 will be automatically change back to 0 after auto-detection; if PB27 is set to 2, resonance will be continuously detected and suppressed. For other details of PB27 parameter operation flow, please refer to the following table.

When PB27 is set to 1 or 2, if the resonance still exists, please check whether any of PB02, PB22 and PB46 is set to 32, if yes, it means that this resonance phenomenon cannot be suppressed by the filter, and it is recommended to reduce the system bandwidth and perform re-estimation; if the parameter value is less than 32 and greater than 0, it means that the resonance frequency is detected by the auto-detection mode. However, the resonance still exists, which is due to the insufficient attenuation rate (Note 1). You can increase the attenuation rate to improve (Note 2). If PB02, PB22 and PB46 are all 0, it means that the resonance frequency is not detected, which may due to the detection level (PB28) is too high, it is recommended to reduce the detection level and set the PB27 to 1 or 2 to re-detect. The complete auto resonance suppression flowchart can be referred in the following table.

Note 1: The attenuation rate detected by the drive is the most suitable attenuation rate. Maybe it’s not the best one, but it can ensure the stable operation of the system.
Note 2: Be careful when manually adjust the attenuation rate, if the setting is too large, it may cause system instability.



During the auto mode execution, the PB27 value would be changed. The following table explains it.

PB27 transient status	Description
0 → 1	Clear PB01, PB02, PB21, PB22, PB45, PB46 values, enable this auto mode.
0 → 2	Clear PB01, PB02, PB21, PB22, PB45, PB46 values, keep this auto mode running.
1 → 0	Store PB01, PB02, PB21, PB22, PB45, PB46 value, disable this auto mode.
1 → 1	The auto mode is not yet finished.
1 → 2	Hold PB01, PB02, PB21, PB22, PB45, PB46 values, keep this auto mode running.
2 → 0	Store PB01, PB02, PB21, PB22, PB45, PB46 value, disable this auto mode.
2 → 1	Clear PB01, PB02, PB21, PB22, PB45, PB46 values, enable this auto mode.
2 → 2	The auto mode is not yet finished.

(2) Automatic low-frequency vibration suppression

When the command is changed instantly, the motor side and the load side cannot be synchronized due to insufficient rigidity of the drive system, it will have mechanical vibration during positioning, and then cause problems such as inaccurate positioning and bad product yield. Usually it can be improved by reducing the bandwidth of the system, but the response will be worse in this case. To suppress vibration without reducing the bandwidth, this servo drive provides Automatic Low-frequency Vibration Suppression, its related parameters, setting ranges, and default values are shown in the following table. It mainly provides two groups of low-frequency vibration filters for you to operate manually or automatically.

Name	Name Abbr	Pr.No	Setting range	Unit	Default value	Control mode
Auto low-frequency vibration suppression mode	AVSM	PB29	0~1	N/A	0	CoE, Pr
Low-frequency vibration detection level	VCL	PB30	1~8000	pulse	50	CoE, Pr
Low-frequency vibration suppression frequency 1	VSF1	PB31	1~3000	0.1Hz	100	CoE, Pr
Low-frequency vibration suppression gain 1	VSG1	PB32	0~15	N/A	0	CoE, Pr
Low-frequency vibration suppression frequency 2	VSF2	PB33	1~3000	0.1Hz	100	CoE, Pr
Low-frequency vibration suppression gain 2	VSG2	PB34	0~15	N/A	0	CoE, Pr

Manual mode:

The SDC servo drive provides two groups of suppression filters for manual suppression. The first group is PB31, PB32, the second group is PB33, PB34, of which PB31 and PB33 are the suppression frequencies, PB32, PB34 are the suppression gains. If the vibration frequency of the mechanism is known, you can manually set the vibration frequency at PB31, PB33, and set PB32, PB34 to 1. In which, 1 represents enabling of the suppression function, 0 represents disabling of the suppression function. Increase the gain value can improve the position response. The larger the value is , the better the response will be(Note 1).

Auto mode:

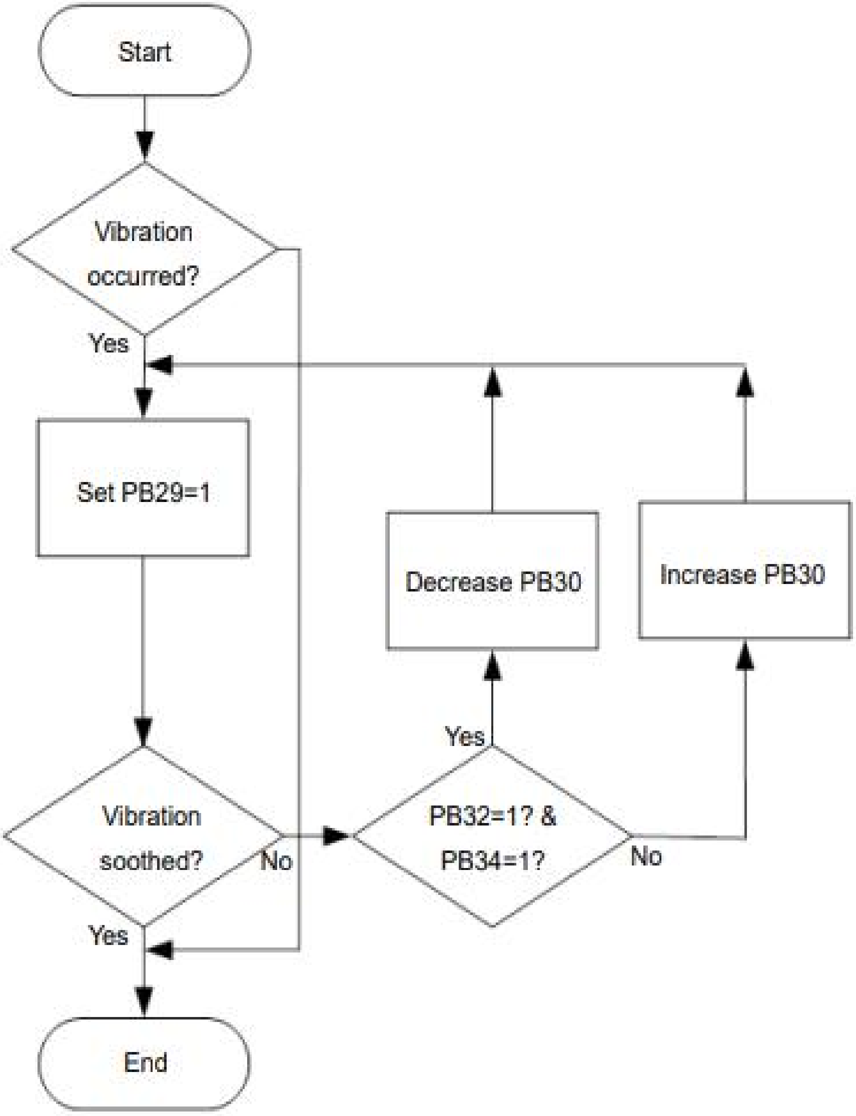
The SDC drive provides two groups of filters to perform auto low-frequency vibration suppression. The first group is PB31 and PB32, the second group is PB33 and PB34, of which PB31 and PB33 are the suppression frequencies, PB32 and PB34 are the suppression gain. When low-frequency vibration occurs, you can set PB29 to 1 to enable the auto suppression function when the vibration frequency is unknown, then the drive will automatically detect the vibration frequency and set the detected results to PB31, PB33 sequentially, and then set PB32, PB34 to 1 to enable the suppression function. PB29 will be automatically set back to 0 after auto-detection, and other detailed PB29 operation flow can be referred to the following table.

When PB29 is set to 1, if vibration still exists, please check whether PB32 and PB34 are both 0. If yes, it means that the vibration frequency is not detected, which may due to the vibration detection level setting is too high(Note 2), and you can lower the setting and perform re-detection. If not, it means that the vibration frequency is incorrectly detected, which may due to the vibration detection level setting is too low and the noise is mistakenly recognized as vibration, you can increase the setting before re-detection. The complete auto-suppression flowchart can be found in the following:

Note 1: Large gain may cause vibrate.
Note 2: Vibration detection level is the vibration peak to peak value, and the unit is pulse.

PB29 flow chart		
PB29 current value	PB29 value to be modified	Function
0	1	Clear PB31~34 values, enable the auto-suppression mode
1	0	Store PB31~34 value, disable the auto-suppression function.
1	1	Clear PB31~34 values, enable the auto -suppression mode

Flow chart of auto-resonance suppression



7.2.6 Gain switching function

The Shihlin servo provides gain switching function that can be used to switch the gain on a running or stopped servo motor. The switching can be performed by DI pins. When using gain switching function, manual mode is required(PA02 is set to □□□0 or □□□1). This function is disabled in auto tuning mode.

Some applicable occasions are as follows::

(1). When servo gain setting is too large and makes big noise during rotation, you can use gain switching to reduce the system gain.

(2). When the load inertia ratio changes drastically during operation, you can use gain switching to change the inertia ratio or gain value to ensure the stability of the servo system,

(3). Gain switching is used to increase the gain to improve the response of the servo system or shorten the settling time.

The gain switching related parameters and its functions are shown below.

Name	Name Abbr	Pr.No	Setting range	Unit	Default value	Control mode
Load to motor inertia ratio	GD1	PB06	0~1200	0.1 times	70	CoE, Pr, S
Position loop gain	PG1	PB07	4~1024	rad/s	45	CoE, Pr
Speed loop gain	VG1	PB08	40~9000	rad/s	183	CoE, Pr, S
Speed integral gain	VIC	PB09	1~1000	ms	34	CoE, Pr, S
Gain switching option	CDP	PB11	0000h~ 0008h	N/A	0000H	CoE, Pr, S
Gain switching condition value	CDS	PB12	0~4000000	Set as per parameter	10	CoE, Pr, S
Gain switching time constant	CDT	PB13	0~1000	ms	1	CoE, Pr, S
Load to motor inertia ratio 2	GD2	PB14	0~1200	0.1 times	70	CoE, Pr, S
Position control gain change rate	PG2	PB15	10~500	%	100	CoE, Pr
Speed control gain change rate	VG2	PB16	10~500	%	100	CoE, Pr, S
Speed integral gain change rate	VIC2	PB17	10~500	%	100	CoE, Pr, S

The gain switching related parameters are introduced as below:

(1). There are 4 gain switching related parameters, which are load inertia ratio GD1, position loop gain value PG1, speed loop gain value VG1, and speed integral gain value VIC, (PB06~PB09). They are adjusted in the same way as the manual mode, but its value may be changed during gain switching.

(2). Gain switching condition option CDP(PB11)

0	0	0	x

This parameter is to set the condition of gain switching by changing the lowest digit of the parameter. It triggers the gain switching by external digital input(DI) signal. The external digital input (DI) signal can be set as the gain switching function by parameters PD02~PD06.

x=0: Disabled gain switching.
x=1: Switching is performed when the gain switching signal CDP is ON.
x=3: Switching when the position deviation pulse is not less than the setting of CDS.
x=4: Switching when the servo motor speed is not less than the setting of CDS.
x=5: Switching when the gain switching signal CDP is OFF.
x=7: Switching when the position deviation pulse is not more than the setting of CDS.
x=8: Switching when the servo motor speed is not more than the setting of CDS.

(3) Gain switching condition value CDS (PB12)
The value (pulse, rpm) for setting the gain switching condition varies according to the setting of the CDP (PB11), and when set to □□□3, it is the pulse number, and when set to □□□4, it is the rpm. and the unit of the setting value varies according to the switching condition items.

PB11 setting	Switching condition	Unit
□□□3	When position deviation pulse is not less than CDS setting	pulse
□□□4	When motor speed is not less than CDS setting.	rpm
□□□7	When position deviation pulse is not more than CDS setting	pulse
□□□8	When motor speed is not more than CDS setting	rpm

(4). Time constant of gain switching CDT(PB13)
It is used to smooth the gain switching. If the gain setting is too large during gain switching, you can use PB13 to suppress the oscillation of the machine

(5). Load to motor inertia ratio 2 GD2 (PB14)
This parameter sets the load inertia ratio value to be switched. If the load inertia ratio does not change during operation, set PB14 to the value of GD1 (PB06).

(6). Change rate of PG2, VG2, and VIC2 during gain switching (PB15~PB17).
When performing the gain switching, the original servo gain value will be change to the set ratio of PG2, VG2, and VIC by a multiplication rate (%).

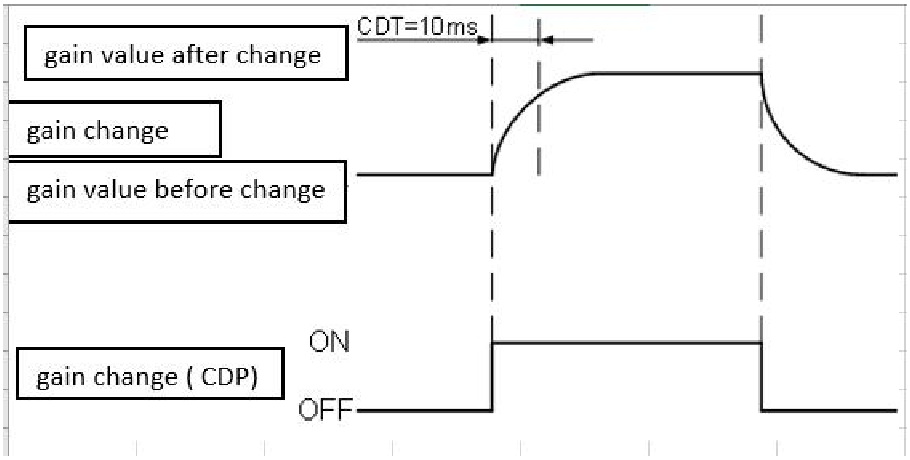
The following are a few gain switching examples.

Example 1: the digital input signal is selected as the switching source.

① The following parameters should be set:

Name	Name Abbr	Pr.No	Setting range	Unit
Load to motor inertia ratio	GD1	PB06	70	0.1 times
Position loop gain	PG1	PB07	100	rad/s
Speed loop gain	VG1	PB08	500	rad/s
Speed integral gain	VIC	PB09	100	ms
Gain switching option	CDP	PB11	0001	N/A
Gain switching time constant	CDT	PB13	10	ms
Load to motor inertia ratio 2	GD2	PB14	20	0.1 times
Position control gain change rate	PG2	PB15	80	%
Speed control gain change rate	VG2	PB16	120	%
Speed integral gain change rate	VIC2	PB17	150	%

② Gain switching diagram



③ The change status of parameters

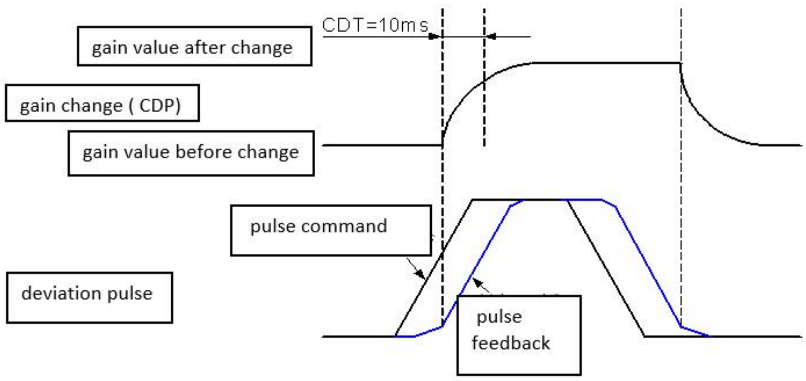
Name	CDP OFF		CDP ON		CDP OFF
Load to motor inertia ratio	10	→	20	→	10
Position loop gain	100	→	80	→	100
Speed loop gain	500	→	600	→	500
Speed integral gain	100	→	150	→	100

Example 2: deviation pulse is selected as switching source

①. The following parameters should be set:

Name	Name Abbr	Pr.No	Setting range	Unit
Load to motor inertia ratio	GD1	PB06	10	0.1 times
Position loop gain	PG1	PB07	100	rad/s
Speed loop gain	VG1	PB08	500	rad/s
Speed integral gain	VIC	PB09	100	ms
Gain switching option	CDP	PB11	0003	N/A
Gain switching condition value	CDS	PB12	100	pulse
Gain switching time constant	CDT	PB13	10	ms
Load to motor inertia ratio 2	GD2	PB14	20	0.1 times
Position loop gain change ratio	PG2	PB15	80	%
Speed loop gain change ratio	VG2	PB16	120	%
Speed integral gain change ratio	VIC2	PB17	150	%

②. Gain switching diagram



③. The change status of parameters

Name	CDP OFF		CDP ON		CDP OFF
Load to motor inertia ratio	10	→	20	→	10
Position loop gain	100	→	80	→	100
Speed loop gain	500	→	600	→	500
Speed integral gain	100	→	150	→	100

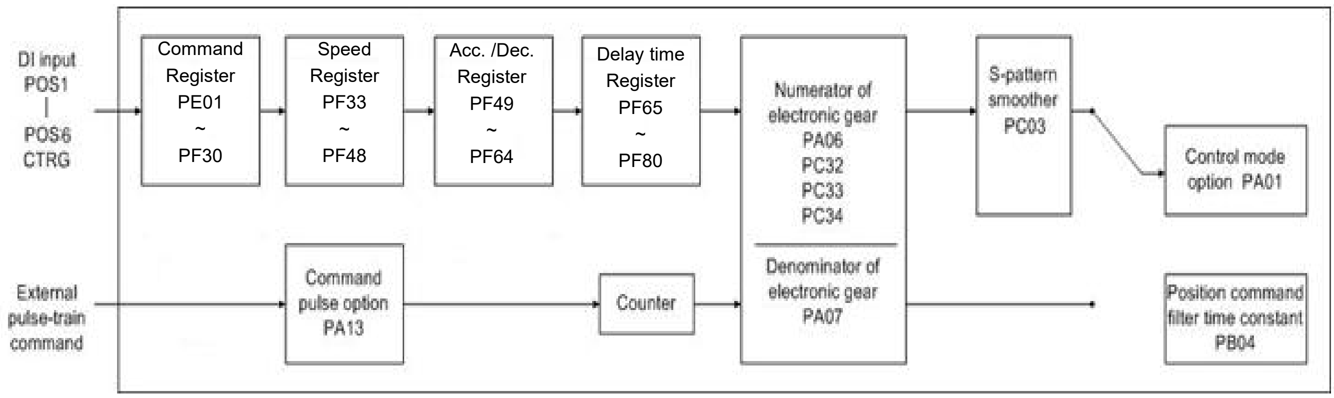
7.3 Position control mode

The Position Control Mode is for applications that require precision positioning, such as industrial machinery, processing machines, and so on. Shihlin servo position control commands apply internal register input mode. With the internal register input mode, you can manually input 63 groups of position command values (please refer to Chapter 8), and assign POS1~POS6 of DI for command switching. The following table describes the settings of terminal input and internal register input:

Name	Name Abbr	Pr.No	Setting range	Unit	Default value	Control mode	Description
Control mode setting value	STY	PA01 (*)	0000h ~ 1122h	N/A	1020h	ALL	Control mode setting value: u z y x x: set control mode x=0: position mode y: Position command input option y=1: internal register input

PA01 changes become valid after power cycling.

(*)The modification of PA01 would be valid by power off once and power on again.



Note: The S-pattern smooth is invalid when the external pulse-train commands are applied.

7.3.1 Internal position command (Pr command)

◆You can refer to details in Chapter 8.

The PR position command source is a 64-group built-in position command register of parameters (PE01~PE98), (PF01~PF30). With external I/O (CN1, POS1 ~ POS6 and CTRG), you can select one of the 64 groups as the position command. The details are shown in the following table.

Position command	POS6	POS5	POS4	POS3	POS2	POS1	CTRG	Related parameters
P0	0	0	0	0	0	0	↑	PE01
								PE02
P1	0	0	0	0	0	1	↑	PE03
								PE04
~								~
P50	1	1	0	0	1	0	↑	PF03
								PF04
P51	1	1	0	0	1	1	↑	PF05
								PF06
~								~
P63	1	1	1	1	1	1	↑	PF29
								PF30

Status of POS1 - POS6: 0 means that DI is off (the circuit is open); 1 means that DI is on (the circuit is closed).

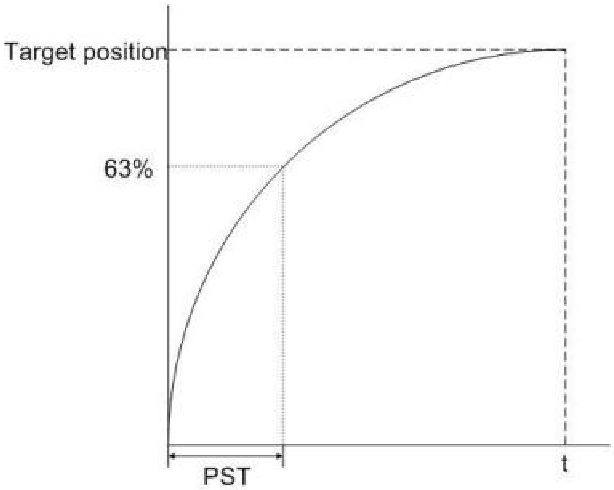
CTRG: indicates the moment the DI is switched from off(0) to on(1).

Absolute and incremental position registers are widely used, which are equivalent to a simple process control. You can easily complete a periodic operation according to the above table.

7.3.2 Smooth position command

When setting the filter time constant of position commands appropriately, the motor run smoothly even if drastically position command changes occur.

Name	Pr.No	Setting range	Unit	Default value	Control mode
Position command filter time constant	PB04	0~20000	ms	3	Pr

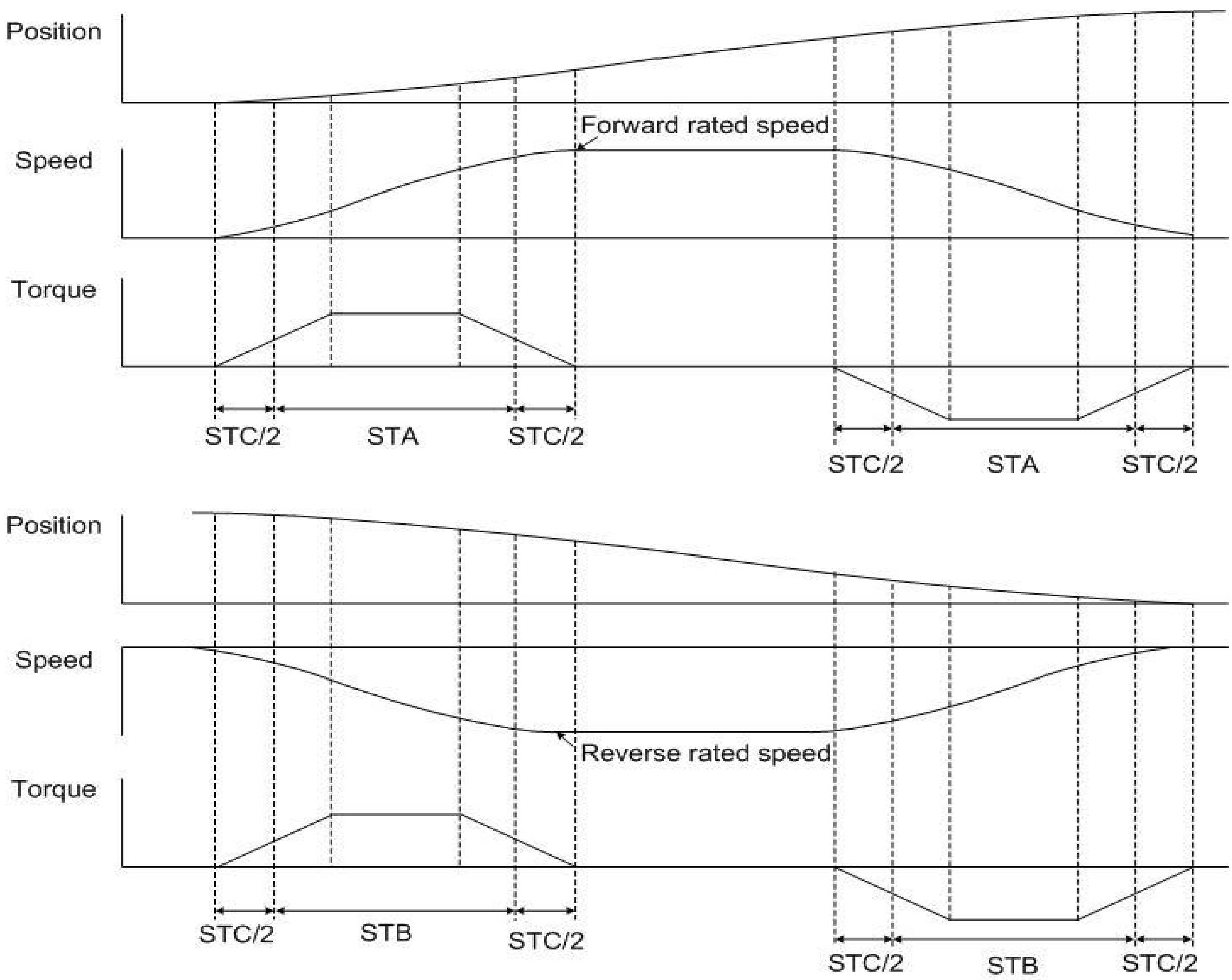


In addition, speed smoothing for acceleration/deceleration can also help the servo motor to run smoother. The speed smoothing parameter for position acceleration/deceleration is as follows:

Name	Name Abbr	Pr.No	Setting range	Unit	Default value	Control mode
S-curve acceleration /deceleration time constant	STC	PC03	0~10000	ms	0	Pr, S
Note: The acceleration and deceleration times for or PR mode, please refer to Chapter 8						

Using speed smoothing can effectively improve the feature of motor during acceleration and deceleration. When the load inertia increases or when the inertia changes significantly, the effects of inertia and friction will make the motor run irregularly. Increasing the setting of STC(PC03) can effectively improve it.

When position command is determined by external pulse, the parameters STA (PC01), STB (PC02), and STC (PC03) will be disabled, due to the external input pulse command has been determined by the upper controller, which is to provide the continuity of speed and angular acceleration.



The above figure shows that the acceleration and deceleration times are controlled by (PF49~PF64) when the position command is forward rotation or reverse rotation.

When using internal register to input position command, it is recommended to manually set the acceleration/deceleration time(PF49~PF64) and the S-curve acceleration/deceleration time constant(PC03), which can make the motor run smoother.

Note: Please refer to Chapter 8 for ACC and DEC settings.

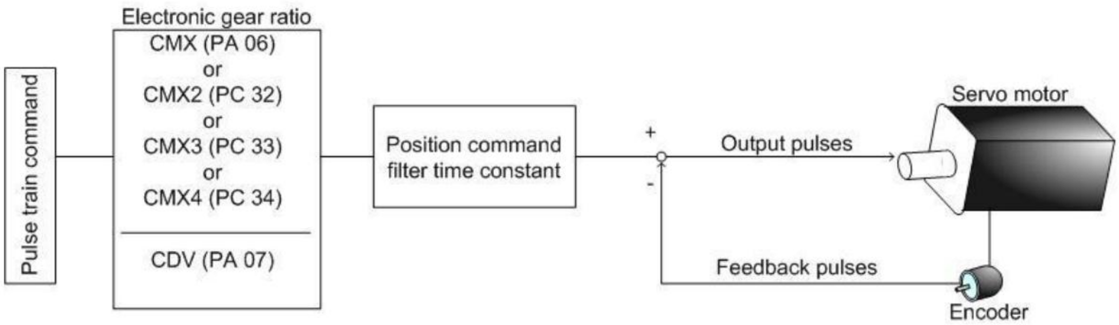
7.3.3 Electronic gear ratio (E-Gear ratio)

By changing the E-gear ratio setting, the transmission device can move different distance. The related parameters are shown in the table below:

Name	Name Abbr	Pr.No	Setting range	Unit	Default value	Control mode
E-Gear ratio numerator	CMX	PA06	$1\sim2^{26}$	N/A	1	CoE, Pr
E-Gear ratio denominator	CDV	PA07	$1\sim2^{26}$	N/A	1	CoE, Pr
E-Gear ratio numerator 2	CMX2	PC32	$1\sim2^{26}$	N/A	1	CoE, Pr
E-Gear ratio numerator 3	CMX3	PC33	$1\sim2^{26}$	N/A	1	CoE, Pr
E-Gear ratio numerator 4	CMX4	PC34	$1\sim2^{26}$	N/A	1	CoE, Pr

Incorrect setting of E-gear ratio will cause servo motor burst, so you should set these parameters when servo is OFF. The setting value must be within the range of 1/50 < (CMX/CDV) < 64000, otherwise the motor cannot operate normally.

The relationship between the numerator and the denominator of the E-gear ratio and the command are showing in the figure below:



There are four groups of E-gear ratio numerators optional, You can set the two DI as CM1 and CM2 to switch them, please refer to the table below.

Name	CM1	CM2	Control mode
E-Gear ratio numerator 1 (PA06)	0	0	CoE, Pr
E-Gear ratio numerator 2 (PC32)	1	0	CoE, Pr
E-Gear ratio numerator 3 (PC33)	0	1	CoE, Pr
E-Gear ratio numerator 4 (PC34)	1	1	CoE, Pr

- 0: CMx-SG is open-circuited, 1: CMx-SG is short-circuited.

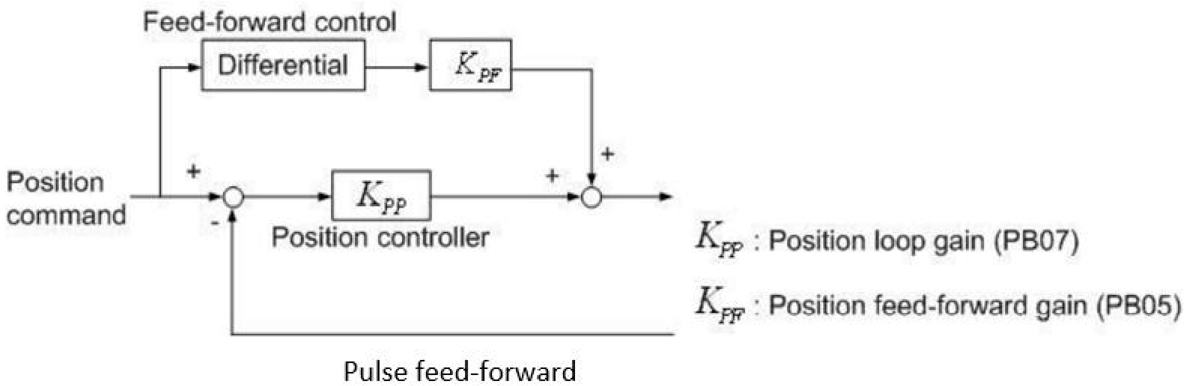
7.3.4 Torque limit of position loop

Same as section 7.2.3

7.3.5 Position loop gain

Since the position loop includes speed loop, if you uses the manual mode to adjust the gain values, it is necessary to set the speed gain related parameters first (refer to section 7.2.4), and then set the position proportional gain and the position feed-forward gain. The position loop gain can be set to 1/4 ~ 1/6 of speed loop gain value.

You can also use the auto-tuning mode to set the position and speed related gain automatically. The block diagram of the position loop is as follows:



The parameters related to position gain adjustment are listed below:

Name	Name Abbr	Pr.No	Setting range	Unit	Default value	Control mode
Auto tuning mode option	ATUM	PA02	0000h~0004h	N/A	0002h	CoE, Pr, S
Auto-tuning response level setting	ATUL	PA03	1~32	N/A	10	CoE, Pr, S
Position feed-forward gain	FFC	PB05	0~200	%	0	CoE, Pr
Position loop gain	PG1	PB07	4~1024	rad/s	45	CoE, Pr

When the position loop gain PG1 (PB07) is set too large, although the bandwidth and response become faster, the motor will rotate back and forth with vibration, which is not allowed in precise position control applications, so you must reduce the PG1 value to avoid vibrate.

If the bandwidth is limited by the mechanical parts, the position command is not able to be tracked, which will cause big position deviation. You can use the position feed-forward gain to reduce the position tracking dynamic deviation, in other words, using position feed-forward gain will shorten the position settling time.

Position feed-forward gain adjustment should set from low to high. Theoretically, setting to 1 should be the best. If the setting is too large, the machine may vibrate. In this case, the position feed-forward value should be reduced until no vibration occurs.

7.4 Dual mode

Shihlin servo supports one dual mode, and you can set PA01 to use it. See the table below:

<table>
<tr><th colspan="2">Mode name</th><th>Mode code</th><th>PA01 setting value</th><th>Description</th></tr>
<tr><td>Dual mode</td><td>Internal register Position-Speed</td><td>Pr-S</td><td>1011h</td><td>Switch Pr and S mode with DI signal.</td></tr>
</table>

When using dual mode, the DI and DO assignment is very important in order to avoid insufficient DI/DO pins.

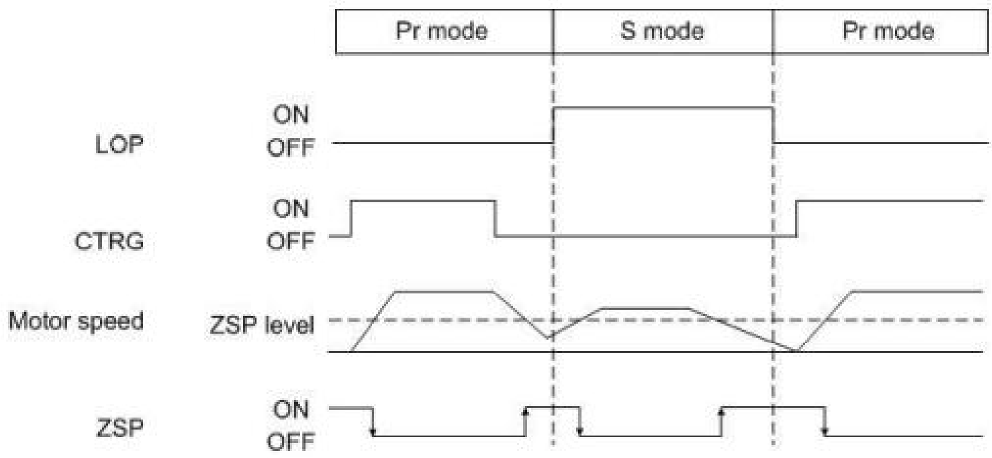
The DI pin of the switching mode is LOP pin, you should enable LOP by DI. And its description is shown in the table below:

<table>
<tr><th>Name</th><th>Name Abbr</th><th>I/O type</th><th>CN1 Pin</th><th>Description</th><th>Control mode</th></tr>
<tr><td>Control mode switch</td><td>LOP</td><td>DI</td><td>CN1-7
~
CN1-11</td><td>Used to select the control mode in position/speed control switching mode<table><tr><th>(Note) LOP</th><th>Control mode</th></tr><tr><td>0</td><td>Position (Pr)</td></tr><tr><td>1</td><td>Speed</td></tr></table>Note:
0: OFF(LOP-SG is open-circuited)
1: ON(LOP-SG is short-circuited)</td><td>Described according to different control mode</td></tr>
</table>

7.4.1 Position/speed dual mode

The Pr/S mode can be switched by the LOP terminal of DI pin. When parameter PA01 is set to Pr/S switching mode, the switching timing diagram is as follows:

The mode cannot be switched if the motor is running at high speed. When DO ZSP is on, you can perform the mode switching, and it is recommended to wait until the motor stops completely before mode switching.



7.5 Other functions

DANGER	●Before connecting to device interface, turn off the power and wait for 20 minutes until the charging LED turns off, and check the residual voltage by meter. Otherwise, it may cause electric shock.

CAUTION	●Please use specified device interface to avoid fire or malfunction.

7.5.1 Selection of regenerative resistor

CAUTION	●Only specified regenerative resistor can be used, otherwise, a fire disaster may occur.

When the direction of torque is opposite to the direction of rotation, the motor is changed to a generator, the energy generated returns to the servo drive from the load, the voltage of P-N will rise during this time. It requires regenerative protection function to stabilize the voltage within the safe value of 370V, and to avoid the destruction of the module and capacitor. The function mainly consists of IGBT and resistor. Regenerative energy is consumed by the resistor, so it is necessary to pay attention to the amount of energy that the resistor can withstand before using it. The regenerative protection function is controlled by the regeneration IGBT, you should check it before using. If the regenerative IGBT is damaged, stop the motor immediately to avoid the continuous regenerative energy, which may cause damage to the drive.

The drive has built-in regenerative resistor, if the regenerative energy is too large, it is not recommended to use the built-in regenerative resistor, you should use an external regenerative resistor instead, to avoid overheating of the built-in regenerative resistor or energy that cannot be consumed which may damage the drive.

For the drive of 400W (including) or above, it has a built-in regenerative resistor in P-C terminal. If external regenerative resistor is needed, please connect it to the P-C terminal. (Do not connect the built-in regenerative resistor to P-C terminal when using an external one.)

The following table describes the specifications of the built-in regenerative resistors of each model:

Drive(W)	Specification of built-in regenerative resistor		The Min permissible resistance (Ω)	Consumption capacity of built-in resistor(W)
	Resistance(Ω)	Capacitor(W)		
100	N/A			
200				
400	100	20	100	10
750	40	40	40	20
1000	40	40	40	20

◆Please set the resistance value (PA10) and capacity (PA11) of the regenerative resistor correctly, otherwise it will affect the function.

◆The regenerative consumption capacity of built-in regenerative resistors is the average value of the regenerative capacity, and its value is 50% of its rated capacity. Same rule should be applied on the external regenerative resistor

If the regenerative capacity exceeds the capacity of the built-in regenerative resistor, an external regenerative resistor should be connected, and it's suggested to choose one with the same resistance value. If connecting series-parallel mode, please make sure that the resistance value meets the limitation. For safety reasons, you can use regenerative resistors equipped with thermal switches to reduce the temperature of resistor, and can also apply forced cooling. Contact the manufacturer for the load characteristics of the regenerative resistor.

When using external regenerative resistor, please use the recommended values in the above table. To easily estimate the required capacity of the regenerative resistor, below is the instruction of selecting the external regenerative resistor capacity:

(a) Without external load torque

If the motor operating in a back-and-forth mode, the regenerative energy generated by the brakes will enter the capacitor of the DC bus first, and the regenerative resistor will consume the excess energy when the voltage of the capacitor exceeds a certain value. Here introduces how to select the regenerative resistor.

The following table provides the formula for energy calculation, you can refer to it when selecting.

Drive(W)		Motor	Motor inertia J(x10^{-4}kgm^2)	Regenerative energy generated when the motor decelerates from the rated speed to 0 without load Es(joule)	Regenerative energy of capacitor Ec(joule)	Max. motor speed (rpm)
Low inertia	100	SME-L00530O□□	0.03	0.15	9.90	3000
		SME-L01030O□□	0.052	0.26	9.90	3000
	200	SME-L02030O□□	0.161	0.79	9.90	3000
	400	SME-L04030O□□	0.277	1.37	9.90	3000
	750	SME-L07530O□□	1.07	5.28	16.80	3000
	1K	SME-L10020O□□	6.1	13.38	16.80	2000

The formula for calculating the capacity of regenerative resistor by using the Es and Ec is as follows:

The capacity of regenerative resistor ==> $2\times\left((N+1)\times E_S - E_C\right)/T$

Where N is the load inertia ratio, T is the operation cycle (manually set).

Assuming that the load inertia is N times the motor inertia, and when the motor decelerates from 3,000 rpm to 0, the regenerative energy is (N+1) x Es and the regenerative resistor needs to consume (N+1) x Es-Ec Joules. Assume that the operation cycle is T sec, then the required power of regenerative resistor = 2 × ((N+1) × Es-Ec)/T.

The calculation is as follows:

In the following table, J is the motor inertia (unit: kg*m2), and Wr is the maximum speed in a action cycle(unit: rpm).

Step	Item	Calculation formula and setting method
1	Set the operation cycle T	Manual input(round-trip action cycle)
2	Set rotation speed Wr	Manual input or read from panel display(r)
3	Set load/motor inertia ratio N	Manual input or read from panel display (Dc) (PA02=0002 is valid)
4	Calculate the maximum regenerative energy Es	Es = J * Wr^2 / 182 (if it's rated speed, you can check the value in the table directly)
5	Set the consumable regenerative energy Ec	Refer to the above table
6	Calculate the capacity of regenerative resistor	2 * ((N + 1) * Es - Ec) / T

Example:

Take 400W model as an example, the operation cycle is T = 0.5 sec, the maximum rotation speed is 3000rpm, the load inertia is 10 times of the motor inertia, then the required capacity of the regenerative resistor = 2 x ((10 + 1) x 1.37 - 9.90) / 0.5 = 13.6W. Therefore, it is necessary to connect an external regenerative resistor more than 16W.

Note: Since the maximum speed of 3000rpm is the rated speed of 400W, the table on the previous page can be used to find out Es = 1.37 J.

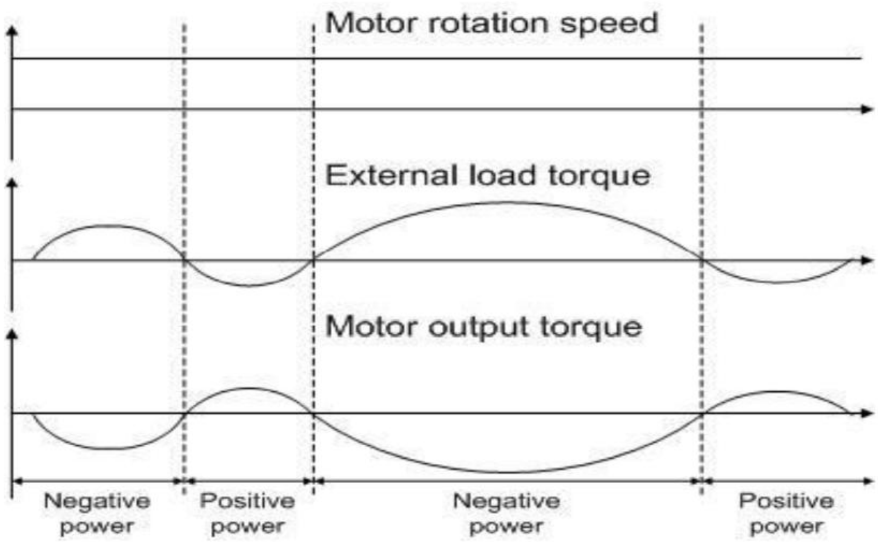
In general, the built-in regenerative resistor can meet the requirement when the external load is not too large. When the regenerative resistance is too small, it will accumulate more and more energy and temperature. When the temperature exceeds a certain value, it is easy to burn out the brake resistor.

You can refer to section 16.2 when using an external regenerative resistor.

(b) When there is external torque and the motor does the negative work.

Usually, the motor does positive work and the motor's torque direction is identical to the rotation direction. However, in some special cases, when the external load exceeds torque, the external energy is applied to the servo drive through the motor and generate regenerative energy.

In the below example, when the motor is running at constant speed, the external load torque is positive in most of the time, and a large amount of energy is transferred quickly to the regenerative resistor.



Negative work by external load torque: TL x ω

In which TL: external load torque(Unit: Nt-m), ω: rotation speed(Unit: rad/s).

For safety, it is suggested calculating in the safest situation.

For example: when the external load torque is +50% of the rated torque and the motor speed reaches 3000 rpm, for a 400W model (rated torque: 1.27Nt-m), an external regenerative resistor which is 2 x (0.5x 1.27) x (3000 x 2 x π/60) = 399W, 100Ω is needed.

Note: 1rpm = 2π / 60 (rad/s).

7.5.2 The use of electromagnetic braking

The drive controls the brake with DO. If (1) MBR is set to off, it means the brake is not operating and the motor is clamped; if (2) MBR is set to on, it means the brake is operating and the motor can run freely. You can use PC16 to control the electromagnetic brake by setting the delay time from SON signal OFF to electromagnetic brake interlock signal (MBR) OFF. An electromagnetic brake is usually applied in the Z-axis (vertical axis) direction. The motor lifetime will be reduced due to the excessive heat generated by continuous resistance. To avoid incorrect operation, the brake can be enabled only when the servo is switched off, the brake signal controls the solenoid valve and provides power for electromagnetic brake operation.

◆ The brake signal controls the solenoid valve to magnetize, making external 24V power supply as a circuit to provide power for turning on the electromagnetic brake.

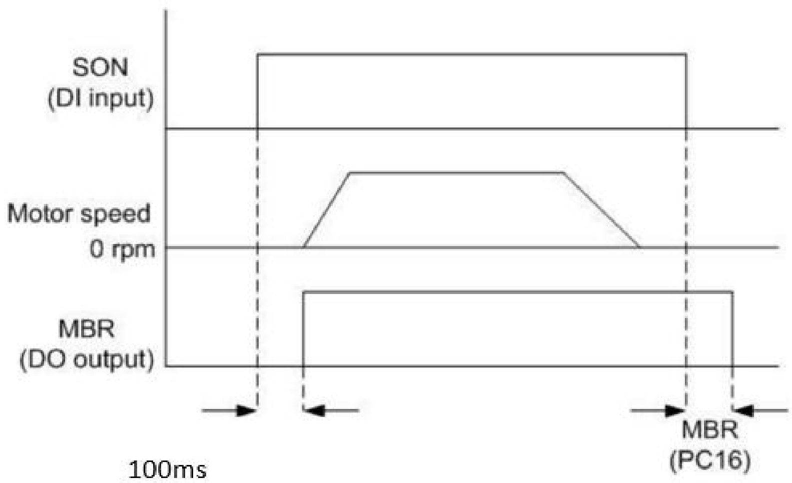
◆ Brake coil has no polarity.

◆ It is prohibited to use the drive's internal +24V power supply (VDD) as the motor brake power supply.

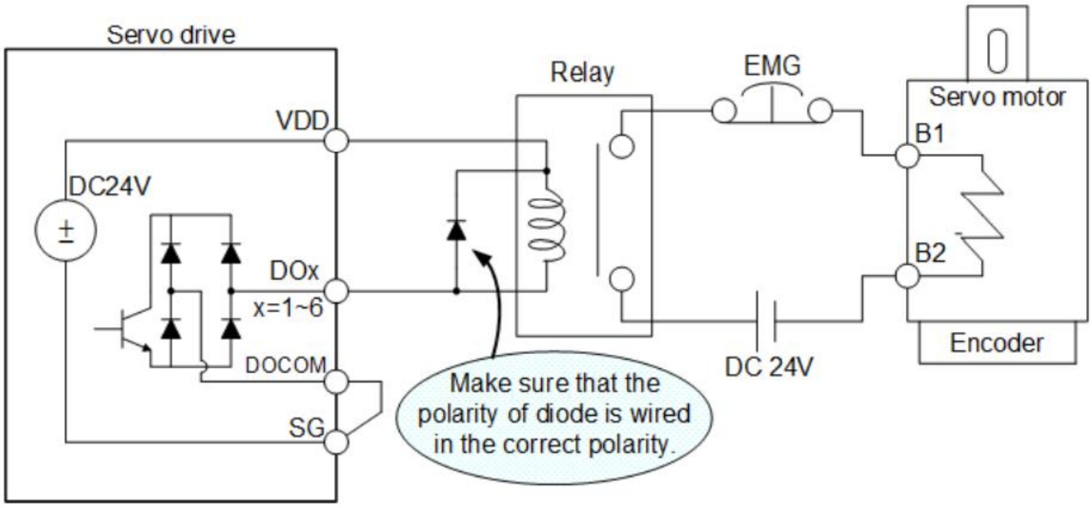
◆ If the MBR DO signal is not applied, you should follow the MBR brake control timing diagram.

◆ To enable the DO MBR function, set PA01 to 01☐☐.

Electromagnetic brake control timing diagram:



Wiring diagram of electromagnetic brake:



Specifications of electromagnetic brake

Motor model name	SME series			
	L01030B	L02030B/ L04030B	L07530B	L10030B
Electromagnetic brake type	Spring-loaded safety brake			
Rated voltage (V)	DC 24V			
Power consumption (W)	7.2	7.6	8	10
Rated current (A)	0.3	0.32	0.33	0.42
Static friction torque (N*m)	0.3	1.3	2.5	3.2

Motor model name	SM3 series		
	M01030B	M02030B/ M04030B/ H04030B	M07530B H07530B M10030B
Electromagnetic brake type	Spring-loaded safety brake		
Rated voltage (V)	DC 24V		
Power consumption (W)	6.1	7.6	10
Rated current (A)	0.25	0.31	0.48
Static friction torque (N*m)	0.32	1.5	3.2

⚠ Caution:

Electromagnetic brake is only for safety holding of the motor in stopped state, not for motor deceleration braking.

8.Parameters

8.1 Parameter definitions

According to the safety and frequency of use, the parameters are divided into basic parameters, gain and filter parameters, extension parameters, and input/output setting parameters. If it is necessary to adjust the parameters read/write access, modify the setting value of parameter PA42 so that the setting of the extension parameter can be changed.
The following are the precautions of parameter setting.

1.Parameter type
In section 8.2, parameters are classified into a parameter list according to its function, which is easy to search. For detailed parameter descriptions, you can refer to section 8.3.

2.Special symbols for parameter codes
(■) Parameter resets to its default value after power cycling.
(*) Parameter changes become valid after power cycling, such as PA01.
(▲) You are not able to set the parameter when Servo is ON, such as PA07. And there are 2 ways to turn off the servo.
(1) Turn off the DI SON signal.

(2) Set SON signal to 0 by changing PD16, and ensure to restore PD16 as external terminal mode after the modification.

They are categorized according to function as follows:

Parameter group	Main content
Basic parameters (No PA□□)	This is the basic parameter to be set when the servo drive is used for position control.
Gain, filter parameters (No PB□□)	When the manual tuning gain is used, please set these parameters.
Extension setting parameters (No PC□□)	This is the main parameter to be set when the servo drive is used in the speed mode, torque control mode, and E-cam function.
Input/output setting parameters (No PD□□)	Used to change the output/input signals of the servo drive.
Pr path parameters 1 (No PE□□)	Related parameters group 1 for Pr position path planning.
Pr path parameters 2 (No PF□□)	Related parameters group 2 for Pr position path planning.

The description of control modes is as follows:

<table>
<tr><th colspan="2">Mode name</th><th>Mode code</th><th>Description</th></tr>
<tr><td rowspan="3">Single mode</td><td>EtherCAT communication mode</td><td>CoE</td><td>In EtherCAT communication mode, the drive receives servo commands from the upper controller and runs the motor to the target position, speed, or torque to complete the control task.</td></tr>
<tr><td>Position mode(internal register input)</td><td>Pr</td><td>The drive receives the position command which is provided by the internal register and runs the motor to the target position.
You can use the DI signal to select the register number.</td></tr>
<tr><td>Speed mode</td><td>S</td><td>The drive receives the speed command and runs the motor to the target speed. The speed command can be selected by DI signal to choose between analog voltage commands or internal speed commands (7 group register)</td></tr>
<tr><td colspan="2">Dual mode</td><td>Pr-S</td><td>Pr/S is switched via the signal of DI.</td></tr>
</table>

8.2 List of parameters

The parameters of Shihlin servo are mainly classified into five groups, they are PA parameter group ~ PF parameter group. PA parameters are basic parameters, such as control mode selection, auto tuning function, etc. The PB parameters are gain and filter parameters. The PB parameters makes the servo motor to run in a more stable state. PC parameters are extension parameters, which include speed mode, torque mode and E-cam function parameters, as well as analog-related parameters and communication settings. PD parameters are input and output setting parameters, which are mainly used to manually set the DI and DO parameters. PE and PF parameters are Pr path planning related parameters. The following table lists all the parameters of Shihlin servo drive, which is easier for you to enquiry.

(1) Basic parameters

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PA01(*)	STY	Control mode setting	1020h	N/A	O	O	O
PA02(▲)	ATUM	AUTO tuning mode setting	0002h	N/A	O	O	O
PA03	ATUL	Auto-tuning response level setting	10	N/A	O	O	O
PA04	HMOV	Homing mode	0000h	N/A		O	
PA05	TL1	Internal torque limit 1	100	%	O	O	O
PA06	CMX	E-gear ratio numerator	1	N/A	O	O	
PA07(▲)	CDV	E-gear ratio denominator	1	N/A	O	O	
PA08	HSPD1	Homing high speed option 1	100	rpm		O	
PA09	HSPD2	Homing high speed option 2	20	rpm		O	
PA10	RES1	Regenerative resistor value	Depend on model	Ohm	O	O	O
PA11	RES2	Regenerated resistor capacity		Watt	O	O	O
PA12	INP	In-position range		pulse	O	O	
PA13		Reserved					
PA14		Reserved					
PA15	CRSHA	Motor crash protection level(torque percentage)	0	%	O	O	O
PA16	CRSHT	Motor crash protection level (protection time)	1	ms	O	O	O
PA17	OVL	Output overload warning level	120	%	O	O	O
PA18	OVS	Over speed protection level	6300	rpm	O	O	O
PA19	OVPE	Position deviation exceed output level	$3*2^{24}$	pulse	O	O	
PA20		Reserved					
PA21		Reserved					

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	**Pr**	**S**
PA22(*)	DBF	Dynamic brake control	0	N/A	O	O	O
PA23(■)	MCS	Memory write-inhibit function	0	N/A	O	O	O
PA24(*)		Reserved					
PA25		Reserved					
PA26		Reserved					
PA27		Reserved					
PA28(*)	ABS	Absolute encoder setting	0000h	N/A	O	O	O
PA29(■)	CAP	Absolute position reset	0000h	N/A	O	O	O
PA30(■)	UAP	Update encoder absolute position	0	N/A	O	O	O
PA31	APST	Absolute coordinate system status	0000h	N/A	O	O	O
PA32	APR	Encoder absolute position (pulse number)	0	pulse	O	O	O
PA33	APP	Encoder absolute position (number of revolutions)	0	rev	O	O	O
PA34		Reserved					
PA35(■)	ATST	One-touch tuning execution	0	-	O	O	O
PA36	AOP3	One-touch tuning function option	0	-	O	O	O
PA37(*)	FNO3	Function option 3**(the function is forbidden to use as it is for factory test)**					
PA38(*)	FNO1	Motor rotation direction option					
PA39(*)		Reserved					
PA40(▲)	SPW	Special parameter write-in function	0000h	N/A	O	O	O
PA41		Reserved					
PA42(*)	BLK	Parameter write-inhibit setting	0000h	N/A	O	O	O
PA43(*)	ENB	Encoder type	0003h	N/A	O	O	O
PA44(*)	EGM	E-gear ratio mode option	0	N/A		O	
PA45(*)	FBP	Position command pulse number setting per revolution	10000	Pulse		O	
PA46		Reserved					
PA47	TLP	Positive torque limit value	5000	0.1%	O	O	O
PA48	TLN	Negative torque limit value	5000	0.1%	O	O	O
PA49(*)	FNO2	Function option 2 **(this function is forbidden to use as it is for factory test)**					
PA50	MLVS	Multi-revolution limit setting	0	rev	O	O	O

(2) Gain and filter parameters

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PB01	NHF1	Frequency of Machine resonance suppression filter 1	1000	Hz	O	O	O
PB02	NHD1	Attenuation rate of machine resonance suppression filter 1	0	dB	O	O	O
PB03	NLP	Resonance suppression low-pass filter	17	0.1 ms	O	O	O
PB04	PST	Position command filter time constant	3	ms	O	O	
PB05	FFC	Position feed-forward gain	0	0.0001	O	O	
PB06	GD1	Load to motor inertia ratio	70	0.1 times	O	O	O
PB07	PG1	Position loop gain	45	rad/s	O	O	
PB08	VG1	Speed loop gain	183	rad/s	O	O	O
PB09	VIC	Speed integral gain	34	ms	O	O	O
PB10	VFG	Speed feed-forward gain	0	%	O	O	O
PB11(*)	CDP	Gain switching option	0000h	N/A	O	O	O
PB12	CDS	Gain switching condition value	10	Kpps /rpm /pulse	O	O	O
PB13	CDT	Gain switching time constant	1	ms	O	O	O
PB14	GD2	Load to motor inertia ratio 2	70	0.1 times	O	O	O
PB15	PG2	Position loop gain change ratio	100	%	O	O	
PB16	VG2	Speed loop gain change ratio	100	%	O	O	O
PB17	VIC2	Speed integral gain change ratio	100	%	O	O	O
PB18	SFLT	Speed command low-pass filter time constant	0	ms	O		O
PB19	TQC	Torque command filter time constant	0	ms			
PB20	SJIT	Speed feedback filter time constant	0	0.1 ms	O	O	O
PB21	NHF2	Frequency of machine resonance suppression filter 2	1000	Hz	O	O	O
PB22	NHD2	Attenuation rate of machine resonance suppression filter 2	0	dB	O	O	O
PB23	NDF	Motor noise suppression function	0	N/A	O	O	O
PB24	VDC	Speed differential compensation	980	N/A	O	O	O
PB25	NHF3	Frequency of mechanical resonance suppression filter 3	1000	Hz	O	O	O
PB26	NHD3	Attenuation rate of mechanical resonance suppression filter 3	0	dB	O	O	O

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PB27	ANCF	Auto resonance suppression mode setting	1	N/A	O	O	O
PB28	ANCL	Auto resonance detection level	50	%	O	O	O
PB29	AVSM	Auto low frequency vibration suppression mode setting	0	N/A	O	O	
PB30	VCL	Low-frequency vibration detection level	50	pulse	O	O	
PB31	VSF1	Low-frequency vibration suppression frequency setting 1	100	0.1Hz	O	O	
PB32	VSG1	Low-frequency vibration suppression gain 1	0	N/A	O	O	
PB33	VSF2	Low-frequency vibration suppression frequency setting 2	100	0.1Hz	O	O	
PB34	VSG2	Low-frequency vibration suppression gain 2	0	N/A	O	O	
PB35	FRCL	Friction compensation level	0	%	O	O	O
PB36	FRCT	Friction compensation smoothing time constant	0	ms	O	O	O
PB37	FRCM	Friction compensation mode option	0	N/A	O	O	O
PB38	FFCT	Position feed forward filter time constant	0	ms	O	O	
PB39		Reserved					
PB40		Reserved					
PB41		Reserved					
PB42		Reserved					
PB43		Reserved					
PB44	PPD	Position loop compensation gain	0	rad/s	O	O	O
PB45	NHF4	Frequency of mechanical resonance suppression filter 4	1000	Hz	O	O	O
PB46	NHD4	Attenuation rate of mechanical resonance suppression filter 4	0	dB	O	O	O
PB47	NHF5	Frequency of mechanical resonance suppression filter 5	1000	Hz	O	O	O
PB48	NHD5	Attenuation rate of mechanical resonance suppression filter 5	0	dB	O	O	O
PB49	DST	External disturbance suppression gain	0	N/A	O	O	O
PB50	MVF	Position command average filter time constant	0	ms	O	O	

(3) Extension parameters

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PC01	STA	Acceleration time constant	200	ms		O	O
PC02	STB	Deceleration time constant	200	ms		O	O
PC03	STC	S-curve acceleration/deceleration time constant	0	ms		O	O
PC04	JOG	JOG speed command	300	rpm	O	O	O
PC05	SC1	Internal speed command 1	100	rpm			O
PC06	SC2	Internal speed command 2	500	rpm			O
PC07	SC3	Internal speed command 3	1000	rpm			O
PC08	SC4	Internal speed command 4	200	rpm			O
PC09	SC5	Internal speed command 5	300	rpm			O
PC10	SC6	Internal speed command 6	500	rpm			O
PC11	SC7	Internal speed command 7	800	rpm			O
PC12		Reserved					
PC13		Reserved					
PC14		Reserved					
PC15		Reserved					
PC16	MBR	Electromagnetic brake output delay time	100	ms	O	O	O
PC17	ZSP	Zero speed range	50	rpm	O	O	O
PC18(*)	COP1	Stop option and power interruption restart option	0010h	N/A	O	O	O
PC19(*)	COP2	Alarm record clear option	0000h	N/A	O	O	O
PC20(*)	SNO	Servo drive communication device number	1	N/A	O	O	O
PC21(*)	CMS	Communication mode setting	0010h	N/A	O	O	O
PC22		Reserved					
PC23	SIC	Serial communication timeout option	0	s	O	O	O
PC24(*)	DMD	Drive status display option	0000h	N/A	O	O	O
PC25	TL2	Internal torque limit 2	100	%	O	O	O
PC26		Reserved					
PC27		Reserved					
PC28		Reserved					
PC29		Reserved					
PC30		Reserved					
PC31		Reserved					

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PC32	CMX2	Electronic gear ratio numerator 2	1	N/A	O	O	
PC33	CMX3	Electronic gear ratio numerator 3	1	N/A	O	O	
PC34	CMX4	Electronic gear ratio numerator 4	1	N/A	O	O	
PC35		Reserved					
PC36		Reserved					
PC37		Reserved					
PC38	ESYC	EtherCAT Sync abnormal value setting	0	N/A	O		
PC39	ESS	EtherCAT communication address option	0	N/A	O		
PC40		Reserved					

(4) Input/output parameters

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PD01(*)	DIA1	Input signal automatic ON option	0000h	N/A	O	O	O
PD02(*)	DI1	Input signal option 1	0000h	N/A	O	O	O
PD03(*)	DI2	Input signal option 2	0000h	N/A	O	O	O
PD04(*)	DI3	Input signal option 3	0000h	N/A	O	O	O
PD05(*)	DI4	Input signal option 4	000Bh	N/A	O	O	O
PD06(*)	DI5	Input signal option 5	0018h	N/A	O	O	O
PD07		Reserved					
PD08		Reserved					
PD09		Reserved					
PD10(*)	DO1	Output signal option 1	0000h	N/A	O	O	O
PD11(*)	DO2	Output signal option 2	0000h	N/A	O	O	O
PD12(*)	DO3	Output signal option 3	0002h	N/A	O	O	O
PD13		Reserved					
PD14		Reserved					
PD15(*)	DIF	Digital input filter setting	0002h	N/A	O	O	O
PD16(■)	IOS	Digital input source control option	0000h	N/A	O	O	O
PD17(*)	DOP1	LSP, LSN stop mode option	0000h	N/A	O	O	O
PD18(*)	DOP2	CR signal clear mode option	0000h	N/A	O	O	
PD19(*)	DOP3	Alarm code output option	0000h	N/A	O	O	O
PD20(*)	DOP4	Operation option when the alarm reset signal is short-circuited	0000h	N/A	O	O	O
PD21		Reserved					
PD22		Reserved					
PD23		Reserved					
PD24		Reserved					
PD25(■)	ITST	Communication control DI status	0000h	N/A	O	O	O
PD26		Reserved					
PD27(*)	DOD	Output signal contact definition	0004h	N/A	O	O	O
PD28	MCOK	Motion completion(DO:MC_OK) option	0000h	N/A		O	
PD29(*)	DID	Software DI A/B contact definition	0000h	N/A	O	O	O
PD30~ PD32		Reserved					
PD33	SFDO	Software DO register	0000h	N/A	O	O	O
PD34~ PD40		Reserved					

(5) Pr position path planning parameters 1

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PE01	ODEF	Homing definition	00000000h	N/A		O	
PE02	ODAT	Origin definition	0	N/A		O	
PE03	PDEF1	PATH#1 definition	00000000h	N/A		O	
PE04	PDAT1	PATH#1 data	0	N/A		O	
PE05	PDEF2	PATH#2 definition	00000000h	N/A		O	
PE06	PDAT2	PATH#2 data	0	N/A		O	
PE07	PDEF3	PATH#3 definition	00000000h	N/A		O	
PE08	PDAT3	PATH#3 data	0	N/A		O	
PE09	PDEF4	PATH#4 definition	00000000h	N/A		O	
PE10	PDAT4	PATH#4 data	0	N/A		O	
PE11	PDEF5	PATH#5 definition	00000000h	N/A		O	
PE12	PDAT5	PATH#5 data	0	N/A		O	
PE13	PDEF6	PATH#6 definition	00000000h	N/A		O	
PE14	PDAT6	PATH#6 data	0	N/A		O	
PE15	PDEF7	PATH#7 definition	00000000h	N/A		O	
PE16	PDAT7	PATH#7 data	0	N/A		O	
PE17	PDEF8	PATH#8 definition	00000000h	N/A		O	
PE18	PDAT8	PATH#8 data	0	N/A		O	
PE19	PDEF9	PATH#9 definition	00000000h	N/A		O	
PE20	PDAT9	PATH#9 data	0	N/A		O	
PE21	PDEF10	PATH#10 definition	00000000h	N/A		O	
PE22	PDAT10	PATH#10 data	0	N/A		O	
PE23	PDEF11	PATH#11 definition	00000000h	N/A		O	
PE24	PDAT11	PATH#11 data	0	N/A		O	
PE25	PDEF12	PATH#12 definition	00000000h	N/A		O	
PE26	PDAT12	PATH#12 data	0	N/A		O	
PE27	PDEF13	PATH#13 definition	00000000h	N/A		O	
PE28	PDAT13	PATH#13 data	0	N/A		O	
PE29	PDEF14	PATH#14 definition	00000000h	N/A		O	
PE30	PDAT14	PATH#14 data	0	N/A		O	
PE31	PDEF15	PATH#15 definition	00000000h	N/A		O	
PE32	PDAT15	PATH#15 data	0	N/A		O	
PE33	PDEF16	PATH#16 definition	00000000h	N/A		O	
PE34	PDAT16	PATH#16 data	0	N/A		O	
PE35	PDEF17	PATH#17 definition	00000000h	N/A		O	

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PE36	PDAT17	PATH#17 data	0	N/A		O	
PE37	PDEF18	PATH#18 definition	00000000h	N/A		O	
PE38	PDAT18	PATH#18 data	0	N/A		O	
PE39	PDEF19	PATH#19 definition	00000000h	N/A		O	
PE40	PDAT19	PATH#19 data	0	N/A		O	
PE41	PDEF20	PATH#20 definition	00000000h	N/A		O	
PE42	PDAT20	PATH#20 data	0	N/A		O	
PE43	PDEF21	PATH#21 definition	00000000h	N/A		O	
PE44	PDAT21	PATH#21 data	0	N/A		O	
PE45	PDEF22	PATH#22 definition	00000000h	N/A		O	
PE46	PDAT22	PATH#22 data	0	N/A		O	
PE47	PDEF23	PATH#23 definition	00000000h	N/A		O	
PE48	PDAT23	PATH#23 data	0	N/A		O	
PE49	PDEF24	PATH#24 definition	00000000h	N/A		O	
PE50	PDAT24	PATH#24 data	0	N/A		O	
PE51	PDEF25	PATH#25 definition	00000000h	N/A		O	
PE52	PDAT25	PATH#25 data	0	N/A		O	
PE53	PDEF26	PATH#26 definition	00000000h	N/A		O	
PE54	PDAT26	PATH#26 data	0	N/A		O	
PE55	PDEF27	PATH#27 definition	00000000h	N/A		O	
PE56	PDAT27	PATH#27 data	0	N/A		O	
PE57	PDEF28	PATH#28 definition	00000000h	N/A		O	
PE58	PDAT28	PATH#28 data	0	N/A		O	
PE59	PDEF29	PATH#29 definition	00000000h	N/A		O	
PE60	PDAT29	PATH#29 data	0	N/A		O	
PE61	PDEF30	PATH#30 definition	00000000h	N/A		O	
PE62	PDAT30	PATH#30 data	0	N/A		O	
PE63	PDEF31	PATH#31 definition	00000000h	N/A		O	
PE64	PDAT31	PATH#31 data	0	N/A		O	
PE65	PDEF32	PATH#32 definition	00000000h	N/A		O	
PE66	PDAT32	PATH#32 data	0	N/A		O	
PE67	PDEF33	PATH#33 definition	00000000h	N/A		O	
PE68	PDAT33	PATH#33 data	0	N/A		O	
PE69	PDEF34	PATH#34 definition	00000000h	N/A		O	
PE70	PDAT34	PATH#34 data	0	N/A		O	
PE71	PDEF35	PATH#35 definition	00000000h	N/A		O	

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PE72	PDAT35	PATH#35 data	0	N/A		O	
PE73	PDEF36	PATH#36 definition	00000000h	N/A		O	
PE74	PDAT36	PATH#36 data	0	N/A		O	
PE75	PDEF37	PATH#37 definition	00000000h	N/A		O	
PE76	PDAT37	PATH#37 data	0	N/A		O	
PE77	PDEF38	PATH#38 definition	00000000h	N/A		O	
PE78	PDAT38	PATH#38 data	0	N/A		O	
PE79	PDEF39	PATH#39 definition	00000000h	N/A		O	
PE80	PDAT39	PATH#39 data	0	N/A		O	
PE81	PDEF40	PATH#40 definition	00000000h	N/A		O	
PE82	PDAT40	PATH#40 data	0	N/A		O	
PE83	PDEF41	PATH#41 definition	00000000h	N/A		O	
PE84	PDAT41	PATH#41 data	0	N/A		O	
PE85	PDEF42	PATH#42 definition	00000000h	N/A		O	
PE86	PDAT42	PATH#42 data	0	N/A		O	
PE87	PDEF43	PATH#43 definition	00000000h	N/A		O	
PE88	PDAT43	PATH#43 data	0	N/A		O	
PE89	PDEF44	PATH#44 definition	00000000h	N/A		O	
PE90	PDAT44	PATH#44 data	0	N/A		O	
PE91	PDEF45	PATH#45 definition	00000000h	N/A		O	
PE92	PDAT45	PATH#45 data	0	N/A		O	
PE93	PDEF46	PATH#46 definition	00000000h	N/A		O	
PE94	PDAT46	PATH#46 data	0	N/A		O	
PE95	PDEF47	PATH#47 definition	00000000h	N/A		O	
PE96	PDAT47	PATH#47 data	0	N/A		O	
PE97	PDEF48	PATH#48 definition	00000000h	N/A		O	
PE98	PDAT48	PATH#48 data	0	N/A		O	
PE99		Reserved					

(6) Pr position path planning parameters 2

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PF01	PDEF49	PATH#49 definition	00000000h	N/A		O	
PF02	PDAT49	PATH#49 data	0	N/A		O	
PF03	PDEF50	PATH#50 definition	00000000h	N/A		O	
PF04	PDAT50	PATH#50 data	0	N/A		O	
PF05	PDEF51	PATH#51 definition	00000000h	N/A		O	
PF06	PDAT51	PATH#51 data	0	N/A		O	
PF07	PDEF52	PATH#52 definition	00000000h	N/A		O	
PF08	PDAT52	PATH#52 data	0	N/A		O	
PF09	PDEF53	PATH#53 definition	00000000h	N/A		O	
PF10	PDAT53	PATH#53 data	0	N/A		O	
PF11	PDEF54	PATH#54 definition	00000000h	N/A		O	
PF12	PDAT54	PATH#54 data	0	N/A		O	
PF13	PDEF55	PATH#55 definition	00000000h	N/A		O	
PF14	PDAT55	PATH#55 data	0	N/A		O	
PF15	PDEF56	PATH#56 definition	00000000h	N/A		O	
PF16	PDAT56	PATH#56 data	0	N/A		O	
PF17	PDEF57	PATH#57 definition	00000000h	N/A		O	
PF18	PDAT57	PATH#57 data	0	N/A		O	
PE19	PDEF58	PATH#58 definition	00000000h	N/A		O	
PF20	PDAT58	PATH#58 data	0	N/A		O	
PF21	PDEF59	PATH#59 definition	00000000h	N/A		O	
PF22	PDAT59	PATH#59 data	0	N/A		O	
PF23	PDEF60	PATH#60 definition	00000000h	N/A		O	
PF24	PDAT60	PATH#60 data	0	N/A		O	
PF25	PDEF61	PATH#61 definition	00000000h	N/A		O	
PF26	PDAT61	PATH#61 data	0	N/A		O	
PF27	PDEF62	PATH#62 definition	00000000h	N/A		O	
PF28	PDAT62	PATH#62 data	0	N/A		O	
PF29	PDEF63	PATH#63 definition	00000000h	N/A		O	
PF30	PDAT63	PATH#63 data	0	N/A		O	
PF31		Reserved					
PF32		Reserved					
PF33	POV1	Speed setting of internal position command 1	50	rpm		O	

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PF34	POV2	Speed setting of internal position command 2	10	rpm		O	
PF35	POV3	Speed setting of internal position command 3	200	rpm		O	
PF36	POV4	Speed setting of internal position command 4	300	rpm		O	
PF37	POV5	Speed setting of internal position command 5	500	rpm		O	
PF38	POV6	Speed setting of internal position command 6	800	rpm		O	
PF39	POV7	Speed setting of internal position command 7	1000	rpm		O	
PF40	POV8	Speed setting of internal position command 8	1200	rpm		O	
PF41	POV9	Speed setting of internal position command 9	1500	rpm		O	
PF42	POV10	Speed setting of internal position command 10	1800	rpm		O	
PF43	POV11	Speed setting of internal position command 11	2000	rpm		O	
PF44	POV12	Speed setting of internal position command 12	2200	rpm		O	
PF45	POV13	Speed setting of internal position command 13	2400	rpm		O	
PF46	POV14	Speed setting of internal position command 14	2700	rpm		O	
PF47	POV15	Speed setting of internal position command 15	3000	rpm		O	
PF48	POV16	Speed setting of internal position command 16	3000	rpm		O	
PF49	POA1	Acceleration/deceleration time 1 of internal position command	200	ms		O	
PF50	POA2	Acceleration/deceleration time 2 of internal position command	300	ms		O	
PF51	POA3	Acceleration/deceleration time 3 of internal position command	500	ms		O	

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PF52	POA4	Acceleration/deceleration time 4 of internal position command	600	ms		O	
PF53	POA5	Acceleration/deceleration time 5 of internal position command	800	ms		O	
PF54	POA6	Acceleration/deceleration time 6 of internal position command	900	ms		O	
PF55	POA7	Acceleration/deceleration time 7 of internal position command	1000	ms		O	
PF56	POA8	Acceleration/deceleration time 8 of internal position command 8	1200	ms		O	
PF57	POA9	Acceleration/deceleration time 9 of internal position command	1400	ms		O	
PF58	POA10	Acceleration/deceleration time 10 of internal position command	1600	ms		O	
PF59	POA11	Acceleration/deceleration time 11 of internal position command	2000	ms		O	
PF60	POA12	Acceleration/deceleration time 12 of internal position command	2500	ms		O	
PF61	POA13	Acceleration/deceleration time 13 of internal position command	3000	ms		O	
PF62	POA14	Acceleration/deceleration time 14 of internal position command	4000	ms		O	
PF63	POA15	Acceleration/deceleration time 15 of internal position command	5000	ms		O	
PF64	POA16	Acceleration/deceleration time 16 of internal position command	6000	ms		O	
PF65	DLY1	Delay time 1 after position reached	0	ms		O	
PF66	DLY2	Delay time 2 after position reached	100	ms		O	
PF67	DLY3	Delay time 3 after position reached	200	ms		O	
PF68	DLY4	Delay time 4 after position reached	300	ms		O	
PF69	DLY5	Delay time 5 after position reached	500	ms		O	
PF70	DLY6	Delay time 6 after position reached	600	ms		O	
PF71	DLY7	Delay time 7 after position reached	800	ms		O	
PF72	DLY8	Delay time 8 after position reached	1000	ms		O	
PF73	DLY9	Delay time 9 after position reached	1200	ms		O	
PF74	DLY10	Delay time 10 after position reached	1500	ms		O	

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PF75	DLY11	Delay time 11 after position reached	2000	ms		O	
PF76	DLY12	Delay time 12 after position reached	2300	ms		O	
PF77	DLY13	Delay time 13 after position reached	2500	ms		O	
PF78	DLY14	Delay time 14 after position reached	3000	ms		O	
PF79	DLY15	Delay time 15 after position reached	4000	ms		O	
PF80	DLY16	Delay time 16 after position reached	5000	ms		O	
PF81	PDEC	Deceleration time for auto-protection	00000000h	ms	O	O	O
PF82(■)	PRCM	PR command trigger register	0	N/A		O	
PF83	EVON	PR number triggered by event rising edge	0000h	N/A		O	
PF84	EVOF	PR number triggered by event falling edge	0000h	N/A		O	
PF85(■)	PMEM	PATH#1 - PATH#2 volatile setting	0000h	N/A	O	O	O
PF86	SWLP	Positive software limit	2^{31}-1	pulse		O	
PF87	SWLN	Negative software limit	-2^{31}+1	pulse		O	
PF88(*)	BLSF	Backlash compensation option	0	N/A	O	O	
PF89	BLSP	Backlash compensation correction pulse number	0	pulse	O	O	
PF90	BLST	Backlash compensation time constant	0	0.1ms	O	O	
PF91 ~ PF99							

Below are parameters list which is categorized by different modes.

Torque control parameters							
Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PA01(*)	STY	Control mode setting	1020h	N/A	O	O	O
PA05	TL1	Internal torque limit 1	100	%	O	O	O
PC05	SC1	Internal speed limit 1	100	rpm			O
PC06	SC2	Internal speed limit 2	500	rpm			O
PC07	SC3	Internal speed limit 3	1000	rpm			O
PC08	SC4	Internal speed limit 4	200	rpm			O
PC09	SC5	Internal speed limit 5	300	rpm			O
PC10	SC6	Internal speed limit 6	500	rpm			O
PC11	SC7	Internal speed limit 7	800	rpm			O
PC25	TL2	Internal torque limit 2	100	%	O	O	O

Speed control parameters							
Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PA01(*)	STY	Control mode setting	1020h	N/A	O	O	O
PA05	TL1	Internal torque limit 1	100	%	O	O	O
PA14(*)	ENR	Encoder output pulse number	10000	pulse /rev		O	O
PB18	SFLT	Speed command low-pass filter time constant	0	ms	O		O
PC05	SC1	Internal speed command 1	100	rpm			O
PC06	SC2	Internal speed command 2	500	rpm			O
PC07	SC3	Internal speed command 3	1000	rpm			O
PC08	SC4	Internal speed command 4	200	rpm			O
PC09	SC5	Internal speed command 5	300	rpm			O
PC10	SC6	Internal speed command 6	500	rpm			O
PC11	SC7	Internal speed command 7	800	rpm			O
PC25	TL2	Internal torque limit 2	100	%	O	O	O

Position control parameters							
Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PA01(*)	STY	Control mode setting	1020h	N/A	O	O	O
PA04	HMOV	Homing mode	0000h	N/A		O	
PA05	TL1	Internal torque limit 1	100	%	O	O	O
PA06	CMX	Electronic gear ratio numerator	1	N/A	O	O	
PA07 (▲)	CDV	Electronic gear ratio denominator	1	N/A	O	O	
PA14 (*)	ENR	Encoder output pulse number	10000	pulse/rev	O	O	O
PA39(*)	POL	Motor rotation direction option	0000h	N/A	O	O	O
PC25	TL2	Internal torque limit 2	100	%	O	O	O
PC32	CMX2	Electronic gear ratio numerator 2	1	N/A	O	O	
PC33	CMX3	Electronic gear ratio numerator 3	1	N/A	O	O	
PC34	CMX4	Electronic gear ratio numerator 4	1	N/A	O	O	
PE01	ODEF	Homing definition	00000000h	N/A		O	
PE02	ODAT	Origin definition	0	N/A		O	
PE03 ~ PE98		Refer to section 8.3 for PR related definition				O	
PF01 ~ PF87		Refer to section 8.3 for PR related definition				O	

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PB01	NHF1	Frequency of machine resonance suppression filter 1	1000	Hz	O	O	O
PB02	NHD1	Attenuation rate of machine resonance suppression filter 1	0	dB	O	O	O
PB03	NLP	Resonance suppression low-pass filter	10	0.1ms	O	O	O
PB04	PST	Position command filter time constant	3	ms	O	O	
PB19	TQC	Torque command filter time constant	0	ms			
PB20	SJIT	Speed feedback filter time constant	0	0.1ms	O	O	O
PB21	NHF2	Frequency of machine resonance suppression filter 2	1000	Hz	O	O	O
PB22	NHD2	Attenuation rate of machine resonance suppression filter 2	0	dB	O	O	O
PB23	NDF	Motor noise suppression function	0	N/A	O	O	O
PB25	NHF3	Frequency of machine resonance suppression filter 3	1000	Hz	O	O	O
PB26	NHD3	Attenuation rate of machine resonance suppression filter 3	0	dB	O	O	O
PB27	ANCF	Auto resonance suppression mode setting	1	N/A	O	O	O
PB28	ANCL	Auto resonance detection level	50	%	O	O	O
PB29	AVSM	Auto low frequency vibration suppression mode setting	0	N/A	O	O	
PB30	VCL	Low-frequency vibration detection level	50	pulse	O	O	
PB31	VSF1	Low-frequency vibration suppression frequency 1	100	0.1Hz	O	O	
PB32	VSG1	Low-frequency vibration suppression gain 1	0	N/A	O	O	
PB33	VSF2	Low-frequency vibration suppression frequency 2	100	0.1Hz	O	O	
PB34	VSG2	Low-frequency vibration suppression gain 2	0	N/A	O	O	
PB35	FRCL	Friction compensation level	0	%	O	O	O
PB36	FRCT	Friction compensation smoothing time constant	0	ms	O	O	O

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PB37	FRCM	Friction compensation mode option	0	N/A	O	O	O
PB38	FFCT	Position feed forward filter time constant	0	ms	O	O	
PB45	NHF4	Frequency of machine resonance suppression filter 4	1000	Hz	O	O	O
PB46	NHD4	Attenuation rate of machine resonance suppression filter 4	0	dB	O	O	O
PB47	NHF5	Frequency of machine resonance suppression filter 5	1000	Hz	O	O	O
PB48	NHD5	Attenuation rate of machine resonance suppression filter 5	0	dB	O	O	O
PC01	STA	Acceleration time constant	200	ms		O	O
PC02	STB	Deceleration time constant	200	ms		O	O
PC03	STC	S-curve acceleration/deceleration time constant	0	ms		O	O
PD17(*)	DOP1	LSP, LSN stop mode option	0000h	N/A	O	O	O

Gain and switching parameters

Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PA02	ATUM	AUTO tuning mode setting	0002h	N/A	O	O	O
PA03	ATUL	Auto-tuning response level setting	0010	N/A	O	O	O
PB05	FFC	Position feed-forward gain	0	0.0001	O	O	
PB07	PG1	Position loop gain	45	rad/s	O	O	
PB08	VG1	Speed loop gain	183	rad/s	O	O	O
PB09	VIC	Speed integral gain	34	ms	O	O	O
PB10	VFG	Speed feed-forward gain	0	0.0001	O	O	O
PB11(*)	CDP	Gain switching option	0000h	N/A	O	O	O
PB12	CDS	Gain switching condition value	10	kpps / pulse / rpm	O	O	O
PB13	CDT	Gain switching time constant	1	ms	O	O	O
PB14	GD2	Load to motor inertia ratio 2	70	0.1 times	O	O	O
PB15	PG2	Position loop gain change ratio	100	%	O	O	
PB16	VG2	Speed loop gain change ratio	100	%	O	O	O
PB17	VIC2	Speed integral gain change ratio	100	%	O	O	O
PB24	VDC	Speed differential compensation	980	N/A	O	O	O

DI/DO parameters							
Pr.No	**Abbr**	**Function**	**Default value**	**Unit**	**Control mode**		
					CoE	**Pr**	**S**
PA12	INP	In-position range	Depends on model	pulse	O	O	
PC17	ZSP	Zero speed range	50	rpm	O	O	O
PC16	MBR	Electromagnetic brake output delay time	100	ms	O	O	O
PD01(*)	DIA1	Input signal automatic ON option	0000h	N/A	O	O	O
PD02(*)	DI1	Input signal option 1(CN1-10)	0000h	N/A	O	O	O
PD03(*)	DI2	Input signal option 2(CN1-9)	0000h	N/A	O	O	O
PD04(*)	DI3	Input signal option 3(CN1-8)	0000h	N/A	O	O	O
PD05(*)	DI4	Input signal option 4(CN1-7)	000Bh	N/A	O	O	O
PD06(*)	DI5	Input signal option 5(CN1-11)	0018h	N/A	O	O	O
PD10(*)	DO1	Output signal option 1(CN1-1)	0000h	N/A	O	O	O
PD11(*)	DO2	Output signal option 2(CN1-3)	0000h	N/A	O	O	O
PD12(*)	DO3	Output signal option 3(CN1-5)	0002h	N/A	O	O	O
PD15(*)	DIF	Digital input filter setting	0002h	N/A	O	O	O
PD16(*)	IOS	Digital input source control option	0000h	N/A	O	O	
PD17(*)	DOP1	LSP, LSN stop mode option	0000h	N/A	O	O	O
PD18(*)	DOP2	CR signal clear mode option	0000h	N/A	O	O	
PD19(*)	DOP3	Alarm code output option	0000h	N/A	O	O	O
PD20(*)	DOP4	Operation option when the alarm reset signal is short-circuited	0000h	N/A	O	O	O
PD25(■)	ITST	Communication control DI status	0000h	N/A	O	O	O
PD27(*)	DOD	Output signal contact definition	0004h	N/A	O	O	O

Communication parameters							
Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PA01(*)	STY	Control mode setting value	1020h	N/A	O	O	O
PA46(*)	CYCL	Control cycle setting	0	N/A	O	O	O
PC38	ESYC	EtherCAT Sync abnormal value setting	0	N/A	O		
PC39(*)	ESS	EtherCAT communication address option	0	N/A	O		

Other parameters							
Pr.No	Abbr	Function	Default value	Unit	Control mode		
					CoE	Pr	S
PA40(▲)	SPW	Special parameter write-in function	0000h	N/A	O	O	O
PA42(*)	BLK	Parameter write-inhibit setting	0000h	N/A	O	O	O
PB06	GD1	Load to motor inertia ratio	70	0.1 times	O	O	O
PB14	GD2	Load to motor inertia ratio 2	70	0.1 times	O	O	O
PC18(*)	COP1	Stop option and power interruption restart option	0010h	N/A	O	O	O
PC19(*)	COP2	Alarm record clear option	0000h	N/A	O	O	O
PD20(*)	DOP4	Operation option when the alarm reset signal is short-circuited	0000h	N/A	O	O	O

8.3 Parameter descriptions

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PA01	STY (*)	Control mode setting u | z | y | x x: to set control mode x=0: PR mode x=1: reserved x=2: speed mode y: to set the command source y=0: reserved y=1: internal register input y=2: EtherCAT communication mode z: to set electromagnetic brake function It is DO function only available on servo motors with electromagnetic brake and it can be controlled by PD10~PD12. z=0: disabled electromagnetic brake function z=1: enabled electromagnetic brake function u: DI,DO option u=0: the value of DI,DO(PD02 ~ PD12) are fixed, DI,DO can be planned at this time. u=1: the value of DI,DO(PD02 ~ PD12) are varied in different control modes, DI,DO cannot be planned at this time.	CoE. Pr.S.	1020h	0000h ~ 1122h	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PA02	ATUM (▲)	Auto tuning mode setting 0 | 0 | y | x <u>y: current low-pass filter setting option</u> y=0: PB03 changes with response level y=1: PB03 is fixed value <u>x: auto gain tuning mode setting</u> x=0~1: manual gain tuning mode(PI control) x=2: auto gain tuning mode 1(adjust load inertia ratio and bandwidth continuously) x=3: auto gain tuning mode 2(fixed load inertia ratio, bandwidth is adjustable) x=4: interpolation mode 1 (fixed PB07, and the remaining gain value is adjustable) x=5: interpolation mode 2(fixed PB06 and PB07, and the remaining gain value is adjustable)	CoE. Pr.S	0002h	0000h ~ 0015h	N/A
PA03	ATUL	Auto tuning response level setting	CoE.Pr.S	10	1~32	N/A

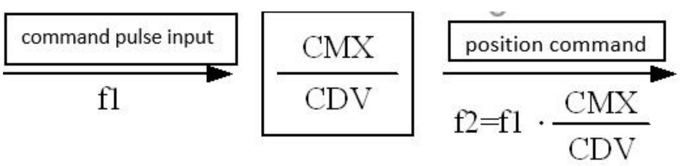
<u>Auto tuning mode response setting</u>

Setting value	Response level	Speed loop response frequency	Setting value	Response level	Speed loop response frequency
1	Low response	10.0	17	Basic response	67.1
2		11.3	18		75.6
3		12.7	19		85.2
4	↕	14.3	20	↕	95.9
5		16.1	21		108.0
6		18.1	22		121.7
7		20.4	23		137.1
8		23.0	24		154.4
9		25.9	25		173.9
10		29.2	26		195.9
11		32.9	27		220.6
12		37.0	28		248.5
13		41.7	29		279.9
14	Basic response	47.0	30	High response	315.3
15		52.9	31		355.1
16		59.6	32		400.0

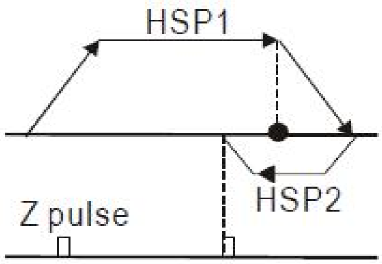
<table>
<tr><th>Pr.No</th><th>Abbr</th><th colspan="3">Function and description</th><th>Control mode</th><th>Default value</th><th>Range</th><th>Unit</th></tr>
<tr><td rowspan="13">PA04</td><td rowspan="13"></td><td colspan="3">Homing mode:
| 0 | z | y | x |</td><td rowspan="13">Pr</td><td rowspan="13">0000h</td><td rowspan="13">0000h
~
0128h</td><td rowspan="13">N/A</td></tr>
<tr><td>z</td><td>y</td><td>x</td></tr>
<tr><td>Limit setting</td><td>Z signal setting</td><td>Homing methods</td></tr>
<tr><td>0~1</td><td>0~2</td><td>0~8</td></tr>
<tr><td></td><td rowspan="4">y=0:return to Z signal
y=1:don’t return to Z signal (go forward to next Z signal)
y=2:do not look for Z signal</td><td>x=0:homing in forward direction and define LSP as origin</td></tr>
<tr><td></td><td>x=1:homing in reverse direction and define LSN as origin</td></tr>
<tr><td rowspan="7">When reaching the limits:
z=0:show error,
z=1:run in reverse direction</td><td>x=2:homing in forward direction.
And define ORGP: OFF->ON as origin</td></tr>
<tr><td>x=3:homing in reverse direction.
And define ORGP: OFF->ON as origin</td></tr>
<tr><td rowspan="2"></td><td>x=4:look for Z signal in forward direction and define it as origin.</td></tr>
<tr><td>x=5:look for Z signal in reverse direction and define it as origin.</td></tr>
<tr><td rowspan="2">y=0:return to Z signal
y=1:don’t return to Z signal (go forward to next Z signal)
y=2:do not look for Z signal</td><td>z=6:homing in forward direction
And define ORGP: ON->OFF as origin</td></tr>
<tr><td>z=7:homing in reverse direction,
And define ORGP: ON->OFF as origin</td></tr>
<tr><td></td><td>z=8:define current position as the origin</td></tr>
</table>

<table>
<tr><th>Pr.No</th><th>Abbr</th><th>Function and description</th><th>Control mode</th><th>Default value</th><th>Range</th><th>Unit</th></tr>
<tr><td>PA05</td><td>TL1</td><td>Internal torque limit 1
This parameter is to limit the torque generated by the servo motor and unit is %. The calculation formula is as follows:
<u>Torque limit value=maximum current of motor / motor rated current * the setting value</u>

<u>When TL and SG are open-circuited, the TL1 options are as follows:</u>
<table>
<tr><th>TL and SG</th><th>Torque limit</th></tr>
<tr><td>Open-circuit</td><td>Torque limit value PA05</td></tr>
<tr><td>Short-circuit</td><td>If PC25 > PA05, TL1=PA05
If PC25 < PA05, TL1=PC25</td></tr>
</table></td><td>CoE.
Pr.S</td><td>100</td><td>0
~
100</td><td>%</td></tr>
<tr><td>PA06</td><td>CMX</td><td>Electronic gear ratio numerator
Note1: In CoE mode, same as CoE Object 6091-01h
Note2: in CoE mode, changes become valid after power cycling.</td><td>CoE.Pr</td><td>1</td><td>1
~
2^{26}</td><td>N/A</td></tr>
<tr><td>PA07</td><td>CDV
(▲)</td><td>Electronic gear ratio denominator
Incorrect setting of E-gear ratio will cause servo motor burst, so you should set parameter when servo is OFF.

To set the command pulse input ratio


Note1: Restrictive condition: 1/50 < (CMX/CDV) < 64000
Note2: In CoE mode, same as CoE Object 6091-02h
Note3: in CoE mode, changes become valid after power cycling.</td><td>CoE.Pr</td><td>1</td><td>1
~
2^{26}</td><td>N/A</td></tr>
</table>

<table>
<tr><th>Pr.No</th><th>Abbr</th><th>Function and description</th><th>Control mode</th><th>Default value</th><th>Range</th><th>Unit</th></tr>
<tr><td>PA08</td><td>HSPD1</td><td>Homing high speed option 1

</td><td>Pr</td><td>100</td><td>1
~
2000</td><td>rpm</td></tr>
<tr><td>PA09</td><td>HSPD2</td><td>Homing high speed option 2</td><td>Pr</td><td>20</td><td>1
~
500</td><td>rpm</td></tr>
<tr><td>PA10</td><td>RES1</td><td>Regenerative resistor value
<table><tr><td>Model</td><td>Default value</td></tr><tr><td>Below 400W</td><td>100Ω</td></tr><tr><td>750W~1KW</td><td>40Ω</td></tr></table></td><td>CoE.
Pr.S</td><td>Depends on model, refer to the left table</td><td>10
~
750</td><td>Ohm</td></tr>
<tr><td>PA11</td><td>RES2</td><td>Regenerated resistor capacity
<table><tr><td>Model</td><td>Default value</td></tr><tr><td>Below 400W</td><td>20W</td></tr><tr><td>750W~1KW</td><td>40W</td></tr></table></td><td>CoE.
Pr.S</td><td>Depends on model, refer to the left table</td><td>0
~
3000</td><td>Watt</td></tr>
<tr><td>PA12</td><td>INP</td><td>In-position range:
In position control mode, when the deviation between the position command and the actual motor position is less than the INP setting, the DO will output INP signal.
<table><tr><td>Encoder type</td><td>default</td></tr><tr><td>17bit magnetic encoders</td><td>1310</td></tr><tr><td>24bit optical encoder</td><td>167772</td></tr></table></td><td>CoE.Pr</td><td>Depends on model, refer to the left table</td><td>0
~
2^{24}</td><td>pulse</td></tr>
<tr><td>PA13
~
PA14</td><td></td><td>Reserved</td><td></td><td></td><td></td><td></td></tr>
<tr><td>PA15</td><td>CRSHA</td><td>Motor crash protection level(torque percentage)
Set protection level (percentage to rated torque, 0=disabled, 1 or above =enabled)</td><td>CoE.
Pr.S</td><td>250</td><td>0~300</td><td>%</td></tr>
</table>

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PA16	CRSHT	Motor crash protection level (protection time) To set protection time. When reaching the protection level, the AL.20 will occur after taken the PA16 setting protection time.	CoE. Pr.S	500	0 ~ 1000	ms
PA17	OVL	Output overload warning level If the setting value is 0~100 and the servo motor output exceeds this level, the warning signal will be activated. PS: the function is disabled when the value is over 100.	CoE. Pr.S	120	0 ~ 120	%
PA18	OVS	Over speed protection level If the feedback speed exceeds the setting value, AL.06 will occur.	CoE. Pr.S	6300	1 ~ 6500	rpm
PA19	OVPE	Position deviation exceed output level when the position deviation exceeds the setting value, AL.08 will occur. <table><tr><td>Encoder type</td><td>Default value</td></tr><tr><td>17bit magnetic encoders</td><td>$3*2^{17}$</td></tr><tr><td>24bit optical encoder</td><td>$3*2^{24}$</td></tr></table>	CoE. Pr	Depends on model and refer to the left table	1 ~ 2^{31}-1	pulse
PA20 ~ PA21		Reserved				
PA22	DBF (*)	Dynamic brake control function Set the dynamic brake operation if an alarm occurs. 0: dynamic brake is enabled and stops motor immediately. 1: dynamic brake is disabled and motor will be in free run state.	CoE. Pr.S	0	0~1	N/A
PA23	MCS (■)	Memory write-inhibit function PA23=0 (All parameters can be written to EEPROM, including PA23.) PA23=1 (All parameters will not be written to EEPROM, Note: PA23 will be set to 0 automatically after power cycling) PA23=2(ONLY PA23 can be written to EEPROM. Note: the setting value stays as 2 after power cycling) Note1: When using communication write parameters, set PA23=2 to prevent from writing continuously, which would reduce EEPROM lifetime.	CoE. Pr.S	0	0~2	N/A

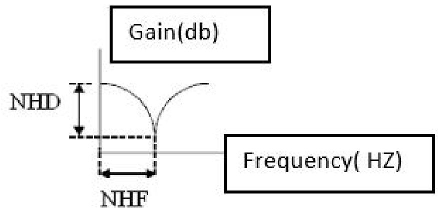
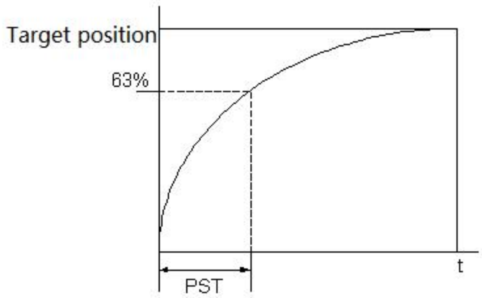
Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PA24 ~ PA27		Reserved				
PA28	ABS (*)	Absolute encoder setting. 0: incremental operation, and absolute motors can be operated as incremental motors. 1: absolute operation	CoE. Pr.S	0000h	0000h ~ 0001h	N/A
PA29	CAP (■)	Absolute position reset If set PA29 to 1, the current absolute position of the encoder will be reset to 0, which is the same as using DI:ABSC to reset the coordinate.	CoE. Pr.S	0000h	0000h ~ 0001h	N/A
PA30	UAP (■)	Update encoder absolute position If PA30=1, update the encoder data to PA31~PA33, and the pulse deviation is not cleared. If PA30=2, update the encoder data to PA31~PA33, and clear the pulse deviation, which means the current position of the motor will be reset as the destination of position command.	CoE. Pr.S	0	0 ~ 2	N/A
PA31	APST	Absolute coordinate system status (read-only) Bit0: 1 means the absolute position has lost, 0 means normal. Bit1: 1 means low battery voltage, 0 means normal. Bit2: 1 means the absolute revolution number overflows, 0 means normal Bit3: reserved (0) Bit4: 1 means the absolute coordinate has not been set. 0 means normal. Bit5 ~ Bit15: reserved (0)	CoE. Pr.S	0	0000h ~ 001Fh	N/A
PA32	APR	Encoder absolute position (pulse number) (read-only) The parameter displays the absolute position feedback pulse number, and it is valid only in absolute system(PA28=1).	CoE. Pr.S	0	0 ~ 2^{24}	pulse
PA33	APP	Encoder absolute position (number of revolutions) (read-only) The parameter displays the absolute position feedback revolution number, and it is valid only in absolute system(PA28=1).	CoE. Pr.S	0	32767 ~ -32768	rev

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PA34		Reserved				
PA35	ATST (■)	One-touch tuning execution **(this function is forbidden to use as it is for factory test)**	CoE. Pr.S.	0	0 ~ FF21h	N/A
PA36	AOP3	One-touch tuning function option 0 | z | y | x <u>x: auto gain tuning function</u> x=0: disabled. x=1: enabled. <u>y: automatic high-frequency resonance suppression function</u> y=0: disabled y=1: enabled <u>z: auto low-frequency vibration suppression function</u> z=0: disabled z=1: enabled Note 1: x=1 is necessary condition to enable one touch tuning function before you can set high-frequency or low-frequency suppression function Note 2: if y=1, you should set PB27 to 0 when one-touch tuning is completed. Note 3: if z=1, you should set PB29 to 0 when one touch tuning is completed.	CoE. Pr.S.	0000h	0000h ~ 0111h	N/A
PA37	FNO3 (*)	Function option 3 **(this function is forbidden to use as it is for factory test)**	CoE. Pr.S.	0000h	0000h ~ FFFFh	N/A

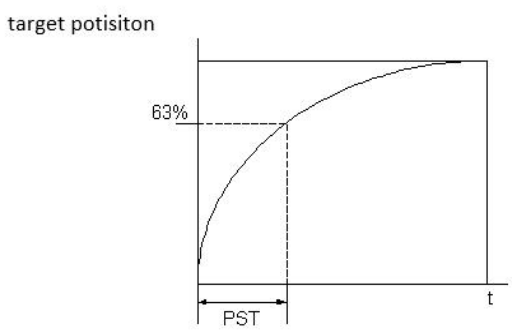
<table>
<tr><th>Pr.No</th><th>Abbr</th><th>Function and description</th><th>Control mode</th><th>Default value</th><th>Range</th><th>Unit</th></tr>
<tr><td>PA38</td><td>FNO1
(*)</td><td>Motor rotation direction and function selection
<table><tr><td>u</td><td>z</td><td>y</td><td>x</td></tr></table>
x: to set motor rotation direction
<table>
<tr><td rowspan="2">Setting value</td><td colspan="2">Servo motor rotation direction</td></tr>
<tr><td>Forward</td><td>reverse</td></tr>
<tr><td>0</td><td>CCW</td><td>CW</td></tr>
<tr><td>1</td><td>CW</td><td>CCW</td></tr>
</table>
In absolute system, you must re-execute homing after power cycling if PA38.x is changed.
y: set forward or reverse start in speed control.
y=0: ST1 ON =>Forward, ST2 ON =>Reverse
y=1: ST1 OFF => Forward, ST1 ON => Reverse. ST2 is invalid, servo lock is disabled.
y=2: ST1 OFF =>Reverse, ST1 ON =>Forward, ST2 is invalid, servo lock is disabled.
z: servo lock options when motor stops in speed control.
z=0: servo lock is enabled and the stop position is held.
z=1: servo lock is disabled, the stop position cannot be held. The drive will control the rotation speed to 0rpm.
u: mode switching options
u=0: the ZSP signal will be referred when the mode is switched
u=1: the ZSP signal will not be referred when the mode is switched.</td><td>CoE.
Pr.S</td><td>0000h</td><td>0000h
~
1121h</td><td>N/A</td></tr>
<tr><td>PA39</td><td></td><td>Reserved</td><td></td><td></td><td></td><td></td></tr>
<tr><td>PA40</td><td>SPW
(▲)</td><td>Special parameter write-in:
When PA40 is set to 0x0088, the servo will return to the factory default value after about 3 seconds. After that, you can operate the drive only after power cycling.</td><td>CoE.
Pr.S</td><td>0000h</td><td>0000h
~
00FFh</td><td>N/A</td></tr>
</table>

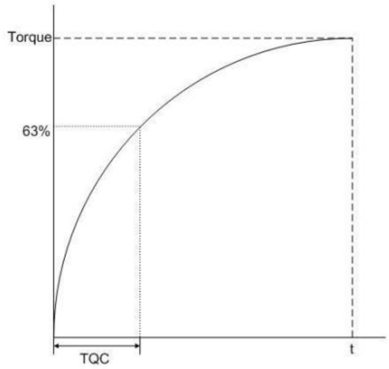
<table>
<tr><th>Pr.No</th><th>Abbr</th><th>Function and description</th><th>Control mode</th><th>Default value</th><th>Range</th><th>Unit</th></tr>
<tr><td>PA41</td><td></td><td>Reserved</td><td></td><td></td><td></td><td></td></tr>
<tr><td>PA42</td><td>BLK
(*)</td><td>Parameter group write-inhibit setting
O: readable and writable
X: unreadable and not writable
<table>
<tr><th>Value</th><th>PA</th><th>PB</th><th>PC</th><th>PD</th><th>PE</th><th>PF</th></tr>
<tr><td>0000
(default value)</td><td colspan="6">O</td></tr>
<tr><td>0001</td><td colspan="5">O</td><td>X</td></tr>
<tr><td>0002</td><td colspan="4">O</td><td colspan="2">X</td></tr>
<tr><td>0003</td><td colspan="3">O</td><td colspan="3">X</td></tr>
<tr><td>0004</td><td colspan="2">O</td><td colspan="4">X</td></tr>
<tr><td>0005</td><td>O</td><td colspan="5">X</td></tr>
<tr><td>0006</td><td colspan="6">Only PA42 is writable, the others is unreadable and not writable.</td></tr>
</table>
Note 1: when the group is unreadable and not writable, it means that this group is hidden from the panel.</td><td>CoE.
Pr.S</td><td>0000h</td><td>0000h
~
00FFh</td><td>N/A</td></tr>
<tr><td>PA43</td><td>ENB
(*)</td><td>Encoder resolution (This is an internal read-only parameter)</td><td>CoE.
Pr.S</td><td>0003h</td><td>0000h
~
0003h</td><td>N/A</td></tr>
</table>

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PA44	EGM (*)	E-gear ratio option PA44 = 0: E-Gear ratio is default value (PA06/PA07). PA44 = 1: E-Gear ratio is 1, (use position command pulse number setting per revolution (PA45)).	Pr	0	0 ~ 1	N/A
PA45	FBP (*)	Position command pulse number setting per revolution. When PA44 = 1, you can use PA45 to set the position command pulse number per revolution.	Pr	10000	500 ~ 10^6	pulse
PA46	CYCL (*)	Reserved				
PA47	TLP	Positive torque limit it is to limit the torque generated during forward rotation. The unit is 0.1%. The calculation is as follows: $Positive\ torque\ limit\ = \frac{motor\ max\ current}{motor\ rated\ current} * \frac{PA47}{30}$	CoE. Pr.S	5000	0 ~ 65535	0.1%
PA48	TLN	Negative torque limit It is to limit the torque generated during reverse rotation. The unit of setting value is 0.1%. The calculation is as follows: $Negative\ torque\ limit\ = \frac{motor\ max\ current}{motor\ rated\ current} * \frac{PA48}{30}$	CoE. Pr.S	5000	0 ~ 65535	0.1%
PA49	FNO2 (*)	Function option 2 **(this function is forbidden to use as it is for factory test)**				
PA50	MLVS	Multi-revolution limit setting It is to set the upper limit value of absolute revolution number, the range is 0~+32767. For example, if PA50 is set to 9999, then the range of PA33 (absolute revolution number) is 0~9999. PA50=0: disabled this function, and enable AL.29 (absolute revolution number overflow). PA50>0: enable this function and disable AL.29 (absolute revolution number overflow).	CoE. Pr.S	0	0 ~ 32767	rev

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PB01	NHF1	Frequency of machine resonance suppression filter 1 It is to set the frequency of machine resonance suppression filter 1. The diagram is as follows: 	CoE. Pr.S	1000	10 ~ 4000	Hz
PB02	NHD1	Attenuation rate of machine resonance suppression filter 1. It is to set attenuation rate of machine resonance suppression and it should be used together with NHF1. 0: disable the Notch filter function.	CoE. Pr.S	0	0 ~ 32	dB
PB03	NLP	Resonance suppression low-pass filter It is to set the time constant of resonance suppression low-pass filter.	CoE. Pr.S	17	0 ~ 10000	0.1ms
PB04	PST	Position command filter time constant It is to set the filter time constant of position command. With an appropriate setting of PB04, it will run the motor more smoothly when the position command changes abruptly.  The actual time to reach the target position is 5 times of PST.	CoE.Pr	3	0 ~ 20000	ms
PB05	FFC	Position feed-forward gain If the system runs smoothly in position control, increase PB05 value will reduce the position tracking deviation. If the system resonance occurs, decrease PB05 value will improve mechanical vibration.	CoE. Pr	0	0 ~ 200	%

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PB06	GD1	Load to motor inertia ratio It's used to set ratio of load inertia to servo motor inertia. When PA02 is set to auto gain tuning mode 1, the tuning result will set in PB06 automatically.	CoE. Pr.S	70	0 ~ 1200	0.1 times
PB07	PG1	Position loop gain Increasing PB07 improves the traceability to position command and reduce the position deviation. But too large setting may cause noise and vibration. When using auto gain tuning mode, PB07 will be set automatically.	CoE.Pr	45	4 ~ 1024	rad/s
PB08	VG1	Speed loop gain Increasing PB08 improves the speed response. But too large setting may cause vibration and noise. When using auto gain tuning mode, PB08 will be set automatically.	CoE. Pr.S.	183	40 ~ 9000	rad/s
PB09	VIC	Speed integral gain It sets the integral time constant of speed loop.	CoE. Pr.S.	34	1~ 1000	ms
PB10	VFG	Speed feed-forward gain value: If the system runs smoothly in speed mode, increasing PB10 reduces speed tracking deviation, and decreasing PB10 can improve the vibration if resonance occurs.	CoE. Pr.S	0	0 ~ 200	%
PB11	CDP (*)	Gain switching option: 0 | 0 | 0 | x x=0: disable gain switching function x=1: switching when CDP is ON. x=2: switching when position command frequency is not less than CDS setting x=3: switching when position deviation pulse is not less than CDS setting. x=4: switching when servo motor rotation speed is not less than CDS setting. x=5: switching when CDP is OFF. x=6: switching when position command frequency is not large than CDS setting x=7: switching when position error pulse is not large than CDS setting x=8: switching when servo motor rotation speed is not large than CDS setting	CoE. Pr.S.	0000h	0000h ~ 0008h	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PB12	CDS	Gain switching condition value: This value and unit vary according to the CDP setting.	CoE. Pr.S.	10	0~ 4000000	pulse
PB13	CDT	Gain switching time constant The switching time constant is used for smooth gain switching, and it is used to set the time constant when switching the gain.	CoE. Pr.S.	1	0 ~ 1000	ms
PB14	GD2	Load to motor inertia ratio 2 It is to set ratio of load inertia to motor inertia, which is only valid during gain switching.	CoE. Pr.S.	70	0~1200	0.1 times
PB15	PG2	Position loop gain change ratio It is to set position loop gain change ratio, and it is valid only after the auto gain tuning function is disabled.	CoE. Pr	100	10 ~ 500	%
PB16	VG2	Speed loop gain change ratio This parameter is to set speed loop gain change ratio, and it is valid only after the auto gain tuning function is disabled.	CoE. Pr.S.	100	10 ~ 500	%
PB17	VIC2	Speed integral gain change ratio This parameter is to set speed integral gain change ratio, and it is valid only after the auto gain tuning function is disabled.	CoE. Pr.S.	100	10 ~ 500	%
PB18	SFLT	Speed command low-pass filter time constant The larger the value, the smoother the command curve will be, but the response will also be slower. Note: 0 means this function is disabled.  The actual time to track the speed command is around 5 times of SFLT.	CoE.S	0	0 ~ 1000	ms

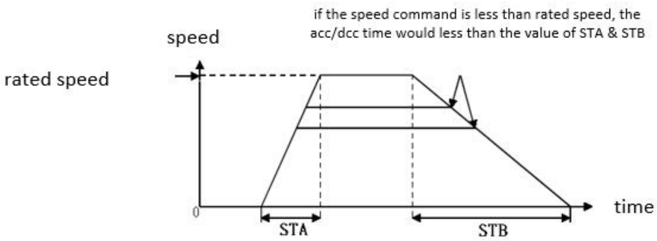
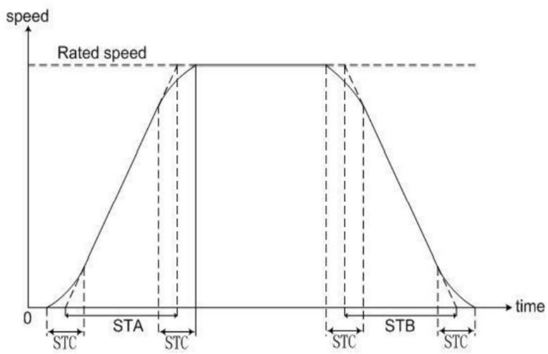
Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PB19	TQC	Torque command filter time constant It is to set filter time constant of torque command. With an appropriate setting, it runs the motor more smoothly when torque command changes abruptly.  The actual time to track torque command is 5 times of TQC.	CoE	0	0 ~ 5000	ms
PB20	SJIT	Speed feedback filter time constant The parameter is to set speed feedback filter time constant.	CoE. Pr.S	0	0 ~ 1000	0.1ms
PB21	NHF2	Frequency of machine resonance suppression filter 2 This parameter is the frequency of machine resonance suppression filter 2, and its usage is same as PB01.	CoE. Pr.S	1000	10 ~ 4000	Hz
PB22	NHD2	Attenuation rate of machine resonance suppression filter 2. This parameter is to set the attenuation rate of machine resonance suppression filter and it should use together with NHF2. Note: 0: disable the Notch filter function	CoE. Pr.S	0	0 ~ 32	dB
PB23	NDF	Motor noise suppression function 0: disable the function. 1: enable the function, which can improve the system response	CoE. Pr.S	0	0 ~ 1	N/A
PB24	VDC	Speed differential compensation This parameter is to set speed differential compensation, it is enabled when DI terminal proportional control signal is ON.	CoE. Pr.S.	980	0 ~ 1000	N/A
PB25	NHF3	Frequency of machine resonance suppression filter 3 This parameter is the frequency of machine resonance suppression filter 3, its usage is the same as PB01.	CoE. Pr.S	1000	10 ~ 4000	Hz

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PB26	NHD3	Attenuation rate of machine resonance suppression filter 3. This parameter is to set attenuation rate of machine resonance suppression filter and it should use together with NHF3. Note: 0: disable the Notch filter function	CoE. Pr.S	0	0 ~ 32	dB
PB27	ANCF	Auto resonance suppression mode setting (Setting for resonance suppression filters 1 and 2) 0: fixed. 1: fixed automatically after auto-suppression. 2: always auto-scan to search the resonance frequency	CoE. Pr.S	0	0 ~ 2	N/A
PB28	ANCL	Auto resonance detection level If PB28 is larger, the resonance detection sensitivity is lower; on the other hand, if PB28 is smaller, the resonance detection sensitivity is higher.	CoE. Pr.S	50	1 ~ 300	%
PB29	AVSM	Auto low-frequency vibration suppression mode 0: fixed. 1: fixed automatically after auto-suppression. Auto mode setting description: When you set the PB29 as 1, the servo drive will find the vibration frequency and suppress it. If the vibration frequency cannot be detected or the vibration frequency is stable, the system resets PB29 to 0 and saves the vibration frequency to PB31(VSF1) automatically.	CoE. Pr	0	0 ~ 1	N/A
PB30	VCL	Low-frequency vibration detection level It is the detection level for auto low-frequency vibration suppression. The lower the value, the more sensitive of the detection, but the system may also misjudge noise or other low-frequency vibrations as frequencies to be suppressed. If the value is high, the system is less likely to misjudge, but if the vibration of the machine is small, the system may not properly detect low-frequency vibrations.	CoE. Pr	50	1 ~ 8000	pulse
PB31	VSF1	Low-frequency vibration suppression frequency 1 It is the first low-frequency vibration suppression frequency. If PB32 is 0, the first low frequency vibration suppression filter is disabled	CoE. Pr	100	1 ~ 3000	0.1Hz

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PB32	VSG1	Low-frequency vibration suppression gain 1 It is the first low-frequency vibration suppression gain. Increasing the value can improve the position response. If the value is too high, the motor may not operate smoothly. The suggested value is 1.	CoE. Pr	0	0 ~ 15	N/A
PB33	VSF2	Low-frequency vibration suppression frequency 2 It is the second low-frequency vibration suppression frequency. If PB34 is 0, the second low frequency vibration suppression filter is disabled	CoE. Pr	100	1 ~ 3000	0.1Hz
PB34	VSG2	Low-frequency vibration suppression gain 2 It is the second low-frequency vibration suppression gain. Increasing the value can improve the position response. If the value is too high, the motor may not operate smoothly. The suggested value is 1.	CoE. Pr	0	0 ~ 15	N/A
PB35	FRCL	Friction compensation level It is the level of friction compensation, which is the percentage of the rated torque. Set the value to 0 to disable the friction compensation function. Set the value to 1 or above to enable the function.	CoE. Pr.S	0	0 ~ 100	%
PB36	FRCT	Friction compensation smoothing time constant It is to set the smoothing time constant of friction compensation.	CoE. Pr.S	0	0 ~ 1000	ms
PB37	FRCM	Friction compensation mode option | 0 | 0 | y | x | <u>x: zero speed friction compensation setting</u> x=0: zero speed friction compensation is enabled. x=1: zero speed friction compensation is disabled. <u>y: automatic friction compensation setting</u> y=0: automatic friction compensation disabled. y=1: automatic friction compensation enabled.	CoE. Pr.S	0	0000h ~ 0011h	N/A
PB38	FFCT	Position feed-forward filter time constant It is to set the filter time constant of position feed-forward gain.	CoE. Pr.S	0	0 ~ 1000	0.1ms

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PB39		Reserved				
PB40		Reserved				
PB41		Reserved				
PB42		Reserved				
PB43		Reserved				
PB44	PPD	Position compensation gain Increasing PPD can improve position command tracking response and system settling time, but if the setting is too large, it may cause machine vibration or overshoot.	CoE. Pr	0	0 ~ 500	rad/s
PB45	NHF4	Frequency of machine resonance suppression filter 4 This parameter is to set the frequency of machine resonance suppression filter, its usage is same as PB01.	CoE. Pr.S	1000	10 ~ 4000	Hz
PB46	NHD4	Attenuation rate of machine resonance suppression filter 4. This parameter is to set attenuation rate of machine resonance suppression filter and it should use together with NHF4. Note: 0: disable the Notch filter function.	CoE. Pr.S	0	0 ~ 32	dB

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PB47	NHF5	Frequency of machine resonance suppression filter 5 This parameter is to set the frequency of machine resonance suppression filter, its usage is same as PB01.	CoE. Pr.S	1000	10 ~ 4000	Hz
PB48	NHD5	Attenuation rate of machine resonance suppression filter 5. This parameter is to set attenuation rate of machine resonance suppression filter and it should use together with NHF5. Note: 0: disable Notch filter function.	CoE. Pr.S	0	0 ~ 32	dB
PB49	DST	External disturbance suppression gain	CoE. Pr.S	0	0 ~ 100	N/A
PB50	MVF	Position command average filter time constant	CoE. Pr	0	0 ~ 50	ms
PB57	TOF (*)	Vertical axis torque compensation For applications using vertical axis with large loads, TOF can be used to compensate the torque command. It can improve the load axis vibration when the brake is released and the SON is turned on.	All	0	3000 ~ -3000	0.1%

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PC01	STA	Acceleration time constant This parameter sets the time for the motor to accelerate from 0 to motor rated speed. For example, if the rated speed of the servo motor is 3000rpm, and this parameter is set to 3000 (3s), and when the speed command is 1000rpm, it will take 1 second for the motor to accelerate from 0rpm to 1000rpm. The acceleration time in JOG mode is also set by PC01. 	Pr.S.	200	0 ~ 65550	ms
PC02	STB	Deceleration time constant This parameter sets the time for the motor to decelerate from motor rated speed to 0. The deceleration time in JOG mode is also set by PC02.	Pr.S.	200	0 ~ 65550	ms
PC03	STC	S-curve acceleration / deceleration time constant The S-curve acceleration/deceleration function is to use a three-step curve of acceleration or deceleration, which can make motor run smoother. An appropriate STC setting can improve the stability of the motor. There will be a slight acceleration/deceleration time deviation after applying S curve. The acceleration time = STA + STC. The deceleration time = STB + STC. 	Pr.S.	0	0 ~ 10000	ms

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PC04	JOG	JOG speed command It's to set JOG speed in JOG operation mode.	CoE. Pr.S	300	0 ~ 6000	rpm
PC05	SC1	Internal speed command 1(limit 1) In speed mode, PC05 is the speed command 1. In torque control mode, PC05 is speed limit 1 regardless of direction. The internal speed command maximum value is the maximum motor speed.	S	100	-6000 ~ 6000	rpm
PC06	SC2	Internal speed command 2 (limit 2) In speed mode, PC06 is the speed command 2. In torque control mode, PC06 is speed limit 2 regardless of direction. The internal speed command maximum value is the maximum motor speed.	S	500	-6000 ~ 6000	rpm
PC07	SC3	Internal speed command 3 (limit 3) In speed mode, PC07 is the speed command 3. In torque control mode, PC07 is speed limit 3 regardless of direction. The internal speed command maximum value is the maximum motor speed.	S	1000	-6000 ~ 6000	rpm
PC08	SC4	Internal speed command 4 (limit 4) In speed mode, PC08 is the speed command 4. In torque control mode, PC08 is speed limit4 regardless of direction. The internal speed command maximum value is the maximum motor speed.	S	200	-6000 ~ 6000	rpm
PC09	SC5	Internal speed command 5 (limit 5) In speed mode, PC09 is the speed command 5. In torque control mode, PC09 is speed limit 5 regardless of direction. The internal speed command maximum value is the maximum motor speed.	S	300	-6000 ~ 6000	rpm

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PC10	SC6	Internal speed command 6 (limit 6) In speed mode, PC10 is the speed command 6. In torque control mode, PC10 is speed limit 6 regardless of direction. The internal speed command maximum value is the maximum motor speed.	S	500	-6000 ~ 6000	rpm
PC11	SC7	Internal speed command 7 (limit 7) In speed mode, PC11 is the speed command 7. In torque control mode, PC11 is speed limit 7 regardless of direction. The internal speed command maximum value is the maximum motor speed.	S	800	-6000 ~ 6000	rpm
PC12 ~ PC15		Reserved				
PC16	MBR	Electromagnetic brake output delay time It is to set the delay time from the SON signal OFF to the electromagnetic brake interlock signal (MBR) OFF.	CoE. Pr.S	100	-1000 ~ 1000	ms
PC17	ZSP	Zero speed range: This parameter sets the speed range when zero speed signal output. If the forward/reverse rotation speed is lower than PC17 setting value, the DO:ZSP will be on.	CoE. Pr.S	50	0 ~ 10000	rpm
PC18	COP1 (*)	Stop option and power interruption restart option | 0 | 0 | y | x | x: power interruption and restart option When the power supply falls below the rated allowable voltage, an under voltage alarm occurs and the servo motor stops. When the power supply voltage returns to normal, the servo motor can be started without resetting the alarm. x=0: invalid x=1: valid y: motor stop mode option Servo stop option in speed control mode. y=1: motor stops immediately y=0: motor decelerates to stop	CoE. Pr.S	0010h	0000h ~ 0011h	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PC19	COP2 (*)	Alarm history clear option and overload early warning option. u | z | y | x x=0: Alarm history not cleared x=1: Alarm history cleared When X=1, the clearing will be performed after the next power on, and x will be set to 0 automatically after the clearing is completed. y=0: no action; y=1: Motor stops immediately when warning occurs z: AL.13 display option (only for CoE mode). z=0: display AL.13 z=1: AL.13 is not displayed. u: panel display options after the alarm is cleared. u=0: stays at the alarm screen (show AL--). u=1: returns to the previous display screen.	CoE. Pr.S	0000h	0000h ~ 0111h	N/A
PC20	SNO (*)	Servo drive communication device number You can manually set the servo drive device number during communication, and different drives should be set to different addresses.	CoE. Pr.S	1	1 ~ 65535	N/A
PC21	CMS (*)	Communication mode option 0 | 0 | y | x y: communication reply delay time (the changes become valid after power cycling) y=0: within 1ms delay y=1: delay over 1ms.	CoE. Pr.S	0010h	0000h ~ 0011h	N/A
PC22		Reserved				
PC23	SIC	Serial communication timeout option The range of PC23 is 1~60 seconds. If the value is 0, the timeout check is invalid.	CoE. Pr.S	0	0 ~ 60	s

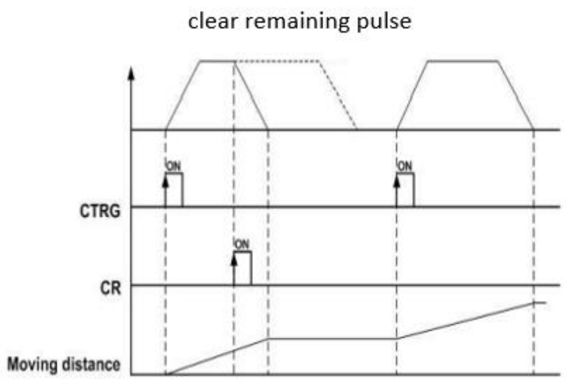
<table>
<tr><th>Pr.No</th><th>Abbr</th><th>Function and description</th><th>Control mode</th><th>Default value</th><th>Range</th><th>Unit</th></tr>
<tr><td>PC24</td><td>DMD
(*)</td><td>Drive status display option
<table><tr><td>0</td><td>y</td><td>x</td></tr></table>
<u>x: display option after power on(hexadecimal)</u>
x=0: motor feedback pulse number (high 5-digit) (before E-Gear ratio)
x=1: motor feedback pulse number (low 5-digit) (before E-Gear ratio)
x=2: input pulse number of pulse command (high 5-digit) (before E-Gear ratio)
x=3: input pulse number of pulse command (low 5-digit) (before E-Gear ratio)
x=4: pulse command and feedback pulse deviation (before E-Gear ratio)
x=5: pulse command input frequency
x=6: current motor speed
x=8: speed command/limit
x=A: torque command/limit
x=B: effective load rate
x=C: peak load rate
x=D: DC Bus voltage
x=E: load inertia ratio
x=F: instantaneous torque
x=10: regenerative load rate
x=11: the absolute pulse number relative to encoder Z phase
<u>y: drive status display on panel after power on</u>
y=1: display status according to PC24.x.
y=0: displays status according to the control mode
<table>
<tr><td>Control mode</td><td>Panel display after power on</td></tr>
<tr><td>Position</td><td>Motor feedback pulse number (Note 1)</td></tr>
<tr><td>Position and speed dual mode</td><td>Motor feedback pulse number(Note 1) /motor speed</td></tr>
<tr><td>Speed</td><td>Motor speed</td></tr>
</table>
Note 1: display the motor feedback pulse number after E-Gear ratio (low 5-digit)</td><td>CoE.
Pr.S</td><td>0000h</td><td>0000h
~
0111h</td><td>N/A</td></tr>
</table>

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PC25	TL2	Internal torque limit 2 The description is the same as PA05. In addition, when using the internal parameter torque limit together with external TL signal, different torque limits can be selected. Please refer to PA05 description.	CoE. Pr.S	100	0 ~ 100	%
PC26		Reserved				
PC27		Reserved				
PC28 ~ PC31		Reserved				
PC32	CMX2	Electronic gear ratio numerator 2 PC32 is to set the 2nd group of electronic gear ratio numerator. Refer detail to 7.3.3	CoE. Pr	1	1 ~ 2^{26}	N/A
PC33	CMX3	Electronic gear ratio numerator 3 PC33 is to set the 3rd group of electronic gear ratio numerator.	CoE. Pr	1	1 ~ 2^{26}	N/A
PC34	CMX4	Electronic gear ratio numerator 4 PC34 is to set the 4th group of electronic gear ratio numerator.	CoE. Pr	1	1 ~ 2^{26}	N/A
PC35 ~ PC37		Reserved				

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PC38	ESYC	EtherCAT Sync abnormal value setting It is to set the abnormal detection value for EtherCAT communication. PC38 = 0: invalid. PC38 > 0: detect the number of Sync signal abnormalities. Note: By setting PC38 > 0, the number of missing Sync signals during communication will be detected and AL.84 will occur.	CoE	0	0 ~ 65535	N/A
PC39	ESS (*)	EtherCAT communication address option It is to set the EtherCAT communication slave node address source. PC39 = 0: SII PC39 > 1: PC39 If the value of PC39 is greater than 0, this parameter is enabled after power cycling. The EtherCAT slave node address is determined by the value of PC39.	CoE	0	0 ~ 65535	N/A
PC40	MBR2	Delay time for enabling the magnetic brake(MBR) when Servo ON. This parameter is to set the delay time from Servo On status to the activation of the magnetic brake signal (MBR) after the SON ON initialization time.	All	0	0 ~ 1000	ms
PC41		Reserved				
PC42		Reserved				
PC43		Reserved				
PC44 ~ PC99		Reserved				

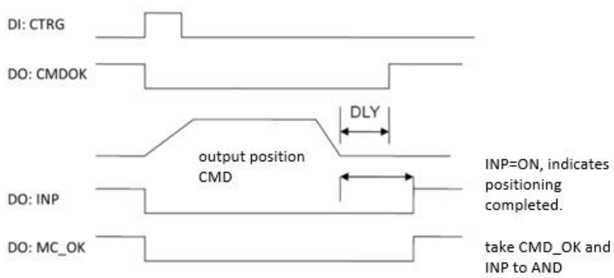
Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PD01	DIA1 (*)	Input signal automatic ON option | u | z | y | x | x=0: the open/short status of SON-SG is controlled by the external circuit of the drive. x=1: SON-SG is auto short-circuited internally without external wiring. y=0: the open/short status of LSP-SG is controlled by the external circuit of the drive. y=1: LSP-SG is auto short-circuited internally without external wiring. z=0: the open/short status of LSN-SG is controlled by the external circuit of the drive. z=1: LSN-SG is auto short-circuited internally without external wiring. u=0: the open/short status of EMG-SG is controlled by the external circuit of the drive. u=1: EMG-SG is short-circuited internally without external wiring.	CoE. Pr.S	0000h	0000h ~ 1111h	N/A
PD02	DI1 (*)	Input signal option 1: To assign the input signal of CN1-10. The input signal varies in different control modes, so the input signal of CN1-10 can be assigned in different modes by setting PD02.	CoE. Pr.S	0000h	0000h ~ 003Fh	N/A
PD03	DI2 (*)	Input signal option 2 To assign the input signal of CN1-9. CN1-9 can be assigned to any input signal, and its parameter setting method is the same as PD02. Please refer to PD02 description	CoE. Pr.S	0000h	0000h ~ 003Fh	N/A
PD04	DI3 (*)	Input signal option 3 To assign the input signal of CN1-8. CN1-8 can be assigned to any input signal, and its parameter setting method is the same as PD02. Please refer to PD02 description	CoE. Pr.S	0000h	0000h ~ 003Fh	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PD05	DI4 (*)	Input signal option 4 To assign the input signal of CN1-7.CN1-7 can be assigned to any input signal, and its parameter setting method is the same as PD02, refer to PD02 description.	CoE. Pr.S	000Bh	0000h ~ 003Fh	N/A
PD06	DI5 (*)	Input signal option 5 To assign the input signal of CN1-11. CN1-11 can be assigned to any input signal, and its parameter setting method is the same as PD02, refer to PD02 description.	CoE. Pr.S	0018h	0000h ~ 003Fh	N/A
PD07 ~PD09		Reserved				
PD10	DO1 (*)	Output signal option 1 PD10 is used to assign output signal of CN1-1. The output signal varies in different control modes, so the output signal of CN1-1 can be assigned in different modes by setting PD10.	CoE. Pr.S	0000h	0000h ~ 002Fh	N/A
PD11	DO2 (*)	Output signal option 2 PD11 is used to assign output signal of CN1-3. CN1-3 can be assigned to any output signal, the setting is the same as PD10. Please refer to PD10 description.	CoE. Pr.S	0000h	0000h ~ 002Fh	N/A
PD12	DO3 (*)	Output signal option 3 PD12 is used to assign output signal of CN1-5. CN1-5 can be assigned to any output signal, the setting is the same as PD10. Please refer to PD10 description.	CoE. Pr.S	0002h	0000h ~ 002Fh	N/A
PD13 ~PD14		Reserved				
PD15	DIF (*)	Digital input filter time option x=0: disable, x=1: 2ms, x=2: 4 ms, x=3: 6 ms, x=4: 8ms, x=5: 10 ms	CoE. Pr.S	0002h	0000h ~ 0005h	N/A
PD16	SDI (■)	Digital input source control option This parameter can be used as DI source control option. Each bit of this parameter determines the signal input source of one DI. Bit0 ~ Bit04 is correspond to DI1 ~ DI5. Bit setting shows as below: 0: input contact status is controlled by external hardware terminal. 1: input contact status is controlled by communication (PD25). For DI pin function assignment, please refer to: DI1 ~ DI5: PD02~PD06	CoE. Pr.S	0000h	0000h ~ 0FFFh	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PD17	DOP1 (*)	The servo emergency stop mode setting when LSN or LSP signal is off. | 0 | 0 | 0 | x | <u>x: options of emergency stop</u> x=0: stop immediately. x=1: decelerate to stop according to the decelerate time constant setting. The decelerate time constant parameter is PF81(deceleration time for automatic protection).	CoE. Pr.S	0000h	0000h ~ 0001h	N/A
PD18	DOP2 (*)	It is to set CR signal clear method. | 0 | 0 | 0 | x | x=0: clear the position pulse command and feedback pulse deviation. When CR is triggered at the rising edge, the deviation will be cleared to 0. x=1: clear the position pulse command and feedback pulse deviation. When CR-SG is short-circuited, the deviation will be kept clear to 0. x=2: stop the positioning function. When the CR -SG rising edge is triggered, the motor will decelerate to stop according to the deceleration time and the remaining pulses will be ignored. When CTRG-SG is short-circuited again, the current position command will be executed (Pr mode). 	CoE. Pr	0000h	0000h ~ 0002h	N/A

<table>
<tr><th>Pr.No</th><th>Abbr</th><th>Function and description</th><th>Control mode</th><th>Default value</th><th>Range</th><th>Unit</th></tr>
<tr><td>PD19</td><td>DOP3
(*)</td><td>Alarm code output option:
<table><tr><td>0</td><td>0</td><td>0</td><td>x</td></tr></table>
<table>
<tr><td rowspan="2">x setting</td><td colspan="3">Pin number</td></tr>
<tr><td>CN1-1</td><td>CN1-3</td><td>CN1-5</td></tr>
<tr><td>0</td><td>DO function</td><td>DO function</td><td>DO function</td></tr>
<tr><td>1</td><td colspan="3">Output an alarm code when an alarm occurs</td></tr>
</table>
Note: DO function is determined by PD10 ~ PD12 setting.
<table>
<tr><td colspan="3">(Note) Alarm code</td><td rowspan="2">Alarm display</td><td rowspan="2">Name</td></tr>
<tr><td>CN1-1</td><td>CN1-3</td><td>CN1-5</td></tr>
<tr><td rowspan="5">0</td><td rowspan="5">0</td><td rowspan="5">0</td><td>AL.09</td><td>Serial communication error</td></tr>
<tr><td>AL.0A</td><td>Serial communication timeout</td></tr>
<tr><td>AL.0E</td><td>IGBT overheat</td></tr>
<tr><td>AL.0F</td><td>Memory error</td></tr>
<tr><td>AL.10</td><td>Overload 2</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>AL.02</td><td>Under voltage</td></tr>
<tr><td rowspan="2">0</td><td rowspan="2">1</td><td rowspan="2">0</td><td>AL.01</td><td>Over voltage</td></tr>
<tr><td>AL.04</td><td>Regeneration error</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>AL.03</td><td>Over current</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>AL.05</td><td>Overload</td></tr>
<tr><td rowspan="3">1</td><td rowspan="3">0</td><td rowspan="3">1</td><td>AL.06</td><td>Over speed</td></tr>
<tr><td>AL.07</td><td>Pulse command abnormal</td></tr>
<tr><td>AL.08</td><td>Position deviation excess</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">1</td><td rowspan="2">0</td><td>AL.0B</td><td>Encoder error 1</td></tr>
<tr><td>AL.0C</td><td>Encoder error 2</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>AL.11</td><td>Motor mismatch</td></tr>
</table>
Note: 0: OFF, 1: ON</td><td>CoE.
Pr.S</td><td>0000h</td><td>0000h
~
0001h</td><td>N/A</td></tr>
</table>

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PD20	DOP4 (*)	Operation option when the alarm reset signal is short-circuited. | 0 | 0 | y | x | x = 0: PWM signal is off(motor is not magnetized) x = 1: PWM signal is on(motor is magnetized) y: ALM output option when a warning occurs y = 0: ALM disabled. y = 1: ALM enabled.	CoE. Pr.S	0000h	0000h ~ 0011h	N/A
PD21 ~PD24		Reserved				
PD25	ITST (■)	Communication control DI status (HEX): Set the parameter to determine the on/off state of Digital Inputs (total 5 DIs) by communication. The bit0~bit5 correspond with DI1~ DI5. In binary bits: 0: DI is OFF 1: DI is ON. PD16 selects the input source, either from external hardware terminals (DI1~DI5) or communication commands (correspond to Bit 0 ~ 4 of PD25). If the bit of PD16 is 1, which means the source is communication DI (PD25), If not, the source is hardware terminal DI. If the value read from PD25 is 0x0011, it indicates that DI1 and DI5 are ON eventually. If the value written into PD25 is 0x0011, which means that the communication contacts DI1 and DI5 are ON. but it does not mean that the terminal signals of the DI1 and DI5 are ON, which are determined by PD16 setting value. For the function definition of DI(DI1~DI5), you can refer to PD02~PD06. Example 1: If set PD16 to 001Fh and PD25 to 0000h. then all DI1~DI5 will be controlled by the communication, and DI1~DI5 are OFF. Even the external actual hardware pins are all activated with SG, the DI signal will not be affected, it still will be controlled by the communication. and the DI contacts DI1~DI5 are still all OFF.	CoE. Pr.S	0000h	0000h ~ 0FFFh	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PD27	DOD (*)	Definition of output signal contact PD27 defines the output contact of DO1~DO3 signal. The bit0~bit3 corresponds to DO1~DO3 pins respectively and A contact or B contact are optional. 0: The output contact is normally open(A contact). 1: The output contact is normally closed(B contact).	CoE. Pr.S	0004h	0000h ~ 003Fh	N/A
PD28	MCOK	Operation option of DO:MC_OK 0 0 y x x=0: output status is not retained. x=1: output status is retained. y=0: disable position deviation warning AL.1B. y=1: enable position deviation warning AL.1B.  1.Command Trigger: Pr new command is enabled and Command 3 output while clearing signals 2, 4, 5, 6. 2.CMD_OK: determine if command 3 output is completed. It can be set delay time(DLY). 3.Command Output: output the curve of position command based on the acceleration / deceleration setting. 4.INP: whether the positioning deviation of the drive is within the range setting by PA12! 5.MC_OK: command output and servo positioning are both completed, which indicate that DO.CMD_OK and DO.INP are both on. 6.MC_OK (retain output): same as 5, but once the output is ON (7), it is retained, regardless of signal 4 status. 7.Selection of the output signal 5 or 6 is specified by PD28.X. 8.Position deviation: If 4 (or 5) turns OFF after 7 has occurred, the position is deviated and AL.1B can be triggered. The parameter PD28.Y sets whether this warning is enabled or not!	Pr	0000h	0000h ~ 0011h	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PD29	DID	Software DI A/B contact setting 1.The corresponding DI Bit is 0. If DI is set to LSP/LSN/EMG signal, it's B contact. If DI is set to a non-LSP/LSN/EMG signal, it's A contact. 2.The corresponding DI Bit is 1. If DI is set to LSP/LSN/EMG signal, it's A contact. If DI is set to a non-LSP/LSN/EMG signal, it's B contact. Note: If some DI contact is set to communication contacts(refer to PD16), PD29 is invalid.	CoE. Pr.S	0000h	0000h ~ FFFFh	N/A
PD30 ~ PD31		Reserved				
PD32	SDLY (*)	SERVO ON delay time To set the SV-ON delay time.	All	0	0 ~ 3000	ms
PD33	SFDO	Software DO register Bit value: 0 means output LOW level. 1 means output HIGH level bit00: corresponds to DO code 0x20 bit01: corresponds to DO code 0x21 bit02: corresponds to DO code 0x22 bit03: corresponds to DO code 0x23 bit04: corresponds to DO code 0x24 bit05: corresponds to DO code 0x25 bit06: corresponds to DO code 0x26 bit07: corresponds to DO code 0x27 bit08: corresponds to DO code 0x28 bit09: corresponds to DO code 0x29 bit10: corresponds to DO code 0x2A bit11: corresponds to DO code 0x2B bit12: corresponds to DO code 0x2C bit13: corresponds to DO code 0x2D bit14: corresponds to DO code 0x2E bit15: corresponds to DO code 0x2F Note:PD10~PD12 should be set to corresponding DO code.	CoE. Pr.S	0000h	0000h ~ FFFFh	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PD34 ~ PD36		Reserved				
PD37	FNO5 (*)	Function option 5 | 0 | 0 | 0 | X | When X=1, the left and right position limit alarm codes are displayed respectively as follows: When LSP_OFF/LSN_ON, displays AL.13. When LSP_ON/LSN_OFF, displays AL.65. When LSP_OFF/LSN_OFF, displays AL.13.	Pr. Pt S	0000h	0000h ~ 0001h	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PE01	ODEF	Definition of homing The detailed description is as follows:	Pr	00000000h	0000000h ~ 10FFFF3Fh	N/A

31~28	27~24	23~20	19~16	15~12	11~8	7~0 bit
BOOT	−	DLY	−	DEC1	ACC	PATH

- PATH: path type(bit0~bit7)

0: Stop: homing complete and then stop.

1~63: Auto: homing completed and automatically execute the specified path.

- ACC: acceleration time selection between the range 0~F, which is correspond to PF49~PF64.

- DEC1: deceleration time selection for the first homing, DEC setting range is 0~F, which is correspond to PF49~PF64.

DLY: delay time selection between the range 0~F, which is correspond to PF65~PF80.

- BOOT: homing option when drive is powered on.

  0: do not execute homing.

  1: execute homing automatically (After powering up, the first SERVO ON).

- Apart from the above definitions, the related settings for homing also include:

  1. PA04 homing mode.
  2. PA08~PA09 speed setting of homing.
  3. PE02: ORG_DEF is the coordinate of the origin and may not be 0. This function is used as a shift of the coordinate.

A: In SDC series, PA04 is not able to control the drive back to origin after homing, but it is able to accomplish by another method. After the origin (sensor or Z) is found, the servo has to decelerate to stop. The stop position exceeds the origin by a short distance:

If returning to the origin is not needed, set PATH to 0.

If returning to the origin is needed, set PATH to a non-zero value and set PABS = ORG_DEF.

B. If the origin is found (sensor or Z), and you want the servo to move an offset S and define the coordinate as P after moving, then PATH = non-zero and set ORG_DEF = P - S, and this absolute position command = P.

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PE02	ODAT	Origin definition 31~16 / 15~0 bit: ORG_DEF(32bit)	Pr	0	$(-2^{31}+1)$ ~ $(2^{31}-1)$	N/A
PE03	PDEF1	PATH#1 definition The detailed parameters description are as follows: Refer to Chapter 8 for a detailed description of the operation in the PR mode.	Pr	00000000h	00000000h ~ FFFFFFFFh	N/A

31~16	15~0 bit
ORG_DEF(32bit)	

	31~28	27~24	23~20	19~16	15~12	11~8	7~4	3~0 bit
PE03	−	−	DLY	−	−	−	OPT	TYPE
PE04	DATA(32bit)							

- TYPE, OPT

OPT option				Path type
7	6	5	4 BIT	3~0 BIT
-	UNIT	AUTO	INS	1: Constant speed control.
CMD		OVLP	INS	2: Single positioning control, It stops when finished.
				3: AUTO positioning control. It loads the next path automatically when finished.
-	-	-	INS	7: JUMP jump to the specified path.
-	-	AUTO	INS	8: Write specified parameter to specified path.

- **TYPE:** When 1, 2, or 3 is executed, it can be interrupted and stopped by DI.STOP and software limits.
- **INS:** When this PATH is executed, the previous path is interrupted.
- **OVLP:** Allow the next path to overlap, but overlap cannot be set in speed mode! DLY is invalid when the overlap is executed in position mode !
- **AUTO:** Executing the next PR path automatically when the current PR is completed
- **CMD:** Refer to Chapter 7 PR command instruction.
- **DLY:** 0 ~ F can use as the delay time number (4 BIT). It is the delay time after the execution of this path. The external INS is invalid! (DLY related parameters: PF65~PF80).

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PE04	PDAT1	PATH#1 data PE03 defines the property of the target point, PE04 defines the target position of PE03 or the target jumping PATH_NO. Note: PATH: Program	Pr	0	Using the non-indexing position control $(-2^{31}) \sim (2^{31}-1)$ Using the indexing position control (0~16777216)	N/A
PE05	PDEF2	PATH#2 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE06	PDAT2	PATH#2 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE07	PDEF3	PATH#3 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE08	PDAT3	PATH#3 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE09	PDEF4	PATH#4 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE10	PDAT4	PATH#4 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE11	PDEF5	PATH#5 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE12	PDAT5	PATH#5 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE13	PDEF6	PATH#6 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE14	PDAT6	PATH#6 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE15	PDEF7	PATH#7 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE16	PDAT7	PATH#7 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE17	PDEF8	PATH#8 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PE18	PDAT8	PATH#8 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE19	PDEF9	PATH#9 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE20	PDAT9	PATH#9 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE21	PDEF10	PATH#10 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE22	PDAT10	PATH#10 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE23	PDEF11	PATH#11 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE24	PDAT11	PATH#11 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE25	PDEF12	PATH#12 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE26	PDAT12	PATH#12 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE27	PDEF13	PATH#13 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE28	PDAT13	PATH#13 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE29	PDEF14	PATH#14 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE30	PDAT14	PATH#14 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE31	PDEF15	PATH#15 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE32	PDAT15	PATH#15 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PE33	PDEF16	PATH#16 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE34	PDAT16	PATH#16 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE35	PDEF17	PATH#17 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE36	PDAT17	PATH#17 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE37	PDEF18	PATH#18 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE38	PDAT18	PATH#18 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE39	PDEF19	PATH#19 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE40	PDAT19	PATH#19 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE41	PDEF20	PATH#20 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE42	PDAT20	PATH#20 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE43	PDEF21	PATH#21 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE44	PDAT21	PATH#21 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE45	PDEF22	PATH#22 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE46	PDAT22	PATH#22 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE47	PDEF23	PATH#23 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE48	PDAT23	PATH#23 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PE49	PDEF24	PATH#24 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE50	PDAT24	PATH#24 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE51	PDEF25	PATH#25 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE52	PDAT25	PATH#25 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE53	PDEF26	PATH#26 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE54	PDAT26	PATH#26 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE55	PDEF27	PATH#27 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE56	PDAT27	PATH#27 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE57	PDEF28	PATH#28 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE58	PDAT28	PATH#28 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE59	PDEF29	PATH#29 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE60	PDAT29	PATH#29 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE61	PDEF30	PATH#30 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE62	PDAT30	PATH#30 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE63	PDEF31	PATH#31 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PE64	PDAT31	PATH#31 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE65	PDEF32	PATH#32 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE66	PDAT32	PATH#32 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE67	PDEF33	PATH#33 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE68	PDAT33	PATH#33 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE69	PDEF34	PATH#34 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE70	PDAT34	PATH#34 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE71	PDEF35	PATH#35 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE72	PDAT35	PATH#35 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE73	PDEF36	PATH#36 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE74	PDAT36	PATH#36 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE75	PDEF37	PATH#37 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE76	PDAT37	PATH#37 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE77	PDEF38	PATH#38 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE78	PDAT38	PATH#38 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PE79	PDEF39	PATH#39 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE80	PDAT39	PATH#39 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE81	PDEF40	PATH#40 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE82	PDAT40	PATH#40 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE83	PDEF41	PATH#41 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE84	PDAT41	PATH#41 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE85	PDEF42	PATH#42 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE86	PDAT42	PATH#42 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE87	PDEF43	PATH#43 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE88	PDAT43	PATH#43 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE89	PDEF44	PATH#44 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE90	PDAT44	PATH#44 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE91	PDEF45	PATH#45 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE92	PDAT45	PATH#45 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PE93	PDEF46	PATH#46 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE94	PDAT46	PATH#46 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE95	PDEF47	PATH#47 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE96	PDAT47	PATH#47 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE97	PDEF48	PATH#48 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PE98	PDAT48	PATH#48 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PE99		Reserved				

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PF01	PDEF49	PATH#49 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PF02	PDAT49	PATH#49 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PF03	PDEF50	PATH#50 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PF04	PDAT50	PATH#50 data Refer to description of PE04.	Pr	0	$-2^{31}+1) \sim (2^{31}-1)$	N/A
PF05	PDEF51	PATH#51 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PF06	PDAT51	PATH#51 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PF07	PDEF52	PATH#52 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PF08	PDAT52	PATH#52 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PF09	PDEF53	PATH#53 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PF10	PDAT53	PATH#53 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PF11	PDEF54	PATH#54 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PF12	PDAT54	PATH#54 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PF13	PDEF55	PATH#55 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PF14	PDAT55	PATH#55 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PF15	PDEF56	PATH#56 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PF16	PDAT56	PATH#56 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PF17	PDEF57	PATH#57 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PF18	PDAT57	PATH#57 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PF19	PDEF58	PATH#58 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PF20	PDAT58	PATH#58 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PF21	PDEF59	PATH#59 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PF22	PDAT59	PATH#59 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PF23	PDEF60	PATH#60 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PF24	PDAT60	PATH#60 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PF25	PDEF61	PATH#61 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PF26	PDAT61	PATH#61 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PF27	PDEF62	PATH#62 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PF28	PDAT62	PATH#62 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PF29	PDEF63	PATH#63 definition Refer to description of PE03.	Pr	00000000h	00000000h~FFFFFFFFh	N/A
PF30	PDAT63	PATH#63 data Refer to description of PE04.	Pr	0	$(-2^{31}+1) \sim (2^{31}-1)$	N/A
PF31		Reserved				
PF32		Reserved				

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PF33	POV1	Speed setting of internal position command 1	Pr	50	1~6000	rpm
PF34	POV2	Speed setting of internal position command 2	Pr	10	1~6000	rpm
PF35	POV3	Speed setting of internal position command 3	Pr	200	1~6000	rpm
PF36	POV4	Speed setting of internal position command 4	Pr	300	1~6000	rpm
PF37	POV5	Speed setting of internal position command 5	Pr	500	1~6000	rpm
PF38	POV6	Speed setting of internal position command 6	Pr	800	1~6000	rpm
PF39	POV7	Speed setting of internal position command 7	Pr	1000	1~6000	rpm
PF40	POV8	Speed setting of internal position command 8	Pr	1200	1~6000	rpm
PF41	POV9	Speed setting of internal position command 9	Pr	1500	1~6000	rpm
PF42	POV10	Speed setting of internal position command 10	Pr	1800	1~6000	rpm
PF43	POV11	Speed setting of internal position command 11	Pr	2000	1~6000	rpm
PF44	POV12	Speed setting of internal position command 12	Pr	2200	1~6000	rpm
PF45	POV13	Speed setting of internal position command 13	Pr	2400	1~6000	rpm
PF46	POV14	Speed setting of internal position command 14	Pr	2700	1~6000	rpm
PF47	POV15	Speed setting of internal position command 15	Pr	3000	1~6000	rpm
PF48	POV16	Speed setting of internal position command 16	Pr	3000	1~6000	rpm
PF49	POA1	Acceleration/deceleration time 1 of internal position command It is to set the acceleration and deceleration time in Pr mode, which is the time required from 0 to the rated speed.	Pr	200	1~65550	ms
PF50	POA2	Acceleration/deceleration time 2 of internal position command Refer to description of PF49.	Pr	200	1~65550	ms
PF51	POA3	Acceleration/deceleration time 3 of internal position command Refer to description of PF49.	Pr	300	1~65550	ms
PF52	POA4	Acceleration/deceleration time 4 of internal position command Refer to description of PF49.	Pr	500	1~65550	ms

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PF53	POV5	Acceleration/deceleration time 5 of internal position command. Refer to description of PF49.	Pr	600	1~65550	ms
PF54	POV6	Acceleration/deceleration time 6 of internal position command. Refer to description of PF49.	Pr	800	1~65550	ms
PF55	POV7	Acceleration/deceleration time 7 of internal position command. Refer to description of PF49.	Pr	900	1~65550	ms
PF56	POV8	Acceleration/deceleration time 8 of internal position command. Refer to description of PF49.	Pr	1000	1~65550	ms
PF57	POV9	Acceleration/deceleration time 9 of internal position command. Refer to description of PF49.	Pr	1200	1~65550	ms
PF58	POV10	Acceleration/deceleration time 10 of internal position command. Refer to description of PF49.	Pr	1400	1~65550	ms
PF59	POV11	Acceleration/deceleration time 11 of internal position command. Refer to description of PF49.	Pr	1600	1~65550	ms
PF60	POV12	Acceleration/deceleration time 12 of internal position command. Refer to description of PF49.	Pr	2000	1~65550	ms
PF61	POV13	Acceleration/deceleration time 13 of internal position command. Refer to description of PF49.	Pr	2500	1~65550	ms
PF62	POV14	Acceleration/deceleration time 14 of internal position command. Refer to description of PF49.	Pr	3000	1~65550	ms
PF63	POV15	Acceleration/deceleration time 15 of internal position command. Refer to description of PF49.	Pr	4000	1~65550	ms
PF64	POV16	Acceleration/deceleration time 16 of internal position command. Refer to description of PF49.	Pr	5000	1~65550	ms
PF65	DLY1	Delay time 1 after position reached To set the delay time in Pr mode.	Pr	0	0~32767	ms
PF66	DLY2	Delay time 2 after position reached Refer to description of PF65.	Pr	100	0~32767	ms
PF67	DLY3	Delay time 3 after position reached Refer to description of PF65.	Pr	200	0~32767	ms
PF68	DLY4	Delay time 4 after position reached Refer to description of PF65.	Pr	300	0~32767	ms
PF69	DLY5	Delay time 5 after position reached Refer to description of PF65.	Pr	500	0~32767	ms

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PF70	DLY6	Delay time 6 after position reached Refer to description of PF65.	Pr	600	0~32767	ms
PF71	DLY7	Delay time 7 after position reached Refer to description of PF65.	Pr	800	0~32767	ms
PF72	DLY8	Delay time 8 after position reached Refer to description of PF65.	Pr	1000	0~32767	ms
PF73	DLY9	Delay time 9 after position reached Refer to description of PF65.	Pr	1200	0~32767	ms
PF74	DLY10	Delay time 10 after position reached Refer to description of PF65.	Pr	1500	0~32767	ms
PF75	DLY11	Delay time 11 after position reached Refer to description of PF65.	Pr	2000	0~32767	ms
PF76	DLY12	Delay time 12 after position reached Refer to description of PF65.	Pr	2300	0~32767	ms
PF77	DLY13	Delay time 13 after position reached Refer to description of PF65.	Pr	2500	0~32767	ms
PF78	DLY14	Delay time 14 after position reached Refer to description of PF65.	Pr	3000	0~32767	ms
PF79	DLY15	Delay time 15 after position reached Refer to description of PF65.	Pr	4000	0~32767	ms
PF80	DLY16	Delay time 16 after position reached Refer to description of PF65.	Pr	5000	0~32767	ms

<table>
<tr><th>Pr.No</th><th>Abbr</th><th>Function and description</th><th>Control mode</th><th>Default value</th><th>Range</th><th>Unit</th></tr>
<tr><td rowspan="2">PF81</td><td rowspan="2">PDEC</td><td>Deceleration time for auto-protection</td><td>CoE.
Pr.S</td><td>00000000h</td><td>0~
F0F0FFFFh</td><td>N/A</td></tr>
<tr><td colspan="5">The parameter setting is divided into 8 digits(hex), which are D, C, B, A, W, Z, Y, and X:
Including:
1.Deceleration time for auto-protection
<table>
<tr><td>Digit</td><td>D</td><td>C</td><td>B</td><td>A</td><td>W</td><td>Z</td><td>Y</td><td>X</td></tr>
<tr><td>function</td><td>STP</td><td>Reserved</td><td>CTO</td><td>Reserved</td><td>SNL</td><td>SPL</td><td>NL</td><td>PL</td></tr>
<tr><td>Range</td><td>0~F</td><td>-</td><td>0~F</td><td>-</td><td>0~F</td><td>0~F</td><td>0~F</td><td>0~F</td></tr>
</table>
2.The definition of the function code is as follows
STP: the second deceleration time of homing, deceleration time of DI:STOP
CTO: the deceleration time when communication timeout or ABS communication alarm occurs.
SNL: the deceleration time when the software negative limit alarm occurs.
SPL: the deceleration time when the software positive limit alarm occurs.
NL: the deceleration time when the LSN reverse limit alarm occurs.
PL: the deceleration time when the LSP positive limit alarm occurs.
0~F is used to index the deceleration time of PF49~PF64.
For example, if X is set to A, the deceleration time of PL is determined by the value of PF58.</td></tr>
<tr><td rowspan="2">PF82
(■)</td><td rowspan="2">PRCM</td><td>Pr command trigger register</td><td>Pr</td><td>0</td><td>0~1000</td><td>N/A</td></tr>
<tr><td colspan="5">Set PF82 to 0 to start homing. Set PF82 to 1~63 to execute the specified PR procedure, which is the same as using DI:CTRG+POSn. You cannot set PF82 to 64~9999 as the value (exceeds the valid range). Write 1000 to execute stop command which is the same as DI:STOP.
When reading PF82, if the command is incomplete, the drive reads the current command. If the command is completed, the drive reads the current command +10000. If the command is completed, DO:INP is on, and motor position is reached, the drive reads the current command +20000. Commands triggered by DI are also applicable.
Example:
Write the positioning command 3 to trigger the PR program 3.
If the value read is 3, it means PR#3 is incomplete.
If the value read is 10003, it means PR#3 command has been sent, but the motor has not reached the target position yet.
If the value read is 20003, it means PR#3 command has been sent and the motor reached the target position.</td></tr>
</table>

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PF83	EVON	PR number triggered by event rising edge	Pr	0000h	0000h ~DDDDh	N/A
		Setting: UZYX It is to set the execute PR number when EVx is ON. X=0: no action when EV1 is ON. X=1~D: execute PR# 51 - 63 when EV1 is ON. Y=0: no action when EV2 is ON. Y=1~D: execute PR# 51 - 63 when EV2 is ON. Z=0: no action when EV3 is ON. Z=1~D: execute PR# 51 - 63 when EV3 is ON. U=0: no action when EV4 is ON. U=1~D: execute PR# 51 - 63 when EV4 is ON.				
PF84	EVOF	PR number triggered by falling edge	Pr	0000h	0000h ~DDDDh	N/A
		Setting: UZYX It is to set the execute PR number when EVx is OFF. X=0: no action when EV1 is OFF. X=1~D: execute PR# 51 - 63 when EV1 is OFF. Y=0: no action when EV2 is OFF. Y=1~D: execute PR# 51 - 63 when EV2 is OFF. Z=0: no action when EV3 is OFF. Z=1~D: execute PR# 51 - 63 when EV3 is OFF. U=0: no action when EV4 is OFF. U=1~D: execute PR# 51 - 63 when EV4 is OFF.				
PF85 (■)	PMEM	PATH#1 - PATH#2 volatile setting It sets by four bits 00YX: X=0: PATH#1 data is non-volatile. X=1: PATH#1 data is volatile. Y=0: PATH#2 data is non-volatile. Y=1: PATH#2 data is volatile. The others are reserved. This parameter allows you to write data to the target continuously through communication.	CoE. Pr.S	0000h	0000h ~ 0011h	N/A

Pr.No	Abbr	Function and description	Control mode	Default value	Range	Unit
PF86	SWLP	Positive software limit In PR mode, if the motor rotates in the forward direction and the position command exceeds PF86, AL.14 will occur.	Pr	2^{31}-1	-2^{31}+1 ~ 2^{31}-1	pulse
PF87	SWLN	Negative software limit In PR mode, if the motor rotates in the reverse direction and the position command exceeds PF87, AL.15 will occur.	Pr	-2^{31}-1	-2^{31}+1 ~ 2^{31}-1	pulse
PF88		Reserved				
PF89 (*)	BLSF	Backlash compensation option 0: invalid 1: forward direction compensation 2: reverse direction compensation	CoE. Pr	0	0 ~ 2	N/A
PF90	BLSP	Backlash compensation value setting (before E-gear)	CoE. Pr	0	-32767 ~ 32767	pulse
PF91	BLST	Backlash compensation time constant setting	CoE. Pr	0	0 ~ 10000	0.1ms
PF92 ~ PF99		Reserved				

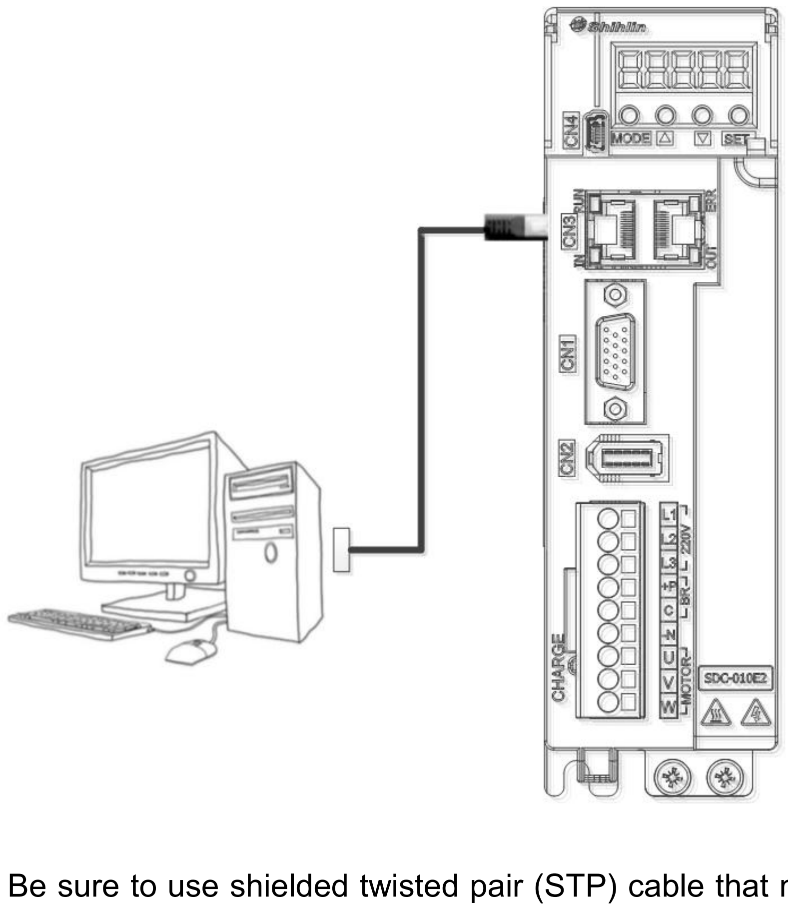
9.Communication Function

9.1 Communication interface and wiring

This servo drive has EtherCAT industrial Ethernet communication function and universal USB serial communication function, which is convenient to drive the servo system, change parameters and monitor the servo system status. You can select the communication mode and drive device number by the parameters to complete the communication pre-work. The communication function parameters are defined in the PC parameters group. The wiring is described as follows:

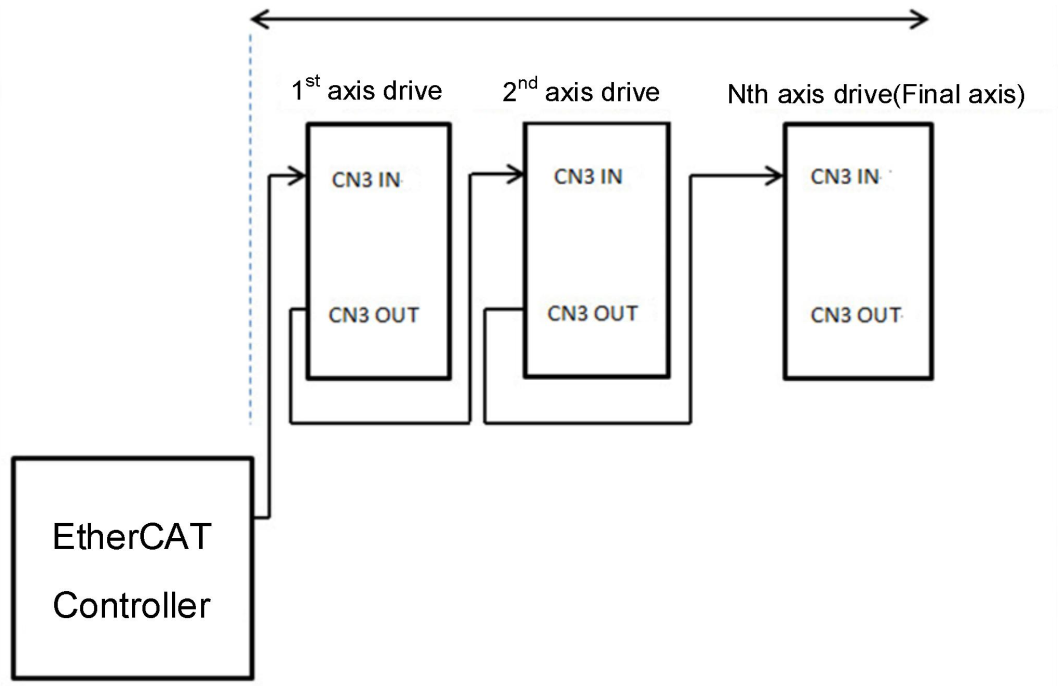
EtherCAT

(1) External sketch:
Servo drive 1-axis operation



- Be sure to use shielded twisted pair (STP) cable that meets the TIA/EIA-568 5e standard specifications or above.

(2) Wiring diagram



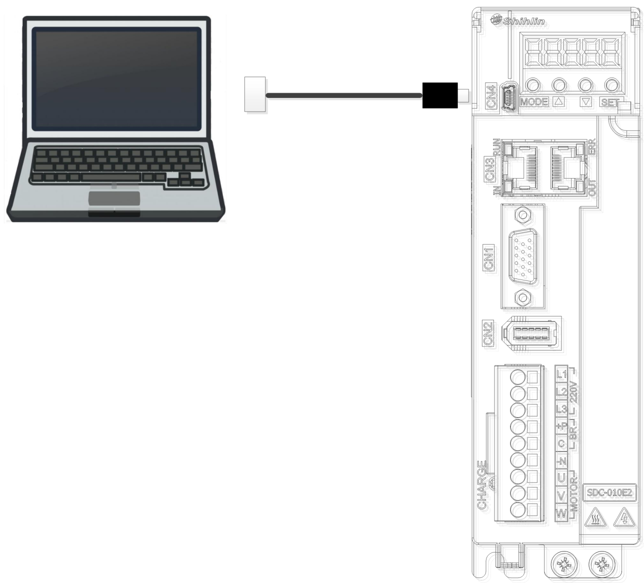
Note 1: The connector for CN3 is an RJ-45 connector.

2: The wiring length is 100m or less in a low noise environment.

USB

(1) External sketch

Use the standard Mini-USB cable, it is recommended to use the USB cable with magnetic ring, which has stronger anti-interference.



9.2 Communication specifications

The communication specifications of SERVO AMP are set as follows when the servo drive is operated by EtherCAT communication.

(1) Mode selection STY (PA01)

Refer to PA01 to select EtherCAT communication for data transmission. Set PA01 to XX20 to enable the EtherCAT communication function.

(2) EtherCAT Sync abnormal detection setting (PC38)

Please refer to PC38 to set the Sync signal detection value for EtherCAT communication, which is Sync Error counts in the communication network of the drive, and the setting range is from 0 to 65535. If the default value is 0, which means that Sync abnormal is not detected.

(3) EtherCAT address selection ESS (PC39)

Refer to PC39 for communication address selection. The setting range is 0 to 65535, and the default value is 0.

0: SII (Slave Information Interface)

1: Communication address is the same as the drive parameter setting value (1~65535).

Item	Content
Physical layer	100BASE-TX
Transmission speed	100Mbps(full duplex)
Network topology	connect in series
Communication connector	RJ45 * 2 (CN3 in / CN3 out)
Communication length	50m between nodes
Slave station number	max. 65535
LED indicator	EtherCAT RUN (Green) EtherCAT ERR (RED) EtherCAT L/A IN (Green) EtherCAT L/A OUT (Green)
FMMU	3 groups
SyncManager	4 groups
Application layer protocol	CoE(CANopen over EtherCAT)
Control mode	Profile Position Mode(PP) Profile Velocity Mode(PV) Profile Torque Mode(PT) Cyclic Synchronous Position Mode(CSP) Cyclic Synchronous Velocity Mode(CSV) Cyclic Synchronous Torque Mode(CST) Homing Mode(HM) Interpolate Position Mode(IP)
Synchronization mode	DC-Synchronous mode (SYNC0) Asynchronous mode (Free Run)
Communication object	PDO(Process data object)/SDO(Service data object)
PDO mapping	TxPDO: 4 groups; RxPDO: 4 groups

9.3 EtherCAT communication protocol

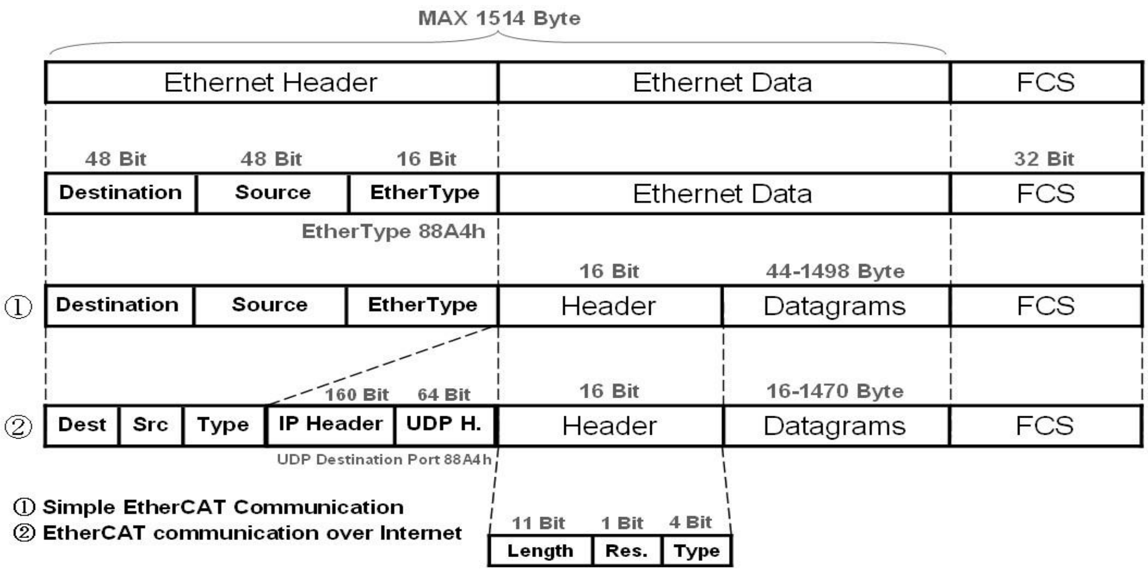
To communicate with the computer, the EtherCAT communication mode value XX20 must be set in parameter PA01 for each servo drive. After that, the computer will start to scan the current communication mode of the servo drives in the network, and if it meets the conditions, the network card will send the transmission signal frame to each drive to confirm the online status. EtherCAT communication is a serial transmission protocol, communication between drives is using standard network cables. The communication address is set by PC39, and the master station use the communication address to monitor the slave stations.

(a)Technical overview

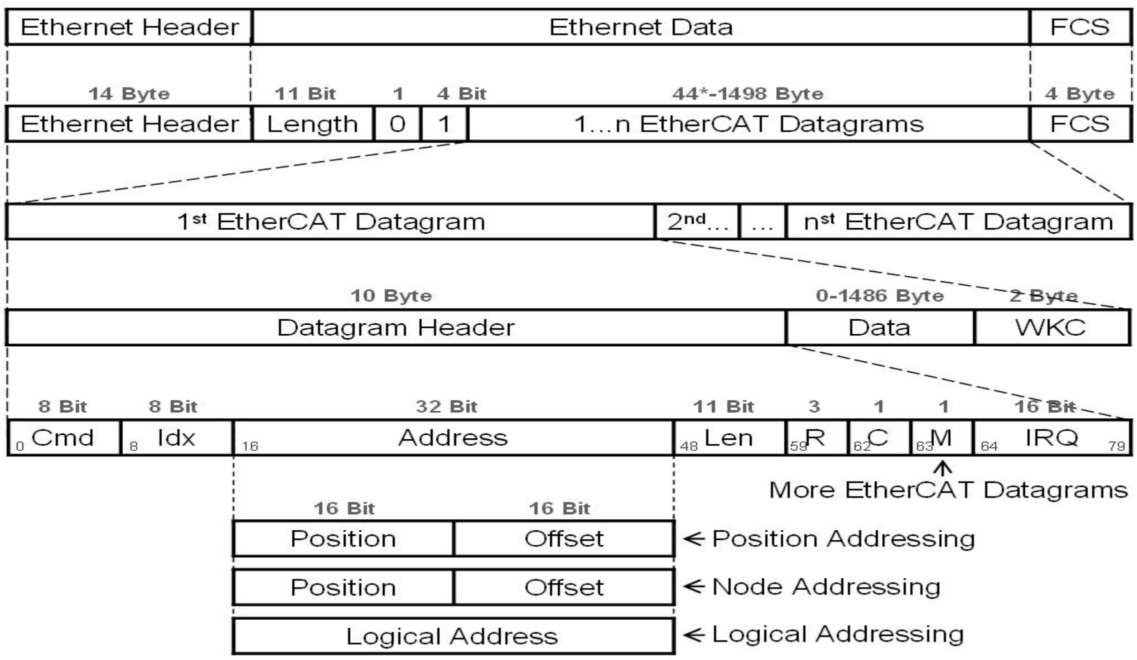
EtherCAT communication technology, known as Ethernet for Control Automation Technology, which is an industrial Ethernet network technology developed by Beckhoff Automation in Germany. It is currently being promoted by the ETG Association (EtherCAT Technology Group), EtherCAT communication is serial transmission between master and slave stations.

(b)Communication specification

EtherCAT improves on Ethernet framework, by using the master-slave transfer method, multiple slaves can be communicated at the same time. Moreover, it has a specialized hardware architecture to handle the data transmission and equipped with an EtherCAT-based frame to complete the master-slave data transmission. The following is the EtherCAT frame structure.



The communication frame includes 3 parts: Ethernet header, Ethernet data and FCS. The Ethernet header contains data source, transmission destination, and the EtherCAT communication mode needs to be selected as EtherType. And Ethernet data content has header and datagrams. The datagrams can set the frame delivery method and check if the read/write action is completed.

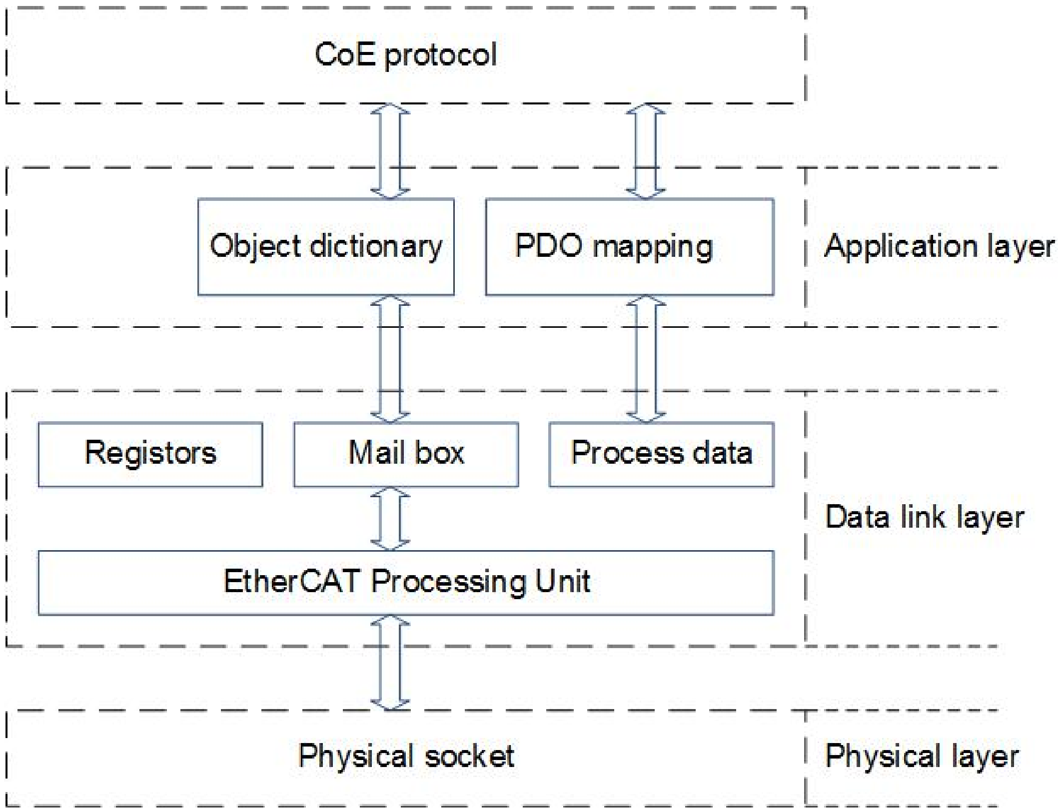


One EtherCAT data frame may contain several datagrams, and the maximum size of an EtherCAT communication frame is 1514 Bytes. The header of datagrams is for the data exchange method selection and the slave address marking, it also reads and writes the EtherCAT internal register's data by determining the slave address.

Datagram header	Data type	Content
Cmd	Byte	EtherCAT transmission command type
Idx	Byte	Frame index number
Address	Byte[4]	Slave address setting
Len	11 bit	Datagram transmission length
R	3 bit	Reserved to 0
C	1 bit	Whether the frame is looped or not
M	1 bit	Whether a datagram coming up next
IRQ	WORD	Interrupt
Data	Byte[n]	Transmission data
WKC	WORD	Confirm read/write status

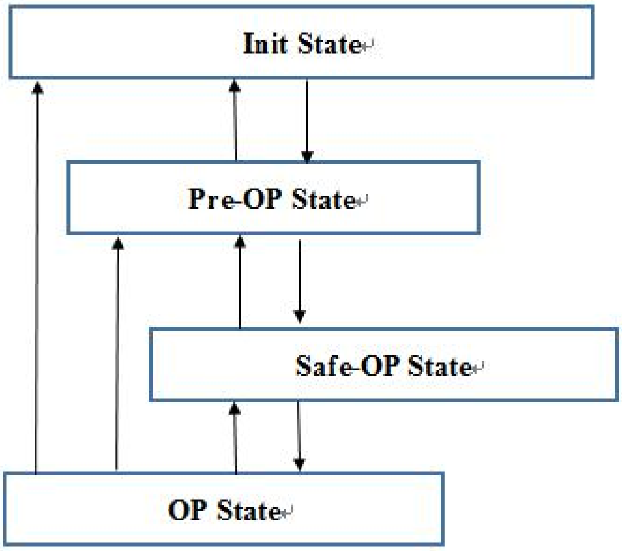
(c)EtherCAT communication architecture

EtherCAT is built base on the framework of Ethernet, and the communication architecture can be divided into physical layer, data link layer and application layer. The physical layer is mainly used for decoding and encoding, the data link layer defines the EtherCAT operation functions, and the application layer is the top layer of the EtherCAT protocol, which is used as the data exchange medium between the network side and the control side. The EtherCAT communication protocol is integrated with many protocols, such as CANopen, SERCOS, etc. The protocol that integrates EtherCAT with CANopen is the CoE communication protocol.



(d)Operation status

In EtherCAT communication, there is an operation mechanism for the state machine switching program, it defines the state and assigns the tasks that need to be executed. The states include Init State (Initial State), Pre-OP State (Pre-Operational State), Safe-OP State (Safe-Operational State), and OP State (Operational State). The state machine switches the states in following sequence.



The execution sequence follows the block diagram from top to bottom. The state can be switched from bottom to top as required. If the final state is the same as command, it means switching process is completed.

State switching	Content
INIT	Master perform initial setting for the data link layer register.
INIT -> PREOP	-Master configures the SyncManager channel for Mailbox communication and initializes the Distributed clock synchronization function. -The master requests a state switching to Pre-Operational State.
PREOP	It can transmit SDO data.
PREOP -> SAFEOP	-Master configures SyncManager channels and parameters for PDO. -Set the FMMU channel at the data link layer. -Master requests a state switching to Safe-Operational State.
SAFEOP	It can transmit SDO data and PDO input(TxPDO).
SAFEOP -> OP	The master can perform a valid PDO output (RxPDO) and request a state switching to the Operational State.
OP	It can transmission PDO and SDO data.

According to the table, it can set the corresponding state to meet the requirements.

(e)PDO data mapping

PDO data mapping is mainly used for cyclic continuous transmission. You can choose different PDO mapping channel according to usage. First, the default PDO transmission channels in ESI file are TxPDO: 1A00h~1A03h, and RxPDO: 1600h~1603h, which are in the index of the object dictionary.

- First group of mapping: for Cyclic Synchronous Position.

RxPDO (1600h)	Controlword (6040h)	Target Position (607Ah)	Target Velocity (60FFh)	Target Torque (6071h)	Max. Torque (6072h)	Mode of Operation (6060h)	Touch Probe Function (60B8h)
TxPDO (1A00h)	Statusword (6041h)	Position Actual Value (6064h)	Torque Actual Value (6077h)	Following Error Actual Value (60F4h)	Mode of Operation Display (6061h)	Touch Probe Status (60B9h)	Touch Probe Value (60BAh)

- Second group of mapping: for Cyclic Synchronous Position.

RxPDO (1601h)	Controlword (6040h)	Target Position (607Ah)
TxPDO (1A01h)	Statusword (6041h)	Position Actual Value (6064h)

- Third group of mapping: for Cyclic Synchronous Velocity

RxPDO (1602h)	Controlword (6040h)	Target Velocity (60FFh)
TxPDO (1A02h)	Statusword (6041h)	Position Actual Value (6064h)

- Forth group of mapping: for Cyclic Synchronous Torque

RxPDO (1603h)	Controlword (6040h)	Target Torque (6071h)	
TxPDO (1A03h)	Statusword (6041h)	Position Actual Value (6064h)	Torque Actual Value (6077h)

Define object 1C12h (Sync Manager PDO Assignment 2) to determine the default channel for RxPDO, and object 1C13h (Sync Manager PDO Assignment 3) to determine the default channel for TxPDO. The default RxPDO/TxPDO of the drive is 1601h/1A01h. Object 1C32h(Sync Manager 2 Synchronization) and object 1C33h(Sync Manager 3 Synchronization) can set the synchronization parameters.

(f) Object descriptions

According to the CiA301 and CiA402 protocols, the object definitions required for CANopen over EtherCAT (CoE) can be divided into two parts, the transmission part (1000h~1FFFh) and the drive part (6000h~6FFFh). In order to complete the control task, you can set the status and send drive commands by writing data to objects.

Object lists of 1xxxh

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
1000h	0	Device Type	UDINT	RO	-	0x00020192	-	-
1001h	0	Error Register	USINT	RO	-	-	-	-
1008h	0	Manufacturer Device Name	STRING	RO	-	-	-	-
100Ah	0	Manufacturer Software Version	STRING	RO	-	-	-	-
1010h	Store Parameters							
	0	Largest sub-index supported	USINT	RO	-	4	-	-
	1	Save all parameters	UDINT	RW	-	0x00000001	0x00000000	0xFFFFFFFF
	2	Save communication	UDINT	RW	-	0x00000001	0x00000000	0xFFFFFFFF
	3	Save application parameters	UDINT	RW	-	0x00000001	0x00000000	0xFFFFFFFF
	4	Save manufacturer defined parameters	UDINT	RW	-	0x00000001	0x00000000	0xFFFFFFFF
1011h	Restore Default Parameters							
	0	Largest sub-index supported	USINT	RO	-	4	-	-
	1	Restore all default	UDINT	RW	-	0x00000001	0x00000000	0xFFFFFFFF
	2	Restore communication default parameters	UDINT	RW	-	0x00000001	0x00000000	0xFFFFFFFF
	3	Restore application default parameters	UDINT	RW	-	0x00000001	0x00000000	0xFFFFFFFF
	4	Restore manufacturer	UDINT	RW	-	0x00000001	0x00000000	0xFFFFFFFF

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
1018h	Identity Object							
	0	Number of entries	USINT	RO	-	4	-	-
	1	Vendor ID	UDINT	RO	-	0x05BC	-	-
	2	Product code	UDINT	RO	-	0xxxxx	-	-
	3	Revision number	UDINT	RO	-	-	-	-
	4	Serial number	UDINT	RO	-	0	-	-
10F3h	Diagnosis history							
	0	Number of entries	USINT	RO	-	19	-	-
	1	Maximum messages	USINT	RO	-	14	-	-
	2	Newest message	USINT	RO	-	-	-	-
	3	Newest acknowledged message	USINT	RW	-	0	0	0
	4	Newest message available	UDINT	RO	-	0	-	-
	5	Flags	UINT	RW	-	0x0007	0	0xFFFF
	6	Diagnosis message 1	STRING	RO	-	-	-	-
	7	Diagnosis message 2	STRING	RO	-	-	-	-
	8	Diagnosis message 3	STRING	RO	-	-	-	-
	9	Diagnosis message 4	STRING	RO	-	-	-	-
	10	Diagnosis message 5	STRING	RO	-	-	-	-
	11	Diagnosis message 6	STRING	RO	-	-	-	-
	12	Diagnosis message 7	STRING	RO	-	-	-	-
	13	Diagnosis message 8	STRING	RO	-	-	-	-
	14	Diagnosis message 9	STRING	RO	-	-	-	-
	15	Diagnosis message 10	STRING	RO	-	-	-	-
	16	Diagnosis message 11	STRING	RO	-	-	-	-
	17	Diagnosis message 12	STRING	RO	-	-	-	-
	18	Diagnosis message 13	STRING	RO	-	-	-	-
	19	Diagnosis message 14	STRING	RO	-	-	-	-

RxPDO data mapping 1600h~1603h

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
1600h	1st Receive PDO Mapping							
	0	Number of objects in this PDO	USINT	RW	-	8	0	8
	1	Mapping entry 1	UDINT	RW	-	0x60400010	0	0xFFFFFFFF
	2	Mapping entry 2	UDINT	RW	-	0x607A0020	0	0xFFFFFFFF
	3	Mapping entry 3	UDINT	RW	-	0x60FF0020	0	0xFFFFFFFF
	4	Mapping entry 4	UDINT	RW	-	0x60710010	0	0xFFFFFFFF
	5	Mapping entry 5	UDINT	RW	-	0x60720010	0	0xFFFFFFFF
	6	Mapping entry 6	UDINT	RW	-	0x60600008	0	0xFFFFFFFF
	7	Mapping entry 7	UDINT	RW	-	0x00000008	0	0xFFFFFFFF
	8	Mapping entry 8	UDINT	RW	-	0x60B80010	0	0xFFFFFFFF
1601h	2nd Receive PDO Mapping							
	0	Number of objects in this PDO	USINT	RW	-	2	0	8
	1	Mapping entry 1	UDINT	RW	-	0x60400010	0	0xFFFFFFFF
	2	Mapping entry 2	UDINT	RW	-	0x607A0020	0	0xFFFFFFFF
	3	Mapping entry 3	UDINT	RW	-	0	0	0xFFFFFFFF
	4	Mapping entry 4	UDINT	RW	-	0	0	0xFFFFFFFF
	5	Mapping entry 5	UDINT	RW	-	0	0	0xFFFFFFFF
	6	Mapping entry 6	UDINT	RW	-	0	0	0xFFFFFFFF
	7	Mapping entry 7	UDINT	RW	-	0	0	0xFFFFFFFF
	8	Mapping entry 8	UDINT	RW	-	0	0	0xFFFFFFFF

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
1602h	3rd Receive PDO Mapping							
	0	Number of objects in this PDO	USINT	RW	-	2	0	8
	1	Mapping entry 1	UDINT	RW	-	0x60400010	0	0xFFFFFFFF
	2	Mapping entry 2	UDINT	RW	-	0x60FF0020	0	0xFFFFFFFF
	3	Mapping entry 3	UDINT	RW	-	0	0	0xFFFFFFFF
	4	Mapping entry 4	UDINT	RW	-	0	0	0xFFFFFFFF
	5	Mapping entry 5	UDINT	RW	-	0	0	0xFFFFFFFF
	6	Mapping entry 6	UDINT	RW	-	0	0	0xFFFFFFFF
	7	Mapping entry 7	UDINT	RW	-	0	0	0xFFFFFFFF
	8	Mapping entry 8	UDINT	RW	-	0	0	0xFFFFFFFF
1603h	4th Receive PDO Mapping							
	0	Number of objects in this PDO	USINT	RW	-	2	0	8
	1	Mapping entry 1	UDINT	RW	-	0x60400010	0	0xFFFFFFFF
	2	Mapping entry 2	UDINT	RW	-	0x60710010	0	0xFFFFFFFF
	3	Mapping entry 3	UDINT	RW	-	0	0	0xFFFFFFFF
	4	Mapping entry 4	UDINT	RW	-	0	0	0xFFFFFFFF
	5	Mapping entry 5	UDINT	RW	-	0	0	0xFFFFFFFF
	6	Mapping entry 6	UDINT	RW	-	0	0	0xFFFFFFFF
	7	Mapping entry 7	UDINT	RW	-	0	0	0xFFFFFFFF
	8	Mapping entry 8	UDINT	RW	-	0	0	0xFFFFFFFF

TxPDO data mapping 1A00h~1A03h

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
1A00h	1st Transmit PDO Mapping							
	0	Number of objects in this PDO	USINT	RW	-	8	0	8
	1	Mapping entry 1	UDINT	RW	-	0x60410010	0	0xFFFFFFFF
	2	Mapping entry 2	UDINT	RW	-	0x60640020	0	0xFFFFFFFF
	3	Mapping entry 3	UDINT	RW	-	0x60770010	0	0xFFFFFFFF
	4	Mapping entry 4	UDINT	RW	-	0x60F40020	0	0xFFFFFFFF
	5	Mapping entry 5	UDINT	RW	-	0x60610008	0	0xFFFFFFFF
	6	Mapping entry 6	UDINT	RW	-	0x60FD0020	0	0xFFFFFFFF
	7	Mapping entry 7	UDINT	RW	-	0x60B90010	0	0xFFFFFFFF
	8	Mapping entry 8	UDINT	RW	-	0x60BA0020	0	0xFFFFFFFF
1A01h	2nd Transmit PDO Mapping							
	0	Number of objects in this PDO	USINT	RW	-	3	0	8
	1	Mapping entry 1	UDINT	RW	-	0x60410010	0	0xFFFFFFFF
	2	Mapping entry 2	UDINT	RW	-	0x60640020	0	0xFFFFFFFF
	3	Mapping entry 3	UDINT	RW	-	0x60FD0020	0	0xFFFFFFFF
	4	Mapping entry 4	UDINT	RW	-	0	0	0xFFFFFFFF
	5	Mapping entry 5	UDINT	RW	-	0	0	0xFFFFFFFF
	6	Mapping entry 6	UDINT	RW	-	0	0	0xFFFFFFFF
	7	Mapping entry 7	UDINT	RW	-	0	0	0xFFFFFFFF
	8	Mapping entry 8	UDINT	RW	-	0	0	0xFFFFFFFF

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
1A02h	3rd Transmit PDO Mapping							
	0	Number of objects in this PDO	USINT	RW	-	3	0	8
	1	Mapping entry 1	UDINT	RW	-	0x60410010	0	0xFFFFFFFF
	2	Mapping entry 2	UDINT	RW	-	0x60640020	0	0xFFFFFFFF
	3	Mapping entry 3	UDINT	RW	-	0x60FD0020	0	0xFFFFFFFF
	4	Mapping entry 4	UDINT	RW	-	0	0	0xFFFFFFFF
	5	Mapping entry 5	UDINT	RW	-	0	0	0xFFFFFFFF
	6	Mapping entry 6	UDINT	RW	-	0	0	0xFFFFFFFF
	7	Mapping entry 7	UDINT	RW	-	0	0	0xFFFFFFFF
	8	Mapping entry 8	UDINT	RW	-	0	0	0xFFFFFFFF
1A03h	4th Transmit PDO Mapping							
	0	Number of objects in this PDO	USINT	RW	-	4	0	8
	1	Mapping entry 1	UDINT	RW	-	0x60410010	0	0xFFFFFFFF
	2	Mapping entry 2	UDINT	RW	-	0x60770010	0	0xFFFFFFFF
	3	Mapping entry 3	UDINT	RW	-	0x60640020	0	0xFFFFFFFF
	4	Mapping entry 4	UDINT	RW	-	0x60FD0020	0	0xFFFFFFFF
	5	Mapping entry 5	UDINT	RW	-	0	0	0xFFFFFFFF
	6	Mapping entry 6	UDINT	RW	-	0	0	0xFFFFFFFF
	7	Mapping entry 7	UDINT	RW	-	0	0	0xFFFFFFFF
	8	Mapping entry 8	UDINT	RW	-	0	0	0xFFFFFFFF

SyncManager channel parameters setting

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
1C00h	Sync Manager Communication Type							
	0	Number of used SyncManager channels	USINT	RO	-	4	-	-
	1	Communication type sync	USINT	RO	-	1	-	-
	2	Communication type sync manager 1	USINT	RO	-	2	-	-
	3	Communication type sync manager 2	USINT	RO	-	3	-	-
	4	Communication type sync	USINT	RO	-	4	-	-
1C12h	Sync Manager PDO Assignment2							
	0	Number of assigned PDOs	USINT	RW	-	1	0	4
	1	Index of assigned RxPDO 1	UINT	RW	-	0x1601	0x1600	0x1603
	2	Index of assigned RxPDO 2	UINT	RW	-	0x0000	0x1600	0x1603
	3	Index of assigned RxPDO 3	UINT	RW	-	0x0000	0x1600	0x1603
	4	Index of assigned RxPDO 4	UINT	RW	-	0x0000	0x1600	0x1603
1C13h	Sync Manager PDO Assignment3							
	0	Number of assigned PDOs	USINT	RW	-	1	0	4
	1	Index of assigned TxPDO 1	UINT	RW	-	0x1A01	0x1A00	0x1A03
	2	Index of assigned TxPDO 2	UINT	RW	-	0x0000	0x1A00	0x1A03
	3	Index of assigned TxPDO 3	UINT	RW	-	0x0000	0x1A00	0x1A03
	4	Index of assigned TxPDO 4	UINT	RW	-	0x0000	0x1A00	0x1A03
1C32h	Sync Manager 2 (process data output) Synchronization							
	0	Number of synchronization parameters	USINT	RO	-	32	-	-
	1	Synchronization type	UINT	RO	-	-	-	-
	2	Cycle time	UDINT	RO	-	-	-	-
	3	Shift time	UDINT	RO	-	0	-	-
	4	Synchronization types supported	UINT	RO	-	0x0017	-	-
	5	Minimum cycle time	UDINT	RO	-	50000	-	-
	6	Calc and copy time	UDINT	RO	-	50000	-	-
	7	Reserved	UDINT	RO	-	0	-	-
	8	Reserved	UINT	RO	-	0	-	-
	9	Delay time	UDINT	RO	-	0	-	-
	10	Sync0 cycle time	UDINT	RO	-	-	-	-
	11	Reserved	UINT	RO	-	0	-	-
	12	SM2 event miss count	UINT	RO	-	-	-	-
	13	Shift time too short	UINT	RO	-	-	-	-
	14	RxPDO toggles failed	UINT	RO	-	-	-	-
	32	Sync error	BOOL	RO	-	-	-	-

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
1C33h	Sync Manager 3 (process data input) Synchronization							
	0	Number of synchronization	USINT	RO	-	32	-	-
	1	Synchronization type	UINT	RO	-	-	-	-
	2	Cycle time	UDINT	RO	-	-	-	-
	3	Shift time	UDINT	RW	-	0	0	Sync0 event cycle - 100000
	4	Synchronization types supported	UINT	RO	-	0x0017	-	-
	5	Minimum cycle time	UDINT	RO	-	0	-	-
	6	Calc and copy time	UDINT	RO	-	0	-	-
	7	Minimum delay time	UDINT	RO	-	0	-	-
	8	Command	UINT	RO	-	0	-	-
	9	Delay time	UDINT	RO	-	0	-	-
	10	Sync0 cycle time	UDINT	RO	-	0	-	-
	11	Cycle time too short	UINT	RO	-	-	-	-
	12	SM2 event miss count	UINT	RO	-	-	-	-
	13	Shift time too short	UINT	RO	-	-	-	-
	14	RxPDO toggles failed	UINT	RO	-	-	-	-
	32	Sync error	BOOL	RO	-	-	-	-

Drive internal parameters setting

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
2000h to 27FFh	0	Servo Parameters(PA01-PH99) A detailed table is available at the object description	-	-	-	-	-	-

Object lists of 6xxxh

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
6007h	0	Abort connection option code	INT	RW	-	0	0	3
603Fh	0	Error Code	UINT	RO	-	-	-	-
6040h	0	Controlword	UINT	RW	-	0	0	0xFFFF
6041h	0	Statusword	UINT	RO	-	-	-	-
605Ah	0	Quick Stop Option Code	INT	RW	-	2	0	7
605Bh	0	Shutdown Option Code	INT	RW	-	0	0	1
605Ch	0	Disable Operation Option Code	INT	RW	-	1	0	1
605Dh	0	Halt Option Code	INT	RW	-	1	0	4
605Eh	0	Fault Reaction Option Code	INT	RW	-	0	0	2
6060h	0	Modes of Operation	SINT	RW	-	0	-128	128
6061h	0	Modes of Operation Display	SINT	RO	-	0	-	-
6062h	0	Position Demand Value	DINT	RO	Pos. unit	-	-	-
6063h	0	Position Actual Internal Value	DINT	RO	Inc	-	-	-
6064h	0	Position Actual Value	DINT	RO	Pos. unit	-	-	-
6065h	0	Following Error Window	UDINT	RW	Pos. unit	5242880	0	1073741823
6066h	0	Following Error Time Out	UINT	RW	ms	0	0	65535
6067h	0	Position Window	UDINT	RW	Pos. unit	30	0	1073741823
6068h	0	Position Window Time	UINT	RW	ms	0	0	65535
6069h	0	Velocity sensor actual value	DINT	RO	-	-	-	-
606Ah	0	Sensor selection code	INT	RO	-	-	-	-
606Bh	0	Velocity Demand Value	DINT	RO	Vel. unit	-	-	-
606Ch	0	Velocity Actual Value	DINT	RO	Vel. unit	-	-	-
606Dh	0	Velocity Window	UINT	RW	Vel. unit	20000	0	65535
606Eh	0	Velocity Window Time	UINT	RW	ms	0	0	65535
606Fh	0	Velocity threshold	UINT	RW	Vel. unit	0	0	65535
6070h	0	Velocity threshold time	UINT	RW	ms	0	0	65535

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
6071h	0	Target Torque	INT	RW	0.1%	0	-32768	32767
6072h	0	Max. Torque	UINT	RW	0.1%	3000	0	65535
6073h	0	Max current	UINT	RO	0.1%	3000	0	65535
6074h	0	Torque Demand Value	INT	RO	0.1%	-	-	-
6075h	0	Motor rated current	UDINT	RO	mA	-	-	-
6076h	0	Motor Rated Torque	UDINT	RO	mNm, mN	-	-	-
6077h	0	Torque Actual Value	INT	RO	0.1%	-	-	-
6078h	0	Current Actual Value	INT	RO	0.1%	-	-	-
6079h	0	DC link circuit voltage	INT	RO	mV	-	-	-
607Ah	0	Target Position	DINT	RW	Pos. unit	0	-2147483648	2147483647
607Bh	Position range limit							
	0	Number of entries	USINT	RO	-	2	-	-
	1	Min. position range limit	DINT	RW	Pos. unit	-2147483647	-2147483648	2147483647
	2	Max. position range limit	DINT	RW	Pos. unit	2147483647	-2147483648	2147483647
607Ch	0	Home Offset	DINT	RW	Pos. unit	0	-2147483648	2147483647
607Dh	Software Position Limit							
	0	Number of entries	USINT	RO	-	2	-	-
	1	Min. position limit	DINT	RW	Pos. unit	0	-2147483648	2147483647
	2	Max. position limit	DINT	RW	Pos. unit	0	-2147483648	2147483647
607Eh	0	Polarity	USINT	RW	-	0	0	255
607Fh	0	Max. Profile Velocity	UDINT	RW	Vel. unit	2147483647	0	4294967295
6080h	0	Max. Motor speed	UDINT	RW	Vel. unit	4294967295	0	4294967295
6081h	0	Profile Velocity	UDINT	RW	Vel. unit	0	0	4294967295
6082h	0	End Velocity	UDINT	RW	Vel. unit	0	0	4294967295

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
6083h	0	Profile Acceleration	UDINT	RW	Acc. unit	10000000	0	4294967295
6084h	0	Profile Deceleration	UDINT	RW	Acc. Unit	10000000	0	4294967295
6085h	0	Quick Stop Deceleration	UDINT	RW	Acc. Unit	4000000000	0	4294967295
6086h	0	Motor profile type	INT	RW	-	0	-32767	32767
6087h	0	Torque Slope	UDINT	RW	0.1% /sec	1000	0	4294967295
6088h	0	Torque profile type	INT	RW	-	0	-32767	32767
608Fh	Position encoder resolution							
	0	Number of entries	USINT	RO	-	2	-	-
	1	Encoder increments	UDINT	RO	Inc	1	1	4294967295
	2	Motor revolutions	UDINT	RO	R (motor)	1	1	4294967295
6091h	Gear Ratio							
	0	Number of entries	USINT	RO	-	2	-	-
	1	Motor revolutions	UDINT	RW	-	PA06	0	4294967295
	2	Shaft revolutions	UDINT	RW	-	PA07	1	4294967295
6092h	Feed constant							
	0	Number of entries	USINT	RO	-	2	-	-
	1	Feed	UDINT	RW	Pos. unit	1	1	4294967295
	2	Shaft revolutions	UDINT	RW	R (shaft)	1	1	4294967295
6098h	0	Homing Method	SINT	RW	-	35	0	37

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
6099h	Homing Speeds							
	0	Number of entries	USINT	RO	-	2	-	-
	1	Speed during search for switch	UDINT	RW	Vel.	500000	0	4294967295
	2	Speed during search for zero	UDINT	RW	Vel. Unit	100000	0	4294967295
609Ah	0	Homing Acceleration	UDINT	RW	Acc. unit	10000000	0	4294967295
60A3h	0	Profile jerk use	USINT	RW	-	1	1	255
60A4h	Profile jerk							
	0	Number of entries	USINT	RO	-	2	-	-
	1	Speed during search for switch	UDINT	RW	Acc. unit	0	0	4294967295
	2	Speed during search for zero	UDINT	RW	Acc. unit	0	0	4294967295
60B0h	0	Position Offset	DINT	RW	Pos. unit	0	-2147483648	2147483647
60B1h	0	Velocity Offset	DINT	RW	Vel. Unit	0	-2147483648	2147483647
60B2h	0	Torque Offset	INT	RW	0.1%	0	-32768	32767
60B8h	0	Touch Probe Function	UINT	RW	-	0	0	0xFFFF
60B9h	0	Touch Probe Status	UINT	RO	-	-	-	-
60BAh	0	Touch Probe 1 position pos Value	DINT	RO	Pos. unit	-	-	-
60BBh	0	Touch Probe 1 position neg Value	DINT	RO	Pos. unit	-	-	-
60BCh	0	Touch Probe 2 position pos Value	DINT	RO	Pos. unit	-	-	-
60BDh	0	Touch Probe 2 position neg Value	DINT	RO	Pos. unit	-	-	-
60C0h	0	Interpolation sub mode	INT	RW	-	0	-3	0
60C1h	Interpolation Data Record							
	0	Number of entries	USINT	RO	-	1	-	-
	1	Interpolation data record	DINT	RW	Pos. unit	0	-2147483648	2147483647

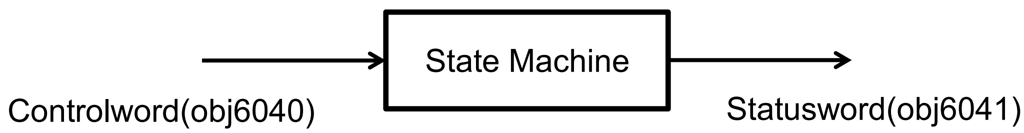
Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
60C2h	Interpolation Time Period							
	0	Highest sub-index supported	USINT	RO	-	2	-	-
	1	Interpolation time period	USINT	RW	-	1	1	250
	2	Interpolation time index	SINT	RW	-	-3	-6	-3
60C4h	Interpolation data configuration							
	0	Highest sub-index supported	USINT	RO	-	6	-	-
	1	Maximum buffer size	UDINT	RW	-	0	0	4294967295
	2	Actual buffer size	UDINT	RW	-	0	0	4294967295
	3	Buffer organization	USINT	RW	-	0	0	1
	4	Buffer position	UINT	RW	-	0	0	32767
	5	Size of data record	USINT	RO	-	1	1	254
	6	Buffer clear	USINT	RO	-	0	0	1
60C5h	0	Max acceleration	UDINT	RW	Acc. unit	4294967295	0	4294967295
60C6h	0	Max deceleration	UDINT	RW	Acc. unit	4294967295	0	4294967295
60E0h	0	Positive torque limit value	UDINT	RW	0.1%	5000	0	65535
60E1h	0	Negative torque limit value	UDINT	RW	0.1%	5000	0	65535
60E3h	Supported homing method							
	0	Highest sub-index supported	USINT	RO	-	32	-	-
	1	1st supported homing method	UINT	RO	-	1	0	32767
	~		UINT	RO	-	-	0	32767
	32	32nd supported homing method	UINT	RO	-	37	0	32767
60F2h	0	Position option code	UINT	RW	-	0	0	65535
60F4h	0	Following Error Actual Value	DINT	RO	Pos. unit	-	-	-
60FAh	0	Control effort	DINT	RO	Vel. Unit	-	-2147483648	2147483647
60FCh	0	Position Demand Internal Value	DINT	RO	Inc	-	-	-
60FDh	0	Digital Inputs	UDINT	RO	-	-	-	-

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
60FEh	Digital outputs							
	0	Highest sub-index supported	USINT	RO	-	2	-	-
	1	Physical outputs	UDINT	RW	-	0	0	0xFFFFFFFF
	2	Mask bit	UDINT	RW	-	0	0	0xFFFFFFFF
60FFh	0	Target Velocity	DINT	RW	Vel. Unit	0	-2147483648	2147483647
6502h	0	Supported Drive Modes	UDINT	RO	-	0x03ED	-	-

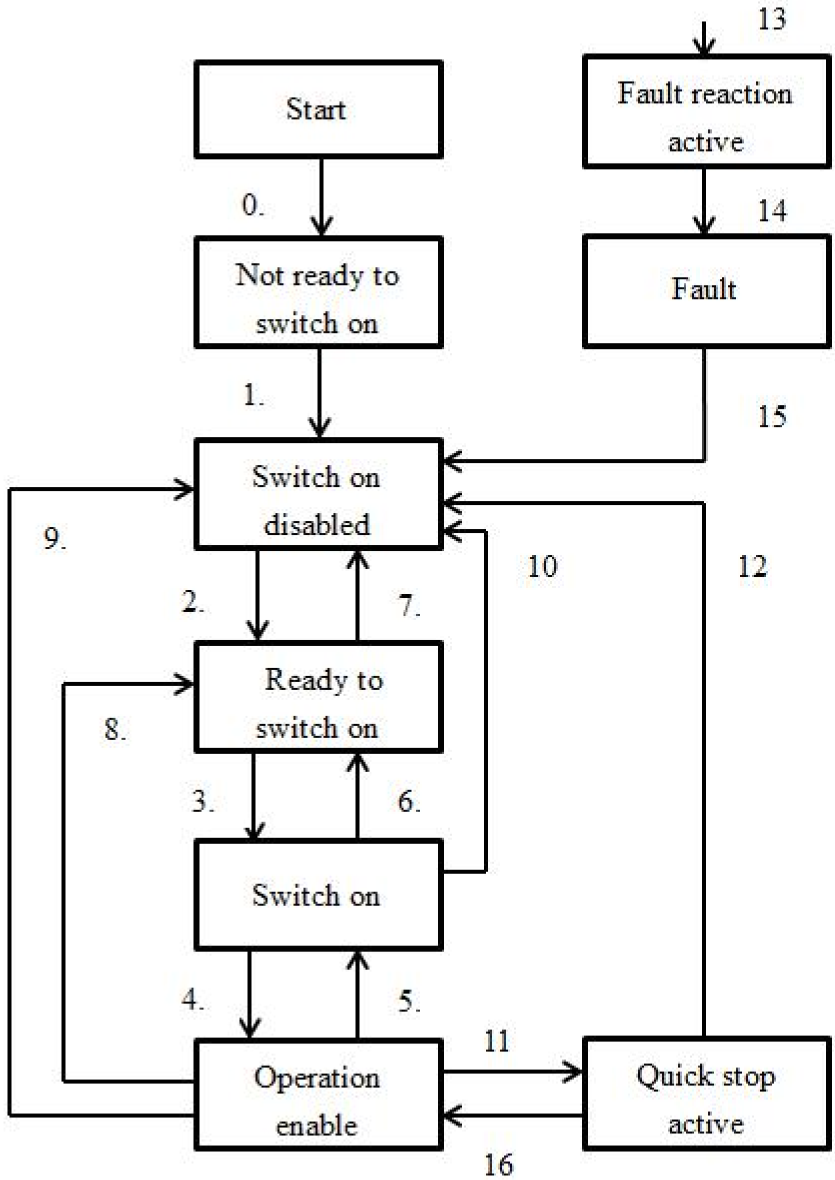
(h)Object definitions

Drive operation status

By changing the value of object 6040h (Controlword), you can set and monitor the current object 6041h (Statusword) to know the current action performed by the drive, and then check with current drive status.



- Drive state machine switching flowchart



Description of drive state switching

Transition	Event	Action
0:Reset	Functional reset	Drive boots and starts initialization.
1:Initialization	Drive initialization succeed	Communication is enabled.
2:Shutdown	Shutdown command	-
3:Switch on	Switch on command	Turn on power module.
4:Enable operation	Enable operation command	Servo switches to Servo On.
5:Disable operation	Disable operation command	Servo switches to Servo Off.
6:Shutdown	Shutdown command	Turn off power module.
7:Disable voltage	EtherCAT state machine returns to Init	-
8:Shutdown	Shutdown command	Servo switches to Servo Off.
9:Disable voltage	Shutdown the power module immediately	Servo switches to Servo Off.
10:Disable voltage	EtherCAT state machine returns to Init	-
11:Quick stop	Quick stop command	Enable emergency stop function
12:Disable voltage	Quick stop action complete	Servo switches to Servo Off.
13:Error occurs	Drive detects an error	Perform error handling.
14:Fault reset	Error occurs	Servo switches to Servo Off.
15:Fault	Error reset command	Error reset is completed.
16:Enable operation	Enable operation command	Servo switches to Servo On.

Object 6040h: Controlword

It controls the operation status and operation mode of the drive, and performs drive operation and error reset by adjusting the value.

Index	Sub -index	Name	Data type	Access	PDO mapping	EEPROM
6040h	0	Controlword	UINT	RW	Yes	No

Controlword internal function description

Switching the drive state by changing the corresponding Bit value.

15~11	10~9	8	7	6~4	3	2	1	0
N/A	Reserved	Halt	Fault reset	Operation mode specific	Enable Operation	Quick Stop	Enable Voltage	Switch on

Drive switch state (Controlword: 6040h)

Command	Bits of the Controlword					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 + enable operation	0	1	1	1	1	3+4
Disable voltage	0	X	X	0	X	7,9,10,12
Quick stop	0	X	0	1	X	7,10,11
Disable operation	0	0	1	1	1	5
Enable operation	0	1	1	1	1	4,16
Fault reset	0 -> 1	X	X	X	X	15

CoE mode description (Controlword: 6040h)

According to the different operation modes, the corresponding Bit4~6 and Bit8 are different, it can change as required.

Operation mode	**Bit4**	**Bit5**	**Bit6**	**Bit8**
Profile position mode	New set-point	Change set Immediately	absolute/relative	Halt
Profile velocity mode	-	-	-	Halt
Profile torque mode	-	-	-	Halt
Cyclic Synchronous Position mode	-	-	-	Halt
Cyclic Synchronous Position mode	-	-	-	Halt
Cyclic Synchronous Position mode	-	-	-	Halt
Homing mode	Start homing	-	-	Halt
Interpolation position mode	Enable interpolation	-	-	Halt

Object 6041h: Statusword

It is used to feedback the object 6040h execution results and monitor the current drive operation status/operation mode.

Index	Sub -index	Name	Data type	Access	PDO mapping	EEPROM
6041h	0	Statusword	UINT	RO	Yes	No

Statusword bit definition:

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

Bit0~3 and Bit5~6 comparison table

Statusword	Status
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

Bit11 Internal limit active trigger condition:

-Software Position Limit is triggered by target position command.

-External limit signal LSP or LSN is triggered.

The functions of Bit10 and Bit12~13 are varies in different operation modes, and it can be changed as required.

Operation mode	Bit10	Bit12	Bit13
Pp	Target reached	Set-point acknowledge	Following error
Pv	Target reached	Speed	-
Pt	Target reached	-	-
Hm	Target reached	Homing attained	Homing error
Ip	Target reached	Ip mode active	-
CSP	-	Operation according to servo command (Note)	Following error
CSV	-	Operation according to servo command (Note)	-
CST	-	Operation according to servo command (Note)	-

Note: The servo commands are operated as follows.

Bit12:0 The servo command is not executed according to Target position/Target velocity/Target torque.

Bit12:1 The servo command is executed according to the value of Target position/Target velocity/Target torque.

Bit14 Torque limit active condition description

Torque limit active bit	0: Torque limit is disabled
	1: Torque limit is enabled

Object 6060h: Modes of operation

The object is used to define the value of the related motion protocol according to CoE communication protocol, and you can enable the current operation mode according to the setting value.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6060h	0	Modes of operation	SINT	RW	Yes	Yes

Setting value	Mode
1.	Profile position mode
3.	Profile velocity mode
4.	Profile torque mode
6.	Homing mode
7.	Interpolated position mode
8.	Cyclic synchronous position mode
9.	Cyclic synchronous velocity mode
10.	Cyclic synchronous torque mode

The CoE mode corresponds to the value declared by Object 6502h: Supported Drive Modes, and the default value of this drive is 0x3ED, which supports the control mode indicated by the corresponding bit.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6502h	0	Supported Drive Modes	UDINT	RO	No	No

Bit NO.	Mode	Support or not
0.	Profile position mode	Yes
1.	Velocity mode	No
2.	Profile velocity mode	Yes
3.	Profile torque mode	Yes
5.	Homing mode	Yes
6.	Interpolated position mode	Yes
7.	Cyclic synchronous position mode	Yes
8.	Cyclic synchronous velocity mode	Yes
9.	Cyclic synchronous torque mode	Yes

Object 6061h: Modes of operation display

According to the CoE communication protocol, this object displays the currently operation mode.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6061h	0	Modes of operation display	SINT	RO	Yes	No

Value	Mode
1.	Profile position mode
3.	Profile velocity mode
4.	Profile torque mode
6.	Homing mode
7.	Interpolated position mode
8.	Cyclic synchronous position mode
9.	Cyclic synchronous velocity mode
10.	Cyclic synchronous torque mode

Object 603Fh: Error Code

According to the CoE communication protocol, this object displays the current error code. When no error generated, the servo is operated normally and 0000h is displayed, once an error occurs, the error code will be displayed in object 603Fh as follows:

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
603Fh	0	Error Code	UINT	RO	Yes	No

FF**h (** stands for planning alarm, its range is 01~90)

If there is an over speed problem in SDC series during operation, error code FF06h will be displayed.

Object 605Ah: Quick Stop Option Code

The motor stops according to the deceleration setting after receiving Quick stop command. Different operation modes have different deceleration options in the CoE communication protocol.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
605Ah	0	Quick Stop Option Code	INT	RW	No	Yes

-Operation Mode PP/PV/HOME/CSP/CSV/IP Setting

Obj605A value	State description
0.	Decelerate time is according to drive parameter PF81 (bit28~31), and the state returns to Switch on disabled
1.	Decelerate time is according to the object Profile Deceleration 6084h (non-HOME mode) and the object Homing Acceleration 609Ah (HOME mode) respectively, and the state returns to Switch on disabled
2.	Decelerate time is according to the object Quick Stop Deceleration 6085h, and the state returns to Switch on disabled
3.	Decelerate time is according to the object Max deceleration 60C6h, and the state returns to Switch on disabled
4.	Decelerate time is according to the drive parameter PF81 (bit28~31), and the state returns to Quick stop active.
5.	Decelerate time is according to the object Profile Deceleration 6084h (non-HOME mode) and the object Homing Acceleration 609Ah (HOME mode) respectively, and the state returns to Quick stop active.
6.	Decelerate time is according to the object Quick Stop Deceleration 6085h, and the state returns to Quick stop active.
7.	Decelerate time is according to the object Max deceleration 60C6h, and the state returns to Quick stop active.

-Operation mode CST/PT setting

Obj605A value	State description
0.	Decelerate time is according to the object Torque Slope 6087h, and the state returns to Switch on disabled.
1.	Decelerate time is according to the object Torque Slope 6087h, and the state returns to Switch on disabled.
2.	Decelerate time is according to the object Torque Slope 6087h, and the state returns to Switch on disabled.
3.	Motor stops when Torque = 0, and the state returns to Switch on disabled.
4.	Motor stops when Torque = 0, and the state returns to Quick stop active.
5.	Decelerate time is according to the object Torque Slope 6087h, and the state returns to Quick stop active
6.	Decelerate time is according to the object Torque Slope 6087h, and the state returns to Quick stop active
7.	Motor stops when Torque = 0, and the state returns to Quick stop active.

Object 605Bh: Shutdown Option Code

After a Shutdown command is received by the drive, the motor stops according to the deceleration setting. Different deceleration methods are available in different operation modes in the CoE communication protocol.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
605Bh	0	Shutdown Option Code	INT	RW	No	Yes

-Operation Mode PP/PV/HOME/CSP/CSV/IP Setting

Obj605B value	State description
0.	Decelerate time is according to the drive parameter PF81 (bit28~31), and the state returns to Ready to switch.
1.	Decelerate time is according to the object Profile Deceleration 6084h (non-HOME mode) and the object Homing Acceleration 609Ah (HOME mode) respectively, and the state returns to Ready to switch on.

-Operation mode CST/PT setting

Obj605B value	State description
0.	Decelerate time is according to the object Torque Slope 6087h and the state returns to Ready to switch on.
1.	Decelerate time is according to the object Torque Slope 6087h and the state returns to Ready to switch on

Object 605Ch: Disable Operation Option Code

The drive receives the disable operation command and stops the motor according to the decelerate setting. Different deceleration methods are available in different operation modes in the CoE communication protocol.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
605Ch	0	Disable Operation Option Code	INT	RW	No	Yes

-Operation Mode PP/PV/HOME/CSP/CSV/IP Setting

Obj605C value	State description
0	Decelerate time is according to the drive parameter PF81 (bit28~31), and the state returns to Switched on disabled.
1	Decelerate time is according to the object Profile Deceleration 6084h (non-HOME mode) and the object Homing Acceleration 609Ah (HOME mode) respectively, and the state returns to Switched on disabled.

-Operation mode CST/PT setting

Obj605C value	State description
0	Decelerate time is according to the object Torque Slope 6087h, and the state returns to Switched on disabled.
1	Decelerate time is according to the object Torque Slope 6087h, and the state returns to Switched on disabled.

Object 605Dh: Halt Option Code

When the Controlword halt bit is set to 1, the motor stops according to the deceleration setting. Different deceleration methods are available in different operation modes in the CoE communication protocol.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
605Dh	0	Halt Option Code	INT	RW	No	Yes

-Operation mode PP/PV/HOME/CSP/CSV/IP Setting

Obj605D value	State description
1	Decelerate time is according to the object Profile Deceleration 6084h, the state is Operation enabled.
2	Decelerate time is according to the object Quick Stop Deceleration 6085h, the state is Operation enabled.
3	Decelerate time is according to the object Max deceleration 60C6h, and the state is Operation enabled.

-Operation mode CST/PT setting

Obj605D value	State description
1	Decelerate time is according to the object Torque Slope 6087h, and the state is Operation enabled.
2	Decelerate time is according to the object Torque Slope 6087h, and the state is Operation enabled.
3	Motor stops when Torque = 0, and the state is Operation enabled.

Object 605Eh: Fault Reaction Option Code

Execute this program when Fault Reaction

(Alarm list: AL.80, AL.81, AL.82, AL.83, AL.84, AL.85, AL.86, AL.87, AL.88, AL.89, AL.90, AL.91)

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
605Eh	0	Reaction Option Code	INT	RW	No	Yes

-Operation Mode PP/PV/IP/HM/CSP/CSV Setting

Obj605E value	State description
0	PA22=0: Enable dynamic braking function, and the state is Fault. PA22=1: Decelerate time is according to drive parameter PF81 (bit28~31), and the state is Fault.
1	Decelerate time is according to the object Profile Deceleration 6084h (non-HOME mode) and the object Homing Acceleration 609Ah (HOME mode) setting respectively, and the state is Fault.
2	Decelerate time is according to the object Quick Stop Deceleration 6085h, and the state is Fault.

-Operation mode CST/PT setting

Obj605E value	State description
0	PA22=0: Enable dynamic braking function, the state is Fault. PA22=1: Decelerate time is according to drive parameter PF81 (bit28~31) setting, and the state is Fault.
1	Decelerate time is according to the object Torque Slope 6087h setting, and the state is Fault.
2	Decelerate time is according to the object Torque Slope 6087h, and the state is Fault.

Following error function setting (PP and CSP mode)

Object 6065h: Following Error Window sets the view scope of following error.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6065h	0	Following Error Window	UDINT	RW	No	Yes

Object 6066h: Following Error Time Out sets the judgment time if the following error exceeds the range. Unit: ms.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6066h	0	Following Error Time Out	UINT	RW	No	Yes

Object 60F4h: Following Error Actual Value is the d-value between object 6062h (Position Demand Value) and object 6064h (Position Actual Value).

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60F4h	0	Following Error Actual Value	DINT	RO	Yes	No

Compare Object 60F4h: Following Error Actual Value with Object 6065h: Following Error Window, if it is greater than the Following Error Window set value, bit13 of the Statusword will be switched to 1, otherwise, the value will be 0.

Target reached Function Setting

Object 6067h: Position Window sets the position reached view range.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6067h	0	Position Window	UDINT	RW	No	Yes

Object 6068h: Position Window Time sets the judgement time in ms when the Position is out of range of Position Window.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6068h	0	Position Window Time	UINT	RW	No	Yes

Compares Object 60F4h: Following Error Actual Value (Note) with Object 6067h, if it is within the Position Window, the value of Statusword bit10 will be switched to 1, otherwise the value will be 0.

Note: Object 60F4h: Following Error Actual Value is the D-value between Object 6062h (Position Demand Value) and Object 6064h (Position Actual Value).

Velocity reached function setting

Object 606Dh: Velocity Window sets the velocity reached view range.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
606Dh	0	Velocity Window Actual Value	UINT	RW	No	Yes

Object 606Eh: Velocity Window Time indicates the minimum time that the actual RPM must be within the Velocity Window range, which is used as the judgment condition of Target reached. Unit: ms.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
606Eh	0	Velocity Window Time	UINT	RW	No	Yes

The sum of object 60FFh (Target Velocity) and object 60B1 (Velocity offset) minus object 606C (Velocity Actual Value), if the value is within the range of Velocity Window and keeps over 606Eh (Velocity Window Time), the value of Statusword bit10 will be switched to 1, otherwise the value will be 0 if it is out of the setting range.

Speed function setting (PV mode)

Object 606Fh: Velocity threshold sets the viewing range of motor speed.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
606Fh	0	Velocity threshold	UINT	RW	No	Yes

Object 6070h: Velocity threshold Time sets the judgement time in ms if the velocity is not in the Velocity threshold range.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6070h	0	Velocity threshold Time	UINT	RW	No	Yes

If Object 606C (Velocity Actual Value) exceeds the value of Velocity threshold, the value of the Statusword bit12 will be 0, otherwise if it is lower than the setting range, the value will be 1.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
606Ch	0	Velocity Actual Value	DINT	RO	Yes	No

The objects for Position

Object 607Ah: Target Position   Unit: Pos unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
607Ah	0	Target Position	DINT	RW	Yes	No

Object 6062h: Position Demand Value   Unit: Pos unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6062h	0	Position Demand Value	DINT	RO	Yes	No

Object 6063h: Position Actual Internal Value   Unit: Increments

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6063h	0	Position Actual Internal Value	DINT	RO	Yes	No

Object 6064h: Current actual position of the motor   Unit: Pos unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6064h	0	Position Actual Value	DINT	RO	Yes	No

Object 60FCh: Internal position demand value   Unit: Pos unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60FCh	0	Position demand internal value	DINT	RO	Yes	No

The Objects for Velocity

Object 60FF: Target Velocity Command   Unit: Vel unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60FFh	0	Target Velocity	DINT	RW	Yes	No

Object 606B: Velocity Demand Value   Unit: Vel unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
606Bh	0	Velocity Demand Value	DINT	RO	Yes	No

Object 606C: Velocity Actual Value Unit: Vel unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
606Ch	0	Velocity Actual Value	DINT	RO	Yes	No

Object 607Fh: Maximum profile velocity limit Unit: Vel unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
607Fh	0	Max Profile Velocity	DINT	RW	Yes	Yes

Object 6080h: Maximum velocity limit for motor operation Unit: Vel unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6080h	0	Max Motor Velocity	UDINT	RW	Yes	Yes

Object 6081h: Profile velocity Unit: Vel unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6081h	0	Profile Velocity	UDINT	RW	Yes	Yes

Object 6083h: Profile acceleration Unit: Acc

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6083h	0	Profile Acceleration	UDINT	RW	Yes	Yes

Object 6084h: Profile Deceleration Unit: Acc unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6084h	0	Profile Deceleration	UDINT	RW	Yes	Yes

Object 6085h: Quick Stop Deceleration Unit: Acc unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6085h	0	Quick Stop Deceleration	UDINT	RW	Yes	Yes

Object 60C5h: Max Acceleration Unit: Acc unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60C5h	0	Max Acceleration	UDINT	RW	Yes	Yes

Object 60C6h: Max Deceleration   Unit: Acc unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60C6h	0	Max Deceleration	UDINT	RW	Yes	Yes

The objects for Torque

Object 6071h: Target Torque Command   Unit: 0.1%

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6071h	0	Target Torque	INT	RW	Yes	No

Object 6074h: Torque Demand Value   Unit: 0.1%

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6074h	0	Torque Demand Value	INT	RO	Yes	No

Object 6077h: Torque Actual Value   Unit: 0.1%.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6077h	0	Torque Actual Value	INT	RO	Yes	No

Object 6072h: Max Torque   Unit: 0.1%

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6072h	0	Max Torque	UINT	RW	Yes	No

Object 6073h: Max Current   Unit: 0.1%

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6073h	0	Max Current	UINT	RO	No	No

Object 6075h: Motor rated current   Unit: mA

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6075h	0	Motor rated current	UDINT	RO	Yes	No

Object 6076h: Motor rated torque   Unit: mNm

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6076h	0	Motor rated torque	UDINT	RO	Yes	No

Object 6078h: Current Actual value Unit: 0.1%

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6078h	0	Current Actual value	INT	RO	Yes	No

Object 6079h: DC link circuit voltage Unit: mV

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6079h	0	DC link circuit voltage	UDINT	RO	Yes	No

Object 6087h: Torque Slope Unit: 0.1%/sec

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6087h	0	Torque Slope	UDINT	RW	Yes	Yes

The objects for Control Command Offset

Object 60B0h: Position Offset Unit: Pos unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60B0h	0	Position Offset	DINT	RW	Yes	No

Object 60B1h: Velocity Offset Unit: Vel unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60B1h	0	Velocity Offset	DINT	RW	Yes	No

Object 60B2h: Torque Offset Unit: 0.1%

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60B2h	0	Torque Offset	INT	RW	Yes	No

Object 607Ch: Home Offset Unit: Pos unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
607Ch	0	Home Offset	DINT	RW	No	Yes

The objects for Homing

Object 6098h: Homing method.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6098h	0	Homing method	SINT	RW	Yes	No

Object 6099h: Homing Speeds　Unit: Vel unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6099h	0	Homing Speeds	USINT	RO	No	No

-Object 6099h-01: Speed during search for switch　Unit: Vel unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6099h	1	Speed during search for switch	UDINT	RW	Yes	Yes

-Object 6099h-02: Speed during search for zero　Unit: Vel unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6099h	2	Speed during search for zero	UDINT	RW	Yes	Yes

Object 609Ah: Homing Acceleration　Unit: Acc unit

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
609Ah	0	Homing Acceleration	UDINT	RW	Yes	Yes

Object 60E3h: Supported homing method

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60E3h	0	Supported homing method	UINT	RO	No	No

The objects for Touch Probe Function

Object 60B8h: Touch probe Function

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60B8h	0	Touch probe Function	UINT	RW	Yes	No

Object 60B9h: Touch probe Status shows the current access status of both positions.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60B9h	0	Touch probe Status	UINT	RO	Yes	No

Object 60BAh: Touch probe1 position pos Value shows access position.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60BAh	0	Touch probe1 position pos Value	DINT	RO	Yes	No

Object 60BBh: Touch probe1 position neg Value shows access position.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60BBh	0	Touch probe1 position neg Value	DINT	RO	Yes	No

Object 60BCh: Touch probe2 position pos Value shows access position.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60BCh	0	Touch probe2 position pos Value	DINT	RO	Yes	No

Object 60BDh: Touch probe2 position neg Value shows access position.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60BDh	0	Touch probe2 position neg Value	DINT	RO	Yes	No

Object 60FD: Digital inputs

The object is used to assign the DI and trigger the LSP, LSN and HOME signals. INP indicates the status of the position reached, it is as below:

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60FDh	0	Digital inputs	UDINT	RO	Yes	No

INP-ON=bit24 of obj60FD is 1   INP-OFF=bit24 of obj60FD is 0
ORGP-ON=bit2 of obj60FD is 1   ORGP-OFF=bit2 of obj60FD is 0
LSP-ON=bit1 of obj60FD is 1   LSP-OFF=bit1 of obj60FD is 0
LSN-ON=bit0 of obj60FD is 1   LSN-OFF=bit0 of obj60FD is 0

Object 60FE: Digital outputs

The object is used to assign DO and trigger the MBR and DO1~DO3 signal

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60FEh	0	Digital outputs	USINT	RO	No	No

Index: 60FE-01h: Physical outputs sets the DO items to be used

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60FEh	1	Physical outputs	UDINT	RW	Yes	No

Index: 60FE-02h: Bit mask. The controller determines the triggered DO items.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60FEh	2	Bit mask	UDINT	RW	Yes	No

Sub-index 01h: Physical outputs

Bit19	Bit18	Bit17	Bit16	Bit0
DO4 signal	DO3 signal	DO2 signal	DO1 signal	MBR

When setting 1 to the corresponding bit of Sub-index 01h means that the DO is defined.

Sub-index 02h: Bit mask

Bit	Name	Value	Status
0	MBR	0	Disable output
		1	Enable output
16	DO1 signal	0	Disable output
		1	Enable output
17	DO2 signal	0	Disable output
		1	Enable output
18	DO3 signal	0	Disable output
		1	Enable output
19	DO4 signal	0	Disable output
		1	Enable output

Object 608F: Position encoder resolution

This object shows the motor resolution per revolution.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
608Fh	0	Position encoder resolution	USINT	RO	No	No

Index: 608F-01h: Encoder increments

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
608Fh	1	Encoder increments	UDINT	RO	No	No

Index: 608F-02h: Motor revolutions

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
608Fh	2	Motor revolutions	UDINT	RO	No	No

Object 6091: Gear Ratio

You can set this object to define the E-gear ratio.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6091h	0	Gear Ratio	USINT	RO	No	No

Index: 6091-01h: The numerator of the E-gear ratio is identical to the parameter PA06.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6091h	1	E-gear ratio numerator	UDINT	RW	Yes	No

Index: 6091-02h: The denominator for E-gear ratios is the same as parameter PA07.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6091h	2	E-gear ratio denominator	UDINT	RW	Yes	No

The E-gear ratio setting is changed by the upper controller writing object 6091-01h and object 6091-02h. To fix the E-gear ratio, you can use the object 1010h (Store Parameters) to write the E-gear ratio into the EEPROM.

Object 1010: Store Parameters

Writing the value 0x65766173 to the object 1010: Store Parameters, it can save the object value to the EEPROM (corresponds to the EEPROM: Yes parts). The value of the object returns to 1 when the operation is completed.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
1010h	0	Store Parameters	USINT	RO	No	No

Index: 1010-01h: Save all parameters (For 1xxxh and 6xxxh objects)

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
1010h	1	Save all parameters	UDINT	RW	No	No

Index: 1010-02h: Save communication (For 1xxxh objects)

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
1010h	2	Save communication	UDINT	RW	No	No

Index: 1010-03h: Save application parameters (For 6xxxh objects)

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
1010h	3	Save application parameters	UDINT	RW	No	No

Index: 1010-04h: Save manufacturer defined parameters (For 2xxxh objects)

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
1010h	4	Save manufacturer defined parameters	UDINT	RW	No	No

Object 1011: Restore Default Parameters

Writing the value 0x64616F6C to this object, it can restore the setting object value to its default value. The object value returns to 1 when the operation is completed.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
1011h	0	Default Parameters	USINT	RO	No	No

Index: 1011-01h: Restore all default (For 1xxxh and 6xxxh objects)

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
1011h	1	Restore all default	UDINT	RW	No	No

Index: 1011-02h: Restore communication default parameters (For 1xxxh objects)

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
1011h	2	Restore communication default parameters	UDINT	RW	No	No

Index: 1011-03h: Restore application default parameters (For 6xxxh objects)

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
1011h	3	Restore application default parameters	UDINT	RW	No	No

Index: 1011-04h: Restore manufacturer default parameters (For 2xxxh objects)

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
1011h	4	Restore manufacturer default parameters	UDINT	RW	No	No

Object 60F2h: Position option code defines positioning basis.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60F2h	0	Position option code	UINT	RW	Yes	Yes

Value 0: Based on Target position (607Ah).

Value 1: Based on Position demand value (6062h).

Value 2: Based on Position actual value (6064h).

Object 10F3h: Diagnosis history indicates the alarm history of the drive.

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
10F3h	0	Number of entries	USINT	RO	No	No
	1	Maximum messages	USINT	RO	No	No
	2	Newest message	USINT	RO	No	No
	3	Newest acknowledged message	USINT	RW	No	No
	4	Newest message available	USINT	RO	No	No
	5	Flags	UINT	RW	No	Yes
	6	Diagnosis message1	STRING	RO	No	No
	7	Diagnosis message2	STRING	RO	No	No
	8	Diagnosis message3	STRING	RO	No	No
	9	Diagnosis message4	STRING	RO	No	No
	10	Diagnosis message5	STRING	RO	No	No
	11	Diagnosis message6	STRING	RO	No	No
	12	Diagnosis message7	STRING	RO	No	No
	13	Diagnosis message8	STRING	RO	No	No
	14	Diagnosis message9	STRING	RO	No	No
	15	Diagnosis message10	STRING	RO	No	No
	16	Diagnosis message11	STRING	RO	No	No
	17	Diagnosis message12	STRING	RO	No	No
	18	Diagnosis message13	STRING	RO	No	No
	19	Diagnosis message14	STRING	RO	No	No

You can see the alarms that have occurred in the drive by the value of object 10F3 to analyze the problem, and the following lists the alarm history.

There are 6 alarms occurred

02h	0Bh
~	
06h	The 5th alarm past
07h	The 4th alarm past
08h	The 3rd alarm past
09h	The 2nd alarm past
0Ah	The last alarm
0Bh	The current alarm
0Ch	0
0Dh	0
0Eh	0
0Fh	0
10h	0
11h	0
12h	0
13h	0

There are 14 alarms occurred

02h	0Bh
~	
06h	The 13th alarm past
07h	The 12th alarm past
08h	The 11th alarm past
09h	The 10th alarm past
0Ah	The 9th alarm past
0Bh	The 8th alarm past
0Ch	The 7th alarm past
0Dh	The 6th alarm past
0Eh	The 5th alarm past
0Fh	The 4th alarm past
10h	The 3rd alarm past
11h	The 2nd alarm past
12h	The last alarm
13h	The current alarm

Object 60E0h: Positive torque limit value

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60E0h	0	Positive torque limit value	UDINT	RW	Yes	Yes

Object 60E1h: Negative torque limit value

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
60E1h	0	Negative torque limit value	UDINT	RW	Yes	Yes

Object list (Some functions are not supported currently)

Index	Sub -index	Name	Data type	Data access	PDO mapping	EEPROM
6007h	0	Abort connection option code	INT	RW	No	Yes
6069h	0	Velocity sensor actual value	DINT	RO	Yes	No
606Ah	0	Sensor selection code	INT	RO	Yes	No
607Bh	0	Position range limit	USINT	RO	No	No
607Eh	0	Polarity	USINT	RW	No	Yes
6082h	0	End Velocity	UDINT	RW	Yes	Yes
6086h	0	Motor profile type	INT	RW	Yes	Yes
6088h	0	Torque profile type	INT	RW	Yes	Yes
6092h	0	Feed constant	USINT	RO	No	No
60A3h	0	Profile jerk use	USINT	RW	No	Yes
60A4h	0	Profile jerk	INT	RO	No	No
60C4h	0	Interpolation data configuration	USINT	RO	No	No
60FAh	0	Control effort	DINT	RO	Yes	No

Description of the drive internal parameters:

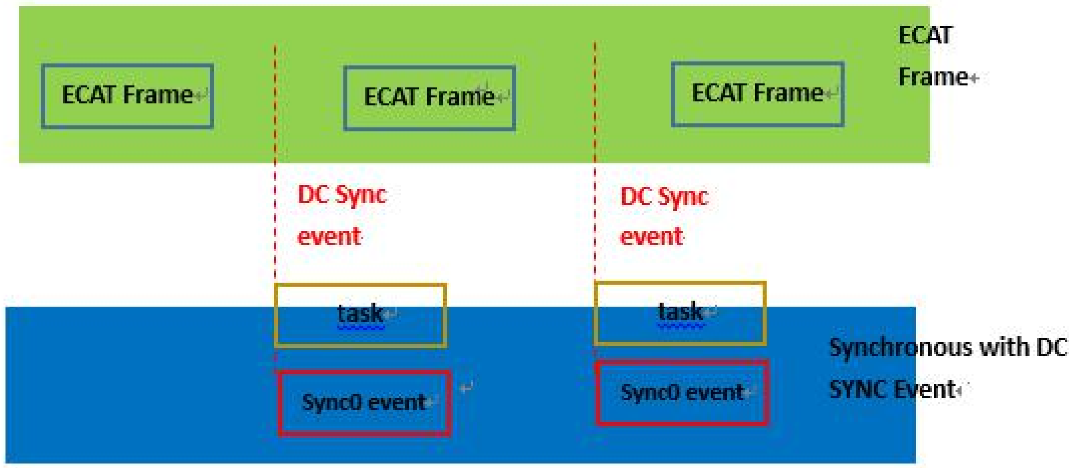
Index	Object	Date type	Name	Description
2001h	VAR	INT(32bit)	PA01	PA Group
2002h	VAR		PA02	PA Group
~	VAR		~	PA Group
200Ah	VAR		PA10	PA Group
200Bh	VAR		PA11	PA Group
~	VAR		~	PA Group
2010h	VAR		PA16	PA Group
~	VAR		~	PA Group
2032h	VAR		PA50	PA Group
2101h	VAR		PB01	PB Group
~	VAR		~	PB Group
2132h	VAR		PB50	PB Group
2201h	VAR		PC01	PC Group
~	VAR		~	PC Group
2260h	VAR		PC96	PC Group
2301h	VAR		PD01	PD Group
~	VAR		~	PD Group
2321h	VAR		PD33	PD Group
2401h	VAR		PE01	PE Group
~	VAR		~	PE Group
2462h	VAR		PE98	PE Group
2501h	VAR		PF01	PF Group
~	VAR		~	PF Group
255Ah	VAR		PF90	PF Group

(i)Synchronization mechanism

This drive supports two synchronous modes: DC Synchronous mode and Free Run mode. According to the DC section in the ESI file, it includes mode selection and related cycle time settings.

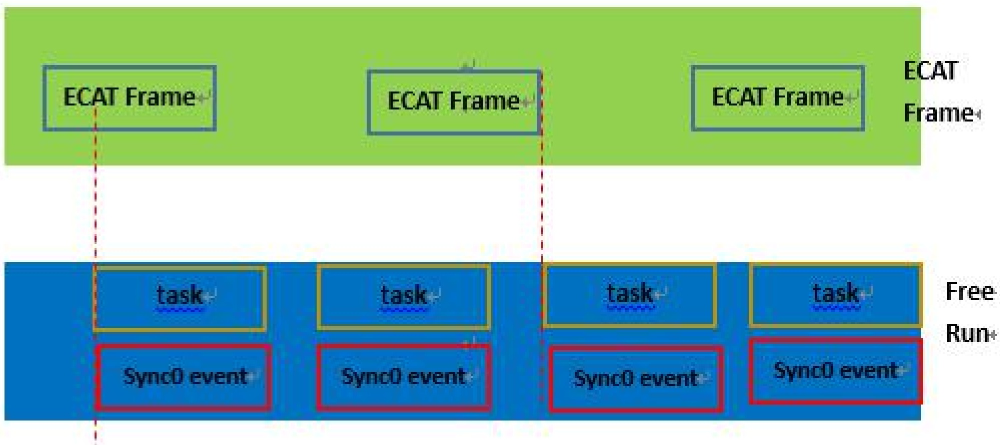
- DC Synchronous mode

In order to achieve consistent system time between the master and slave stations, it is necessary to calculate the offset and delay time between the slave stations. The master writes the time into the corresponding slave register after the calculation, and corrects the time of some individual slaves to align the slaves cycle time.



-Free run mode

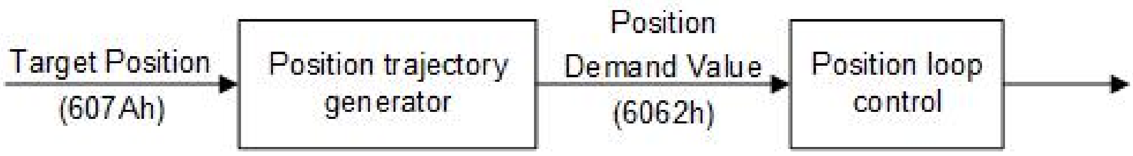
The master and slave stations run asynchronously. Each station has an individual clock to calculate time. The command and feedback transmissions between the master and slave are based on a sequential order instead of a precise time synchronization.



10.CANopen Mode

10.1 Profile Position Mode

In profile position control mode, the drive has trajectory planning function, and you need input the target position, profile velocity, profile acceleration and deceleration for the PTP operation during the process.



10.1.1 Operation steps

1.Set the object (Mode of operations: 6060h) to 0x01 to set the mode as Profile Position Mode.

2.Set the object (Target position: 607Ah) to the target position value in pulse and plan the path.

3.Set the object (Profile velocity: 6081h) to the profile velocity value, unit: Pulse / s.

4.Set the object (Profile acceleration: 6083h) and the object (Profile deceleration: 6084h) for the acceleration/deceleration value (millisecond from 0 rpm to 3000 rpm) in Pulse / s^2.

5.Set the object (Controlword: 6040h) by using the value 0x06 -> 0x07 -> 0x0F to make the control system in Servo On state, when the value is switching from 0x0F -> 0x1F, it will triggered the positioning control.

6.You can define the allowed positive or negative error of reaching target position by setting the object (Position window: 6067h), which is to confirm whether the target position is reached or not. In addition, the object (Position window time: 6068h) is used to set how long (ms) it stays within the error range and the Target Reached can be determined.

7.Object (Following error window: 6065h) sets position command error allowable value. The object (Following error window time: 6068h) can be used to set how long (ms) it stays within the error range and confirm whether it is positioned in a relative position.

10.1.2 Related objects setting

Description of Controlword(Bit4~6)

Bit	Name	Value	Description
4.	New set-point	0	No target position set
		1	Set target position
5.	Change set immediately	0	The new command is acknowledged and executed after the current command is complete.
		1	The servo interrupts the current command immediately and executes the new command once receiving the new triggered command.
6.	Absolute/relative	0	Absolute position
		1	Relative position

Description of Statusword

Bit	Name	Value	Description
10.	Target reached	0	Target position is not reached
		1	Target position is reached
13.	Following error	0	The value of Object 60F4 is within the setting range.
		1	The value of Object 60F4 is out of the setting range.

10.1.3 List of related objects

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
6040h	0	Controlword	UINT	RW	-	0	0	0xFFFF
6041h	0	Statusword	UINT	RO	-	-	-	-
6060h	0	Modes of Operation	SINT	RW	-	0	-128	128
6061h	0	Modes of Operation Display	SINT	RO	-	0	-	-
6062h	0	Position Demand Value	DINT	RO	Pos. unit	-	-	-
6064h	0	Position Actual Value	DINT	RO	Pos. unit	-	-	-
6065h	0	Following Error Window	UDINT	RW	Pos. unit	5242880	0	1073741823
6066h	0	Following Error Time Out	UINT	RW	ms	0	0	65535
6067h	0	Position Window	UDINT	RW	Pos. unit	30	0	1073741823
6068h	0	Position Window Time	UINT	RW	ms	0	0	65535
`606Ch	0	Velocity Actual Value	DINT	RO	Vel. unit	-	-	-
6072h	0	Max. Torque	UINT	RW	0.1%	Motor max. torque	0	65535
607Ah	0	Target Position	DINT	RW	Pos. unit	0	-2147483648	2147483647
607Dh	Software position limit							
	0	Number of entries	USINT	RO	-	2	-	-
	1	Min. position limit	DINT	RW	Pos. unit	0	-2147483648	2147483647
	2	Max. position limit	DINT	RW	Pos. unit	0	-2147483648	2147483647
6081h	0	Profile Velocity	UDINT	RW	Vel. unit	0	0	4294967295
6083h	0	Profile Acceleration	UDINT	RW	Acc. unit	10000000	0	4294967295
6084h	0	Profile Deceleration	UDINT	RW	Acc. Unit	10000000	0	4294967295
60F4h	0	Following Error Actual Value	DINT	RO	Pos. unit	-	-	-
60FCh	0	Position Demand Internal Value	DINT	RO	Inc	-	-	-

10.2 Interpolation Position Mode

By sending commands to the drive from the upper controller, each command needs to contain an interpolation data to calculate the next position value. During each interpolation cycle, the drive calculates the required position value by the interpolation position.

10.2.1 Operation steps

1.Set the object (Mode of operations: 6060h) to 0x07 to set the mode as Interpolation Position Mode

2.The object (Interpolation sub mode select: 60C0h) default value is 0, which is line interpolation mode.

3.The object (Interpolation time period: 60C2h) sets the interpolation cycle value, which is the same as the synchronization signal SYNC0 cycle.

-Object 60C2h Sub-1 is interpolation cycle time, its range is from 1 to 250.

-Object 60C2h Sub-2 is Interpolation time index, its default value is -3 (Interpolation time unit 10^-3 seconds).

10.2.2 Related objects setting

Interpolation mode setting(Controlword: 6040h)

Bit	Name	Value	Description
4.	Enable IP mode	0	Disable interpolation mode
		1	Enable interpolation mode
8.	Halt	0	Execute motion command
		1	Stop motion axis

Interpolation mode setting(Statusword: 6041h)

Bit	Name	Value	Description
10.	Target reached	0	Target position is not reached
		1	Target position is reached
12.	IP mode active	0	Interpolation mode is disabled
		1	Interpolation mode is enabled

10.2.3 List of related objects

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
6040h	0	Controlword	UINT	RW	-	0	0	0xFFFF
6041h	0	Statusword	UINT	RO	-	-	-	-
6060h	0	Modes of Operation	SINT	RW	-	0	-128	128
6061h	0	Modes of Operation Display	SINT	RO	-	0	-	-
60C0h	0	Interpolation sub mode	INT	RW	-	0	-3	0
60C1h	Interpolation Data Record							
	0	Number of entries	USINT	RO	-	1	-	-
	1	Interpolation data record	DINT	RW	Pos. unit	0	-2147483648	2147483647
60C2h	Interpolation Time Period							
	0	Highest sub-index supported	USINT	RO	-	2	-	-
	1	Interpolation time period	USINT	RW	-	1	1	250
	2	Interpolation time index	SINT	RW	-	-3	-6	-3
60C4h	Interpolation data configuration							
	0	Highest sub-index supported	USINT	RO	-	6	-	-
	1	Maximum buffer size	UDINT	RW	-	0	0	4294967295
	2	Actual buffer size	UDINT	RW	-	0	0	4294967295
	3	Buffer organization	USINT	RW	-	0	0	1
	4	Buffer position	UINT	RW	-	0	0	32767
	5	Size of data record	USINT	RO	-	1	1	254
	6	Buffer clear	USINT	RO	-	0	0	1

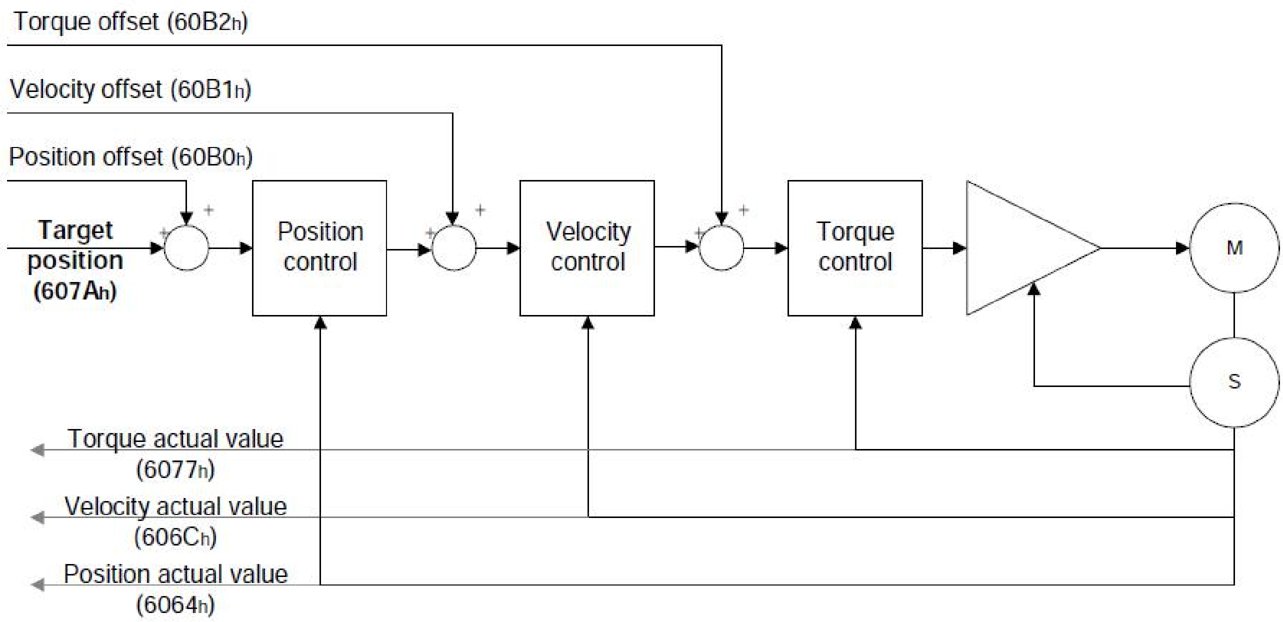
10.3 Cyclic Synchronous Position Mode

The system has trajectory planning function in this mode. You only need to input the target position, and the position command will be delivered to the drive in a cyclic synchronous way.

10.3.1 Operation steps

1.Set the object (Mode of operations: 6060h) to 0x08 to set the operation mode as Cyclic Synchronous Position Mode and write the target position to the object (Target position: 607Ah) in pulse.

2.Set the object (Controlword: 6040h) by using the value 0x06 -> 0x07 -> 0x0F to make the system in Servo On state and the motor starts to run.



10.3.2 List of related objects

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
6040h	0	Controlword	UINT	RW	-	0	0	0xFFFF
6041h	0	Statusword	UINT	RO	-	-	-	-
6060h	0	Modes of Operation	SINT	RW	-	0	-128	128
6061h	0	Modes of Operation Display	SINT	RO	-	0	-	-
607Ah	0	Target Position	DINT	RW	Pos. unit	0	-2147483648	2147483647
607Dh	Software Position Limit							
	0	Number of entries	USINT	RO	-	2	-	-
	1	Min. position limit	DINT	RW	Pos. unit	0	-2147483648	2147483647
	2	Max. position limit	DINT	RW	Pos. unit	0	-2147483648	2147483647
6083h	0	Profile Acceleration	UDINT	RW	Acc. unit	10000000	0	4294967295
6084h	0	Profile Deceleration	UDINT	RW	Acc. Unit	10000000	0	4294967295
6085h	0	Quick Stop Deceleration	UDINT	RW	Acc. Unit	4000000000	0	4294967295
60B0h	0	Position Offset	DINT	RW	Pos. unit	0	-2147483648	2147483647
60B1h	0	Velocity Offset	DINT	RW	Vel. Unit	0	-2147483648	2147483647
60B2h	0	Torque Offset	INT	RW	0.1%	0	-32768	32767

10.4 Homing Mode

In this mode, the drive can perform homing, and the homing speed and homing acceleration /deceleration can be set. And the drive plans the path.

10.4.1 Operation steps

1.Set the object (Mode of operations: 6060h) to 0x06 to set the operation mode as Homing Mode.

2.Set the object (Homing speeds: 6099h Sub-1) for the speed during searching for the home switch, and set the object (Homing speeds: 6099h Sub-2) for the speed during searching for the zero point.

3.Set the object (Homing acceleration: 609Ah) for the homing acceleration (unit: Pulse / s^2).

4.Select the homing method by setting the object (Homing method: 6098h) within the range of 1 to 37, and the default value is 35.

5.Set the object (Controlword: 6040h) by using the value 0x06 -> 0x07 -> 0x0F to make the control system in Servo On state. When the object (Controlword: 6040h) is switched from 0x0F to 0x1F, it starts to search the home switch and perform homing.

10.4.2 Homing objects setting

Mode setting (Controlword: 6040h)

Bit	Name	Value	Description
4.	Homing operation start	0	Homing mode is disabled
		1	Homing mode is enabled
8.	Halt	0	Execute motion command
		1	Stop motion axis

Homing setting (Statusword: 6041h)

Bit	Name	Value	Description
10.	Target reached	0	The origin is not reached
		1	The origin is reached
12.	Homing attained	0	Homing is not completed
		1	Homing is completed
13.	Homing error	0	No homing error
		1	Homing error occurs

Homing status

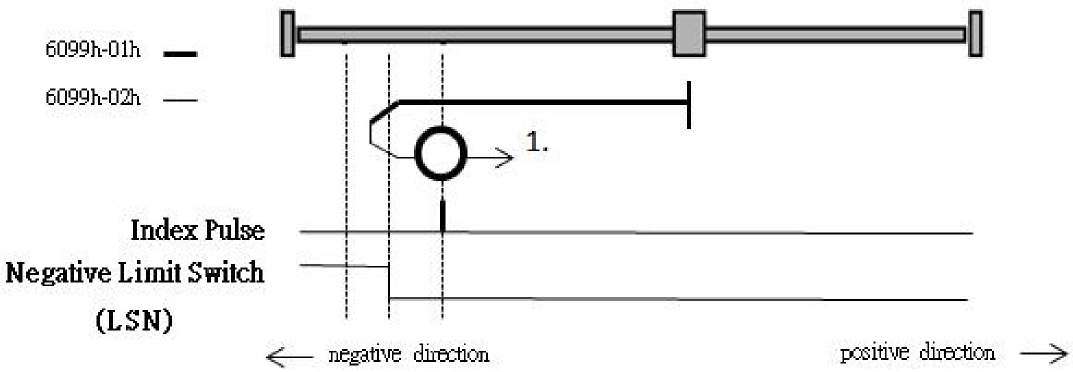
Bit 10	Bit 12	Bit 13	Definition
0	0	0	Homing in process
1	0	0	Homing suspended or not yet started
0	1	0	Homing completed but not reached target position
1	1	0	Homing completed.
0	0	1	Homing error occurs but still running
1	0	1	Homing error occurs and stopped.

10.4.3 List of related objects

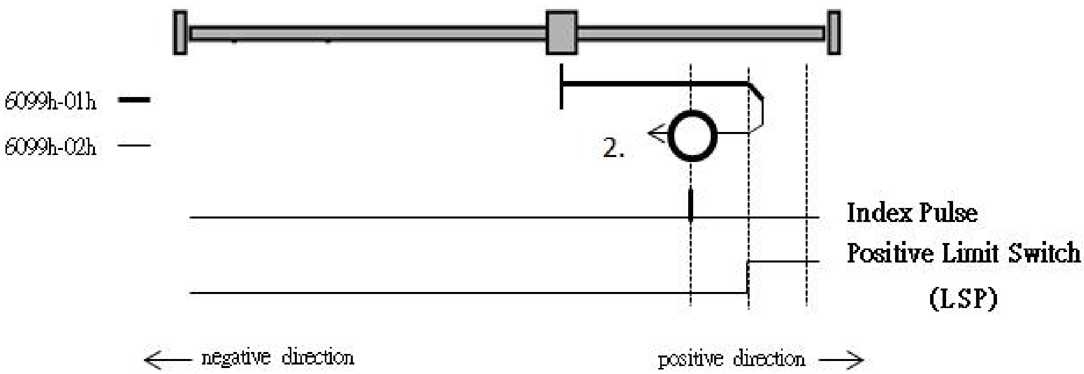
Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
6040h	0	Controlword	UINT	RW	-	0	0	0xFFFF
6041h	0	Statusword	UINT	RO	-	-	-	-
6060h	0	Modes of Operation	SINT	RW	-	0	-128	128
6061h	0	Modes of Operation Display	SINT	RO	-	0	-	-
607Ch	0	Home Offset	DINT	RW	Pos. unit	0	-2147483648	2147483647
6098h	0	Homing Method	SINT	RW	-	35	0	37
6099h	Quick Stop Deceleration							
	0	Number of entries	USINT	RO	-	2	-	-
	1	Speed during search for switch	UDINT	RW	Vel.	500000	0	4294967295
	2	Speed during search for zero	UDINT	RW	Vel. Unit	100000	0	4294967295
609Ah	0	Homing Acceleration	UDINT	RW	Acc. unit	10000000	0	4294967295

10.4.4 Homing method: 6098h

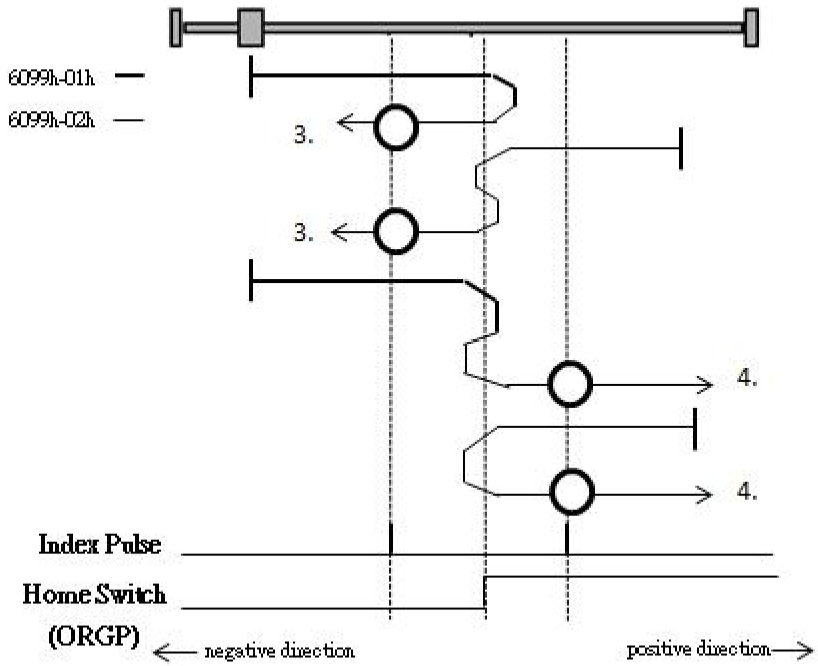
Homing method	Path description
Method 1	After reaching the reverse limit, rotate forwardly to search the Z-phase for homing.



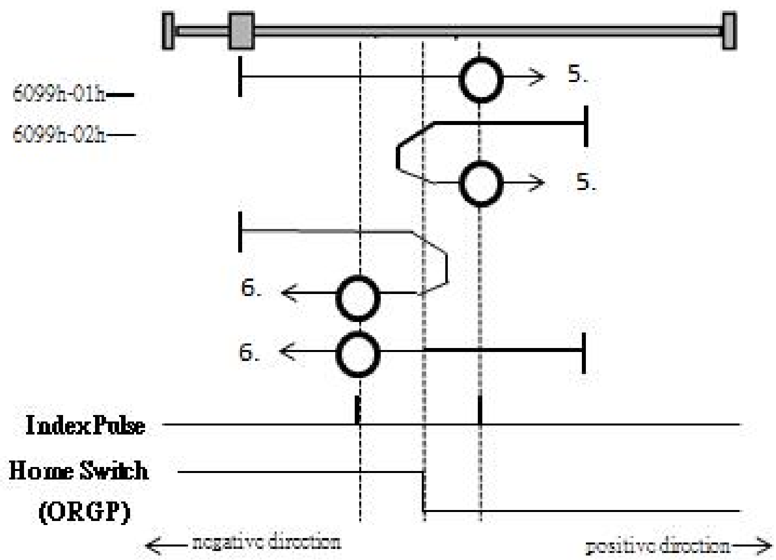
Homing method	Path description
Method 2	After reaching the positive limit switch, rotate reversely to search for the Z-phase for homing.



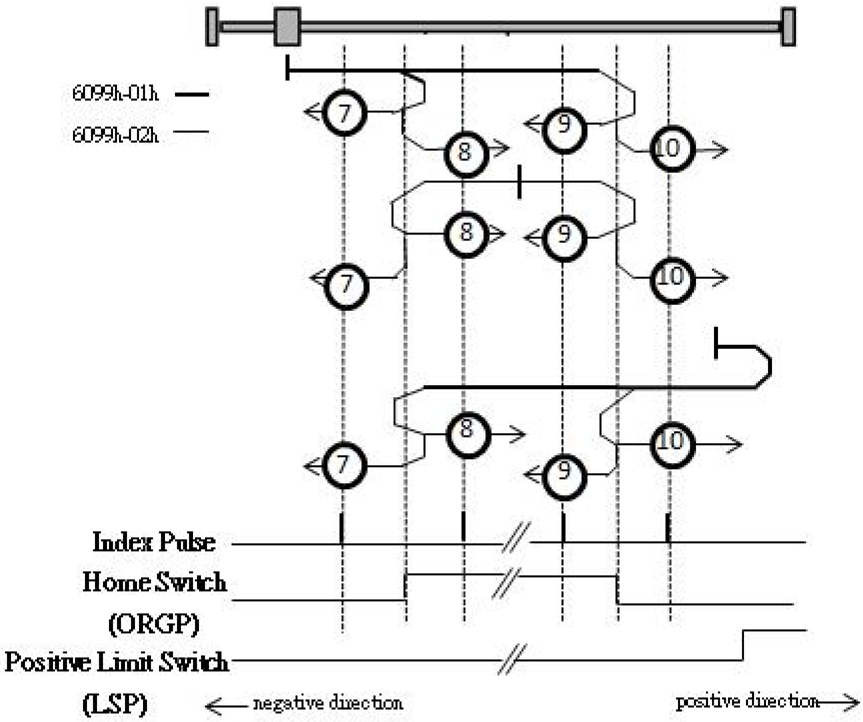
Homing method	Path description
Method 3	Trigger ORGP signal: ON -> OFF during forward rotation and search Z-phase for homing.
Method 4	Trigger ORGP signal: OFF -> ON during forward rotation and search Z-phase for homing.



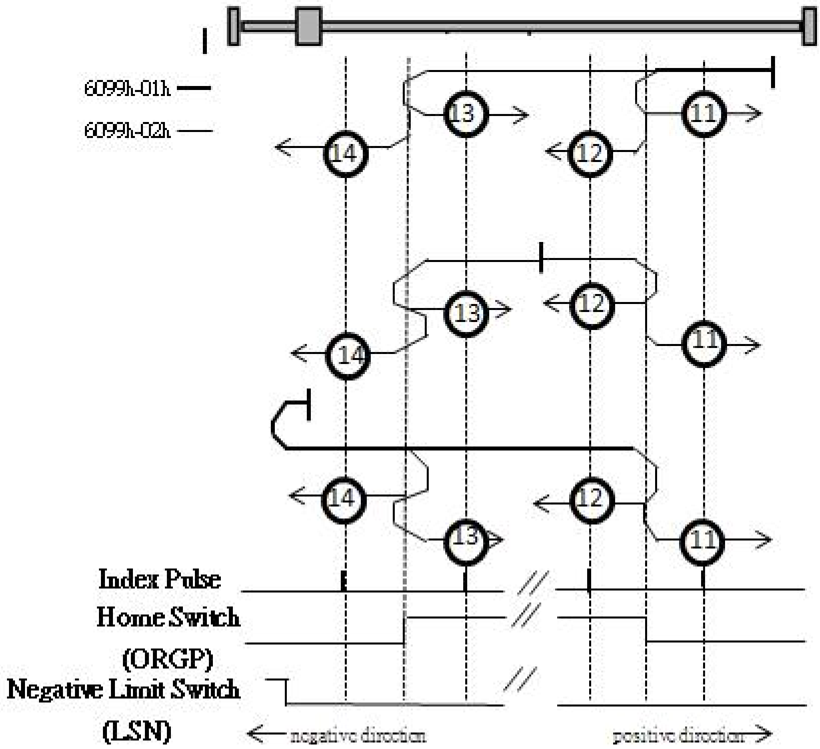
Homing method	Path description
Method 5	Trigger ORGP signal: ON -> OFF during reverse rotation and search Z-phase for homing.
Method 6	Trigger ORGP signal: OFF -> ON during forward rotation and search Z-phase for homing.



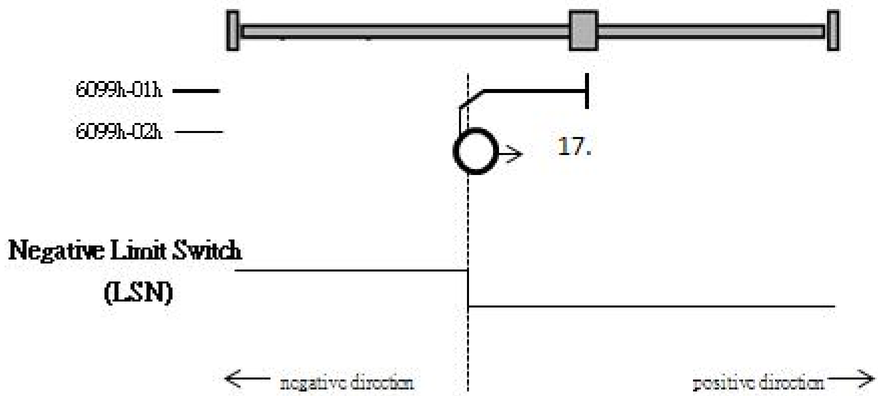
Homing method	Path description
Method 7	Trigger ORGP signal: ON -> OFF during forward rotation and search Z-phase for homing.
Method 8	Trigger ORGP signal: OFF -> ON during forward rotation and search Z-phase for homing.
Method 9	Trigger ORGP signal: ON -> OFF-> ON during forward rotation and search Z-phase for homing.
Method 10	Trigger ORGP signal: ON -> OFF during forward rotation and search Z-phase for homing.



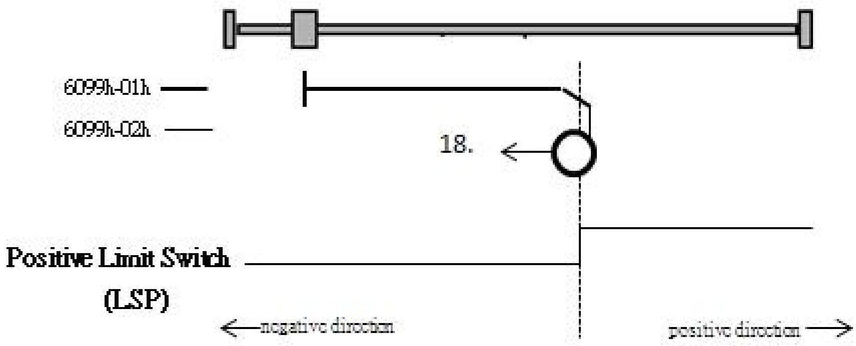
Homing method	Path description
Method 11	Trigger ORGP signal: ON -> OFF during reverse rotation and search Z-phase for homing.
Method 12	Trigger ORGP signal: OFF -> ON during reverse rotation and search Z-phase for homing.
Method 13	Trigger ORGP signal: ON -> OFF-> ON during reverse rotation and searching Z-phase for homing.
Method 14	Trigger ORGP signal: ON -> OFF during reverse rotation and search Z-phase for homing.



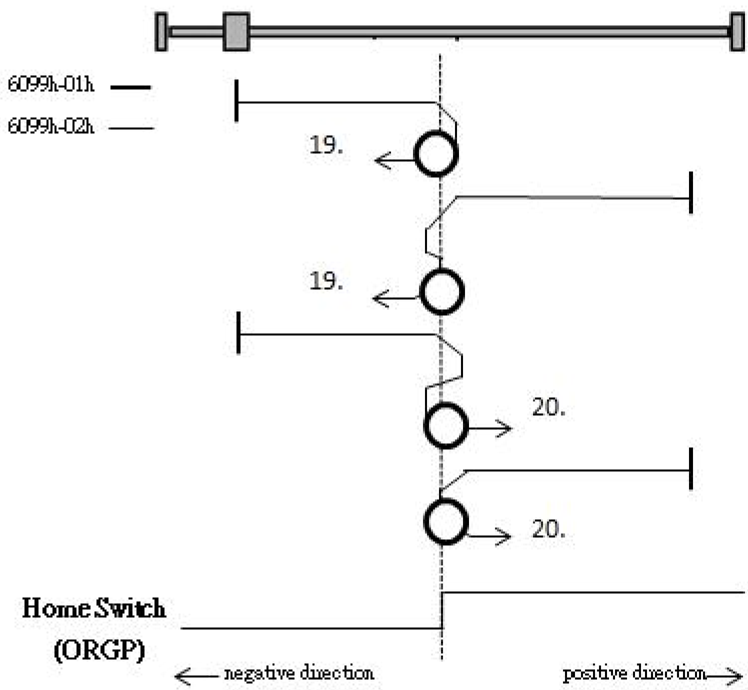
Homing method	Path description
Method 17	Trigger LSN signal: ON -> OFF during reverse rotation and not search Z-phase for homing.



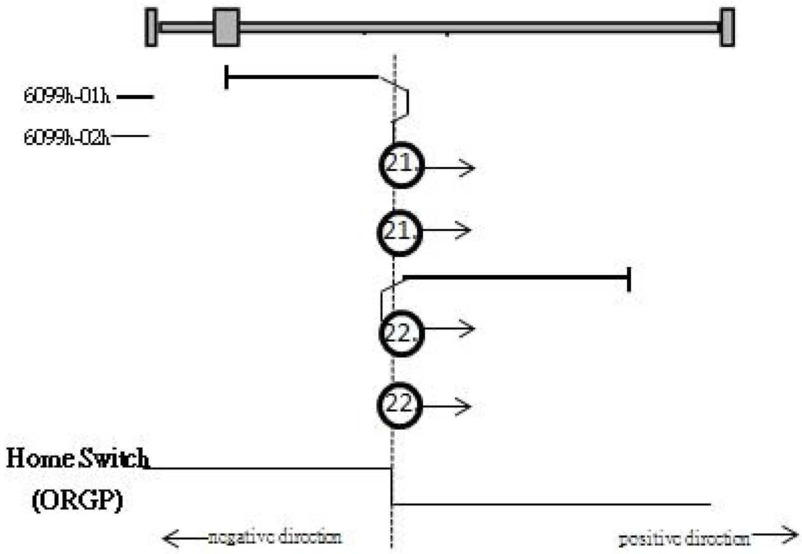
Homing method	Path description
Method 18	Trigger LSP signal: ON -> OFF during forward rotation and not search Z-phase for homing.



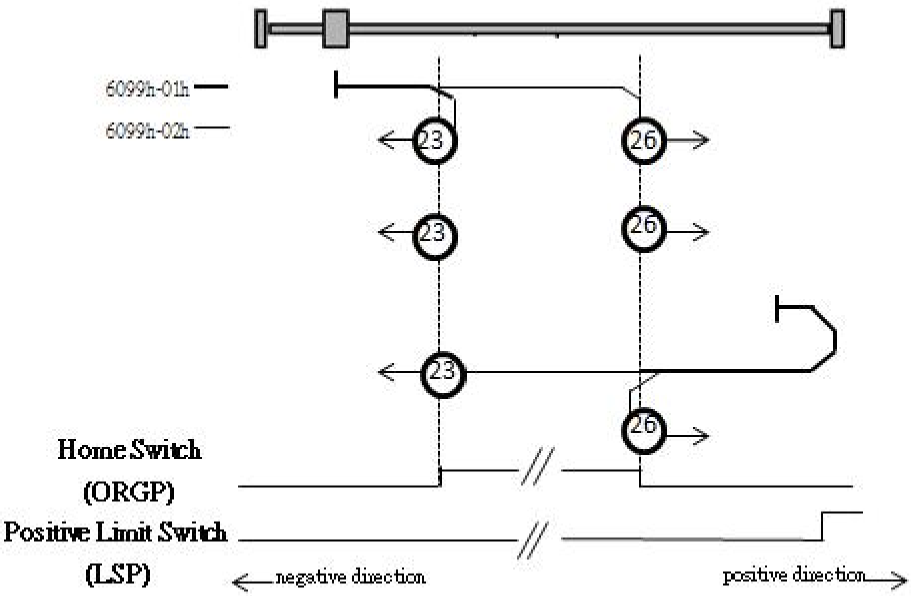
Homing method	Path description
Method 19	Trigger ORGP signal: ON -> OFF during forward rotation and not search Z-phase for homing.
Method 20	Trigger ORGP signal: ON -> OFF during forward rotation and not search Z-phase for homing.



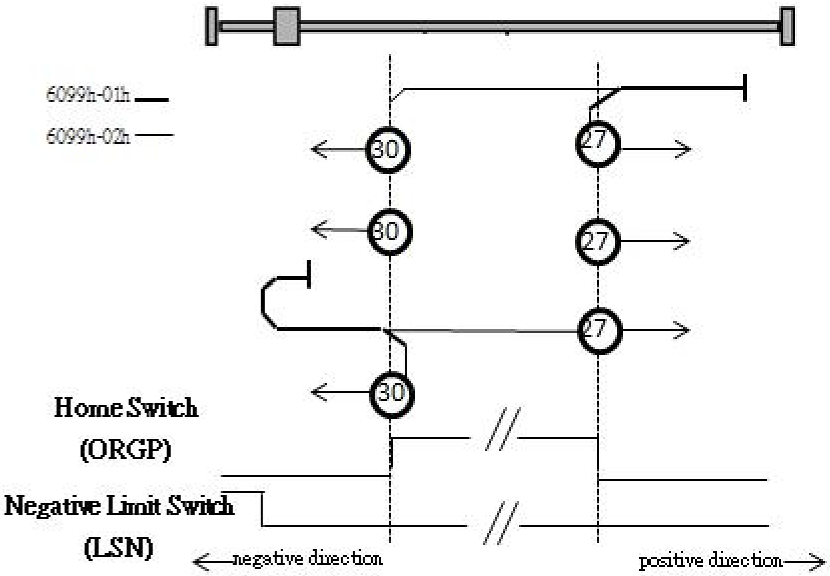
Homing method	Path description
Method 21	Trigger ORGP signal: ON -> OFF during forward rotation and not search Z-phase for homing.
Method 22	Trigger ORGP signal: ON -> OFF during reverse rotation and not search Z-phase for homing.



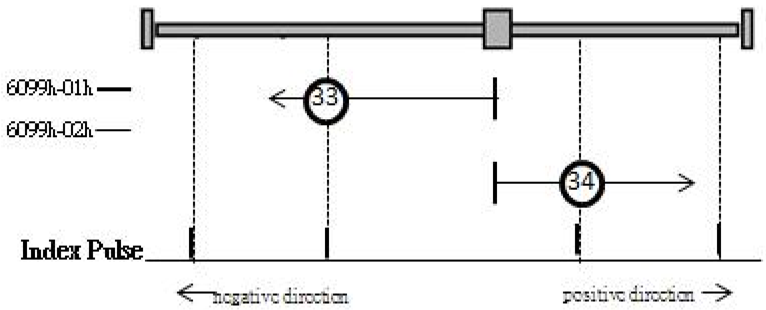
Homing method	Path description
Method 23	Trigger ORGP signal: ON -> OFF during forward rotation and not search Z-phase for homing.
Method 26	Trigger ORGP signal: ON -> OFF during forward rotation and not search Z-phase for homing.



Homing method	Path description
Method 27	Trigger ORGP signal: ON -> OFF during reverse rotation and not search Z-phase for homing.
Method 30	Trigger ORGP signal: ON -> OFF during reverse rotation and not search Z-phase for homing.



Homing method	Path description
Method 33	Start homing reversely to reach Z phase for homing
Method 34	Start homing forwardly to reach Z phase for homing



Homing method	Path description
Method 35	Use the current motor position as the origin.
Method 37	Use the current motor position as the origin.

10.5 Profile Velocity Mode

Set the target speed and plan the acceleration/deceleration path to reach the target speed.

10.5.1 Operation steps

1.Set the object (Mode of operations: 6060h) to 0x03 to set the operation mode as Profile Velocity Mode.

2.Set the object (Controlword: 6040h) by using the value 0x06 -> 0x07 -> 0x0F to make the drive in Servo On state.

3.Set Object(Profile acceleration: 6083h) and object(Profile deceleration: 6084h) to plan the acceleration/deceleration velocity. (Unit Pulse / s^2)

4.Set Object(Max acceleration: 60C5h) and Object(Max deceleration: 60C6h) to plan the maximum acceleration and deceleration velocity. (Unit Pulse / s^2)

5.Set the target velocity object (Target velocity: 60FFh) in Pulse / s. The motor runs to the target velocity according to the setting value.

10.5.2 Statusword function description

Name	Value	Description
Target reached	0	Target speed not yet reached.
	1	Target speed reached.
Speed	0	Speed is not 0
	1	Speed is 0

List of related objects

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
6040h	0	Controlword	UINT	RW	-	0	0	0xFFFF
6041h	0	Statusword	UINT	RO	-	-	-	-
6060h	0	Modes of Operation	SINT	RW	-	0	-128	128
6061h	0	Modes of Operation Display	SINT	RO	-	0	-	-
606Bh	0	Velocity Demand Value	DINT	RO	Vel. unit	-	-	-
606Ch	0	Velocity Actual Value	DINT	RO	Vel. unit	-	-	-
606Dh	0	Velocity Window	UINT	RW	Vel. unit	20000	0	65535
606Eh	0	Velocity Window Time	UINT	RW	ms	0	0	65535
607Fh	0	Max. Profile Velocity	UDINT	RW	Vel. unit	2147483647	0	4294967295
6081h	0	Profile Velocity	UDINT	RW	Vel. unit	0	0	4294967295
6083h	0	Profile Acceleration	UDINT	RW	Acc. unit	10000000	0	4294967295
6084h	0	Profile Deceleration	UDINT	RW	Acc. Unit	10000000	0	4294967295
6085h	0	Quick Stop Deceleration	UDINT	RW	Acc. Unit	4000000000	0	4294967295
60FFh	0	Target Velocity	DINT	RW	Vel. Unit	0	-2147483648	2147483647

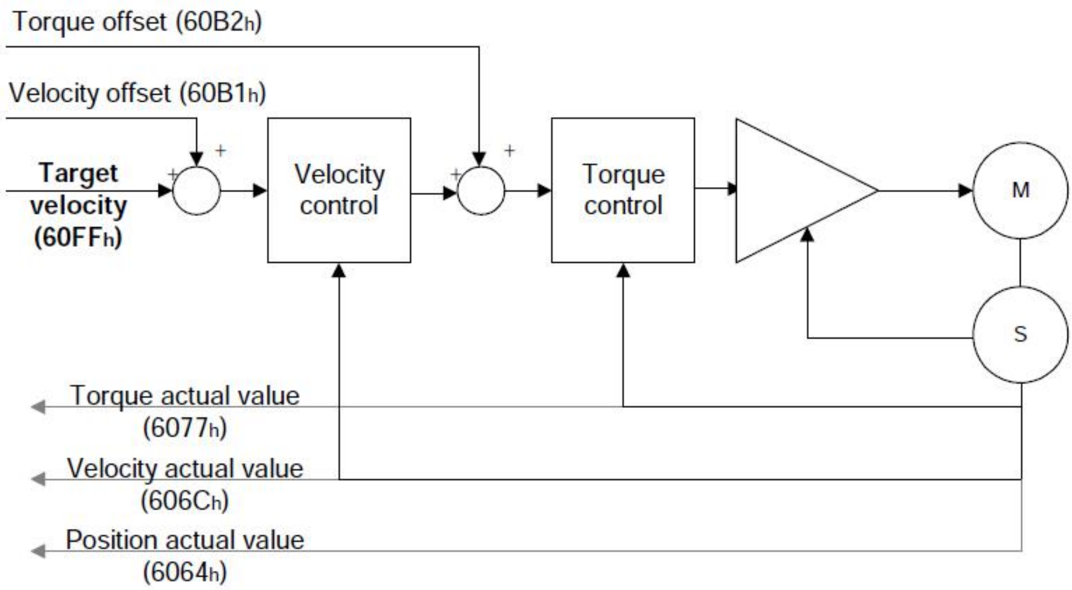
10.6 Cyclic Synchronous Velocity Mode

The system has trajectory planning function in this mode. You only need to input the target speed, and the speed command will be delivered to the drive in a cyclic synchronous way.

10.6.1 Operation steps

1.Set the object (Mode of operations: 6060h) to 0x09 to set the operation mode as Cyclic Synchronous Velocity Mode and write the target velocity to the object (Target position: 60FFh) in Pulse / s.

2.Set the object (Controlword: 6040h) by using the value 0x06 -> 0x07 -> 0x0F to make the control system in Servo On state and the motor starts to run.



List of related objects

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
6040h	0	Controlword	UINT	RW	-	0	0	0xFFFF
6041h	0	Statusword	UINT	RO	-	-	-	-
6060h	0	Modes of Operation	SINT	RW	-	0	-128	128
6061h	0	Modes of Operation Display	SINT	RO	-	0	-	-
606Bh	0	Velocity Demand Value	DINT	RO	Vel. unit	-	-	-
606Ch	0	Velocity Actual Value	DINT	RO	Vel. unit	-	-	-
606Dh	0	Velocity Window	UINT	RW	Vel. unit	20000	0	65535
606Eh	0	Velocity Window Time	UINT	RW	ms	0	0	65535
6083h	0	Profile Acceleration	UDINT	RW	Acc. unit	10000000	0	4294967295
6084h	0	Profile Deceleration	UDINT	RW	Acc. Unit	10000000	0	4294967295
6085h	0	Quick Stop Deceleration	UDINT	RW	Acc. Unit	4000000000	0	4294967295
60B1h	0	Velocity Offset	DINT	RW	Vel. Unit	0	-2147483648	2147483647
60B2h	0	Torque Offset	INT	RW	0.1%	0	-32768	32767
60FFh	0	Target Velocity	DINT	RW	Vel. Unit	0	-2147483648	2147483647

10.7 Profile Torque Mode

This mode is to perform torque mode by planning the target torque and setting the motor rotation speed.

10.7.1 Operation steps

1.Set the object (Mode of operations: 6060h) to 0x04 to set the operation mode as Profile Torque Mode.

2.Set the object (Torque slope: 6087h) to adjust the torque slope (unit: 0.1%).

3.Set the object (Controlword: 6040h) by using the value 0x06 -> 0x07 -> 0x0F to make the drive in Servo On state and the motor starts to run. You can set the target torque to the object (Target torque: 6071h) and set the maximum speed limit to the object (Max motor speed: 6080h).

List of related objects

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
6040h	0	Controlword	UINT	RW	-	0	0	0xFFFF
6041h	0	Statusword	UINT	RO	-	-	-	-
6060h	0	Modes of Operation	SINT	RW	-	0	-128	128
6061h	0	Modes of Operation Display	SINT	RO	-	0	-	-
6071h	0	Target Torque	INT	RW	0.1%	0	-32768	32767
6072h	0	Max. Torque	UINT	RW	0.1%	Motor max. torque	0	65535
6074h	0	Torque Demand Value	INT	RO	0.1%	-	-	-
6075h	0	Motor rated current	UDINT	RO	mA	-	-	-
6077h	0	Torque Actual Value	INT	RO	0.1%	-	-	-
6078h	0	Current Actual Value	INT	RO	0.1%	-	-	-
6085h	0	Quick Stop Deceleration	UDINT	RW	Acc. Unit	4000000000	0	4294967295
6087h	0	Torque Slope	UDINT	RW	0.1% /sec	1000	0	4294967295

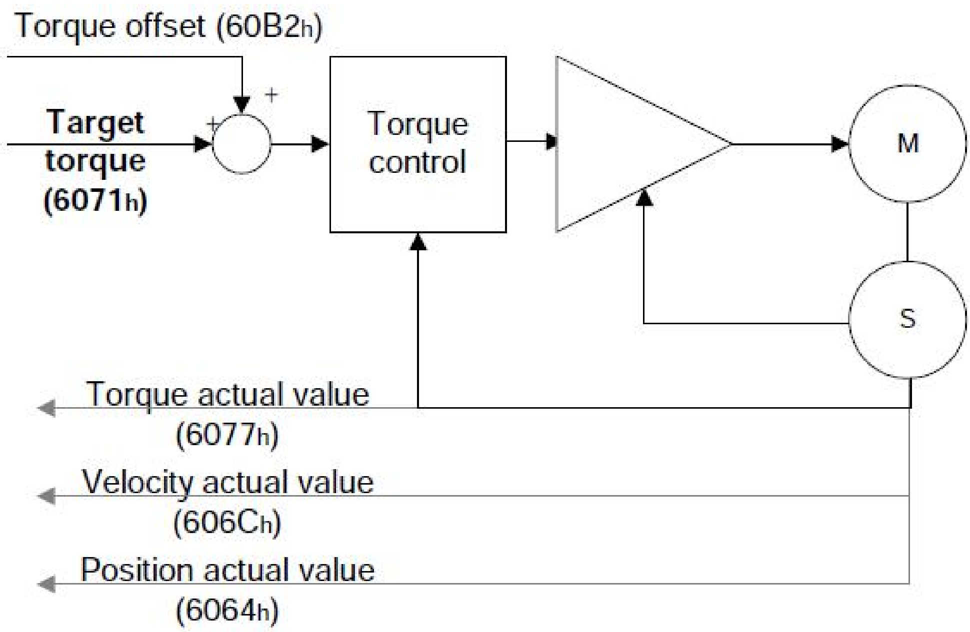
10.8 Cyclic Synchronous Torque Mode

The system has trajectory planning function in this mode. You only need to input the target torque, and the control command will be delivered to the drive in a cyclic synchronous way.

10.8.1 Operation steps

1.Set the object (Mode of operations: 6060h) to 0x10 to set the operation mode as Cyclic Synchronous Torque Mode. Set the target torque to the object (Target torque: 6071h) and set the maximum speed limit to the object (Max motor speed: 6080h).

2.Set the object (Controlword: 6040h) by using the value 0x06 -> 0x07 -> 0x0F to make the control system in Servo On state and the motor starts to run.



List of related objects

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
6040h	0	Controlword	UINT	RW	-	0	0	0xFFFF
6041h	0	Statusword	UINT	RO	-	-	-	-
6060h	0	Modes of Operation	SINT	RW	-	0	-128	128
6061h	0	Modes of Operation Display	SINT	RO	-	0	-	-
6064h	0	Position Actual Value	DINT	RO	Pos. unit	-	-	-
606Ch	0	Velocity Actual Value	DINT	RO	Vel. unit	-	-	-
6071h	0	Target Torque	INT	RW	0.1%	0	-32768	32767
6072h	0	Max. Torque	UINT	RW	0.1%	Motor max. torque	0	65535
6077h	0	Torque Actual Value	INT	RO	0.1%	-	-	-
6087h	0	Torque Slope	UDINT	RW	0.1%/sec	1000	0	4294967295
60B2h	0	Torque Offset	INT	RW	0.1%	0	-32768	32767

10.9 Touch Probe Function

You can use external latch input signal or encoder Z phase to record the current position actual value in this function.

10.9.1 Operation steps

1.By setting the value of Touch probe function, you can read the touch probe status to confirm the position latch status. If it is executed correctly, the latch position will be write into the following objects respectively: (Touch probe pos1 pos value: 60BAh), (Touch probe pos1 neg value: 60BBh), (Touch probe pos2 pos value: 60BCh), (Touch probe pos2 neg value: 60BDh). The trigger signal source is external latch input command or encoder Z phase signal. Setting DI code 0x29 or 0x2A to enable external triggers.

List of related objects

Index	Sub -index	Name	Date type	Access	Unit	Default value	Min value	Max value
6040h	0	Controlword	UINT	RW	-	0	0	0xFFFF
6041h	0	Statusword	UINT	RO	-	-	-	-
6060h	0	Modes of Operation	SINT	RW	-	0	-128	128
6061h	0	Modes of Operation Display	SINT	RO	-	0	-	-
60B8h	0	Touch Probe Function	UINT	RW	-	0	0	0xFFFF
60B9h	0	Touch Probe Status	UINT	RO	-	-	-	-
60BAh	0	Touch Probe 1 position pos Value	DINT	RO	Pos. unit	-	-	-
60BBh	0	Touch Probe 1 position neg Value	DINT	RO	Pos. unit	-	-	-
60BCh	0	Touch Probe 2 position pos Value	DINT	RO	Pos. unit	-	-	-
60BDh	0	Touch Probe 2 position neg Value	DINT	RO	Pos. unit	-	-	-

Related objects setting

Touch probe function description

Bit	Value	Description
0	0	Switch off touch probe 1
	1	Enable touch probe 1
1	0	Trigger first event
	1	Continuous
2	0	Trigger with touch probe 1 input
	1	Trigger with zero impulse signal of encoder
3	-	Reserved
4	0	Switch off sampling at positive edge of touch probe 1
	1	Enable sampling at positive edge of touch probe 1
5	0	Switch off sampling at negative edge of touch probe 1
	1	Enable sampling at negative edge of touch probe 1
6~7		Reserved
8	0	Switch off touch probe 2
	1	Enable touch probe 2
9	0	Trigger first event
	1	Continuous
10	0	Trigger with touch probe 2 input
	1	Trigger with zero impulse signal of encoder
11	-	Reserved
12	0	Switch off sampling at positive edge of touch probe 2
	1	Enable sampling at positive edge of touch probe 2
13	0	Switch off sampling at negative edge of touch probe 2
	1	Enable sampling at negative edge of touch probe 2
14~15		Reserved

Touch probe status description

Bit	Value	Description
0	0	Touch probe 1 is switched off
	1	Touch probe 1 is enabled
1	0	Touch probe 1 has no positive edge value stored
	1	Touch probe 1 has positive edge value stored
2	0	Touch probe 1 has no negative edge value stored
	1	Touch probe 1 has negative edge value stored
3~7	-	Reserved
8	0	Touch probe 2 is switched off
	1	Touch probe 2 is enabled
9	0	Touch probe 2 has no positive edge value stored
	1	Touch probe 2 has positive edge value stored
10	0	Touch probe 2 has no negative edge value stored
	1	Touch probe 2 has negative edge value stored
11~15	-	Reserved

11.STO Function Description

11.1 Preface

11.1.1 Description of safety related words

STO is to cut off the energy supply to the servo motor and stop the torque output. When using this servo drive, the internal electronic energy supply of the servo drive will be cut off.

The purpose of this safety function is as follows.

(1) Comply with uncontrolled stops in IEC/EN 60204-1 category 0.

(2) Prevent accidental restart.

11.1.2 Cautions

Please well understand below cautions for safety to avoid personal injury or equipment damage.

Allow only authorized and qualified personnel to perform installation, start, repair, adjustment, etc.

The technician must know the local law related to this device very well, especially the rules mentioned in this manual.

To comply with safety regulations, the technician must be authorized by the company before start-up, programming, set-up and maintenance of the device.

Danger	● Improper installation of safety related equipment or systems may result in danger during operation, and may also result in accidents or fatalities.

This servo drive provides STO(Safe Torque Off) function as per IEC/EN 61800-5-2. When external forces are applied to the servo motor itself, additional safety solutions such as braking and balancing is needed.

The STO function meets the following international specifications:
ISO 13849-1: Category 3 PL d
IEC 61508 SIL2
IEC 62061 SIL CL 2
IEC 60204-1 Category 0

11.1.3 Residual risk of STO function

The device manufacturer is responsible for all assessed risks and associated residual risks. The following are the residual risks associated with the STO function. Shihlin are not responsible for any damages, injuries, or other accidents caused by residual risks.

(1) The STO function is a function that nullifies the energy supply to the servo motor, but does not physically disconnect the servo drive from the servo motor. Therefore, the risk of electric shock remains. To prevent electric shock, you can use an electromagnetic contactor or a non-fuse circuit breaker on the servo drive main circuit power supply (L1, L2, L3).

(2) The STO function is a function that disables the energy supply capability to the servo motor by cutoff electronic. It does not guarantee the sequence of stopping control or deceleration control.

(3) Please read each safety-related instruction manual carefully to make sure set up, wiring, and adjust correctly.

(4) Use verified or specified parts(soft component) on safety circuits.

(5) The STO function cannot guarantee that the servo motor will not run due to external forces or other factors

(6) Until the installation or adjustment of safety related components in the system is completed, safety cannot be guaranteed

(7) When replacing this servo drive, make sure that the new product is the same model as the previous one. Before running the system after installation, be sure to check the performance of the safety functions.

(8) Analyze and evaluate the machinery or the device.

(9) In order to prevent accumulation of malfunctions, the safety functions should be verified at regular intervals, including a risk assessment of machinery and equipment. Regardless of the system security level, security testing should be performed at least once a year.

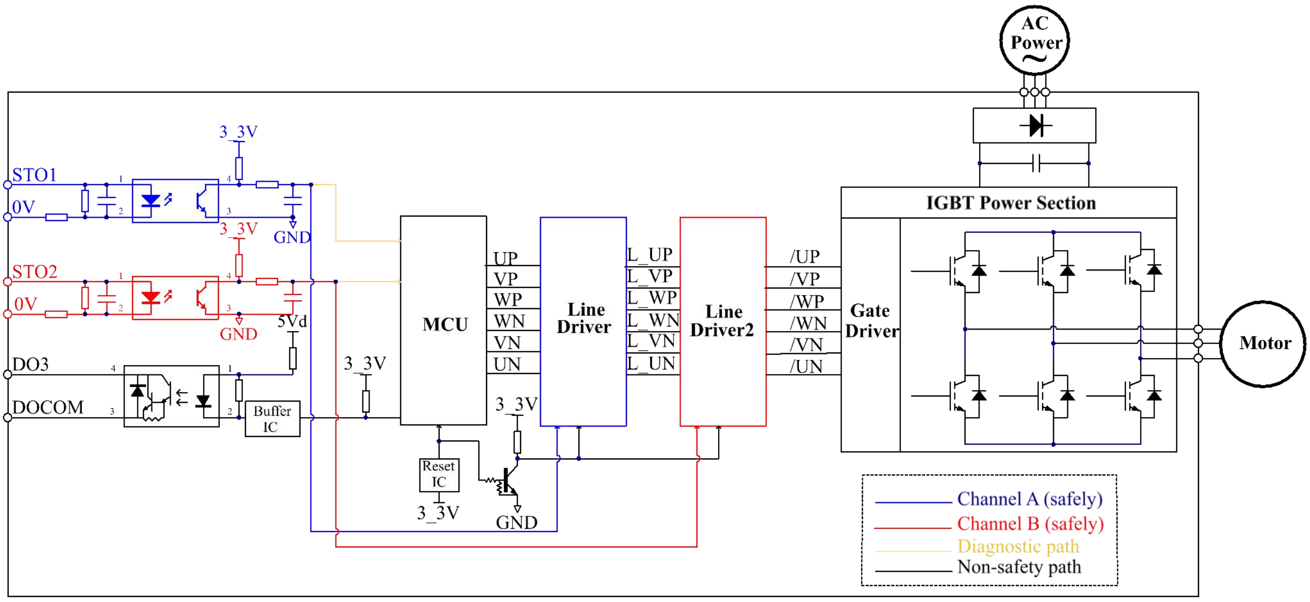
(10) When a short-circuit occurs in the power supply module inside the servo drive, the servo motor will rotate a maximum of 0.5 revolution.

(11) The upper frame and lower frame should not share same power supply for the STO input signals (STO1, STO2). Otherwise, when turning off the power supply, the circuitous current may cause the STO malfunction, which means the STO cannot cut the power off.

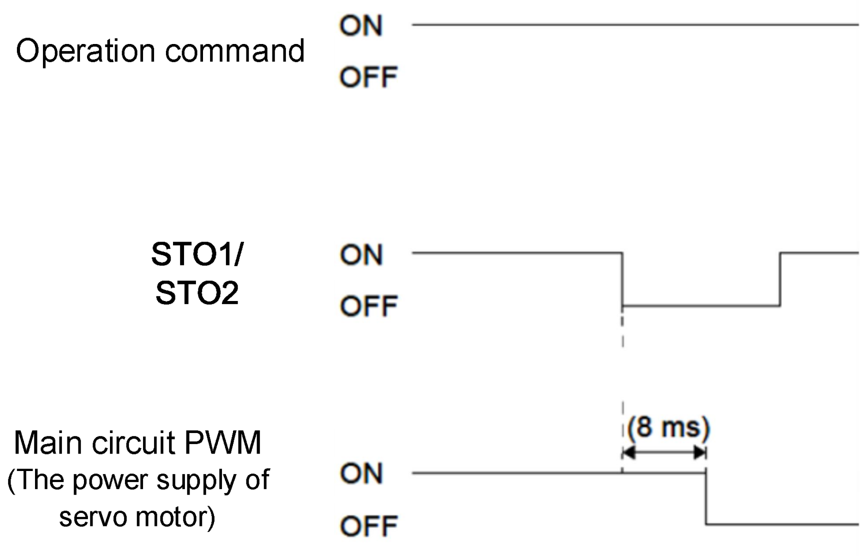
(12) Use insulation strengthened SELV (safety extra low voltage) power supply for the input and output signals of the STO function.

11.1.4 Specifications

(1) Function structure diagram(STO function)



(2) Operation timing diagram(STO function)



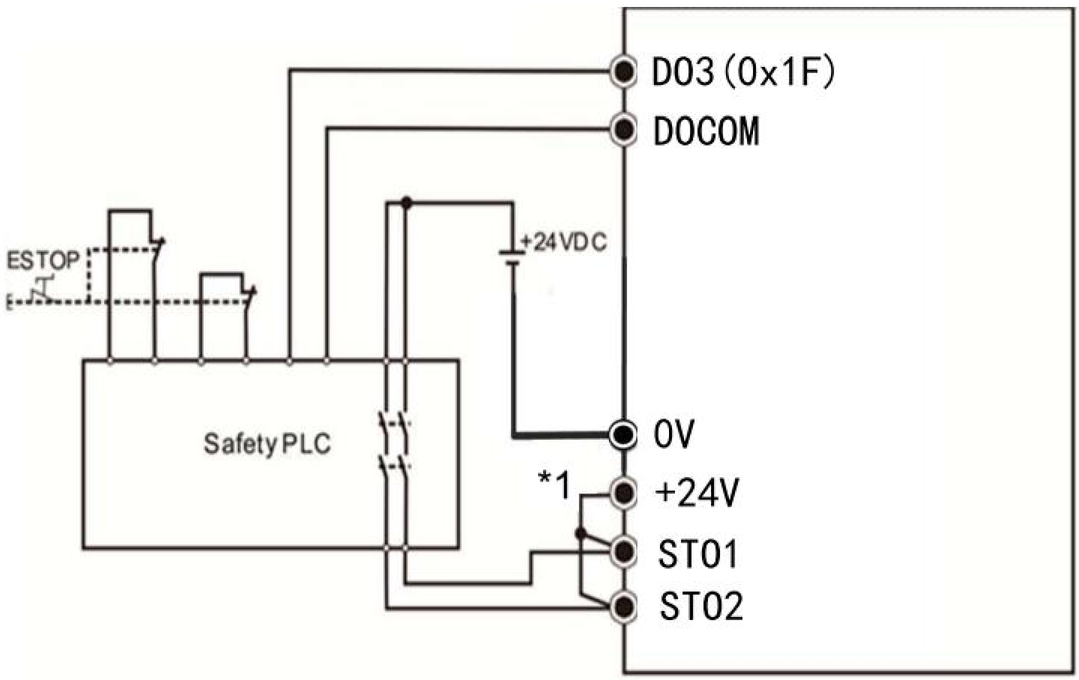
(3) STO wiring diagram

The terminals +24V-STO1-STO2 in the Safety Control Circuit are short-circuited together with a short-circuiting piece during manufacturing process, and the external wiring requirements for STO function are as follows:

(1) Remove the short-circuiting piece between +24V, STO1, STO2.

(2) The wiring is shown in the diagram below. Normally, the ESTOP contact must be short-circuited to run the drive.

(3) In STO mode, when opening ESTOP contact, the drive stops output and the panel displays AL.35 Alarm.



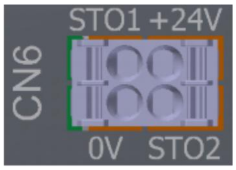
External wiring diagram for STO function

Note: *1 is the short-circuiting piece between +24V, STO1 and STO2. Remove this piece when using STO function.

11.2 STO DI/DO connector(CN6) and signal arrangement

11.2.1 Signal arrangement

Note ● Connector pin arrangement is seen from the connector wiring part of the cable.

Terminal name	Connector and its pin assignment		
			
	Pin sign	Signal name	Function
STO (CN6)	1	+24V	Drive internal +24V power
	2	STO1	STO input 1
	3	STO2	STO input 2
	4	0V	STO reference ground

11.2.2 Signal name

The following table describes the functions of the STO related terminals.

<table>
<tr><th>Terminal name</th><th>Function</th><th>Description</th></tr>
<tr><td>+24V</td><td>Drive Internal +24V power supply</td><td>Output Voltage Range: +24V±10%
Output current range: below 200mA</td></tr>
<tr><td>STO1</td><td>STO input 1</td><td rowspan="3">STO1/STO2
Rated Input Voltage: +24V±10%
STO action mode
Input voltage level: 0~5V
STO response time: <=8mS
STO cut-off mode
Input voltage level: 18~30V</td></tr>
<tr><td>STO2</td><td>STO input 2</td></tr>
<tr><td>0V</td><td>STO reference ground</td></tr>
<tr><td>DO3</td><td>DO3</td><td rowspan="2">When the DO3 function code is set to 0x1F, the STO1/STO2 input status can be monitored.</td></tr>
<tr><td>DOCOM</td><td>Digital Outputs common terminal</td></tr>
</table>

The STO action principle is described in the following table

STO1 input	STO2 input	Drive Status	DO3 Output status
H	L	PWM signal is disabled, torque output stops.	Open
L	H	PWM signal is disabled, torque output stops.	Open
L	L	PWM signal is disabled, torque output stops.	Open
H	H	Normal	Close

STO action principle

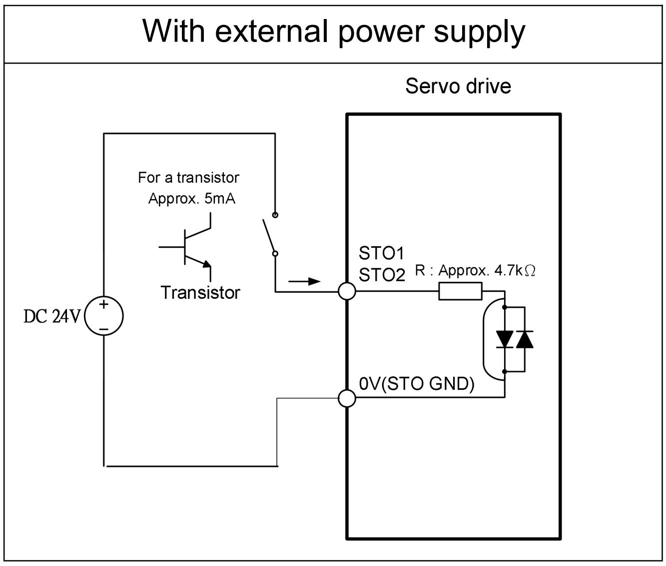
If any one of the STO1 signal input and STO2 signal input is L (the input voltage is less than 5V), it indicates that the safety circuit is abnormal(the DO3 output status is Open at this time);Only when they are both H (the input voltage is more than 18V and less than 30V), it means the safety circuit is normal (DO3 output status is Close at this time).

11.3 Detailed description of the interface

This section introduces the details of the input and output signal interfaces (refer to the I/O descriptions in the table). You need to refer to this section before connecting to external machines.

Source input/output interface

The input/output interface of this servo drive can use the Source type. In this case, all input signals and output signals are in Source type. The wiring should follow below diagram:



11.4 STO alarm description and troubleshooting

AL.35: STO1/STO2 module error

Reasons for Alarms	Alarm analysis	Alarm troubleshooting
STO function enabled	Check or reconnect STO1/STO2 module wiring, If the issue persists, send back to the distributor or contact Shihlin.	

AL.36: STO1 module error

Reasons for Alarms	Alarm analysis	Alarm troubleshooting
STO function enabled	Check or reconnect STO1 module wiring, If the issue persists, send back to the distributor or contact Shihlin.	

AL.37: STO2 module error

Reasons for Alarms	Alarm analysis	Alarm troubleshooting
STO function enabled	Check or reconnect STO2 module wiring, If the issue persists, send back to the distributor or contact Shihlin.	

AL.38: Internal diagnostic circuit error

Reasons for Alarms	Alarm analysis	Alarm troubleshooting
Internal diagnostic circuit error	After confirming that all external wiring is correct and meets the requirements, then restart the power, If the issue persists, send back to the distributor or contact Shihlin.	

STO test and troubleshooting

After wiring according to the STO wiring diagram, please follow the below steps to test the STO function:

(1).When the drive is powered on, make sure that the input voltage of STO1 and STO2 is between 18~30V. The drive enters the standby mode and waits for the operation instruction, and no alarm code shows on panel screen.

(2).Press the button to run the motor. After the output speed reaches the target, press the emergency button or other to make both the input voltage of STO1 and STO2 are within 0~5V, and the drive enters the STO mode, then the drive stops and the panel displays AL.35, the response time between STO1 and STO2 input voltage and output voltage stop<=8mS. Restore STO1 and STO2 input voltage to 18~30V, the panel displays no abnormal after power cycling, and then the drive enters the standby mode, waiting for the operation command.

(3).Press the button to run the motor. After the output speed reaches the target, press the emergency button or other to make the input voltage of STO1 is within 0~5V and STO2 input voltage is within 18~30V, the drive enters the STO mode, then the drive stops and the panel displays AL.36, the response time between STO1 input voltage and output voltage stop<=8mS. Restore STO1 input voltage to 18~30V, the panel displays no abnormal after power cycling, and then the drive enters the standby mode, waiting for the operation command.

(4).Press the button to run the motor. After the output speed reaches the target, press the emergency button or other to make the input voltage of STO1 is within 18~30V and STO2 input voltage is within 0~5V, the drive enters the STO mode, then the drive stops and the panel displays AL.37, the response time between STO2 input voltage and output voltage stop<=8mS. Restore STO2 input voltage to 18~30V, the panel displays no abnormal after power cycling, and then the drive enters the standby mode, waiting for the operation command.

(5).If the above 4 steps can be proceeded successfully, it means that the STO function circuit is normal. It is as shown in the following table. Otherwise, please refer to Section 11.4 alarm code and troubleshooting.

STO1 input	**STO2 input**	**Drive status**	**DO3 output status**
H	L	PWM signal is disabled, torque output stops.	Open
L	H	PWM signal is disabled, torque output stops.	Open
L	L	PWM signal is disabled, torque output stops.	Open
H	H	Normal	Close

STO action principle

Note: If any one of the STO1 signal input and STO2 signal input is L (the input voltage is less than 5V), it indicates that the safety circuit is abnormal. Only when they are both H (the input voltage is more than 18V and less than 30V), it means the safety circuit is normal.

12.Troubleshooting

> CAUTION
>
> - When an alarm occurs, you should troubleshoot it first to ensure safety. Wait until the alarm is cleared before running, otherwise it may cause accidental injury.

12.1 Alarm list and clear methods

Alarms or warnings are displayed when an error occurs during operation. When an alarm or warning occurs, please follow the procedure in section 12.2. Set PD19 to xxx1 to output the alarm code.

The alarm code is output as ON/OFF between each PIN and SG, and warnings (AL12-AL1B) have no code.

When alarm occurs, the drive output the alarm in below table. In normal state, it output the signal as per setting.

(CN1-1: DO1, CN1-3: DO2, CN1-5: DO3)

	Display	**Alarm code**			**Alarm name**	**How to clear the alarm?**		
		CN1-1	CN1-3	CN1-5		Power OFF →ON	Press SET button in current alarm screen	RES signal
Alarm	AL.01	0	1	0	Over voltage	o		
	AL.02	0	0	1	Under voltage	o	o	o
	AL.03	0	1	1	Over current	o		
	AL.04	0	1	0	Regeneration error	o	o	o
	AL.05	1	0	0	Overload 1	o	o	o
	AL.06	1	0	1	Over speed	o	o	o
	AL.08	1	0	1	Position deviation excessive	o	o	o
	AL.09	0	0	0	Serial communication error	o	o	o
	AL.0A	0	0	0	Serial communication timeout	o	o	o
	AL.0B	1	1	0	Position encoder error 1	o		
	AL.0D	1	1	0	Fan error	o		
	AL.0E	0	0	0	IGBT overheat	o		
	AL.0F	0	0	0	Memory error	o		
	AL.10	0	0	0	Overload 2	o		
	AL.11	1	1	1	Motor mismatch	o		
	AL.20	1	1	1	Motor collision error	o		
	AL.21	1	1	1	Motor UVW disconnection	o		

	Display	Alarm code			Alarm name	How to clear the alarm?		
		CN1-1	CN1-3	CN1-5		Power OFF ➔ON	Press SET button in current alarm screen	RES signal
Alarm	AL.22	1	1	0	Encoder communication error	o		
	AL.24	0	0	0	Motor encoder type error	o		
	AL.26	1	1	0	Encoder error 3	o		
	AL.27	1	1	0	Encoder error 4	o		
	AL.28	1	1	0	Encoder overheat	o		
	AL.29	1	1	0	Encoder error 5(overflow)	Automatic cleared after eliminating the cause		
	AL.2A	1	1	0	Absolute encoder error 1	Automatic cleared after eliminating the cause		
	AL.2B	1	1	0	Absolute encoder error 2	Automatic cleared after eliminating the cause		
	AL.2E	0	1	1	Control circuit error	o		
	AL.2F	0	1	1	Regenerative energy error	o		
	AL.30	0	1	1	Pulse output frequency excess	o		
	AL.31	0	1	1	Over current 2	o		
	AL.32	0	1	1	Control circuit error 2	o		
	AL.34	0	0	0	Overload 4	o		
	AL.35	1	0	1	STO module error	o	o	o
	AL.36	1	0	1	STO1 module error	o	o	o
	AL.37	1	0	1	STO2 module error	o	o	o
	AL.38	1	0	1	Internal diagnostic circuit error	o		
	AL.80				Sync Manager WDT error	o	o	o
	AL.81				EtherCAT state switching program error	o	o	o
	AL.82				EtherCAT sends error state machine value	o	o	o
	AL.83				ESC DC register setting alarm	o	o	o
	AL.84				Synchronization error	o	o	o
	AL.85				ESC initialization error	o	o	o
	AL.86				Watchdog buffer setting error			
	AL.87				SII version validation error	o	o	o

	Display	Alarm code			Alarm name	How to clear the alarm?		
		CN1-1	CN1-3	CN1-5		Power OFF ➔ON	Press SET button in current alarm screen	RES signal
Alarm	AL.88				Communication cycle time setting error	o	o	o
	AL.89				Wrong control mode	o	o	o
	AL.90				Mailbox SM related settings error	o	o	o
					Mailbox SM2/3 related settings error			
					EtherCAT data transmission mode setting error			
	AL.91				Tx/Rx PDO data type assignment error			

	Display	Alarm code			Alarm name	How to clear the alarm?		
		CN1-1	CN1-3	CN1-5		Power OFF ➔ON	Press SET button in current alarm screen	RES signal
warning	AL.12				Emergency stop	Automatic cleared after eliminating the cause		
	AL.13				Forward and reverse limit error			
	AL.14				Positive software limit			
	AL.15				Negative software limit			
	AL.16				Early overload warning	Automatic cleared after eliminating the cause		
	AL.17				ABS timeout warning	o	o	o
	AL.19				Pr command error	Perform homing		
	AL.1A				Undefined index coordinate	Automatic cleared after eliminating the cause		
	AL.1B				Position shift warning			
	AL.1C				Early overload warning 4	Automatic cleared after eliminating the cause		
	AL.2C				Absolute encoder error 3	Automatic cleared after eliminating the cause		
	AL.2D				Encoder battery under voltage	power cycling after eliminating the cause		
	AL.61				Parameter group range excess	o	o(Note 1)	o
	AL.62				Parameter number range excess	o	o	o
	AL.63				Pr mode parameter range excess	o	o	o
	AL.64				Pr mode parameter write error	o	o	o
	AL.65				Reverse rotation limit error	o	o	o

Note 1: Turning the drive Servo OFF ➔ Servo ON can also clear the warning.

Note 2: The DO ALM pin will be active when an alarm occurs.

Note 3: The DO WNG pin will be active when a warning occurs.

12.2 Causes and corrective actions

AL.01 Over voltage

Alarm cause	Checking method	Corrective action
Main circuit voltage exceeds the rated allowable value.	Use a voltmeter to check if the input voltage of the main circuit is within the allowable rated value.	Use the right voltage source or connect the voltage regulator in series.
Incorrect power input (incorrect power system).	Use a voltmeter to check if the power system meets the spec.	Use the right voltage source or connect the voltage regulator in series.
Drive hardware failure.	If the alarm occurs when the input voltage of the main circuit measured by the voltmeter is within the allowable rated value	Return to distributor or contact Shihlin
Built-in regenerative resistor or regenerative device is disconnected.	Check whether the PD short-circuited piece is connected correctly, or whether the regenerative resistor or device wiring is disconnected.	Wire the short-circuited piece correctly or change the wiring cable.
Burned or damaged of the built-in regenerative resistor or regenerative related device	Check whether the regenerative resistor or regenerative related device is burnt or damaged.	When using the built-in regenerative resistor, please replace the drive; When using the regenerative related device, please replace it.
The capacity of built-in regenerative resistor or regenerative related device is insufficient.	Refer to section 7.5.1, check the capacity of regenerative resistor.	Increase the capacity or add additional regenerative device.

AL.02 Under voltage

Alarm cause	Checking method	Corrective action
Main circuit voltage is below the rated value.	Check if the wiring of input voltage for the main circuit is normal	Check if the voltage wiring is correct.
No voltage input to the main circuit.	Use a voltmeter to check if the main circuit voltage is normal	Check the switch of the power supply
Incorrect power input (incorrect power system).	Use a voltmeter to check if the power system complies with the specifications.	Check if using the right voltage source or connecting the voltage regulator in series
In the 7KW model, the short-circuited piece between P1 and P are removed.	Check if the short-circuited piece between P1 and P has been removed.	If P1 and P are not connected to a DC reactor, short-circuit P1 and P.

AL.03 Over current

Alarm cause	Checking method	Corrective action
Motor wiring is error	Check if you have followed the wiring sequence for connecting the motor to the servo drive as described in this manual	Followed the wiring sequence as described in this manual.
The servo drive output is short-circuited.	Check the connection between the motor and servo drive and make sure that the wire is not short-circuited.	Check and make sure that the wire is not short-circuited. Do not expose the metal part of the wiring.
IGBT is abnormal.	Check if the temperature of the heat sink is abnormal.	Return to distributor or contact Shihlin.
The control parameters setting are abnormal.	Check if the setting value of the parameters are much greater than the default.	Reset the parameters to the factory default setting and then modify the setting gradually.

AL.04 Regeneration error

Alarm cause	Checking method	Corrective action
Invalid regenerative brake transistor.	Check if the regenerative brake transistor is short-circuited.	Return to distributor or contact Shihlin.
The regenerative resistor is disconnected	Check the connection of the regenerative resistor.	Reconnect the regenerative resistor.

AL.05 Overload 1

Alarm cause	Checking method	Corrective action
The load is over the rated value continuously.	Check if the load is too large.	Increase the motor capacity or reduce the load.
Improper parameters setting.	Check if there is any mechanical vibration.	Execute auto acceleration /deceleration tuning.
Unstable system.	Acceleration/deceleration time constant is too short.	Increase acceleration/ deceleration time.
Incorrect wiring of motor and encoder.	Check if the wiring of the UVW and the position encoder cables are correct.	Wiring correctly.

AL.06 Over speed

Alarm cause	Checking method	Corrective action
The input frequency of pulse command is too high.	Check whether the input frequency of pulse command is too high.	Correctly set the pulse frequency.
Improper setting for acceleration/deceleration time parameters.	Check whether the acceleration /deceleration time constant are too short.	Increase the acceleration /deceleration time constant.
Unstable servo system which cause large overshoot.	Check whether the system has been vibrating.	1.Set proper gain value. 2.If it's not working, (a).Decrease the load inertia ratio. (b).Change the accelerate /decelerate time constant.

AL.08 Position deviation excessive

Alarm cause	Checking method	Corrective action
Improper setting of acceleration/deceleration time parameters.	Check if the acceleration/deceleration time constant are too short.	Increase the acceleration /deceleration time constant.
Improper torque limit setting.	Check if the torque limit parameter(PA05) setting is too small.	Increase the torque limit parameter setting value.
Gain setting is too low.	Check if the position gain (PB07) is too small.	Increase the position loop gain value.
Excessive external load.	Check the external load.	Reduce the external load or re-evaluate the motor capacity.

AL.09 Serial communication error

Alarm content: AL.09 occurs when RS-232/485 communication is abnormal.

Alarm cause	Checking method	Corrective action
Incorrect communication protocol setting.	Check if the communication protocol setting is correct.	Correctly set the communication parameter value.
Incorrect communication address.	Check communication address.	Correctly set communication address.
Incorrect communication value.	Check the access value.	Correctly set the communication value.

AL.0A Serial communication timeout

Alarm cause	Checking method	Corrective action
Servo drive has not received the communication message for a long time	Check if the communication cable is broken or loose.	Replace the cable or reconnect the wiring.
Improper parameter setting for PC23.	Check the setting value of PC23.	Correctly set the value of PC23.

AL.0B Position encoder error 1

Alarm cause	Checking method	Corrective action
Encoder wiring is incorrect.	Check if the wiring follows the instructions in the user manual.	Wiring correctly.
Encoder connector is loose.	Check if the connector is well connected.	Re-install.
Encoder is damaged.	Check if the motor is abnormal.	Replace the motor.
Encoder wiring is poor.	Check if there is any poor wiring.	Reconnect the wiring.

AL.0C Position encoder error 2

Alarm cause	Checking method	Corrective action
Encoder initial magnetic field error	Turn the motor shaft and cycle the power, if the issue persists, send back to the distributor or contact Shihlin.	
Bad wiring of position encoder	Check if there is any poor wiring.	Reconnect the wiring

AL.0D Fan error

Alarm cause	Checking method	Corrective action
Fan stops working.	Turn off the power and replace the fan, or send back to distributor or contact Shihlin.	

AL.0E IGBT overheat

Alarm cause	Checking method	Corrective action
The load is over the rated value continuously, or the servo drive output is short-circuited.	Check if the servo drive overload or motor over current. Check if the wiring of servo drive output is correct.	Reduce the load or replace a larger capacity drive.

AL.0F Memory error

Alarm cause	Checking method	Corrective action
Memory data access abnormal.	Reset the parameters and then cycle the power	If the issue persists, send the servo drive back to the distributor or contact Shihlin.

AL.10 Overload 2

Alarm cause	Checking method	Corrective action
Mechanical collision.	Check if the path configuration is correct.	Adjust the motion curve or add limit switches.
Motor wiring is wrong.	Check if the motor wiring is correct.	Wiring correctly.
The System is operating with vibration.	Check if the mechanical has high frequency noise.	Reduce the rigidity setting or change to manual adjustment.
Encoder error	Check if encoder is normal.	Replace servo motor.

AL.11 Motor mismatch

Alarm cause	Checking method	Corrective action
Motor and drive capacity are inconsistent.	Check if the capacity for motor and drive are match.	Use the correct motor which matches the drive.

AL.12 Emergency stop

Alarm content: AL.12 occurs when emergency stop button is pressed.

Alarm cause	Checking method	Corrective action
The emergency stop button is pressed.	Make sure the emergency stop button is off.	Release the emergency stop switch

AL.13 Forward and reverse limit error

Alarm cause	Checking method	Corrective action
Positive limit switch is triggered.	Make sure the positive limit switch is off.	Release the positive limit switch.
Negative limit switch is triggered.	Make sure the negative limit switch is off.	Release the negative limit switch.

AL.14 Positive software limit error

Alarm cause	Checking method	Corrective action
In Pr Mode, if the position command pulse number exceeds the software positive limit PF86.	The software positive limit is calculated based on the position command rather than the actual feedback position, because the command always arrives earlier than the feedback. When the limit protection is enabled, the actual position may not exceed the limit, you can set an appropriate deceleration time to achieve the requirement. Refer to the description of PF86.	Adjust the pulse number of position command to be smaller than the positive software limit.

AL.15 Negative software limit error

Alarm cause	Checking method	Corrective action
In Pr Mode, if the position command pulse number less than the software negative limit PF87.	Stop the motor by PF81 setting keep it in SERVO LOCK status	Adjust the pulse number of position command to be greater than the negative software limit.

AL.16 Early overload warning

Alarm cause	Checking method	Corrective action
The load exceeds the protection curve of PA17 setting time (Please refer to section 14.2 of SDC series manual for protection curve).	1.Check if the servo drive is overloaded. 2.Check if the parameter PA17(overload output level percentage) is too small.	1.Refer to the corrective actions of AL.05 2.Set the PA17 value higher, or set the value greater than 100 to disable the warning function.

AL.17 ABS timeout warning

Alarm cause	Checking method	Corrective action
The signal waiting time of absolute position communication is too long.	Check if the host has not sent a signal request (ABSQ) for more than 5 seconds.	Turn off the ABSE or ABSM signal terminal to clear the alarm, and check whether the communication format of the controller is wrong.

AL.19 Pr command error

Alarm cause	Checking method	Corrective action
The position command counter overflows.	**Incremental system:** If in PR mode, the motor keeps running in a single direction, it will cause the feedback position register overflow and the coordinate system fail to reflect the correct position. This error occurs if the PR absolute positioning command is issued at this time. **Absolute system:** This error occurs when the absolute positioning command is issued in the following conditions: 1.The feedback position register overflows. 2.The homing program is not executed after changing the E-Gear ratio (PA06, PA07). 3.Execute absolute position command when DO:HOME signal is OFF.	Execute homing.

AL.20 Motor collision error

Alarm cause	Checking method	Corrective action
When the motor current reaches the value of PA15 and the protection time of PA16 has run out.	1.Check if PA15 is valid. 2.Check if PA15 setting is too low, and if PA16 is too short.	1.Set PA15 to 0 if you open it by mistake. 2.Set with actual torque. If the setting is too low, it will cause malfunction, and if the setting is too high, the protection function will be invalid.

AL.21 Motor UVW disconnection

Alarm cause	Checking method	Corrective action
When Motor U,V,W cable disconnection is detected.	Check if the Motor U,V,W cable is loose.	1.Reconnect the U,V,W cables. 2.If the connection is good, send back to distributor or contact Shihlin.

AL.22 Encoder communication error

Alarm cause	Checking method	Corrective action
The encoder has three consecutive CRC code errors or internal register errors.	1.Check if the grounding of motor is normal. 2.Check whether the encoder signal line is separated from the power line or high current line to avoid interference. 3.Check if it's shielded cable	1.Make sure the power cable (green end) is grounded to the servo drive heat sink. 2.Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference 3.Use shielded cable. 4.If the issue persists, send it back to the distributor or contact Shihlin.

AL.24 Motor encoder type error

Alarm cause	Checking method	Corrective action
The incremental motor is not able to perform absolute function.	1.Check the motor is incremental type or absolute type encoder. 2.Check parameter PA28.	Please use absolute motor to enable absolute function. If absolute function is not needed, please set PA28 to 0.

AL.26 Encoder error 3

Alarm cause	Checking method	Corrective action
Encoder LED light decay or encoder rotation count value is in error.	Restart the motor and check whether the alarm recurs.	If the issue persists, send it back to the distributor or contact Shihlin

AL.27 Encoder error 4

Alarm cause	Checking method	Corrective action
The internal register of encoder is in error.	1.Check if the grounding of motor is normal. 2.Check if the encoder signal line is separated from the power line or high current line to avoid interference. 3.Check if it's shielded cable	1.Make sure the power cable (green end) is grounded to the servo drive heat sink. 2.Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference 3.Use shielded cable 4.If the issue persists, send it back to the distributor or contact Shihlin.

AL.28 Encoder overheat

Alarm cause	Checking method	Corrective action
Encoder operating temperature is higher than 95℃.	Put encoder away from heat source and do not operate in high temperature environment.	1.Do not operate in high temperature environment and wait for the encoder board cool down to room temperature. 2.If the issue persists, send it back to the distributor or contact Shihlin.

AL.29 Encoder error 5

Alarm cause	Checking method	Corrective action
The move distance of the absolute position revolution number is out of range.	Check if the absolute motor revolution number is within the range between -32768 and +32767.	Re-execute homing and initialize absolute coordinate according to chapter 15 description.

AL.2A Absolute encoder error 1

Alarm cause	Checking method	Corrective action
Encoder backup battery voltage is too low.	Check whether the battery voltage is lower than 2.45V (TYP).	Replace the battery, and then perform homing and initialize absolute coordinate according to the description of chapter 15 or PA29.
Poor connection or disconnection of battery power supply circuit.	1.Check the encoder wiring. 2.Check the connection between the battery external box and drive.	Connect or fix the connection to make sure the encoder power supply is normal, and perform homing, and then initialize absolute coordinate according to the description of chapter 15.

AL.2B Absolute encoder error 2

Alarm cause	Checking method	Corrective action
The revolution count value of absolute encoder is in error.	Restart the motor and check whether the alarm recurs.	If the issue persists, send it back to the distributor or contact Shihlin.

AL.2C Absolute encoder error 3

Alarm cause	Checking method	Corrective action
Replace the battery when the drive control power is OFF.	Do not replace or remove the battery when the drive control power is OFF.	Perform homing and initialize absolute coordinate according to Chapter 15 or PA29 description.
After the absolute function is enabled, the absolute position coordinate initialization is not completed.	1.Install the battery 2.Check the connection between the battery external box and drive. 3.Check the encoder wiring	Perform homing and initialize absolute coordinate according to chapter 15 or PA29 description.

AL.2D Encoder battery under voltage

Alarm cause	Checking method	Corrective action
Encoder backup battery voltage is too low.	1.Check whether the panel battery voltage is lower than 3.0V (TYP). 2.Check if the battery voltage is lower than 3.0V(TYP)	Replace the battery when the drive control power is ON. After that AL.2D is automatically cleared.

AL.2E Control circuit error

Alarm cause	Checking method	Corrective action
When the motor is running with large external load, the servo ON (SON) state is instantly switched OFF→ON.	Check whether the servo ON (SON) is operate by mistake.	Correctly operate the servo ON (SON) command.
The drive current feedback is abnormal.	Restart the drive. If the issue persists, send your drive back to the distributor or contact Shihlin.	

AL.2F Regeneration energy error

Alarm cause	Checking method	Corrective action
The regenerative load rate exceeds 100%.	1.Check if the acceleration /deceleration time is too short. 2.Check if the frequency of forward and reverse rotation is too fast.	1.Adjust the acceleration /deceleration time, or reduce the frequency of forward and reverse rotation. 2.Restart the power.

AL.30 Pulse output frequency excess

Alarm cause	Checking method	Corrective action
Pulse output error which is caused by encoder error.	Check the error history if it is accompanied with an encoder error (AL0B,AL0C,AL22, AL26,AL27).	Follow the corrective action of AL.0B,AL.0C,AL.22,AL.26, AL.27.

AL.31 Over current 2

Alarm cause	Checking method	Corrective action
The drive current feedback is abnormal.	Restart the drive. If the issue persists, send your servo drive back to the distributor or contact Shihlin.	

AL.32 Control circuit error 2

Alarm cause	Checking method	Corrective action
FPGA is abnormal.	Cycle the power of drive. If the issue persists, send your servo drive back to the distributor or contact Shihlin.	

AL.34 Over load 4

Alarm cause	Checking method	Corrective action
The load is over the rated value continuously	Check if the frequency of the repeatable operation cycle is too fast.	Increase motor capacity or reduce operation cycle.
Unstable system.	Check whether the acceleration /deceleration time setting is too short.	Increase the setting value of acceleration/deceleration time.

AL.35 STO module abnormal

Alarm cause	Checking method	Corrective action
STO safety signal is triggered.	Check the STO module wiring and reconnect, If the issue persists, send your servo drive back to the distributor or contact Shihlin.	

AL.36 STO1 module abnormal

Alarm cause	Checking method	Corrective action
STO safety signal is triggered.	Check the STO1 module wiring and reconnect, If the issue persists, send your servo drive back to the distributor or contact Shihlin.	

AL.37 STO2 module abnormal

Alarm cause	Checking method	Corrective action
STO safety signal is triggered.	Check the STO2 module wiring and reconnect, If the issue persists, send your servo drive back to the distributor or contact Shihlin.	

AL.38 Internal diagnostic circuit error

Alarm cause	Checking method	Corrective action
Internal diagnostic circuit is in error	Check if all the external wiring is correct and cycle the power. If the issue persists, send your servo drive back to the distributor or contact Shihlin.	

AL.80 Sync Manager WDT error

Alarm cause	Checking method	Corrective action
Hardware incorrect wiring	Check if the EtherCAT cable is properly connected and the connection lamps in the communication ports are illuminated correctly.	After troubleshooting the condition，an error reset command is issued by the upper controller, or the drive is rebooted for initialization.
Wire interference	This alarm occurs when the servo is running on-line. If the hardware connection is normal, it may be caused by communication interference.	Preliminary eliminate the possible sources of interference，use shielded and metal cased communication cable. If the issue persists, please contact the distributor or Shihlin for help.

AL.81 EtherCAT state switching program error

Alarm cause	Checking method	Corrective action
The EtherCAT state machine executes a command which is not comply with normal procedures.	The upper control EtherCAT state machine must comply with the following sequence, Init -> Pre-OP -> SAFE-OP ->OP	The upper controller sends reset command to clear the alarm.

AL.82 EtherCAT sends error state machine value

Alarm cause	Checking method	Corrective action
The EtherCAT state machine send an undefined state command.	Check EtherCAT state command by the upper controller to troubleshoot the condition and execute the correct command.	The upper controller sends reset command to clear the alarm.

AL.83 ESC DC register setting alarm

Alarm cause	Checking method	Corrective action
ESC DC register Setting is in error.	Check the related register setting of Distributed Clocks.	Reset the DC mechanism related register.

AL.84 Synchronization error

Alarm cause	Checking method	Corrective action
Synchronization mechanism detection error	Check the value of PC38 and check the initial setting of the EtherCAT synchronization mechanism (when PC38=0, the alarm is not able to be detected).	If the issue persists, please contact the distributor or Shihlin for help.

AL.85 ESC initialization error

Alarm cause	Checking method	Corrective action
Control board is in error	Reboot the drive, if the issue persists, return to distributor or contact Shihlin.	

AL.86 Watchdog buffer setting error

Alarm cause	Checking method	Corrective action
Watchdog buffer register value setting is in error	The final product value of ESC register address 0x0400 and 0x0420 is less than the following limitations 1.Free Run mode: the value setting is less than 2ms. 2.DC mode: the value setting is less than 2 times the communication cycle.	Reset Watchdog register Values

AL.87 SII version validation error

Alarm cause	Checking method	Corrective action
The SII version conflicts with the firmware version.	Check related values of Vendor_ID/Product_code/Revision_number (obj1018_Identity)	Send back to distributor or Shihlin to upgrade the SW.

AL.88 Communication cycle time setting error

Alarm cause	Checking method	Corrective action
Communication cycle time setting is in error	Check the communication cycle time value of the upper controller (cycle time and shift time value, avoid shift time value greater than cycle time, or set unsupported cycle time), the following communication cycle times 125us/250us/500us/1ms/2ms/4ms/8ms are supported.	Reset communication cycle time

AL.89 Wrong control mode

Alarm cause	Checking method	Corrective action
The value of 6060h(Mode of operation) is not supported by the control command.	Check if the value of object 6060h comply with the control mode setting in user manual.	Resend the correct command and reset by upper controller command.

AL.90 Mailbox SM related settings error

Alarm cause	Checking method	Corrective action
Mailbox SM setting is in error	Check the setting of SM0/1 register address 0x08xx as follows. 1.The reading and writing start length of SM should not overlap. 2.The control register of ESC SM is set incorrectly. 3.SM length setting is out of range. 4.SM physical address is not in the specified range.	Reset Sync Manager related settings, if the issue persists, send it back to the distributor or contact Shihlin.
SyncManager2/3 setting is in error	Check the setting of SM2/3 register address 0x08xx as follows. 1.The reading and writing start length of SM should not overlap. 2.The control register of ESC SM is set incorrectly. 3.SM length setting is out of range. 4.SM physical address is not in the specified range.	Reset Sync Manager related settings, if the issue persists, send it back to the distributor or contact Shihlin.
EtherCAT data transmission mode setting is in error	Check the internal data contents of objects 1C32h:01 and 1C33h:01, or set the unsupported Sync mode.	Reset Sync Manager 2/3 related settings

AL.91 TxPDO/RxPDO data type assignment error

Alarm cause	Checking method	Corrective action
TxPDO/RxPDO data type assignment is in error	Check if the TxPDO/RxPDO Mapping object exceeds 32 bytes.	Reset TxPDO/RxPDO Data Settings

AL.1A Undefined index coordinate

Alarm cause	Checking method	Corrective action
When using the indexing function, you need to execute homing to define the origin of the indexing coordinates. otherwise, an alarm will occur.	Check whether homing has been executed.	1.Before using the indexing function, execute homing first to avoid this alarm. 2.Use DI:Alm reset function to clear the alarm. 3.This alarm can also be cleared when Servo is ON.

AL.1B Position shift warning

Alarm cause	Checking method	Corrective action
When DO: MC_OK ON→OFF. Please refer to PD28 description.	When DO:MC_OK is already on, it may turn off when DO:INP turns off, The external force after motor completed positioning may cause the position shift.	1.Turn on RES signal. 2.Press Set button in alarm display screen. 3.Cycle the power. 4.Cycle the SON signal

AL.61 Parameter group range excess

Alarm cause	Checking method	Corrective action
The parameter group of PR is out of range.	The parameter group setting is out of range when writing the parameter by PR procedure.	Clear the alarm by any of the following solutions: 1.Cycle the power. 2.Press SET button at alarm display screen. 3.Turn on RES signal.

AL.62 Parameter number range excess

Alarm cause	Checking method	Corrective action
The parameter number of PR is out of range.	The parameter group setting is out of range when writing the parameter by PR procedure.	Clear the alarm by any of the following solutions: 1.Cycle the power. 2.Press the SET button in alarm display screen. 3.Turn on the RES signal.

AL.63 Pr mode parameter range excess

Alarm cause	Checking method	Corrective action
The parameters of PR command Type 8 are out of range.	The parameter group setting is out of range when writing the parameters by PR procedure.	Clear the alarm by any of the following solutions: 1.Cycle the power. 2.Press the SET button in alarm display screen. 3.Turn on the RES signal.

AL.64 Pr mode parameter write error

Alarm cause	Checking method	Corrective action
Write the parameters by PR command TYPE 8 during Servo ON.	Check if PR program writes the parameters during Servo ON or the value is not reasonable.	Revise PR commands and parameters

AL.65 Reverse rotation limit error

Alarm cause	Checking method	Corrective action
When PD37=0001, the negative limit switch is triggered.	Check the position of switch.	Release negative limit switch to clear the alarm.

13.Product Specifications

13.1 Standard specifications of servo drive

Drive Model SDC-□□□E2			010	020	040	075	100
Servo Motor Model SME-□□□□			L010	L020	L040	L075	L100
Motor capacity			100W	200W	400W	750W	1.0KW
Power	**Input**	**Voltage 50/60Hz**	Single-phase or Three-phase 200~240 VAC				
		Permissible voltage Variation 50/60Hz	Single-phase or Three-phase 170～264 VAC				
		Permissible Frequency Variation	±5%				
	Output	**Voltage**	0~240VAC				
		Current	1.0A	1.8A	3.2A	5.8A	6.1A
		Frequency	0~250Hz				
Control method			IGBT-PWM control (SVPWM)				
Dynamic brake			Software(built-in), Hardware(optional purchase)				
Protection function			Over current, under voltage, over voltage, overheat, overload(electron accumulated heat), encoder error protection, over speed protection, excessive deviation protection, motor mismatch error, motor collision error, motor UVW cable disconnection, control circuit error.				
Feedback encoder			Magnetic encoder resolution: Single turn: 17bit (131072 Pulse); Multi-turn: 17bit/16bit Optical encoder resolution: Single turn: 24bit (16777216 Pulse); Multi-turn: 24bit/16bit				
Communication interface			EtherCAT, USB				

Position control mode (CSP)	**Command source**	EtherCAT communication control.
	smoothing method	Low-pass filter smoothing / Linear smoothing / PS-curve smoothing
	Command pulse ratio	E-gear ratio A/B times A: 1 to 67108864, B: 1 to 67108864 (Limitation: 1/50 < A/B < 64,000)(24bit encoder) (Limitation: 1/50 < A/B < 25,600)(17bit encoder)
	Deviation excess	±3 revolutions
	Torque limit	EtherCAT communication setting
	Feed-forward compensation	Internal parameter setting or EtherCAT communication setting (0 to 200%)
Speed control mode (CSV)	**Speed control range**	Internal speed command 1:5000
	Command source	EtherCAT communication control
	smoothing method	Low-pass filter Linear acceleration and deceleration curve S-curve smoothing
	Speed change rate	Load fluctuation 0~100% maximum ±0. 01% Power fluctuation ±10% maximum 0.01%
	Torque limit	EtherCAT communication setting
	Bandwidth	Maximum 2KHz
Torque control mode (CST)	**Command source**	EtherCAT communication control
	smoothing method	Low-pass filter smoothing
	Speed limit	EtherCAT communication setting
Digital input	**Digital Input**	Servo on, forward and reverse rotation limit, torque direction option, speed command option, forward and reverse rotation command, proportional control switching, torque limit switching, alarm reset, emergency stop, gain switching, position command option, position command trigger, motor stop, event trigger command, origin point, homing activated.

Digital output	**Digital Output**	Torque limit reached, speed limit reached, servo ready, zero speed reached, target position reached, target speed reached, servo alarm, servo warning, homing completed, overload level reached, internal position attained, position command overflows, software positive limit reached, software reverse limit reached.				
Environment	**Temperature**	0℃~55℃ (If the operating temperature is above 45˚C, forced cooling is required) Storage: -20~65℃ (non-freezing)				
	Humidity	Maximum 90% RH (non-condensing) Storage: below 90%RH (non-condensing)				
	Installation site	Indoors (avoid direct sunlight), no corrosive vapor, avoid flammable gases, fumes and dust.				
	Altitude	Below 1000m				
	Vibration	Maximum 5.9m/s^2				
Cooling method		Air convection cooling. Open type(IP20)			Fan cooling. Open type(IP20)	
Weight(kg)		1.4	1.4	1.4	1.7	1.7

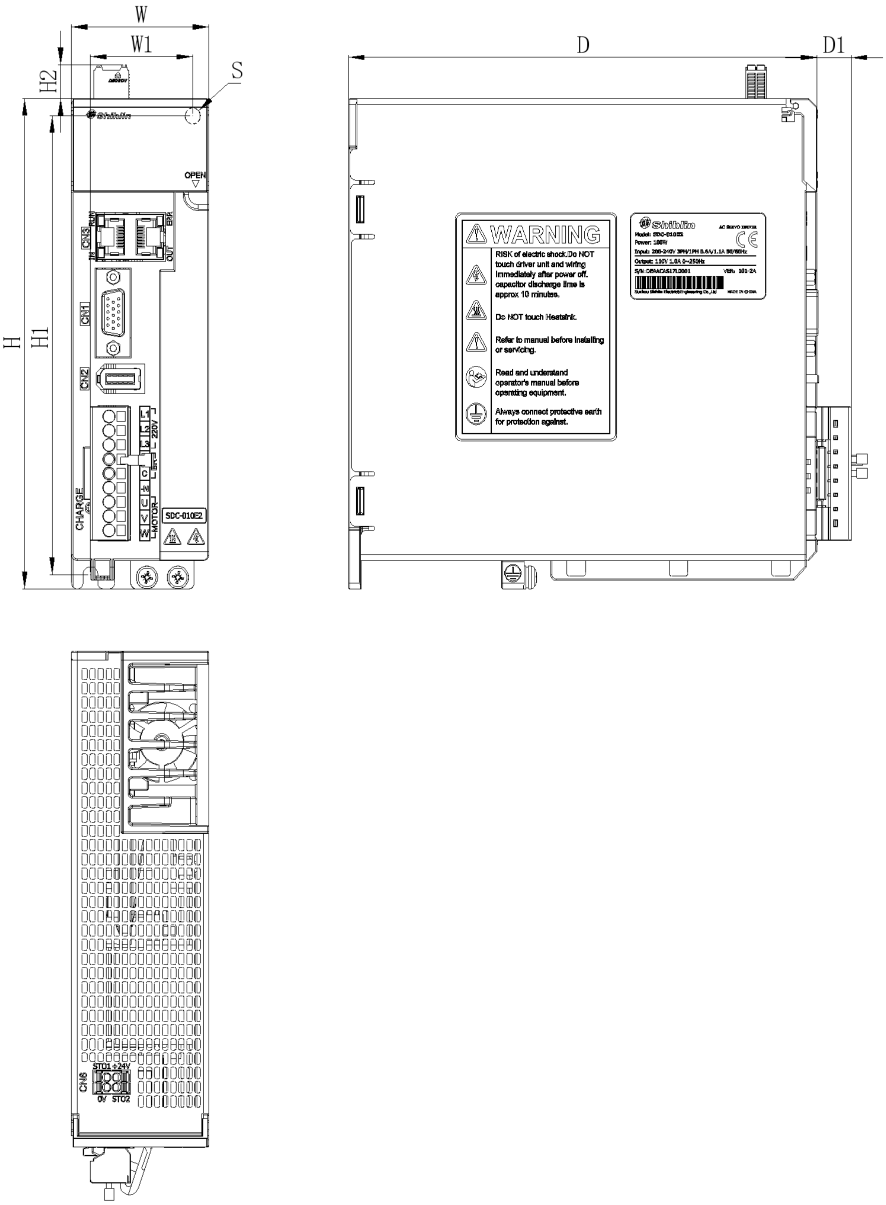
Note: *1 when command is the rated speed, the speed change rate calculation is: (speed with no load - speed with full load) / rated speed.

13.2 Interface of servo drive

DIMENSIONAL (unit[mm])

MODEL	W	W1	H	H1	H2	D	D1	S
SDC010E2	51	38	172	161	12	174	12.6	5.6
SDC020E2								
SDC040E2								
SDC075E2								
SDC100E2								

13.3 Dimensions of servo drive



Note: Dimensions of the servo drive may be updated without prior notice. And 400W (incl.) and below models are without fan.

13.4 Standard specifications of servo motor

13.4.1 SME series : Specification of Low Capacity Servo Motor

Motor model □□□□		--	L010	L020	L040	L075	L100
Flange number		mm	□40	□60		□80	
Rated output capacity		W	100	200	400	750	1000
Rated torque(Note 1)		Nm	0.32	0.64	1.27	2.4	3.2
Maximum torque		Nm	0.96	1.92	3.81	7.2	9.5
Rated speed		rpm	3000				
Maximum speed		rpm	6000				5000
Rated current		A	0.85	1.7	2.8	5.8	5.5
Maximum current		A	2.7	5.2	9.0	18.5	18.2
Rotor inertia *J* ($x10^{-4}$) (Note 2)		kg-m2	0.0518 (0.0523)	0.161 (0.178)	0.277 (0.294)	1.07 (1.11)	1.89 (1.91)
Power at continuous rated torque		kw/s	19.6	25.2	58.5	53.3	53.6
Mounting aluminum plate size		mm	250 x 250 x 6				
Insulation class		--	CE(B) & UL(A)				
Insulation impedance		--	100MΩ @ DC500V				
Insulation strength		--	60sec @ AC1500V				
Encoder resolution		--	(Optical) Single-turn resolution 24bit; multi-turn 16bit (65,536 Turn) (Magnetic) Single-turn resolution 17bit; multi-turn 16bit (65,536 Turn)				
Motor structure(Note 3)		--	Full-closed and Air convection cooling(IP rating IP65)				
Vibration grade		--	V-15				
Operation environment	Temperature	--	0℃～40℃(Non- freezing) / Storage: -15℃～70℃(Non- freezing)				
	Humidity	--	Below 80%RH (Non-condensing) ,Storage: below 90%RH (Non-condensing)				
	Altitude	--	Below 1000m				
	Environment restrictions	--	Indoors (avoid direct sunlight), no corrosive vapor, avoid flammable gases, fumes and dust.				
	Vibration capacity	--	5G				
Shaft allowable load(Note 5)	Fd	mm	20	25		35	
	Radial loading Fr	N	68.6	245		392	
	Axial loading Fa	N	39.2	98		147	

Motor model □□□□		--	L010	L020	L040	L075	L100
Brake spec (Note4)	Input voltage	V	DC 24V ± 10%				
	Brake holding torque	Nm	0.3	1.3		2.5	3.2
	Power consumption	W	7.2	7.6		8	10
	Current consumption	A	0.3	0.32		0.33	0.42
	Impedance @20℃	Ω	80	75.4		72	57.6
	Release time	ms	40	60		60	60
	Close time	ms	20	40		40	40
Motor weight(Note 2)		Kg	0.51 (0.73)	0.95 (1.31)	1.34 (1.71)	2.34 (3.07)	3.61 (4.4)

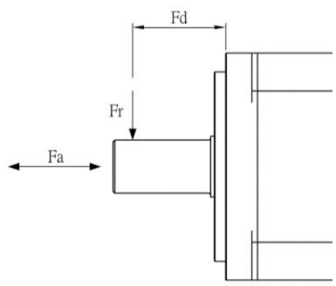
Note 1: For lifting axes or reciprocating loads, please make sure the average load ratio is not more than 75%. (Please refer to section 14.1 for S-T curve.).

Note 2: () for the rotor inertia and weight with electromagnetic brake.

Note 3: The motor IP65 protection test is for the motor body, excluding the output shaft and the connector itself.

Note 4: The electromagnetic brake is used for holding when the mechanism stops, and it cannot be used for braking during operation.

Note 5: The diagram of permissible load on output shaft is as below:



13.4.2 SM3 series : Specification of Low Capacity Servo Motor

□□□□ Motor type	--	M010	M020	M040	H040	M075	H075	M100
Flange number	mm	□40	□60			□80		
Rated power	W	100	200	400	400	750	750	1000
Rated torque(Note 1)	Nm	0.318	0.64	1.27	1.27	2.39	2.39	3.18
Maximum torque	Nm	0.955	1.92	3.82	3.82	7.16	7.16	9.55
Rated speed	rpm	3000						
Maximum speed	rpm	6500			6000	6500	6000	5000
Rated current	A	0.85	1.5	2.8	2.8	5.0	5.0	5.0
Maximum current	A	2.975	5.3	9.8	9.8	17.5	17.5	17.5
Rotor inertia *J* ($x10^{-4}$) (Note 2)	$kg\text{-}m^2$	0.039 (0.041)	0.230 (0.247)	0.427 (0.442)	0.660 (0.670)	1.360 (1.412)	2.009 (2.059)	1.744 (1.796)
Power at continuous rated torque	kw/s	25.72	17.81	39.54	24.56	42.72	28.44	59.11
Mounting aluminum plate size	mm	250 x 250 x 6 (A6061)						
Insulation class	--	CE(B) / UL(A)						
Insulation resistance	--	100MΩ @ DC500V						
Insulation strength	--	60sec @ AC1500V						
Encoder resolution	--	(Optical) Single-turn resolution 22bit; multi-turn 16bit (65,536 Turn) (Magnetic) Single-turn resolution 20bit; multi-turn 16bit (65,536 Turn)						
Motor structure(Note 3)	--	Fully closed and Air convection cooling(IP rating IP67)						
Vibration grade	--	V-15						
Operation environment: temperature	--	0℃～40℃(Non- freezing) / Storage:-20℃～80℃(Non- freezing)						
Operation environment: humidity	--	Below 80%RH(Non-condensing) Storage : below 90%RH(Non-condensing)						
Operation environment: Altitude	--	Below 1,000m above sea level						
Operation environment: Environment restrictions	--	Indoors (avoid direct sunlight), no corrosive vapor , avoid flammable gases, fumes and dust.						
Operation environment: magnetic field interference	--	<20mT **(Note 6)**						
Operation environment: Vibration resistant	--	5G						

□□□□ Motor type			M010	M020	M040	H040	M075	H075	M100
Axial allowable load(Note 5)	Fd	mm	20	25			35		
	radial loading Fr	N	68.6	245			392		
	axial loading Fa	N	39.2	98			147		
Brake specification (Note4)	Input voltage	V	DC 24V ± 10%						
	Brake holding torque	Nm	0.32	1.5			3.2		
	power consumption	W	6.1	7.6			10		
	Current consumption	A	0.25	0.31			0.48		
	impedance @20℃	Ω	94.4	76			50.1		
	Brake release time	ms	50	60			60		
	Brake close time	ms	40	20			40		
Motor weight(Note 2)		Kg	0.49 (0.70)	0.78 (1.19)	1.13 (1.55)	1.14 (1.55)	2.37 (3.18)	2.56 (3.38)	2.86 (3.66)

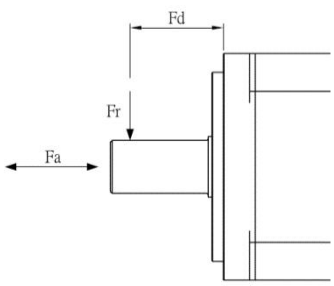
Note 1: In the vertical lift or reciprocating mechanism application,please make sure the average load rate is below 75%. (refer to P. 292 for S-T curve)

Note 2: () is the rotor inertia and weight with electromagnetic brake.

Note 3: The motor IP65 protection test is for the motor body, excluding the output shaft and the connector itself.

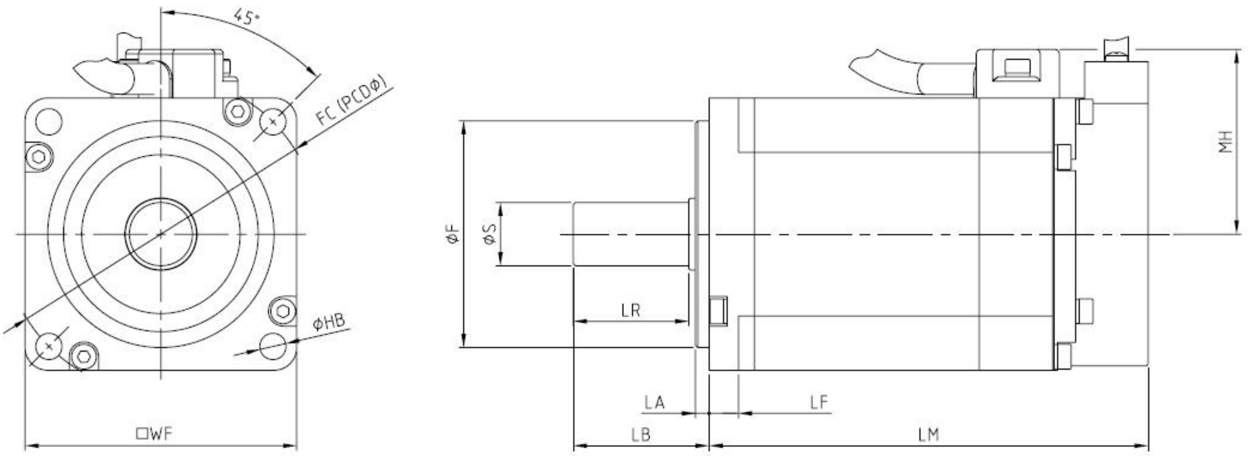
Note 4: The electromagnetic brake is used for holding when the mechanism stops, and cannot be used for braking during operation.

Note 5: Output shaft allowable load diagram



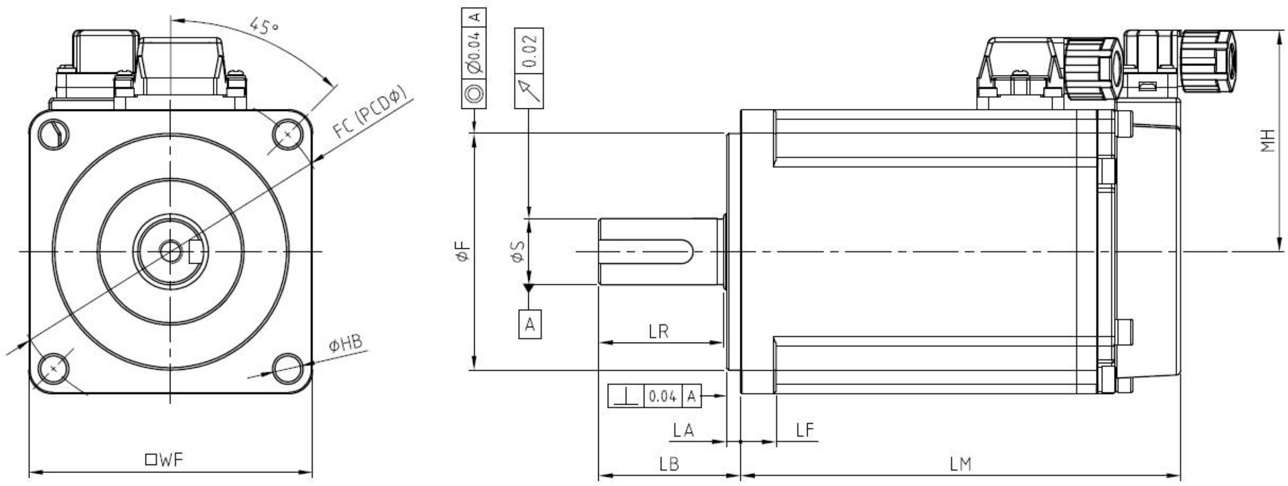
13.5 Motor dimensions

13.5.1 Dimensions of 3000rpm motor



<table>
<tr><th rowspan="2">Model</th><th colspan="11">Dimensions(mm)</th></tr>
<tr><th>WF</th><th>ψS</th><th>ψF</th><th>LA</th><th>LB</th><th>LF</th><th>LR</th><th>MH</th><th>LM</th><th>FC</th><th>HB</th></tr>
<tr><td>SME-L010(B)</td><td>40</td><td>$\varphi 8\ ^{0}_{-0.009}$</td><td>$\varphi 30\ ^{0}_{-0.03}$</td><td>2.5</td><td>25</td><td>5.5</td><td>21.2</td><td>32</td><td>97.8
(132.5)</td><td>46</td><td>2-ψ4.5</td></tr>
<tr><td>SME-L020(B)</td><td rowspan="2">60</td><td rowspan="2">$\varphi 14\ ^{0}_{-0.011}$</td><td rowspan="2">$\varphi 50\ ^{0}_{-0.03}$</td><td rowspan="2">3</td><td rowspan="2">30</td><td rowspan="2">6.5</td><td rowspan="2">25.5</td><td rowspan="2">42</td><td>94.2
(129.2)</td><td rowspan="2">70</td><td rowspan="2">4-ψ5.8</td></tr>
<tr><td>SME-L040(B)</td><td>114.2
(149.2)</td></tr>
<tr><td>SME-L075(B)</td><td rowspan="2">80</td><td rowspan="2">$\varphi 19\ ^{0}_{-0.013}$</td><td rowspan="2">$\varphi 70\ ^{0}_{-0.03}$</td><td rowspan="2">3</td><td rowspan="2">40</td><td rowspan="2">7.5</td><td rowspan="2">35.3</td><td rowspan="2">52</td><td>119.2
(158.2)</td><td rowspan="2">90</td><td rowspan="2">4-ψ6.6</td></tr>
<tr><td>SME-L100(B)</td><td>159.2
(203.5)</td></tr>
</table>

LM ( ): length of model with brake.



Model	Dimensions(mm)										
	WF	ψS	ψF	LA	LB	LF	LR	MH	LM	FC	HB
SM3-M010(B)	40	$Ø8^{0}_{-0.009}$	$Ø30^{0}_{-0.021}$	2.5 ±0.5	25 ±0.5	5	22	41.5	95 (122)	46	4-ø4.5
SM3-M020(B)	60	$Ø14^{0}_{-0.011}$	$Ø50^{0}_{-0.025}$	3 ±0.5	30 ±0.5	7.5	26.5	47	74 (107)	70	4-ø5.5
SM3-M040(B)	60	$Ø14^{0}_{-0.011}$	$Ø50^{0}_{-0.025}$	3 ±0.5	30 ±0.5	7.5	26.5	47	93 (126)	70	4-ø5.5
SM3-H040(B)	60	$Ø14^{0}_{-0.011}$	$Ø50^{0}_{-0.025}$	3 ±0.5	30 ±0.5	7.5	26.5	47	93 (126)	70	4-ø5.5
SM3-M075(B)	80	$Ø19^{0}_{-0.013}$	$Ø70^{0}_{-0.03}$	3 ±0.5	35 ±0.5	8	31.5	55.5	108.5 (147.5)	90	4-ø6.6
SM3-H075(B)	80	$Ø19^{0}_{-0.013}$	$Ø70^{0}_{-0.03}$	3 ±0.5	35 ±0.5	8	31.5	55.5	113 (152)	90	4-ø6.6
SM3-M100(B)	80	$Ø19^{0}_{-0.013}$	$Ø70^{0}_{-0.03}$	3 ±0.5	35 ±0.5	8	31.5	55.5	123.5 (162.5)	90	4-ø6.6

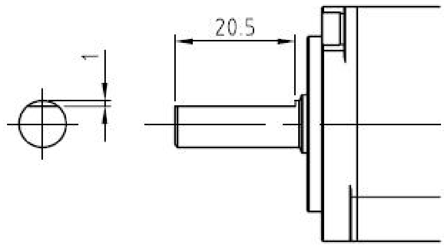
LM ( ):Length of model with brake

13.5.2 Dimensions of 2000 RPM motor

There is no 2000 rpm motor in SDC series currently.

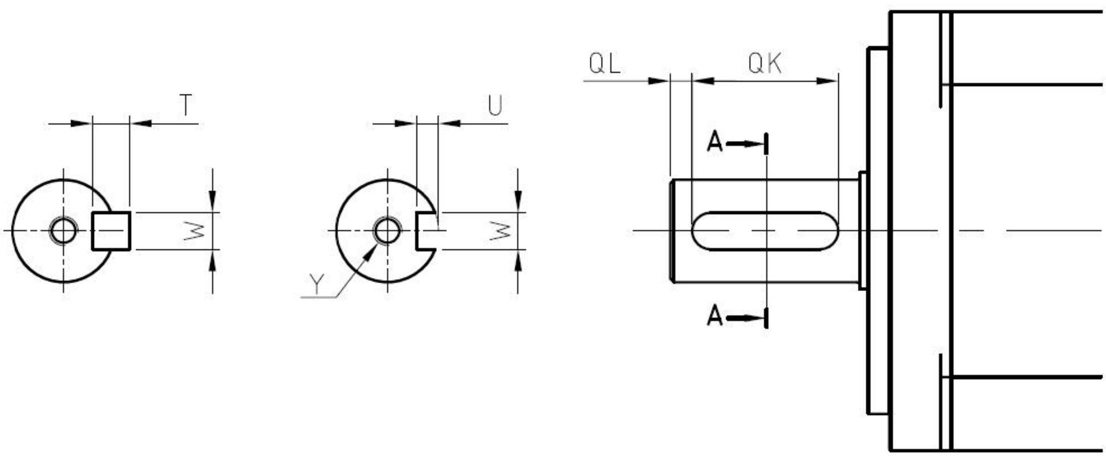
13.5.3 Dimensions of servo motor keyway

D type keyway applicable model: L010(B)

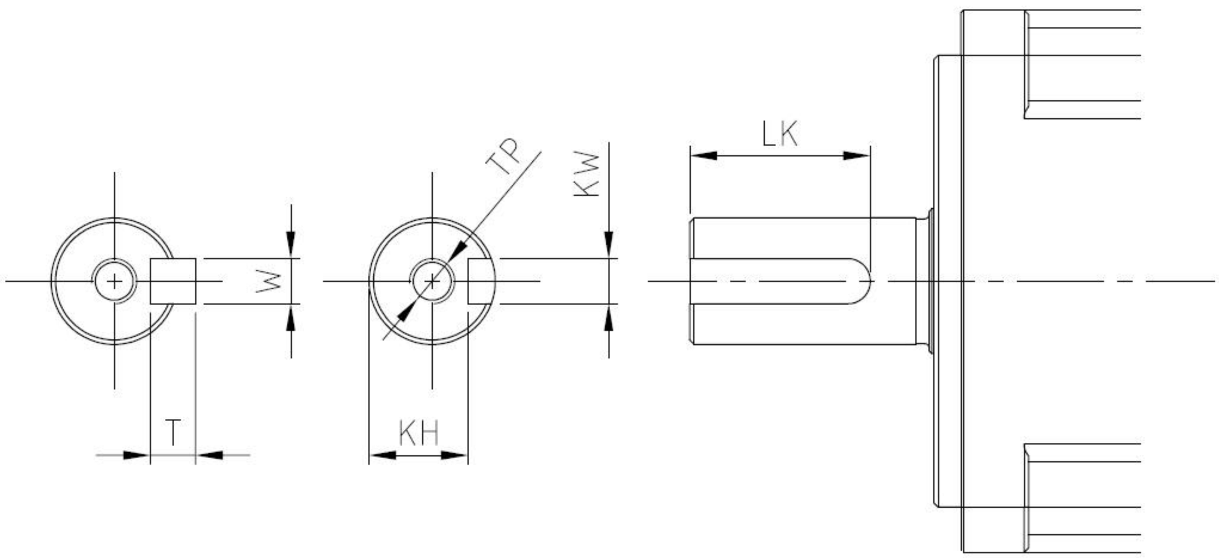


General keyway

Model	Dimensions					
	QL	QK	W	T	U	Y
SME-L020(B) \ SME-L040(B)	3	20	$5\ ^{0}_{-0.03}$	5	3	M4x depth 15
SME-L075(B) \ SME-L100(B)	5	25	$6\ ^{0}_{-0.03}$	6	3.5	M5x depth 20



Model	Dimensions(mm)					
	W	T	KW	KH	LK	TP
SM3-M010(B)	$3^{0}_{-0.03}$	$3^{0}_{-0.03}$	$3^{0}_{-0.03}$	$6.2^{0}_{-0.1}$	15.5	M3 x depth 6
SM3-M020(B) SM3-M040(B) SM3-H040(B)	$5^{0}_{-0.03}$	$5^{0}_{-0.03}$	$5^{0}_{-0.03}$	$11^{0}_{-0.1}$	20	M4 x depth15
SM3-M075(B) SM3-H075(B) SM3-M100(B)	$6^{0}_{-0.03}$	$6^{0}_{-0.03}$	$6^{0}_{-0.03}$	$15.5^{0}_{-0.1}$	25	M5 x depth 20



13.6 Electromagnetic interference filter (EMI Filter)

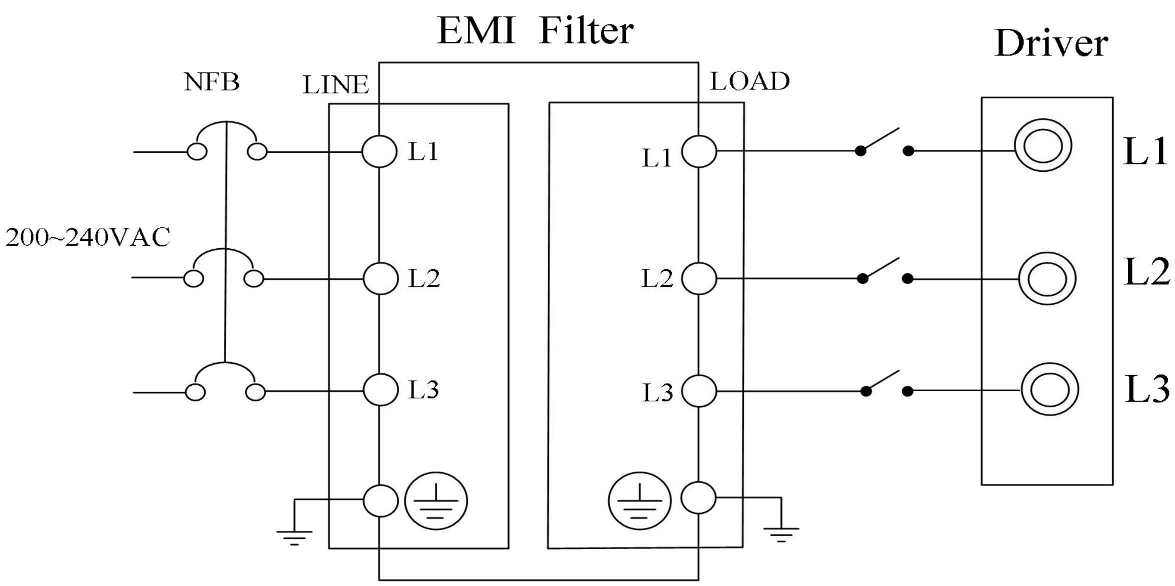
To comply with EMI directive of EN specifications, it is recommended to use the following filters:

Servo drive	Recommended filter
SDC-010E2	NF312C5/05
SDC-020E2	
SDC-040E2	NF312C10/05
SDC-075E2	NF312C20/05
SDC-100E2	

★ Filter is optional purchase item.

★ The filter installation should be decided after considering whether there is any EMI phenomenon in site.

The diagram of the drive connected to the three-phase power supply after connecting the EMI filter can be seen in the following figure:



★ Ground the EMI Filter.

13.7 EMI prevention countermeasures

The following diagram shows the recommended wiring of the servo drive on the distribution panel.

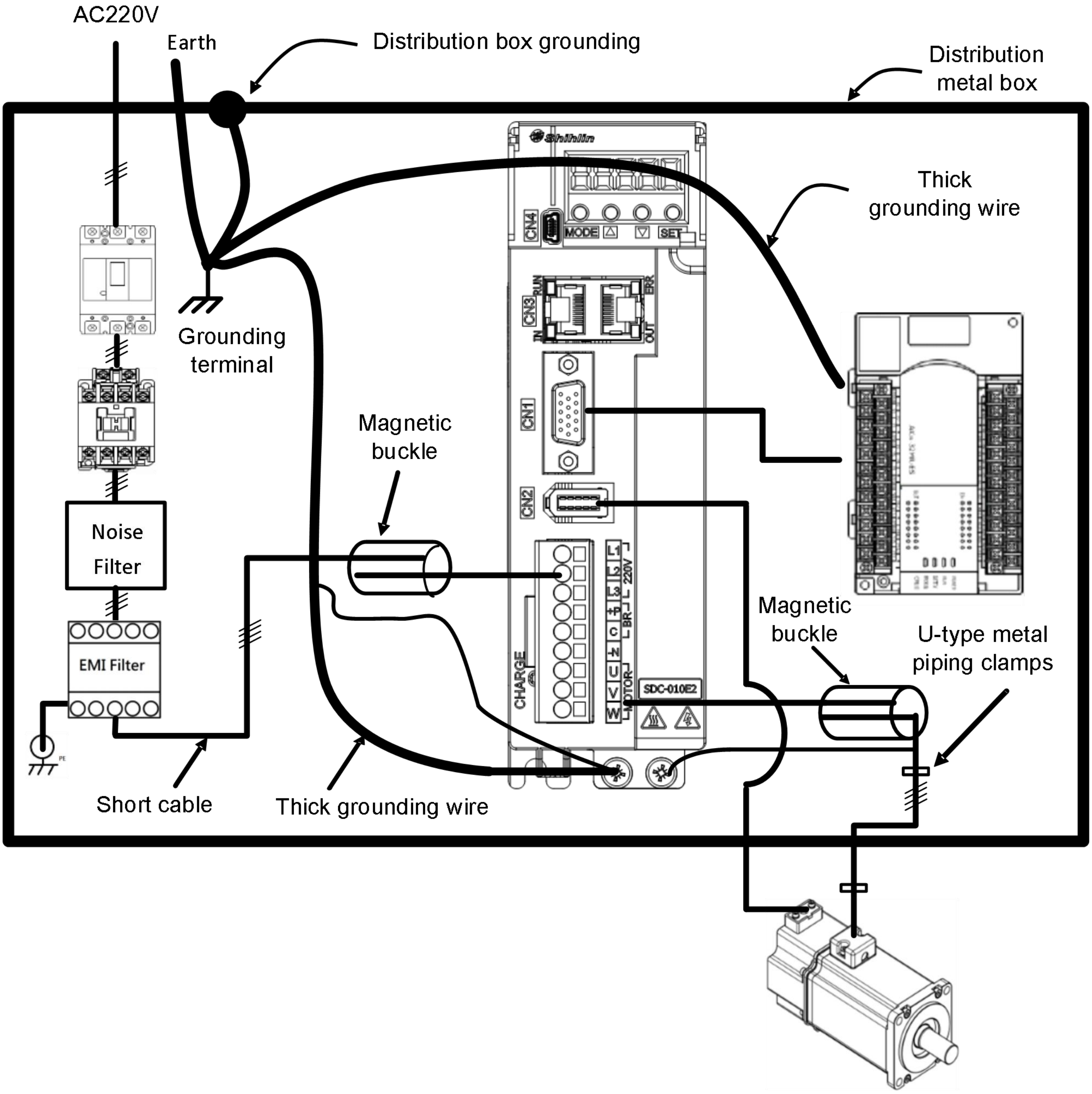


Figure 1: Recommended wiring diagram

The selection of motor power cable and the installation of related accessories are the key to electromagnetic interference. To effectively reduce the noise interference, the following items should be noted when wiring on the distribution panel.

1.The EMI filter and servo drive should be installed on the same metal plate, and the wiring between them should be shortened as much as possible.

2.The servo drive and metal casing of EMI filter installed in the metal plane of the disk must be fixed on the metal plane, and the two contact surface of the metal plane should be as good as possible (the isolation paint needs to be removed).

3.Use power cable with isolation net for the motor power cable, and double isolation net is preferred.

4.The isolation net at both ends of the motor power cable must be grounded with the largest contact area (U-type metal piping clamps).

5.U-type metal piping clamps are screwed on the metal plane of the distribution panel (the isolation paint needs to be removed) to ensure good contact, please see Figure 2 below.

6.The distribution box and the distribution door should have good conductivity, and the thick grounding wire or metal isolation net should be assembled between frame and door to avoid noise interference.

7.The magnet buckle must be wound more than one turn on the power wiring (except the ground wire), and should be as close as possible to the servo drive to prevent common mode noise interference.

8.Power lines and I/O lines should be far away from each other and should not wiring in parallel direction.

9.For the metal parts of the motor-configured equipment, please use a thick ground wire or metal isolation net to connect the ground terminal.

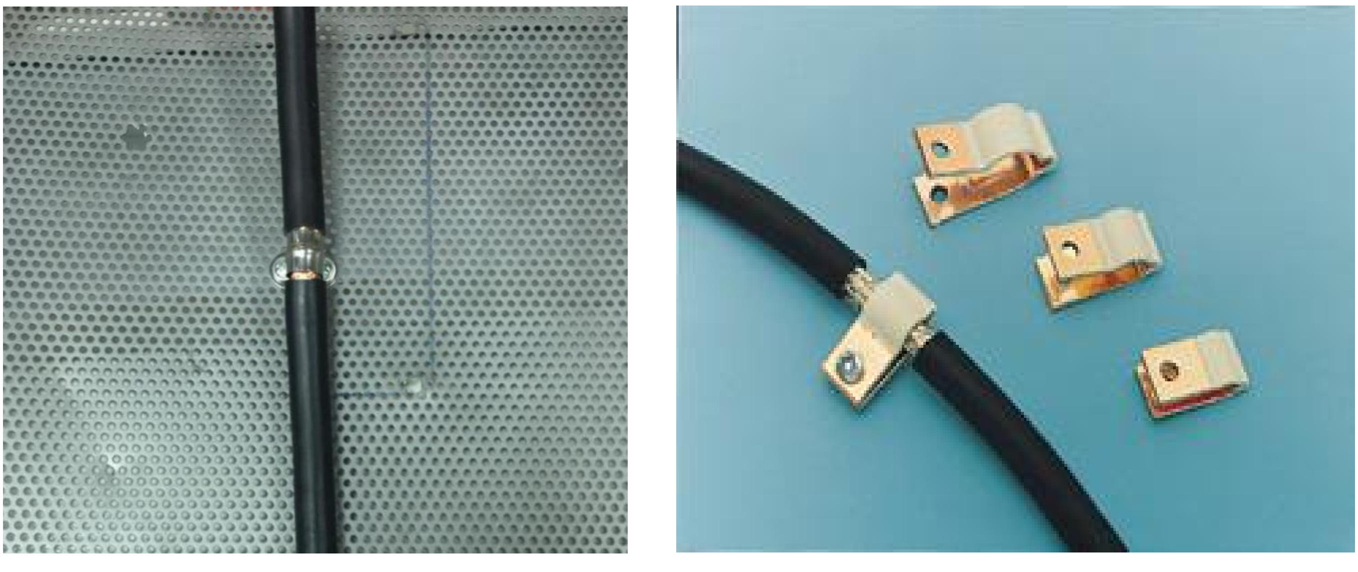


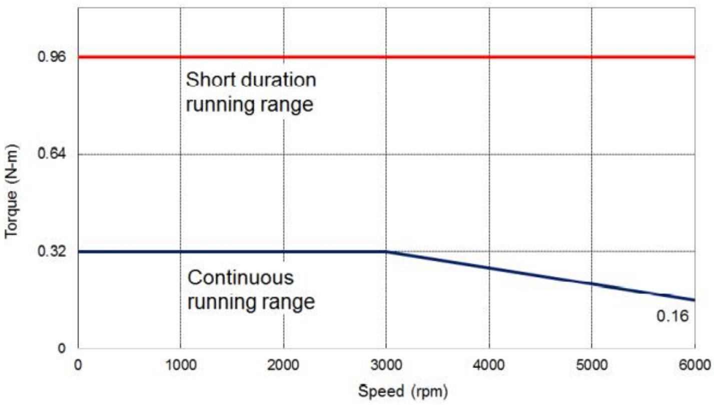
Figure 2 U-type metal piping clamps

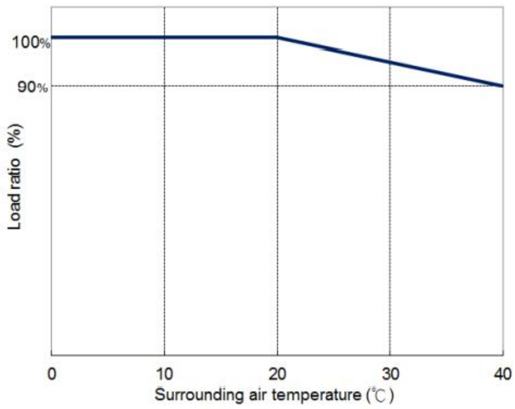
14.Features

14.1 Motor T-N curve/S-T curve

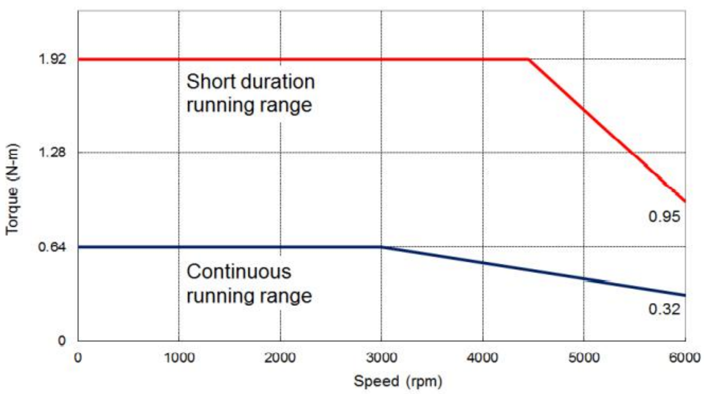
Insufficient voltage will reduce the motor feature of three-phase 220V power supply.

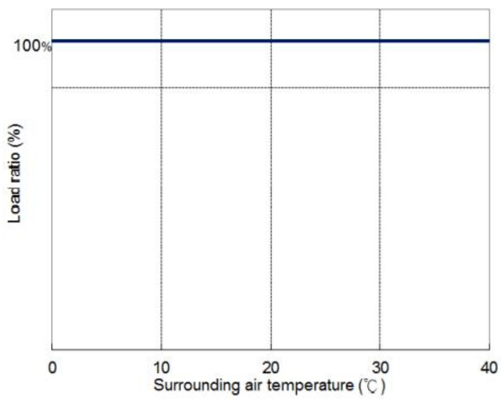
【SME-L010】



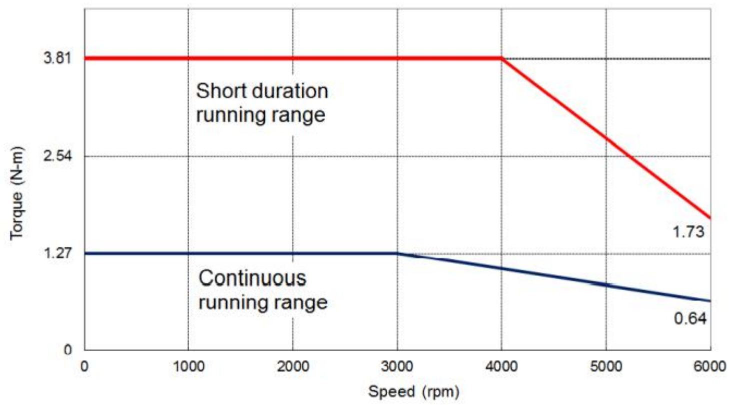


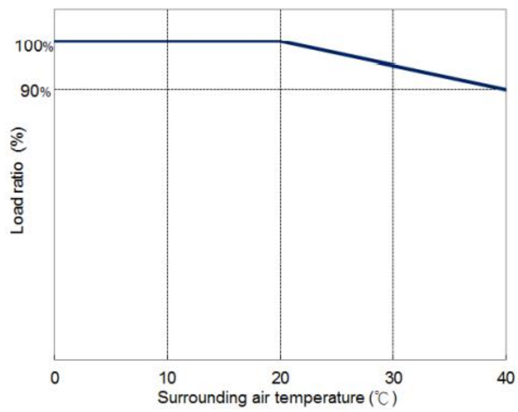
【SME-L020】



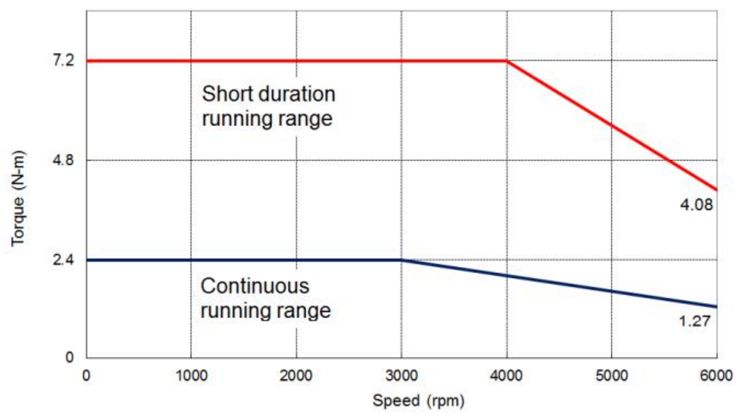


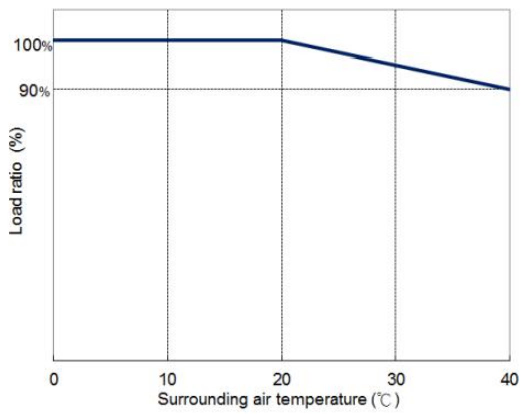
【SME-L040】



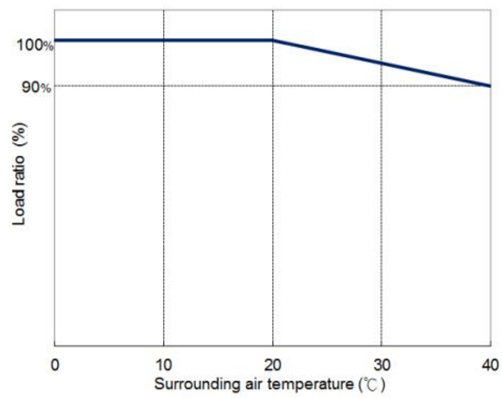


【SME-L075】

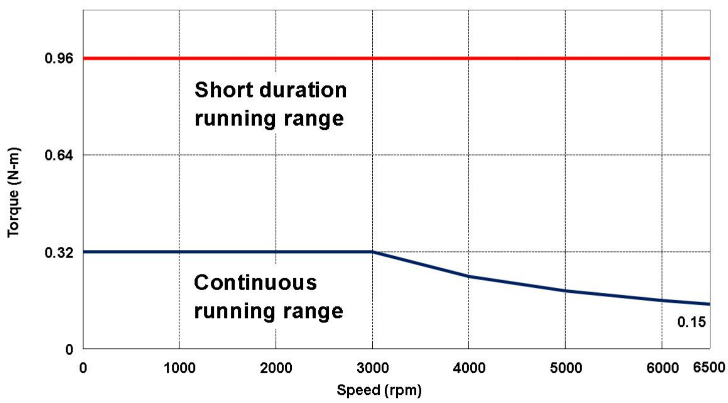


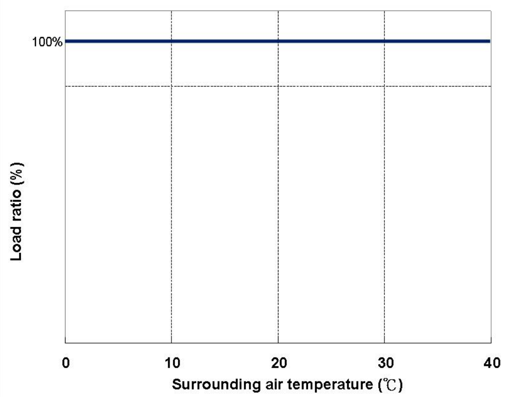


【SME-L100】

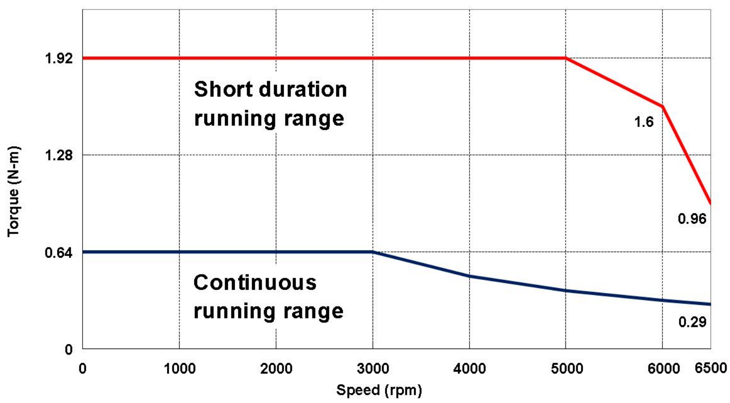


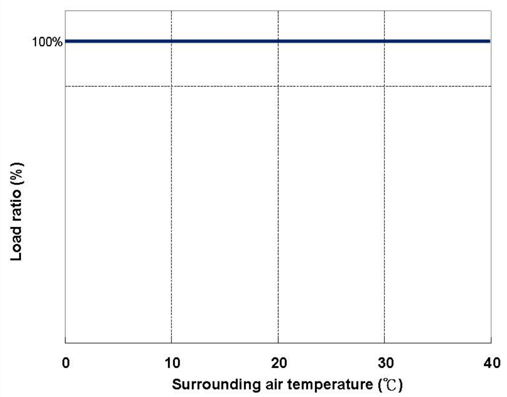
【SM3-M010】



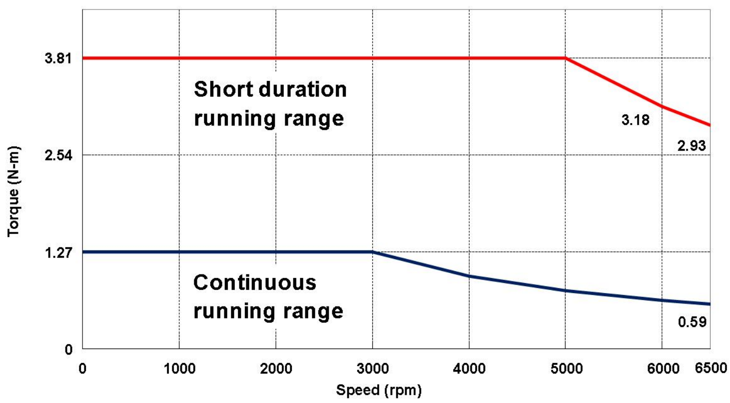


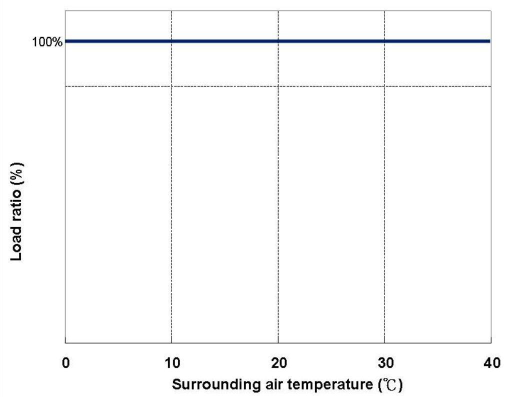
【SM3-M020】



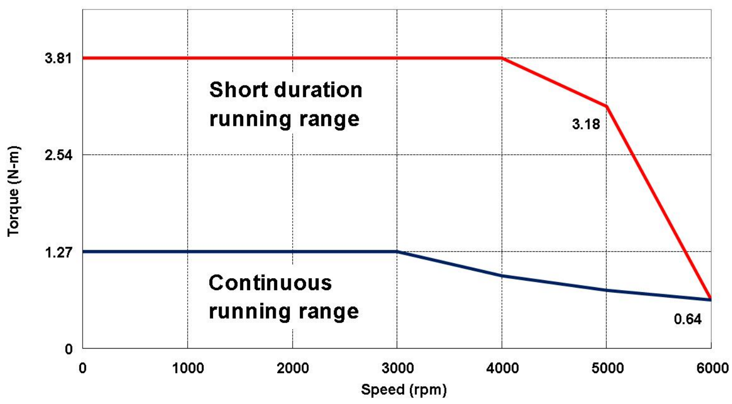


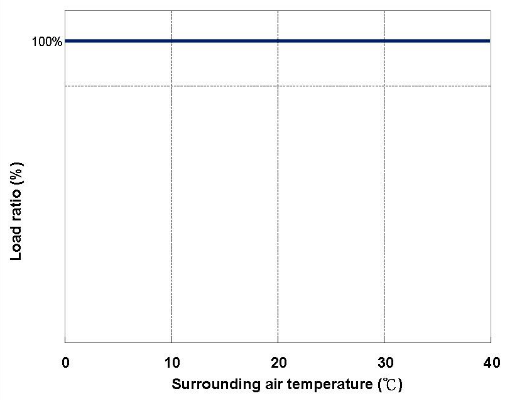
【SM3-M040】



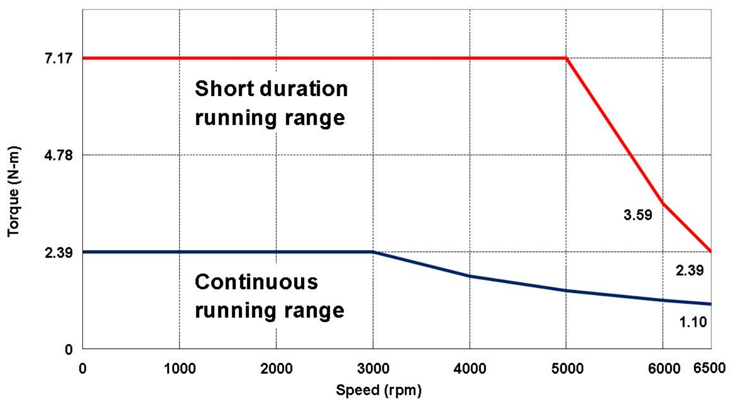


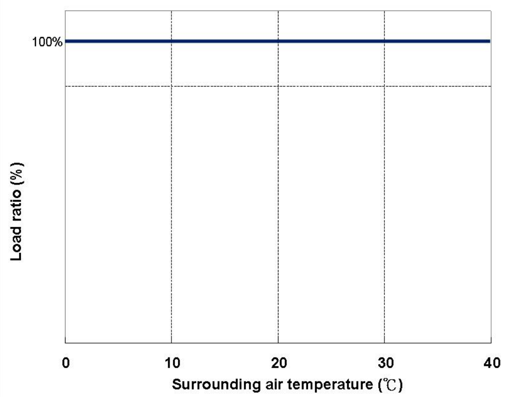
【SM3-H040】



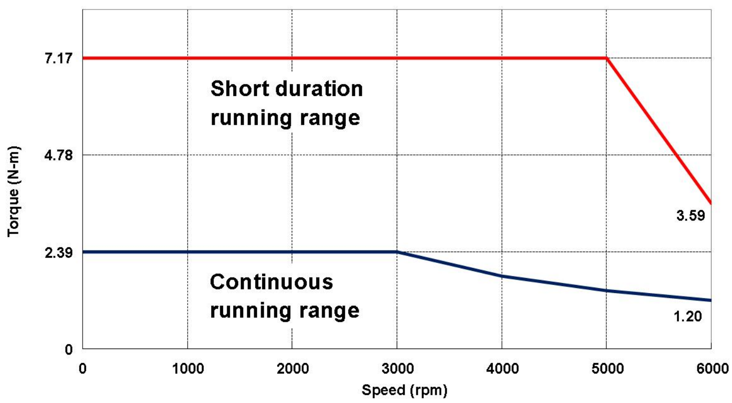


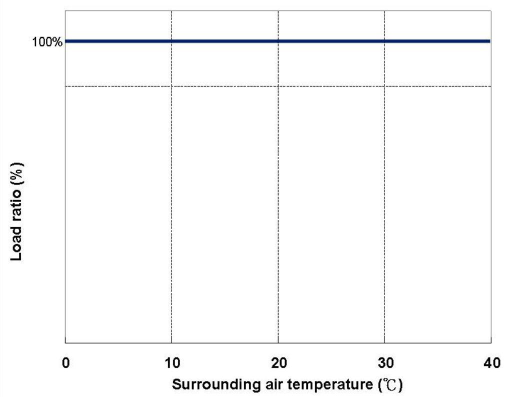
【SM3-M075】



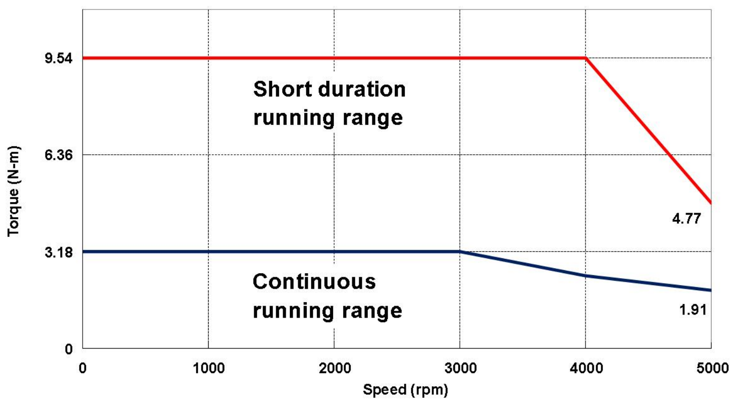


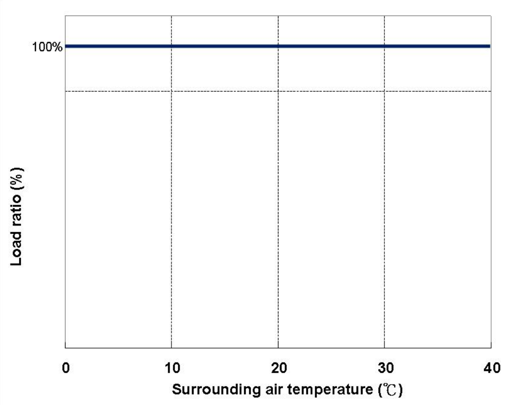
【SM3-H075】





【SM3-M100】





★ This feature is applicable for single-phase 200~240V power supply.

14.2 Overload protection feature

Overload protection is to prevent the servo motor from overload operation.

The causes of overload can be summarized as follows:

(1). Excessive inertia ratio.

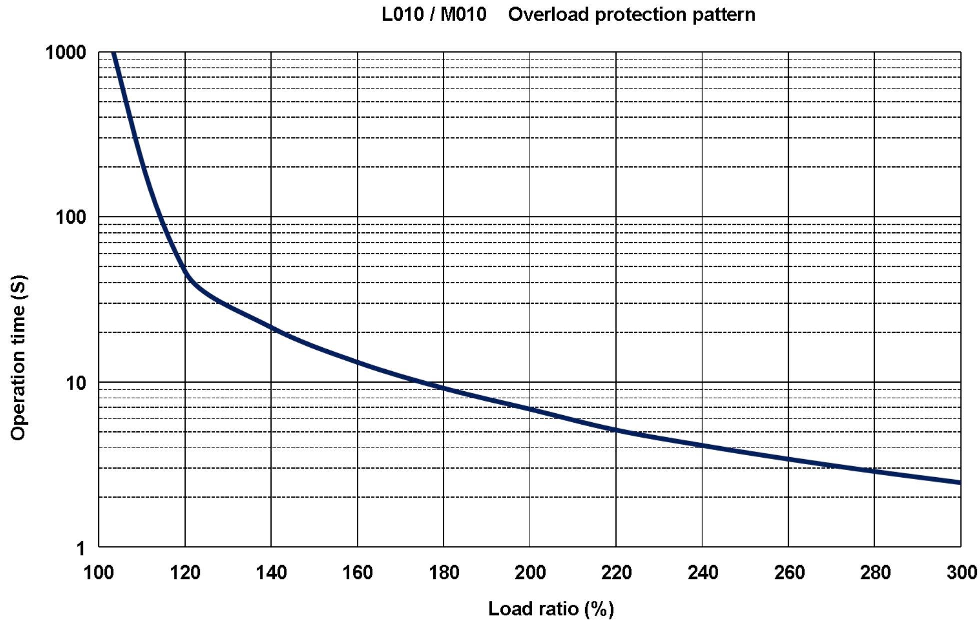
(2). The acceleration and deceleration time setting is too small during loading.

(3). The motor torque exceeds the rated range and the operating time is too long.

(4). Large servo gain setting causes resonance and the motor keeps running.

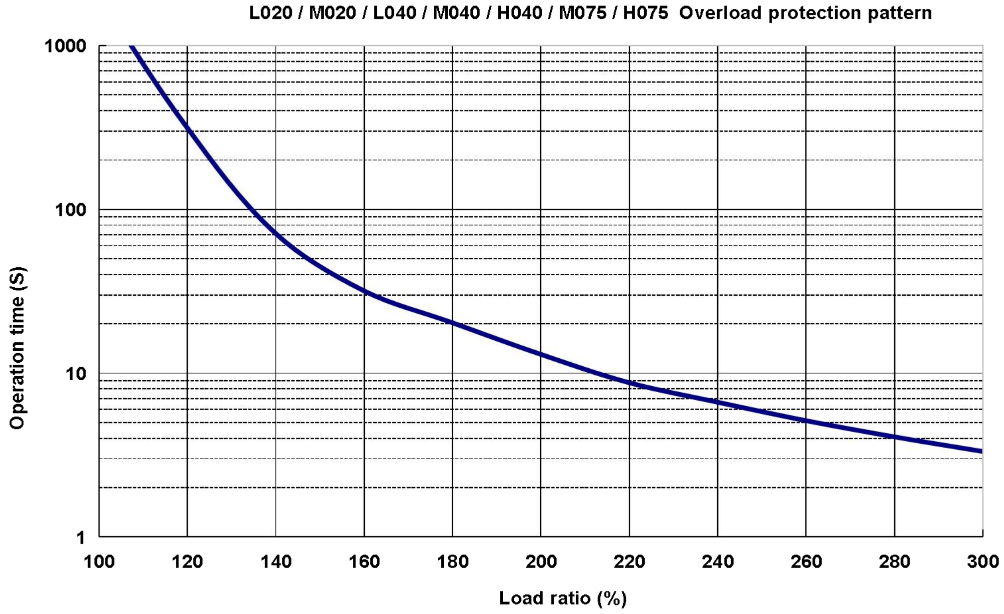
(5). Motor power cable and encoder cable are wired incorrectly.

If the motor torque exceeds the rated range, you can refer to the load ratio and operating time graphs as follows:



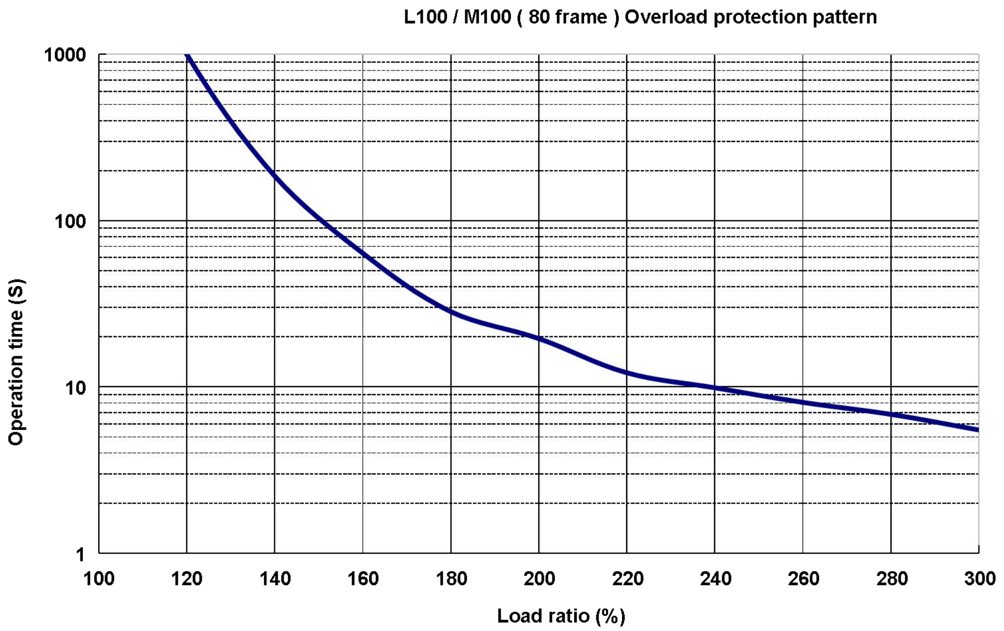
Load ratio (%)	Operation time (S)
100	2000.0
120	46.71
140	21.41
160	13.17
180	9.17
200	6.85
220	5.12
240	4.13
260	3.41
280	2.87
300	2.46

Operating time is 2.46 seconds at 300% load.



Load ratio (%)	Operation time (S)
100	2000.00
120	313.60
140	71.14
160	31.76
180	20.30
200	13.02
220	8.74
240	6.65
260	5.13
280	4.09
300	3.33

Operating time is 3.33 seconds at 300% load



Load ratio (%)	Operation time (S)
100	10000.00
120	1000.00
140	185.15
160	63.70
180	28.35
200	19.53
220	12.16
240	9.88
260	8.08
280	6.84
300	5.51

Operating time is 5.51 seconds at 300% load.

15.Absolute Servo System

The absolute system includes a servo drive, an absolute servo motor, and an absolute encoder cable (with battery box). Instead of storing data in the PLC controller, the absolute position detection system detects the absolute position of the machine and stores the data with battery power. Therefore, once the origin point is set during installation, it is easy to resume operation even in the event of a power failure or malfunction.

If the absolute system parameter is enabled, the absolute servo motor is needed, and if the incremental servo motor is used, the alarm AL.24 will occur.

The description of absolute motor model is as follows:

SME-□○○○△△M□□

M: Absolute servo motor

Note	When [Absolute Position Loss] or [Absolute Position Overflow] occurs, it is necessary to set the origin point again.
	Please put the battery into the battery box to prevent unexpected factors such as battery short-circuiting.
	When using an absolute servo motor, make sure that the motor speed is less than 50 rpm at power-on.
	Do not exceed 50rpm in battery mode when the drive is powered off.

Keynote	The absolute position disappears when the battery is removed, be sure to set the origin again before operation.

Restricted items:

Absolute position system is not applicable in the following conditions.

(1) Speed control mode and torque control mode.

(2) Switching mode.

(3) Rotary axis, infinite path positioning.

(4) Chang the E-Gear ratio after setting the origin.

(5) Alarm code output is used.

How to replace batteries:

(1) When the drive displays the alarm AL.2D for under voltage, please replace the battery immediately to avoid data loss.

(2) When the battery voltage is less than 2.45V, the motor position data has been lost, and it is necessary to replace the battery and start the homing program again.

☆☆☆**Attention！!**

It is recommended to replace the battery when the drive is powered on to avoid absolute position data loss.

(1).Install the absolute motor and battery.

(2).Set parameter PA28 to 1 to enable the absolute system, and restart the power.

(3).The alarm [AL.2A Absolute encoder error 1] occurs after power on. You can cycle the power to clear this alarm.

(4).The alarm [AL.2C Absolute encoder error 3] occurs after power on, you need to <u>reset the origin of absolute system</u> to clear the alarm.

<u>Set parameter PA29 = 1 to finish coordinate initialization.</u>

<u>Cautions</u>

In the absolute system, the position movement has certain restrictions. If the number of motor revolutions exceeds the range of -32768 ~ +32767 revolutions, alarm AL.29 will occur.

<u>Calculation of pulse number</u>

The maximum countable number of motor revolutions ranges is from -32768 to +32767. If the number of revolutions is out of this range, an overflow alarm (AL.29) will occur, and according to the model of the motor encoder, the pulse number of a single revolution of the motor is 131072 (17bit).

The revolution number and pulse number of absolute servo system can be read through the communication or DI/DO, the total pulse value is calculated as follows.

Total pulse number = r(revolution number) x 131072 + pulse number (0~131071)

If the motor has made 10 revolutions and 50,000 pulses, according to the above formula, the total pulse value is as follows:

Total pulse number = 10 x 131072 + 50000

= 1360720(pulse)

Reading the absolute position by communication

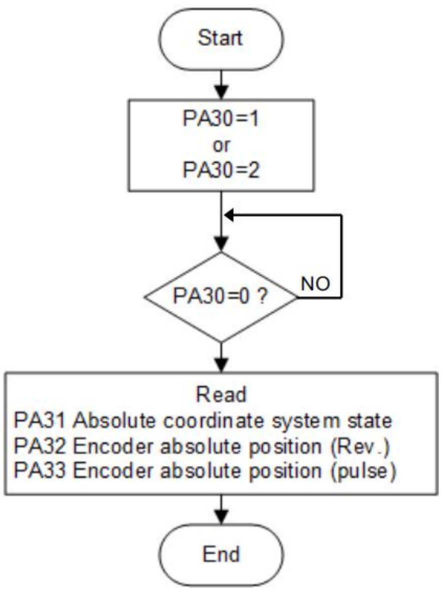
It is generally recommended to use the parameters in the following table to read the pulses number and revolutions number of the absolute encoder. (Please refer to Chapter 9 for detailed description)

Address	NO.	Parameters description	Data type
0x201E	PA30	Update encoder absolute position parameter	UDINT
0x201F	PA31	Absolute coordinate system status (read-only, not valid for writing)	UDINT
0x2020	PA32	Encoder absolute position (pulse number within single turn) (read only, not valid for writing)	UDINT
0x2021	PA33	Encoder absolute position (number of revolutions) (read only, not valid for writing)	UDINT

When setting PA30 by communication, the current encoder status and the absolute motor position will be updated. If PA30 = 1, the drive does not clear the deviation when reading the position value, if PA30 = 2, the deviation will be cleared at the same time when reading the position value.

The servo motor will make small position correction even in the stationary state. To avoid the absolute coordinate values are different from the actual position of the motor, you can set PA30 to clear the position deviation and read the coordinates at the same time. When the encoder status and the absolute position of the motor are updated, the drive will automatically return PA30 to 0, which means the upper controller can read the data.

If the encoder status shows "Absolute Position loss" or "Absolute revolution Overflows", the absolute position data is invalid. In this case, you must perform the coordinate initialization or homing again.



Absolute Battery Specifications

Precautions:

To avoid damage or danger, please read and observe the following precautions, use batteries of the specified specifications.

1.The installation environment must be free of moisture, corrosive and flammable gas.

2.Correctly place the battery into the battery box to avoid short-circuiting.

3.Do not short-circuit the positive and negative electrodes of the battery, and do not install the battery in reverse direction.

1.Do not expose the battery to high temperatures above 100˚C (212˚F) or to flames, as it may result in fire and explosion.

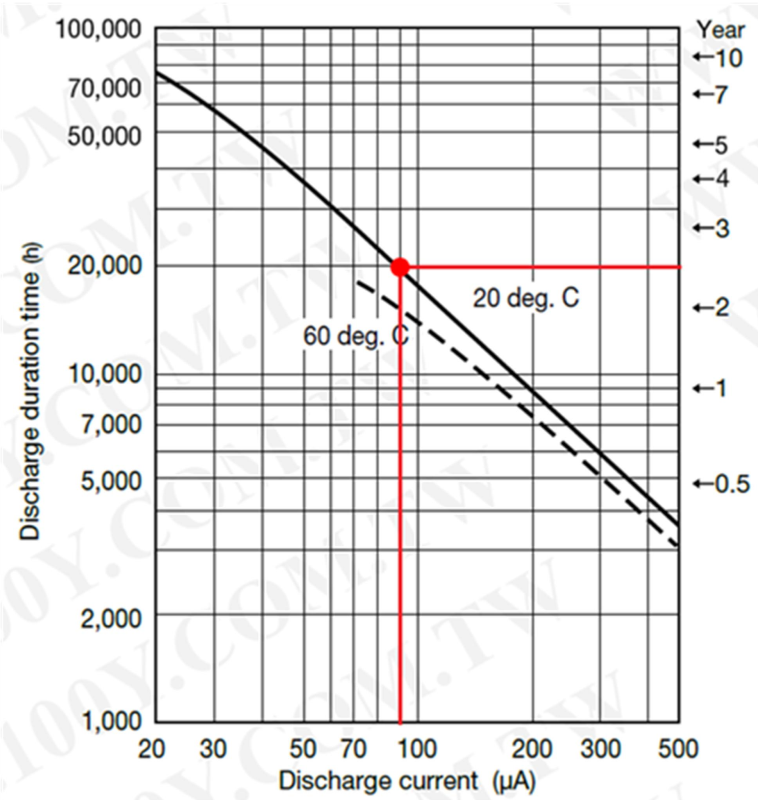
2.The battery is a single-use disposable battery, do not recharge the battery. Otherwise it may cause an explosion.

3.Do not directly weld on the surface of the battery.

Battery specifications

Name	Lithium-thionyl chloride /inorganic electrolyte battery
Type	ER6C
Shihlin model name:	SDH-BAT
Standard voltage	3.6 V
Standard capacity	1800 mAh
Continuous discharge current	100 μA
Dimension(D x H)	14.5 x 51 mm
Weight	15 g
Operating temperature	-55˚C~85˚C (-67˚F~185˚F)

Battery life



The above graph shows the battery life curve provided by the battery manufacturer. According to the curve shown above, if the consumption current of the absolute encoder is 90μA, the expected battery life is around 20,000hrs, which is equivalent to 2.3 years.

16.Appendix

16.1 Accessories

Item	Name	Shihlin model name	Length (mm)
Encoder connector (CN2)	Low inertia (100W~1kW) encoder connector	SDH-ENCNL	--
	Middle & High inertia (100W~ 1kW) encoder junction connector (lead out in direction of motor shaft)	SM3-ENF	--
	Middle & High inertia (100W~ 1kW) encoder junction connector (lead out in opposite direction of motor shaft)	SM3-ENR	--
Encoder cable	Low inertia (100W~1kW) encoder cable 2meters	SDH-ENL-2M-L/H	2000±100
	Low inertia (100W~1kW) encoder cable 5meters	SDH-ENL-5M-L/H	5000±100
	Low inertia (100W~1kW) encoder cable 10meters	SDH-ENL-10M-L/H	10000±100
	Middle & High inertia (100W~ 1kW) Single turn encoder cable 2meters (lead out in direction of motor shaft)	SM3-ENFS-2M-L/H	2000±100
	Middle & High inertia (100W~ 1kW) Single turn encoder cable 5meters (lead out in direction of motor shaft)	SM3-ENFS-5M-L/H	5000±100
	Middle & High inertia (100W~ 1kW) Single turn encoder cable 10meters (lead out in direction of motor shaft)	SM3-ENFS-10M-L/H	10000±100
	Middle & High inertia (100W~ 1kW) Multiple turn encoder cable 2meters (lead out in direction of motor shaft)	SM3-ENFM-2M-L/H	2000±100
	Middle & High inertia (100W~ 1kW) Multiple turn encoder cable 5meters (lead out in direction of motor shaft)	SM3-ENFM-5M-L/H	5000±100
	Middle & High inertia (100W~ 1kW) Multiple turn encoder cable 10meters (lead out in direction of motor shaft)	SM3-ENFM-10M-L/H	10000±100
	Middle & High inertia (100W~ 1kW) Single turn encoder cable 2meters (lead out in opposite direction of motor shaft)	SM3-ENRS-2M-L/H	2000±100
	Middle & High inertia (100W~ 1kW) Single turn encoder cable 5meters (lead out in opposite direction of motor shaft)	SM3-ENRS-5M-L/H	5000±100

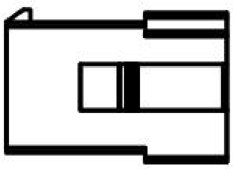
Encoder cable	Middle & High inertia (100W~ 1kW) Single turn encoder cable 10meters (lead out in opposite direction of motor shaft)	SM3-ENRS-10M-L/H	10000±100
	Middle & High inertia (100W~ 1kW) Multiple turn encoder cable 2meters (lead out in opposite direction of motor shaft)	SM3-ENRM-2M-L/H	2000±100
	Middle & High inertia (100W~ 1kW) Multiple turn encoder cable 5meters (lead out in opposite direction of motor shaft)	SM3-ENRM-5M-L/H	5000±100
	Middle & High inertia (100W~ 1kW) Multiple turn encoder cable 10meters (lead out in opposite direction of motor shaft)	SM3-ENRM-10M-L/H	10000±100
Power connector	Low inertia (100W~1kW)power connector without brake	SDA-PWCNL1	--
	Low inertia (100W~1kW)power connector with brake	SDA-PWCNL2	--
	Middle & High inertia (100W~ 1kW) power junction connector without brake (lead out in direction of motor shaft)	SM3-PWF	--
	Middle & High inertia (100W~ 1kW) power junction connector with brake (lead out in direction of motor shaft)	SM3-PWFB	--
	Middle & High inertia (100W~ 1kW) power junction connector without brake (lead out in opposite direction of motor shaft)	SM3-PWR	--
	Middle & High inertia (100W~ 1kW) power junction connector with brake (lead out in opposite direction of motor shaft)	SM3-PWRB	--
Power cable	Low inertia (100W~1kW) power cable 1(without brake)	SDA-PWCNL1-2M-L/H	2000±100
	Low inertia (100W~1kW) power cable 2(without brake)	SDA-PWCNL1-5M-L/H	5000±100
	Low inertia (100W~1kW) power cable 3(without brake)	SDA-PWCNL1-10M-L/H	10000±100
	Middle & High inertia (100W~ 1kW) power junction cable 1 without brake (lead out in direction of motor shaft)	SM3-PWF-2M-L/M	2000±100
	Middle & High inertia (100W~ 1kW) power junction cable 2 without brake (lead out in direction of motor shaft)	SM3-PWF-5M-L/M	5000±100
	Middle & High inertia (100W~ 1kW) power junction cable 3 without brake (lead out in direction of motor shaft)	SM3-PWF-10M-L/M	10000±100

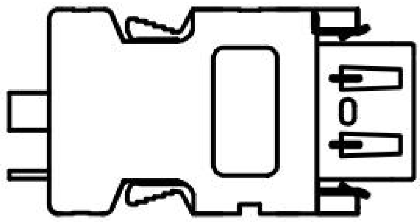
Power cable	Middle & High inertia (100W~ 1kW) power junction cable 1 without brake (lead out in opposite direction of motor shaft)	SM3-PWR-2M-L/M	2000±100
	Middle & High inertia (100W~ 1kW) power junction cable 2 without brake (lead out in opposite direction of motor shaft)	SM3-PWR-5M-L/M	5000±100
	Middle & High inertia (100W~ 1kW) power junction cable 3 without brake (lead out in opposite direction of motor shaft)	SM3-PWR-10M-L/M	10000±100
	Low inertia (100W~1kW) power cable 1(with brake)	SDA-PWCNL2-2M-L/H	2000±100
	Low inertia (100W~1kW) power cable 2(with brake)	SDA-PWCNL2-5M-L/H	5000±100
	Low inertia (100W~1kW) power cable 3(with brake)	SDA-PWCNL2-10M-L/H	10000±100
	Middle & High inertia (100W~ 1kW) power junction cable 1 with brake (lead out in direction of motor shaft)	SM3-PWFB-2M-L/M	2000±100
	Middle & High inertia (100W~ 1kW) power junction cable 2 with brake (lead out in direction of motor shaft)	SM3-PWFB-5M-L/M	5000±100
	Middle & High inertia (100W~ 1kW) power junction cable 3 with brake (lead out in direction of motor shaft)	SM3-PWFB-10M-L/M	10000±100
	Middle & High inertia (100W~ 1kW) power junction cable 1 with brake (lead out in opposite direction of motor shaft)	SM3-PWRB-2M-L/M	2000±100
	Middle & High inertia (100W~ 1kW) power junction cable 2 with brake (lead out in opposite direction of motor shaft)	SM3-PWRB-5M-L/M	5000±100
	Middle & High inertia (100W~ 1kW) power junction cable 3 with brake (lead out in opposite direction of motor shaft)	SM3-PWRB-10M-L/M	10000±100
Communication cable(CN4)	USB communication cable for drive and computer	SDA-USB3M	3000
Communication cable CN3/CN3L)	Data transmission cable 1.5meters	SNKCBL1R5GTN2	1500
	Data transmission cable 3 meters	SNKCBL3GTN2	3000
	Data transmission cable 5 meters	SNKCBL5GTN2	5000
	Data transmission cable 10 meters	SNKCBL10GTN2	10000

I/O connector (CN1)	I/O connector	SDA-CN1	--
	I/O cable	SDA-TBL05M	500±10
	I/O cable	SDA-TB1M	1000±10
	I/O cable	SDA-TBL2M	2000±10
	I/O terminal block	SDA-TBL50	--
Battery set (CN5)	Absolute encoder battery set	SDH-BAT-SET	--
	Absolute encoder battery	SDH-BAT	--

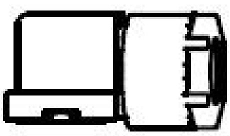
- **Encoder connector**

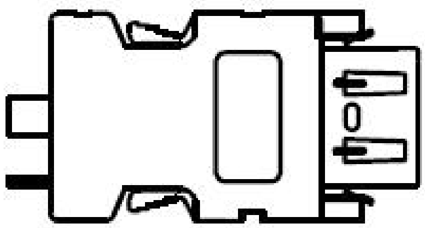
Shihlin part number: SDH-ENL (for SME 100W~1KW motor)





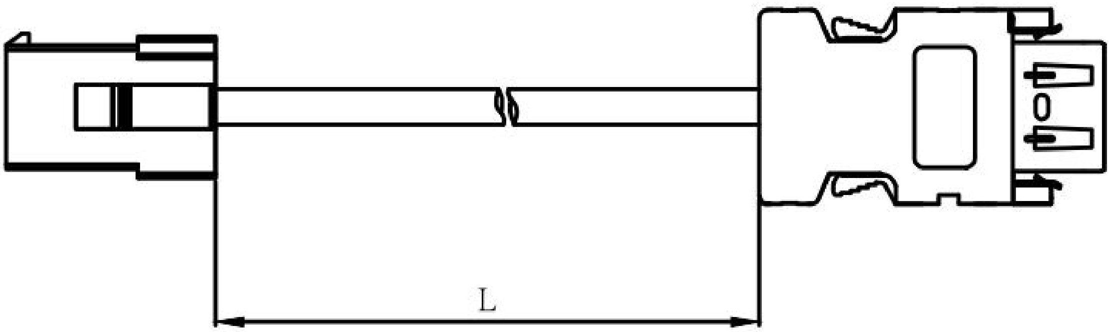
Shihlin part number: SM3-ENF、SM3-ENR (for SM3 100W~1KW motor)



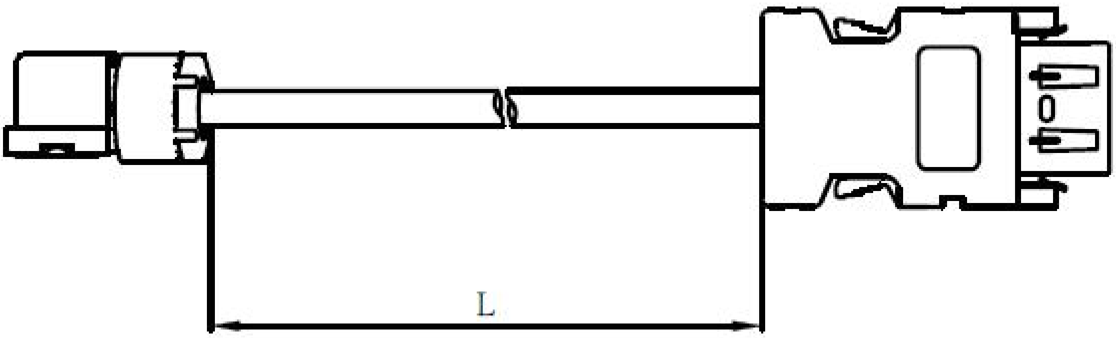


❖ **Encoder cable**

Low inertia encoder cable:(for SME 100W~1KW motor)

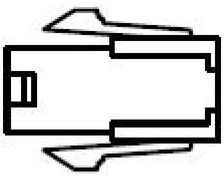


Medium/high inertia encoder cable:(for SM3 100W~1KW motor)

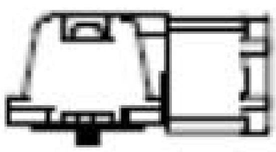


❖ **Power connector**

Shihlin part number: SDA-PWCNL1 (SME series 100W~1kW without brake)
SDA-PWCNL2 (SME series100W~1kW with brake)

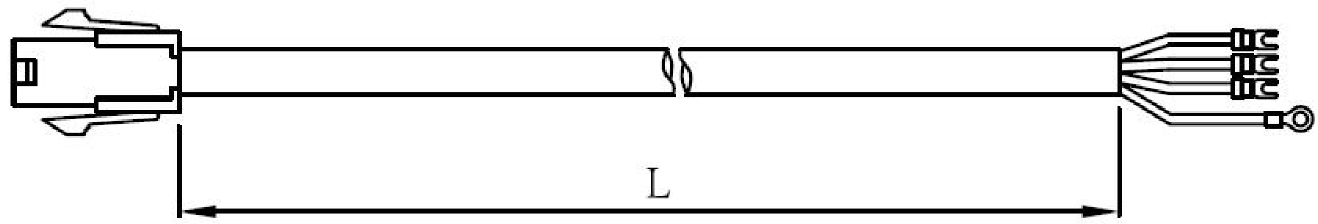


Shihlin part number: SDA-PWCNL1 (SM3 series 100W~1kW without brake)
SDA-PWCNL2 (SM3 series 100W~1kW with brake)

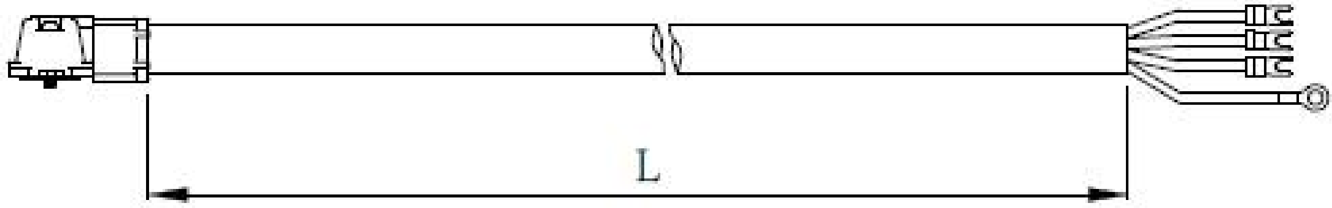


- **Power cable**

  Low inertia power cable: (SME series 100W~750W)

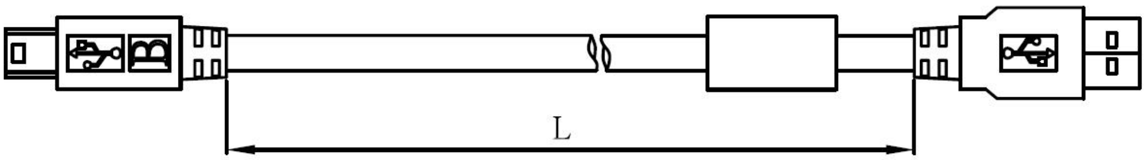


  Mediym and high inertia power cable: (SM3 series 100W~1KW)



- **USB communication cable between drive and computer**

  Shihlin part number: SDA-USB3M



- **I/O connector terminal**

  Shihlin part number: SDC-CN1

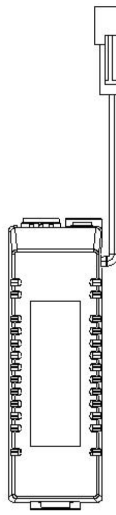
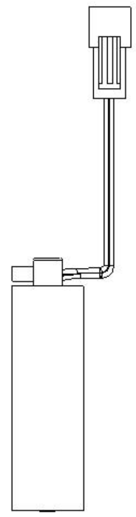
- **I/O connector terminal cables**

  Shihlin part number: SDC-TBL05M, SDC-TBL1M, SDC-TBL2M

- **I/O connector terminal block**

  Shihlin part number: SDC-TB15

Absolute encoder accessories:

Absolute encoder battery pack	Absolute encoder battery
Shihlin part number: SDH-BAT-SET	Shihlin part number: SDH-BAT
	

16.2 Regenerative resistor

Drive model	Built-in regenerative resistor specification			
	Resistance value (Ω)	Capacity (W)	PA10 Regenerative resistance value	PA11 Regenerative resistance capacity
SDC-010E2□□	Without built-in regenerative resistor			
SDC-020E2□□				
SDC-040E2□□	100	20	100	20
SDC-075E2□□	40	40	40	40
SDC-100E2□□	40	40	40	40

Drive model	Specification of external resistor(recommended)				Resistor part number
	Min allowance resistance value (Ω)	Recommended capacity (W)	PA10 Regenerative resistance value	PA11 Regenerative resistance capacity	
SDC-010E2□□	100	300	100	300	ABR-300W100
SDC-020E2□□	100	300	100	300	ABR-300W100
SDC-040E2□□	100	300	100	300	ABR-300W100
SDC-075E2□□	40	500	40	500	ABR-500W40
SDC-100E2□□	40	500	40	500	ABR-500W40

16.3 Compliance with global standards

16.3.1 Safety description

Please read this manual carefully to ensure proper use before installing this equipment. This section describes safety regulations for operation of the equipment.

DANGER
Wiring or inspections should be performed after the power has been turned off for more than 20 minutes, the charging indicator light has been turned off and a voltage test is done to check the residue voltage, otherwise it may cause electric shock.

16.3.2 Professional technicians

Only the professional technician who has received professional training can install the SDC servo drive.

16.3.3 Compliance with standards

(1) Safety regulations

SDC servo drives comply with IEC/EN61800-5-1.

(2) EU compliance

SDC servo comply with EMC directive (2014/30/EU) and low voltage directive (2014/35/EU).

(3) Compliance with U.S./Canada regulations

This servo drives are designed to comply with UL 61800-5-1 and CSA C22.2 No. 274-17.

(a) Installation

The minimum size of the distribution box is 200% of the volume of the SDC servo drive. Fan ventilation should be considered to keep the ambient temperature below 55°C. Only copper wires can be used for wiring, and the drive should be installed in a metal distribution box.

(b) Overload protection feature

The SDC servo drive has overload protection feature. (It is specified based on 120% of the rated current of the servo drive (full load current)).

(c) Motor over-temperature protection

There is no temperature sensor inside the motor, and the SDC series does not provide over-temperature protection.

(d) Capacitor discharge

Do not touch the servo body and terminals immediately after the power is turned off, it takes 20 minutes for the capacitor to discharge.

(e) About wiring protection

When installing the equipment in the U.S.A., branch circuit protection is in accordance with the National Electrical Code and local codes. When installing equipment in Canada, branch circuit protection is based on the Canadian Electrical Code and provincial codes.

16.3.4 Usage tips

The equipment must comply with the specifications (voltage, temperature.... etc., please refer to section 13.1 for details).

(1) Power cable

Refer to section 3.1.6 for the detailed power cable list.

Note 1 When connecting to the terminal block, use the screws supplied with the terminal block.

Note 2. The letters in the table indicate the crimping tool. Refer to the recommended crimping terminal table for crimping terminals and the appropriate tools.

Note 3. Cable size depends on the specifications of the connected servo motor.

(2) Fixed terminal block torque: crimp terminals must comply with UL specifications and must use insulation sleeve to prevent direct contact.

Drive	**Recommended torque(Nt-m)**			
	L1, L2	**U, V, W**	**P, C, N**	**PE**
SDC-010E2□	0.8	0.8	0.8	1.4
SDC-020E2□				
SDC-040E2□				
SDC-075E2□				
SDC-100E2□				

(3) Examples of non-fuse circuit breaker selection:

Drive	Current limiting circuit breaker(UL certified)	Example
SDC-010E2	240 V, 5 A	**NF50-SVFU 5A**
SDC-020E2		
SDC-040E2	240 V, 10 A	**NF50-SVFU 3P 10A**
SDC-075E2	240 V, 15 A	**NF50-SVFU 3P 15A**
SDC-100E2		

In order to comply with the requirements of the North American Safety Standard UL61800-5-1, you must connect a circuit breaker at the input side to prevent accidents caused by short circuits in the internal circuit. Install adequate branch circuit short-circuit protection in accordance with applicable codes and this manual. This product is applicable for the circuits which the rated fusing capacity is less than 5000A and the maximum voltage is 240Vac.

16.3.5 Basic inspection and maintenance

Basic inspection

It is recommended to do the following inspections regularly. Before inspection, please check carefully whether the power has been turned off and whether the charging indicator is off:

- ◆ Please tighten the screws on the terminal block, drive installation part, servo motor and the connection of the mechanism if there is any loosening.
- ◆ Avoid placing the controller in a place where harmful gases exist.
- ◆ Avoid placing conductive objects next to the drive and drive wiring.
- ◆ Avoid excessive length of bare wires, and avoid to use damaged or broken wires.
- ◆ Wiring terminals should be well insulated.
- ◆ Make sure the external AC220V voltage is correct.
- ◆ Make sure the control operation switch is OFF.
- ◆ Check if there are any errors in the wiring of the self-made power cable and encoder cable.

Maintenance

Please do not disassemble the servo drive when performing maintenance. Please follow below instruction for regular maintenance:

- ◆ Wipe the servo drive and servo motor regularly to avoid dust.
- ◆ Do not operate the servo in a harsh environment for a long time.
- ◆ Ventilation of the servo drive should be kept clean to avoid dust accumulation.

Parts service life

The service life of the parts varies according to the operating environment. It needs to be replaced immediately if any abnormality occurs, and you can contact Shihlin distributors for parts replacement.

The service life of the parts are as follows:

Parts name	Approximate service life	Description
Relay	100,000 times	The power capacity affects its service life, its accumulative number of switching is about 100,000 times.
Cooling fan	10,000~30,000 hours (2~3 years)	Continuous operation or placing the servo drive in a place with harmful gas will shorten the service life of the fan. Normally the lifetime is about 2 to 3 years. However, if the fan runs with abnormal noise, it needs to be replaced.
Rectified capacitor	10 years	If the rectified capacitor is affected by the ripple current, its features will be worsened. The service life of the capacitor is affected by the ambient temperature and conditions. If the servo is used in an air-conditioning environment, the service life is about 10 years.

16.4 Manual version

Manual version: V1.02

Released month: Feb 2024

Release date	Version	Revision contents
2022/12/01	V1.00	Initial release.
2023/06/27	V1.01	1.Add parameter PB57. 2.Add parameter PD37.
2024/02/01	V1.02	1.Added SM3 series motor specifications